APPENDIX 6E

PREVIOUS GROUNDWATER STUDIES IN BLESSINGTON AREA

BLESSINGTON GRAVEL AQUIFER

GROUNDWATER POTENTIAL

AND VULNERABILITY

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BLESSINGTON GRAVEL AQUIFER

1. Introduction

Blessington is situated approximately 48 km southwest of Dublin and 10 km southeast of Naas. The Pollaphuca Reservoir was developed at Blessington to provide water for Dublin and has since become a popular water recreation centre. In recent years the area is also becoming a very popular residential centre. The area depends on surface water and groundwater for its water supply and so it is essential that the quality of the water is in keeping with drinking water standards. It has been known for some years that large gravel deposits exist in the Blessington area which could constitute a significant groundwater resource which is still largely undeveloped. This study was undertaken to assess the groundwater potential and its vulnerability.

2. Area Description and Topography

The Blessington area is located on the western side of the Wicklow Mountains with elevations between 180 and 250 m OD (Ordnance Datum).

The topography of the region reflects the glacial overburden rather than any change in bedrock structures. The subsoils are mainly glacial till (Lower Palaeozoic till, i.e. till containing clasts of Lower Palaeozoic rocks) with glaciofluvial sands and gravels especially to the west and northwest of Blessington village.

Surface drainage is southeastwards into the Pollaphuca Reservoir and then northeast and west via the River Liffey.

This study concentrates on the main gravel deposit in the Blessington area, which lies to the north of the village, essentially north of the R410 road and between the Pollaphuca Reservoir and the county boundary with Kildare (Map 1). Other gravel deposits occur a little further from Blessington, but they are much smaller and hence do not have nearly the same groundwater potential.

3. Aims and Objectives

The aims of this study were to assess the aquifer potential in the area and vulnerability to groundwater pollution.

A number of objectives were set:

- To compile all the available geological and hydrogeological information.
- To assess the type of glacial deposits and their thickness.
- To establish the aquifer potential of the gravel deposits.
- To establish the vulnerability of the aquifer.

4. Methodology

The assessment of the area involved (a) detailed desk study, (b) fieldwork and analysis of available data. The desk study compiled the information from all available data sources.

The second stage comprised site visits and fieldwork in the surrounding area by a Quaternary Geologist to determine the nature, thickness and type of glacial deposits. Several depth to bedrock drilling sites were selected to determine the thickness of the underlying subsoils.

At present there are no County Council groundwater supplies in this area although there are several private group schemes in operation. No pumping tests were carried out as part of this study to examine the aquifer characteristics nor detailed groundwater analyses to determine the water chemistry and water quality.

This report details the limited information available for the area and highlights the need for more hydrogeological information.

5. Geology

5.1 Bedrock geology

The underlying bedrock geology comprises rocks of the Kilcullen Group which are mainly greywackes and shales deposited as turbidites. The Kilcullen Group rocks are Silurian in age and are divided into five formations, of which only the Pollaphuca, the Slate Quarries, and the Glen Ding formations are present around Blessington. The only rock exposures in the area are on the northwest side of Glen Ding.

The Pollaphuca Formation consists of coarse grey greywacke sandstones and grits and dark grey shales and is classified as a **Poor Aquifer, generally unproductive except in local zones (Pl)**. The Slate Quarries Formation consists of dark grey slates with occasional minor interbedded grey greywackes. The Glen Ding Formation has dark green to grey greywacke sandstones and shales. These two formations are classified as a **Poor Aquifer, generally unproductive (Pu)**.

These bedrock aquifers are not considered further in this report. Some further details of their aquifer potential are contained in the Main Report.

5.2 Quaternary (subsoils) geology

The entire area is covered with glacial deposits ranging from tills to glaciofluvial sand and gravel with glaciolacustrine deposits near the reservoir. Information is available from GSI Quaternary mapping in Wicklow and Kildare, and from boreholes and trial pits by K.T. Cullen & Co. (1977b).

The distribution of the subsoils in the area is illustrated in Map 1.

5.2.1 Glaciofluvial sand and gravel

The dominant sediments in the area are the gravels, deposited in a subaqueous environment by glacial meltwaters which drained into a glacial lake which existed between the Wicklow Mountains and the margin of the ice sheet. The meltwater channels cut into the underlying sediments and bedrock indicate flow to the southeast. The gravels occur as delta deposits on the flanks of a ridge. The deposits are characterised by steeply dipping foreset beds and interbedded sands and gravels. Limestone is the dominant clast type. The largest gravel area is about 5.5 km^2, just north of Blessington, and is currently being extensively quarried. The gravel deposits occur as hummocks or delta-terraces.

South of Kilbride, a limestone dominated gravel occurs and was deposited as a large sheet of about 2 km^2 (Map 1). These gravels are now being eroded by the meandering River Liffey. Although the exposure is limited and very poor, the flat morphology suggests these gravels were deposited in a pro-glacial outwash plain after the lake had disappeared.

5.2.2 Tills

To the west, south and east of Blessington there are poorly to moderately permeable Lower Palaeozoic tills, matrix supported and characterised by a generally silty to silty sandy texture. Particle size analyses show that 30% of the bulk of the sample are fines (clay and silt) and about 40% sand.

Clasts are angular to subangular and consist of mica-schists, shales and granites. Where bedrock is close to the surface, the clast content is higher and the till may be characterised as stony silty.

A small area to the north of Blessington is covered by a chert-rich till which is characterised by a clayey silty or silty matrix and also contains limestone and shale clasts. This till is matrix supported.

The tills are interpreted as lodgement tills deposited by ice from the Wicklow Mountains during the last glacial period.

5.2.3 Glaciolacustrine deposits

The glaciolacustrine sediments found around the current Pollaphuca Reservoir were deposited in a lake which was maintained between ice masses and between the hills. The deposits are often laminated, reflecting the annual variations in deposition. The sediments consist of silts, generally deposited in the summer by meltwater discharge, and clays, generally deposited in the winter when the lake was frozen. There is evidence that the lake existed for at least 85 years, in which time the deposits were able to accumulate to a thickness of 1 to 1.5 metres. The fine grained sediments overlie subglacial bedrock or tills. The largest area of lake deposits occurs on the low ground between Blessington and Kilbride.

5.3 Depth-to-bedrock

Rock outcrops occur predominantly in the upland areas along palaeo-meltwater channels, streams and along roads, and in areas with thin till. To the east of Pollaphuca Reservoir the subsoils reach thicknesses of about 2 to 8 m. West and north of the reservoir the Lower Palaeozoic tills seem to be much thicker (up to 14 m) and locally overlie gravelly deposits. The thickest deposits are the glaciofluvial gravels to the west of Blessington, with depths of over 20 m and up to 74 m.

Fifteen augered holes were drilled by the GSI around this area to investigate the subsoils and determine the depth to bedrock. Six additional boreholes were drilled by Roadstone Ltd. under supervision by K.T. Cullen & Co. Ltd. Depth-to-rock drilling by the GSI revealed depths from approximately 1 m to over 14 m. The exact depths to rock could not be established, as the upper part of the shale bedrock is highly weathered, thus it was often difficult to distinguish between subsoil and rock. The maximum depth of the augering equipment was 14 m.

Drilling by K.T. Cullen & Co. (1997b) on the Ashton site to depths of 12-14 metres met no bedrock.

6. Hydrogeology

6.1 Data availability

Hydrogeological data are moderately good for the Blessington area, although there is little detailed information, in particular pumping test data and water quality data. There are limited records of water level data to construct a water table map to determine the groundwater flow directions. Many wells are dug wells or springs which may only be tapping a perched water table within the till. The groundwater flow direction is generally to the southeast towards the Pollaphuca Reservoir.

There are some details of wells drilled in the Blessington area including wells depths, discharges and pumping test data.

Five wells have been drilled within the sand and gravel aquifer at the Council Depot, Naas Road, Blessington. The first two wells were drilled in 1993, for private housing estates (Ballymore Homes, 2921SW030 & 2921SW064, for their Ashton and Beechdale developments). Wicklow County Council then drilled a further three wells in 1995, the first of which was abandoned as no water was encountered. The remaining two wells, WCC No.1 (2921SW066, 18.6 m) and WCC No.2 (2921SW067, 14.6 m), were tested. (see data in Appendix).

Site investigations for the Ashton development (K.T. Cullen & Co. Ltd., 1997b) 1 km from the village along the Naas Road provided details of the subsoils, depths and a pumping test.

In the townlands of Deerpark and Dillonsdown, one mile northwest of Blessington village, extensive drilling to prove the sand and gravel reserves has provided information on the thickness of the gravel deposits and the depth of the water table.

There are also water quality analyses available for this sand and gravel aquifer from 1993 and 1996. No sampling of this source was conducted as part of this project. Analyses are also available from Deerpark and Dillonsdown.

6.2 Groundwater levels, flow directions and gradients

Groundwater is generally close to the surface. The static water levels in the wells range up to 20 metres below ground level.

Regional groundwater flow is generally southeastwards towards the Pollaphuca Reservoir, but locally it is dependent on topography. A report by K.T. Cullen & Co. (1997a) identified a groundwater divide running SW-NE through Deerpark townland, in the northwestern part of the main gravel deposit. This can be taken as the effective boundary of the aquifer.

The Ashton report (K.T. Cullen & Co., 1997b) inferred a flow direction just south of east. This is somewhat at variance with the topographic gradient and is based on just three water levels.

Groundwater gradients in the general area may range from approximately 0.007 to 0.07. Detailed work (K.T. Cullen & Co., 1997a) shows a rather steep gradient in Deerpark, where the saturated aquifer is thin, whereas nearer the Depot a gradient of 0.007 is given (K.T. Cullen & Co., 1997b) By interpolation, an average gradient of about 0.025 is inferred between Deerpark and the Council Depot, and the gradient near the Depot is probably between 0.01 and 0.02.

6.3 Rainfall, Evaporation and Recharge

The nearest rainfall station is at Blessington Garda Station in the village (altitude 206 m). Mean annual rainfall (1951-1980) recorded by Met Eireann was 938 mm. Potential evapotranspiration (PE) is estimated from a Met Eireann contoured map as 500 mm/yr. Actual evapotranspiration (AE) was estimated at 475 mm as a percentage (95%) of the PE, allowing for seasonal soil moisture deficits.

From the above figures the effective rainfall (ER) is taken to be approximately 460 mm/year. As the Quaternary deposits are relatively free-draining, a high proportion of the effective rainfall infiltrates to the water table. Estimating runoff at 20%, the actual annual recharge to the aquifer is estimated to be 370 mm/year. This compares with 375 mm estimated by K.T. Cullen & Co. (1997b).

These calculations are summarised below:

Average annual rainfall	938 mm
Estimated PE	500 mm
Estimated AE (95% PE)	475 mm
Effective rainfall (ER)	460 mm
Recharge (70% ER)	370 mm

6.4 Hydrochemistry and Water Quality

Water quality analyses are available from 1993 (2 no.) and 1996 (4 no.) from wells at the Roadstone site and the County Council Depot (Table 1). These analyses indicate that the water is a calcium bicarbonate type which is hard and typical of a limestone-dominated gravel aquifer. The samples contained abnormally high chloride values (75 to 80 mg/l) and 57 mg/l of sodium. While these values for sodium and chloride pose no threat to health, they may indicate some contamination and further monitoring should be carried out to establish if this aquifer is being contaminated, perhaps by salting of road surfaces. No sampling of this source was conducted as part of this project.

Table 1 Water Quality Analyses from boreholes near Blessington

Townland			Deerpark/Dillonstown			Blessington Demesne		
Site			Roadstone Ltd			WCC Depot		
Data source			K.T. Cullen & Co. Ltd.			KTC		WCC
Site id No.			2921SW 022	2921SW 024	2921SW 025	2921SW 030	2921SW 030	2921SW 066
Sample date			21/11/1996	21/11/1996	21/11/1996	07/12/1993	07/12/1993	22/02/1996
Laboratory code								WCC
Sample reference								140
Parameters	**Units**	**MAC**						
Colour		20	<5	<5	<5	<5	<5	20
Turbidity		4				<0.05	<0.05	1.3
Temperature								13
Alkalinity	mg/l	-	256	269	218	280	292	205
Aluminium	mg/l	0.2	[illegible]	[illegible]	[illegible]	<0.05	<0.05	
Ammonium as N	mg/l	0.23	<0.05	<0.05	<0.05	<0.05	<0.05	0.02
Arsenic	mg/l	0.05	<0.05	<0.05	<0.05			
Barium	mg/l	0.5	0.22	0.13	0.2			
Boron	mg/l	2	0.01	0.01	0.02			
Cadmium	mg/l	0.005	<0.005	<0.005	<0.005			
Calcium	mg/l	200	100	105	70	113	111	
Chloride	mg/l	250	28	14	12	81	79	76
Chromium	mg/l	0.05	0.01	<0.01	<0.01			
Copper	mg/l	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	
Electrical Conductivity	µS/cm	1,500	530	510	430	735	735	653
Hardness	mg/l	-	303	298	228	309	303	308
Iron (total)	mg/l	0.2	[illegible]	[illegible]	[illegible]	0.01	<0.01	
Lead	mg/l	0.05	<0.05	<0.05	<0.05			
Magnesium	mg/l	50	13	9	13	6.6	6.4	
Manganese	mg/l	0.05	[illegible]	[illegible]	[illegible]	<0.01	<0.01	
Mercury	mg/l	0.001	<0.0005	<0.0005	<0.0005			
Nickel	mg/l	0.05	0.01	0.01	0.01			
Nitrate as N	mg/l	11.3						3.2
Nitrate as NO_3	mg/l	50	12	8	5	18	18	14
Nitrite as N	mg/l	0.03	0.15	<0.01	0.02	<0.01	<0.01	
pH		6-9	7.5	7.3	7.6	7.4	7.4	7.3
Phosphorus	mg/l	5	0.13	0.05	0.11			0.2
Potassium	mg/l	12	1.7	1.6	2.7	<1	<1	
Sodium	mg/l	150	13	8	10	57	56	
Strontium	mg/l	-	0.25	0.2	0.18			
Sulphate	mg/l	250	20	9	9	14	14	
Zinc	mg/l	1	0.02	0.02	0.03			
Total Coliforms	n/100ml	0				0	0	0
E. coli	n/100ml	0				0	0	0
Greater than Guide levels								
Greater than MAC levels								

An iron and manganese treatment plant is installed in the pump house at the Council Depot and the water samples were probably taken after treatment as they do not indicate an iron and manganese problem.

The analyses from Deerpark and Dillonsdown (Table 1) indicate good water quality and show normal levels of sodium and chloride, although they also showed high iron, manganese and aluminium levels. The water quality as shown is generally good with no bacterial contamination and all the major

cations, anions and trace elements are within the Irish Drinking Water Standards and the EU limits except for the iron and manganese levels which are naturally high. Colour and turbidity levels are often high or above the MAC and may be a result of poor well development or precipitation of the iron and manganese upon oxidation at the ground surface.

6.5 Blessington Sand and Gravel Aquifer

The Blessington gravel aquifer covers an area within Co. Wicklow of approximately 5.5 km^2 and varies in thickness, but is generally 10 to 35 m thick. The area extends from west of Blessington village and continues into Co. Kildare. The extent of the aquifer in Co. Kildare is approximately km^2. A deep borehole drilled by the GSI in 1980 recorded a depth of 74 m in Newpaddocks, half a mile north of Blessington, with water at 22 m. At Bishopslane, Co. Kildare, two miles south-southwest of Blessington, another deep borehole drilled by the GSI in 1980 encountered gravels to a depth of 104 m and did not hit bedrock.

At the Council Depot on the Naas Road, five wells have been drilled within the sand and gravel aquifer. The first two wells, drilled in 1993 for private housing estates, had yields from 300 to 660 m^3/d; a specific capacity was calculated at 2170 $m^3/d/m$ and transmissivity estimated at 1500 m^2/d.

Wicklow County Council drilled a further three wells in 1995. The first (2921SW065) was abandoned at 33.5 m as no water was encountered. The remaining two wells, WCC No.1 (2921SW066, 18.6 m) and WCC No.2 (2921SW067, 14.6 m) were tested:

- WCC No.1 was tested at 455 m^3/d with a drawdown of 5.3 m, giving an apparent transmissivity of 400 m^2/d and a specific capacity of 85$m^3/d/m$. The adjacent wells were monitored during the test and none showed drawdowns of more than a few centimetres.
- WCC No.2 was tested at 300 m^3/d. The drawdown was 9.66 m, giving a specific capacity of 30 $m^3/d/m$. The adjacent Council well (No.1) showed a drawdown of 0.11 m and the private well 0.12 m from the pumping of Well No.2. No other wells were affected during this pumping test.

The results of the tests (see Appendix) were difficult to analyse as the gravel aquifer responds rapidly to any rainfall events which can mask the effects of the pumping. Analysis was also made difficult by variations in the pumping rate.

Site investigations 1 km from the village along the Naas Road (K.T. Cullen & Co. 1997b) indicated similar geological conditions, with over 14 m of glacial sediments. A pumping test yielded 340 m^3/d with a drawdown of 2.4 m, giving a specific capacity of 140 $m^3/d/m$.

In this area of Co. Wicklow, most private groundwater supplies are obtained from the sand and gravel deposits, with many housing estates being supplied by group scheme wells, sourced in this sand and gravel.

The Blessington sand and gravel aquifer has a high permeability and transmissivity; and if properly developed and managed can provide a significant sustainable groundwater resource. However, Roadstone's drilling in the more elevated part of the deposit indicated very little gravel below the water table. Moreover, the lack of water in the first WCC borehole at the Depot (33.5 m deep), and in two wells at the Ashton site (K.T. Cullen & Co., 1997b) is worrying, suggesting patchy permeability.

6.6 Aquifer category

A sand/gravel deposit is normally classed as an aquifer by GSI if it is greater than one square kilometre in areal extent and is more than 10 m thick (or has a saturated zone more than 5 m thick).

Sand/gravel aquifers are classified as regionally important or locally important, depending on their areal extent and estimated annual throughput.

A regionally important gravel aquifer should have an areal extent greater than 10 km^2. This is to ensure that, assuming an average annual effective rainfall of 400 mm, there will be enough recharge to provide a supply of one million cubic metres per year from the whole aquifer. A locally important aquifer on the other hand is required to have sufficient yield to supply a small group scheme or village.

Considering the aquifer in terms of its areal extent (9 km^2), thickness, and well yields the Blessington sand and gravel aquifer is classed as a **Locally important sand and gravel aquifer (Lg).**

6.7 Aquifer Development Potential

Assuming an aquifer area of 9 km^2 and an annual recharge of 370 mm, a simple calculation reveals that a total of 3.3 x 10^6 m^3/yr would be expected to recharge the aquifer, equivalent to about 9000 m^3 per day. The actual amount which could be exploited would be significantly less than this, but abstraction of over 2000 m^3/day should certainly be possible. The optimum method of abstraction would depend on a number of factors, including the potential borehole vulnerability in relation to likely source of contamination.

As in all gravel aquifers, production wells will require the installation of wellscreens, followed by careful well development. Wells should be appropriately located, designed and constructed in order to work efficiently over a number of years.

Information which has recently come to hand from well drilling near Tulfarris House has revealed a productive gravel aquifer at a depth of over 40 metres, well protected from contamination. The thickness of this aquifer has not been determined. The existence of this aquifer suggests that, where the bedrock is deep (at least 20 metres) careful exploratory drilling may prove very worthwhile.

7. Source Protection Areas

Taking the Council Depot 'wellfield' as the source, provisional source protection areas can be demarcated: Inner (100-day travel time zone) and Outer (remainder of Zone of Contribution, ZOC).

The Inner Protection Area (SI) as defined by an approximate calculation is 120 metres up-gradient and 70 metres down-gradient. To allow a safety margin, an Inner Area of 150 metres radius is recommended, as shown in Map 2.

The Outer Protection Area (SO) or Zone of Contribution extends northwestwards to the groundwater divide, but in County Kildare its extent is difficult to define. Its total area depends on the average abstraction rate: for a hypothetical rate of 1000 m^3/d, it amounts to some 1.2 km^2. The down-gradient limit of the ZOC, using the Uniform Flow Equation, is set at 300 m from the wellfield.

The Source Protection Areas, which extend substantially into County Kildare, are shown on Map 2.

8. Groundwater Vulnerability

Sands and gravels have a high permeability. The depth to water table is generally more than three metres. Under the GSI vulnerability mapping criteria (DELG/EPA/GSI 1999) the entire gravel deposit has a 'high' vulnerability rating.

The till deposit in Newtownpark townland, in Co. Kildare, is assumed to be free-draining and therefore of moderate permeability. Its thickness is not known, so is assumed to be not greater than 5 metres (either above rock or above gravel deposits). Hence its vulnerability classification is taken to be 'high'.

There is a small area of exposed rock and very thin subsoils in the northwestern corner of the Zone of Contribution, in Glen Ding and to the west, which is classed as of 'extreme' vulnerability.

9. Groundwater Source Protection Zones

From the above discussion of source protection areas and vulnerability, it follows that there are only three source protection zones to be delineated for the Council Depot Wellfield (Map 2):

SI/H

SO/E

SO/H

10. Potential Pollution Sources

The primary threat to this gravel aquifer is the major housing development which is occurring in the area. Other obvious potential hazards would be spillages on the R410 road, and gravel workings in the up-gradient area, although this should be easy to control and monitor. K.T. Cullen & Co. (1997b) mention three septic tanks on the western boundary of the Ashton site.

In general, the water quality may be affected by landspreading, septic tanks and farm effluent. All potentially polluting activities within the area should be controlled and monitored by the Council. Since some of the aquifer is within County Kildare, this will require co-operation with Kildare County Council.

11. Conclusions and Recommendations

- The Blessington gravel deposits constitute a locally important sand and gravel aquifer which is highly vulnerable to pollution. The aquifer is an important groundwater resource which could be further developed and adequate planning is required to protect this resource.
- The water analyses indicate that there are no major water quality problems, except for the naturally high iron and manganese.
- It is recommended that the Council sample the raw water from the Council Depot to monitor the iron, manganese, nitrate, potassium, chloride and conductivity levels, and to examine the effects of the potentially polluting activities near to the well.
- The Council should control and monitor potentially polluting activities within the aquifer area.
- In order to define source protection areas and the ultimate sustainable yield of the aquifer, it is recommended that a programme of test drilling be carried out, including the area in County Kildare to the west.
- Further controlled pumping tests should be carried out to improve the characterisation of the aquifer and enable numerical modelling to define the source protection areas.

12. References

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Appendix

Pumping Test Data

Pumping Test on Ballymore Homes well, Council Depot, Blessington

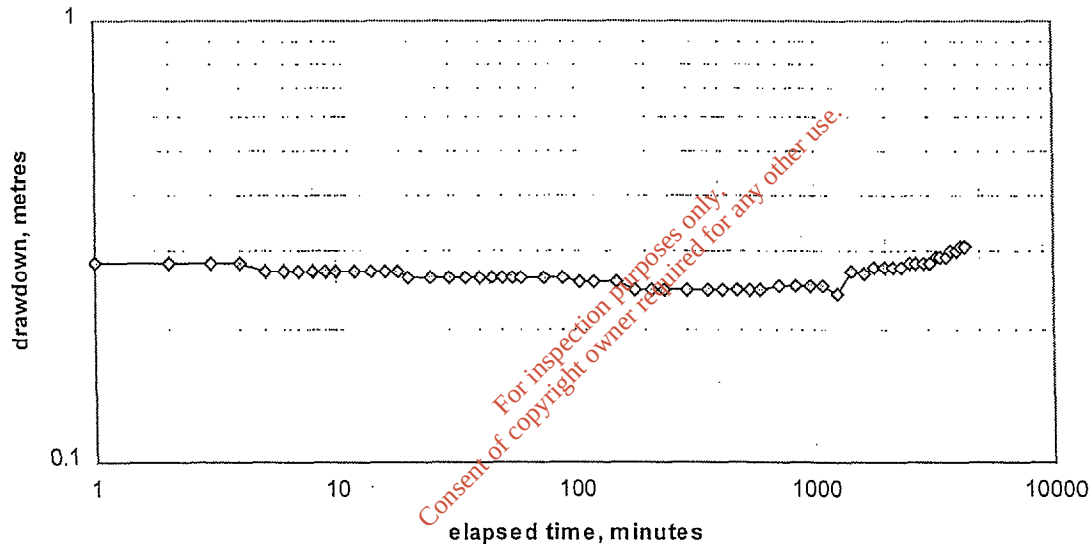
Date	Time	elapsed time (min)	water level m	drawdown m	pumping rate m^3/d	temperature	
						well	stream
17/05/1995	13:31	0	3.11	0		10	12.5
	13:32	1	3.39	0.28	662.4		
	13:33	2	3.39	0.28	662.4		
	13:34	3	3.39	0.28	662.4		
	13:35	4	3.39	0.28	676.8		
	13:36	5	3.38	0.27	656.64		
	13:37	6	3.38	0.27	662.4		
	13:39	8	3.38	0.27	662.4		
	13:41	10	3.38	0.27	662.4		
	13:43	12	3.38	0.27	662.4		
	13:45	14	3.38	0.27	669.6		
	13:47	16	3.38	0.27	662.4		
	13:49	18	3.38	0.27	662.4		
	13:51	20	3.37	0.26	662.4		
	13:56	25	3.37	0.26	665.28	10	12.5
	14:01	30	3.37	0.26	662.4		
	14:11	40	3.37	0.26	662.4		
	14:21	50	3.37	0.26	665.28		
	14:31	60	3.37	0.26	662.4		
	14:46	75	3.37	0.26	662.4	10	13.5
	15:01	90	3.37	0.26	663.84		
	15:16	105	3.365	0.255	663.84		
	15:31	120	3.365	0.255	663.84		
	16:01	150	3.365	0.255	663.84	10	13.5
	16:31	180	3.355	0.245	663.84		
	17:01	210	3.355	0.245	662.4	10	14
	17:31	240	3.355	0.245	663.84		
	18:31	300	3.355	0.245	666.72	10	13
	19:31	360	3.355	0.245	662.4		
	20:31	420	3.355	0.245	663.84	10	12
	21:31	480	3.355	0.245	663.84		
	22:31	540	3.355	0.245	660.96	10	11
	23:31	600	3.355	0.245	662.4		
18/05/1995	01:31	720	3.36	0.25	662.4	10	9
	03:31	840	3.36	0.25	688.32		
	05:31	960	3.36	0.25	637.92	10	8
	07:31	1080	3.36	0.25	662.4		
	10:31	1260	3.35	0.24	662.4	10	10
	13:31	1440	3.38	0.27	665.28	10	10
	16:31	1620	3.375	0.265	669.6		
	19:31	1800	3.385	0.275	653.76		
	22:31	1980	3.385	0.275	665.28		
19/05/1995	01:31	2160	3.385	0.275	655.2		
	04:31	2340	3.385	0.275	666.72		
	07:31	2520	3.39	0.28	663.84	10	9
	10:31	2700	3.39	0.28	658.08	10	12
	13:31	2880	3.39	0.28	662.4	10	15
	16:31	3060	3.39	0.28	665.28	10	14
	19:31	3240	3.4	0.29	659.52	10	13
	22:31	3420	3.4	0.29	636.48		
20/05/1995	01:31	3600	3.4	0.29	709.92		
	04:31	3780	3.41	0.3	640.8	10	11
	07:31	3960	3.41	0.3	662.4	10	10
	10:31	4140	3.415	0.305	665.28	10	10
	13:31	4320	3.415	0.305	662.4	9.9	10.2

Pumping Test on WCC #2 well, Council Depot, Blessington (Well No. 2921SWw067)

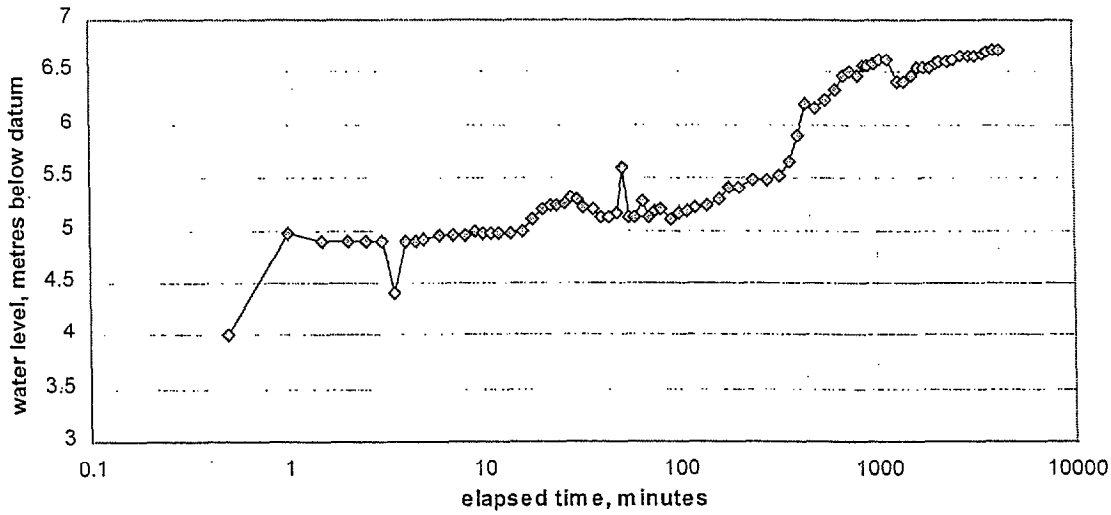
Date	Time	Elapsed time (min)	water level, m	Drawdown, m	meter gallons	pumping rate m3/d
31/10/1995		0	3.4	0	2405600	0
		0.5	4.01	0.61	2405650	655
		1.00	4.98	1.58	2405670	262
		1.50	4.9	1.50	2405700	393
		2.00	4.9	1.50	2405720	262
		3.00	4.9	1.50	2405765	327
		4.00	4.9	1.50	2405810	262
		5	4.92	1.52	2405855	327
		6	4.95	1.55	2405900	295
		8	4.96	1.56	2405988	295
		10	4.98	1.58	2406077	308
		12	4.98	1.58	2406166	295
		14	4.97	1.57	2406256	295
		16	4.99	1.59	2406345	291
		18	5.1	1.7	2406435	295
		20	5.19	1.79	2406525	295
		22	5.24	1.84	2406613	288
		24	5.24	1.84	2406700	285
		26	5.26	1.86	2406793	304
		28	5.31	1.91	2406883	295
		30	5.29	1.89	2406973	295
		32	5.22	1.82	2407064	298
		36	5.19	1.79	2407244	295
		40	5.12	1.72	2407423	293
		44	5.13	1.73	2407603	295
		48	5.17	1.77	2407784	296
		52	5.6	2.2	2407965	296
		56	5.12	1.72	2408146	296
		60	5.13	1.73	2408329	299
		65	5.27	1.87	2408554	295
		70	5.13	1.73	2408780	296
		75	5.18	1.78	2409050	353
		80	5.2	1.8	2409231	237
		90	5.1	1.7	2409684	297
		100	5.17	1.77	2410136	296
		110	5.18	1.78	2410589	297
		120	5.22	1.82	2411043	297
		140	5.24	1.84	2411951	297
		160	5.3	1.9	2412854	296
		180	5.4	2	2413716	282
		200	5.4	2	2414671	313
		240	5.49	2.09	2416595	315
		280	5.49	2.09	2418319	282
		320	5.53	2.13	2420143	298
		360	5.65	2.25	2421972	299
		400	5.9	2.5	2423818	302
		440	6.2	2.8	2425610	293
		500	6.16	2.76	2428362	300
		560	6.24	2.84	2431015	289
		620	6.33	2.93	2433841	308
		680	6.47	3.07	2436581	299
		740	6.51	3.11	2439318	299
		800	6.46	3.06	2442050	298
		860	6.56	3.16	2444768	297
		920	6.56	3.16	2447474	295
		980	6.59	3.19	2450205	298
		1040	6.63	3.23	2452923	297
		1160	6.63	3.23	2458285	292
		1280	6.42	3.02	2463751	298
		1400	6.42	3.02	2469200	297

		1520	6.46	3.06	2474663	298
		1640	6.54	3.14	2480133	298
		1760	6.54	3.14	2485638	300
		1880	6.55	3.15	2491142	300
		2000	6.59	3.19	2496650	300
		2120	6.6	3.2	2502153	300
		2320	6.6	3.2	2511374	302
		2520	6.62	3.22	2520595	302
		2770	6.66	3.26	2532098	301
		3020	6.65	3.25	2543620	302
		3270	6.65	3.25	2555193	303
		3520	6.67	3.27	2566541	297
		3770	6.7	3.3	2578059	302
		4020	6.72	3.32	2589544	301
03/11/1995		4270	6.72	3.32	2601043	301

Pumping Test, Ballymore Homes Well No.2,
Council Depot, Blessington, 17- 20 May 1995



Pumping Test, WCC Well #2, Council Depot, Blessington
31 October - 3 November 1995

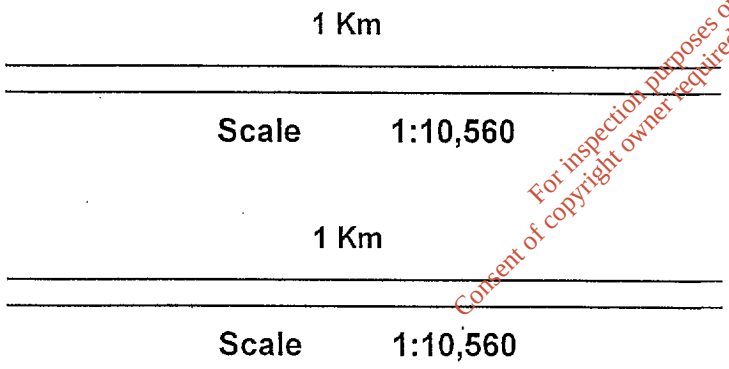


BLESSINGTON GRAVEL AQUIFER
MAP 1: Subsoils

LEGEND

- ☐ Rock at or close to surface
- ☐ Glacial Till
- ☐ Glaciofluvial Sands & Gravels
- ☐ Lake Clays

BLESSINGTON GRAVEL AQUIFER
MAP 2: Source Protection Areas:
Council Depot Wellfield



Council Depot Wellfield

100-day Travel-time Zone

Groundwater Catchment Boundary

SI/H

SO/H

SO/E

Zone of Contribution

1 Km

Scale 1:10,560

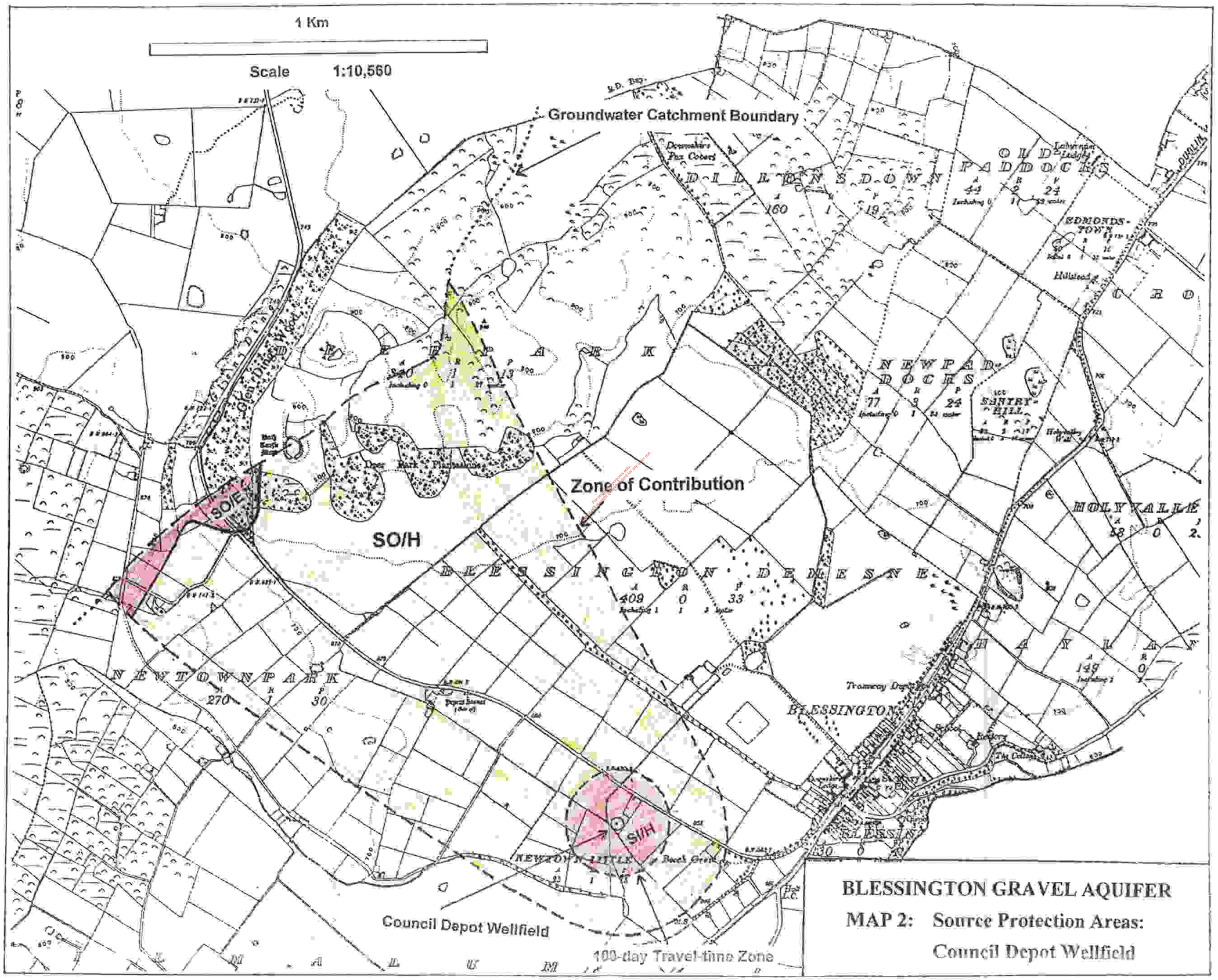
LEGEND

- Rock at or close to surface
- Glacial Till
- Glaciofluvial Sands & Gravels
- Lake Clays

Council Depot Wellfield

BLESSINGTON GRAVEL AQUIFER

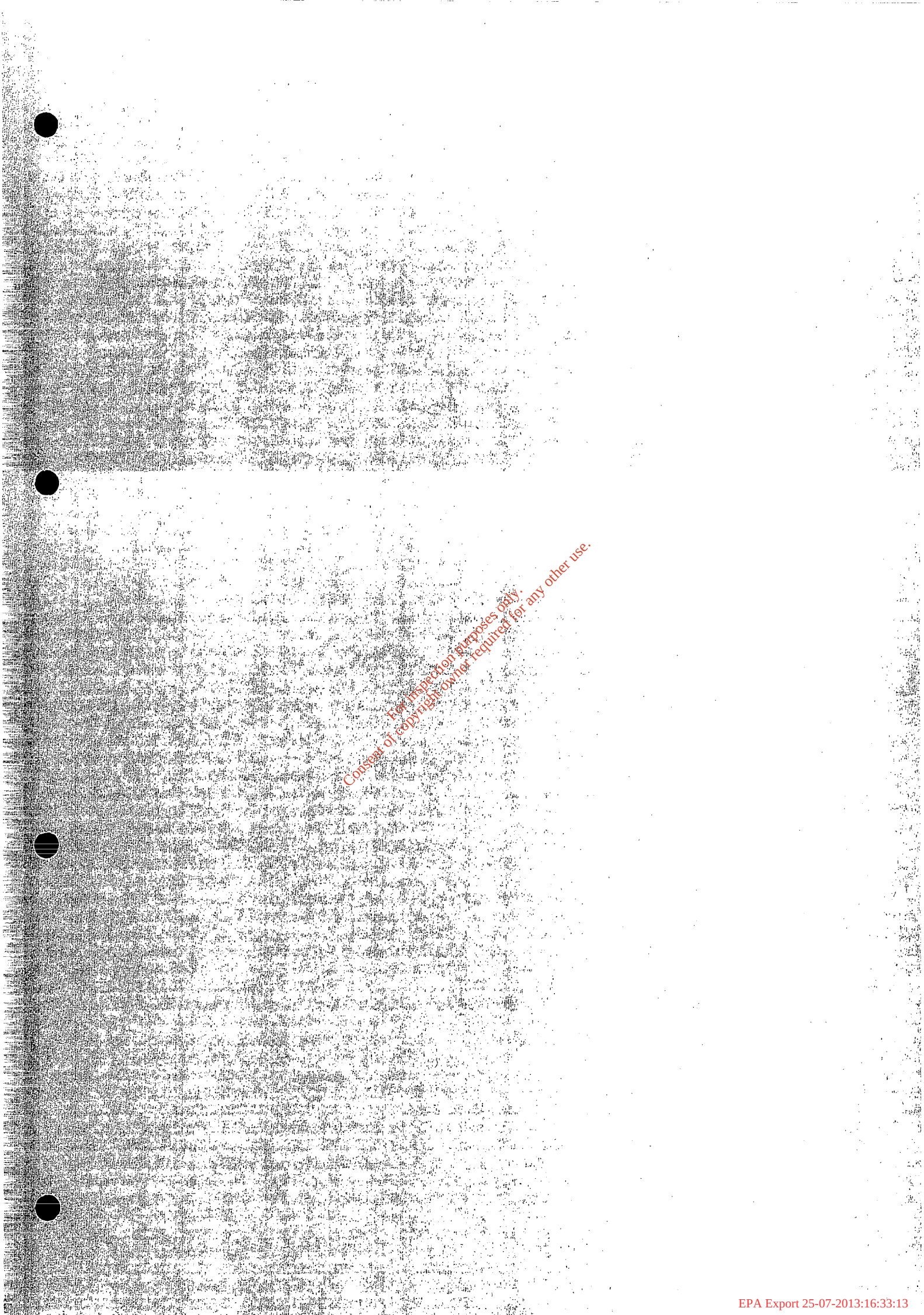
MAP 1: Subsoils



BLESSINGTON GRAVEL AQUIFER

MAP 2: Source Protection Areas:

Council Depot Wellfield



Report on the Further Information
Ashton Vulnerability
July 1997

Prepared at the request of;

Fahy Fitzpatrick
Consulting Engineers
72 Northumberland Road
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Prepared by:

K.T. Cullen & Co. Ltd.,
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FURTHER INFORMATION REQUESTED IN CONNECTION WITH PLANNING PERMISSION FOR MARGROVE HOUSING DEVELOPMENT, ASHTON, BLESSINGTON.

1. INTRODUCTION.

Margrove Ltd intend to develop an estate of 169 houses at Ashton Blessington. The potable water requirements of this development will be met by groundwater from a well. The demand of the devlopment is estimated to be 200 m3/day. Previous works and studies carried out by this office established that a trial well drilled on this site was capable of meeting the potable water requirements of the proposed development. A vulnerability assessment of the proposed site was also carried out. The works and studies described in this report dated 12th August 1997 were carried out in response to a request for further information by Wicklow County Council. The report deals particularly with an assessment of the risks to the quality of the well water supply. This report describes the ground conditions found at Ashton from the results of boreholes and trial pits completed on the development site. This information is incorporated into a conceptual model for the hydrogeological conditions operating here including the level of the water table and the measured groundwater flow direction. A risk assessment is then provided which outlines the vulnerability of the proposed water supply and groundwater generally at the site in terms of likely pollution sources. The works carried out in order to comply with these requests were as follows.

i) Two boreholes were drilled to provide data on overburden composition and water table.

ii) 5 trial pits were excavated to provide additional information on the overburden composition and to provide samples of overburden for sieve analysis.

iii) The locations of all septic tanks within 300 metres of the well were identified.

iv) The well information for the area was collected from the GSI.

v) The hydraulic gradient and groundwater flow rates were computed.

2. SITE DESCRIPTION.

The proposed development site is located approximately 1 km west of Blessington along the Naas Road. The site is bordered on the east by a small stream that flows south westwards into the Blessington Lake Reservoir. Away from the stream the ground rises towards the north with an elevation rise of some 7m .

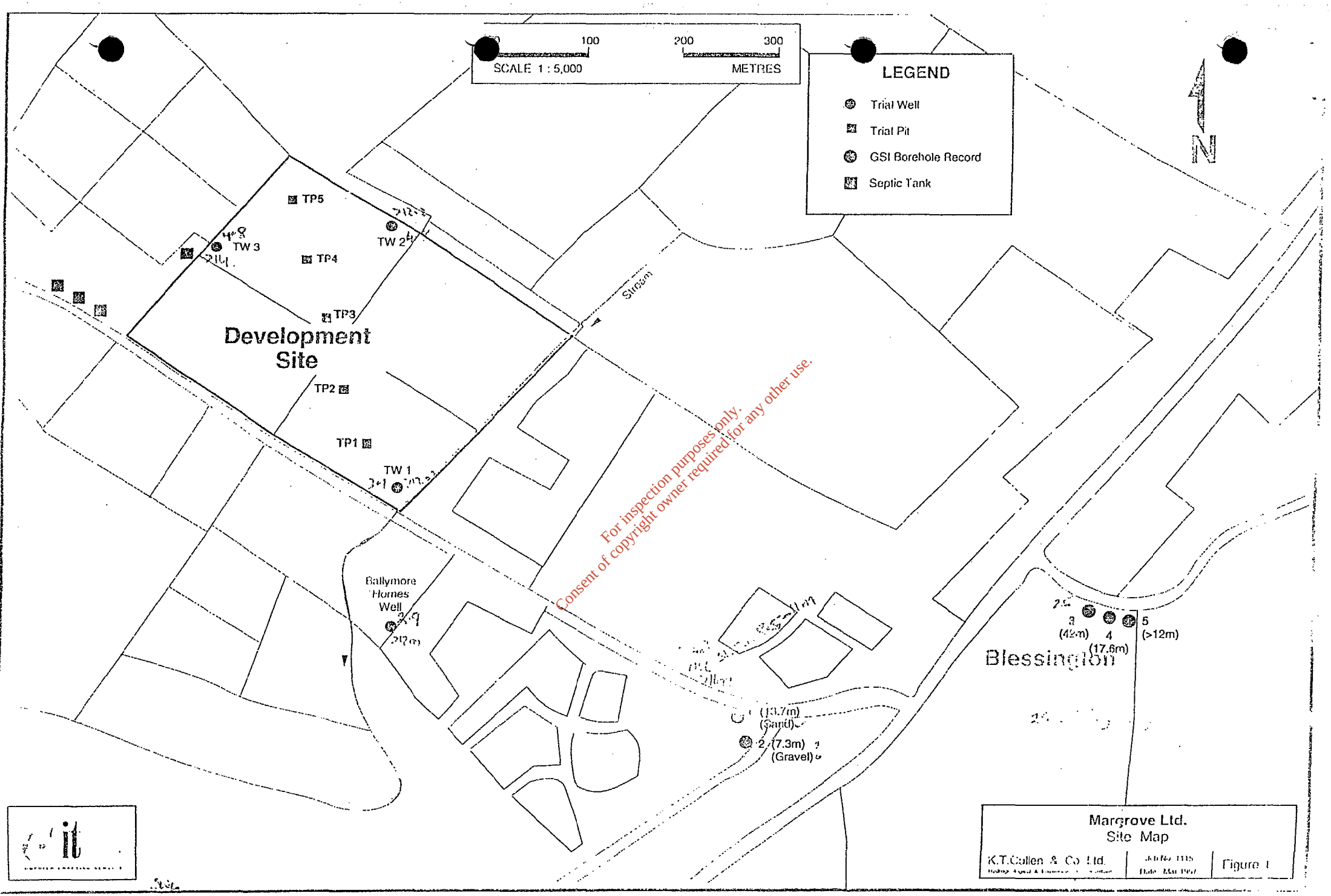
Land use on and to the north of the development site is rural in character and devoted to rough pasture and grazing with little tillage taking place. There is a housing development to south east of the site and potable water for these houses is provided from a well drilled on the southern side of the road and its location is shown in Figure 1.

3. HYDROGEOLOGICAL CONDITIONS

The development site is located in a broad expanse of undulating topography which is characterised by large thicknesses of glacial tills and outwash deposits. The underlying bedrock consists of Lower Palaeozoic meta-sediments which flank the Wicklow granite pluton. Outcrops are rare in this area and, as a borehole completed to 14 metres here remained in glacial sediments. The bedrock does not play a significant role in the groundwater regime of interest to this study. In contrast, the complex glacial sediments found in west Wicklow control the groundwater flow pattern and the following sections discuss the nature and thickness of glacial sediments at Ashton in some detail.

3.1 Borehole Drilling.

Two additional boreholes (TW 2 and TW 3) were drilled to provide information on the direction of groundwater flow and the distribution of overburden material over the site. The logs of these boreholes are contained in the appendix. TW 1 was drilled in 1996 and the log of this well is shown as it was reported by the driller. The well was tested



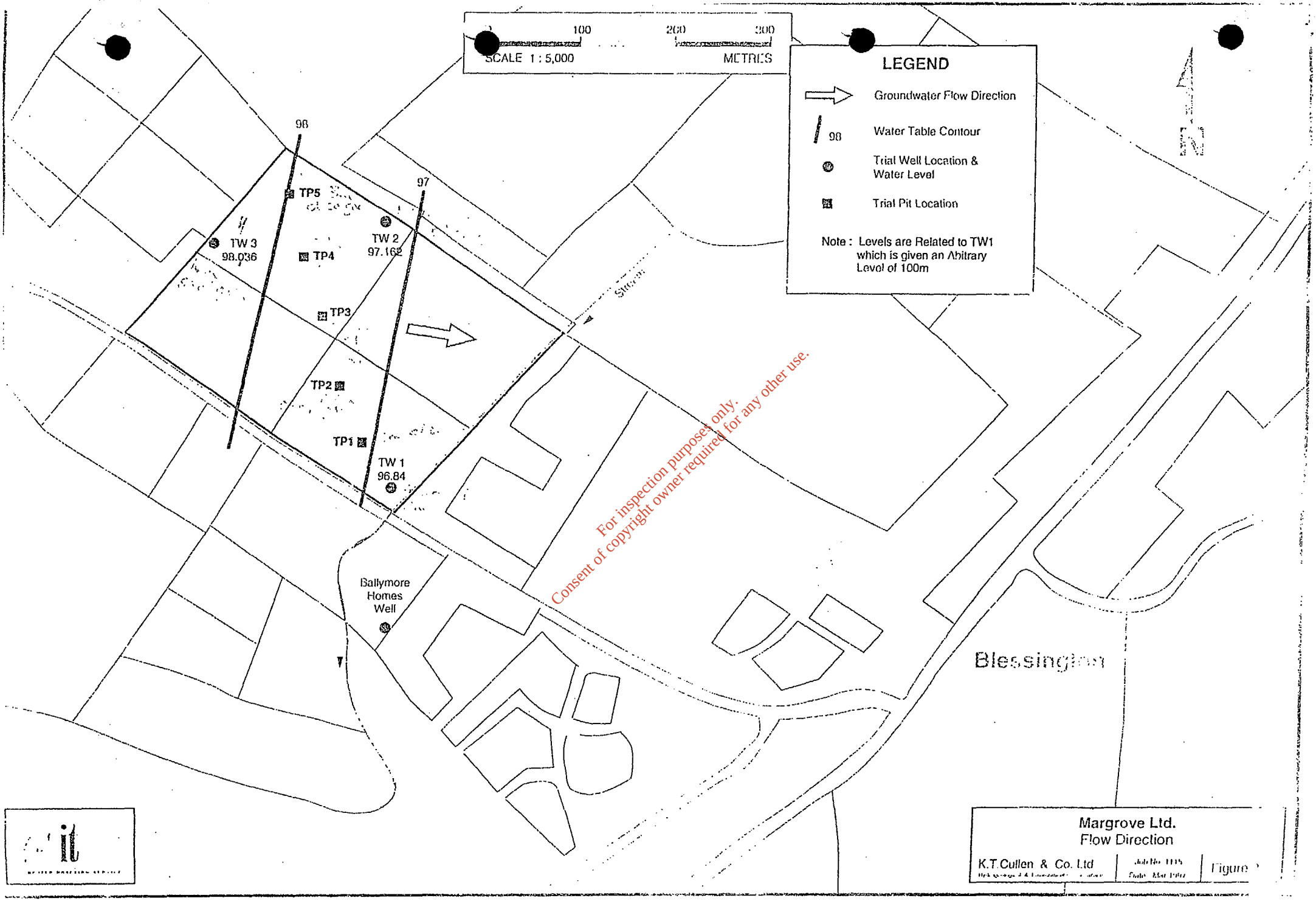
and shown to be capable of supplying the requirements of the proposed development. TW 2 and TW 3 were drilled in 1997. The results from the wells drilled in the northern part of the site contrasted with TW 1 in the fact that no major inflows were noted however it should be noted that the wells were only drilled to a depth where water was encountered as the main concern was the establishment of the water table and groundwater flow direction. The wells all encountered sandy clayey gravel throughout The material became slightly more gravelly with depth. The levels of the wells were surveyed in and the direction of groundwater flow and hydraulic gradient was established. The groundwater flow direction is almost directly from west to east as shown in Figure 2.

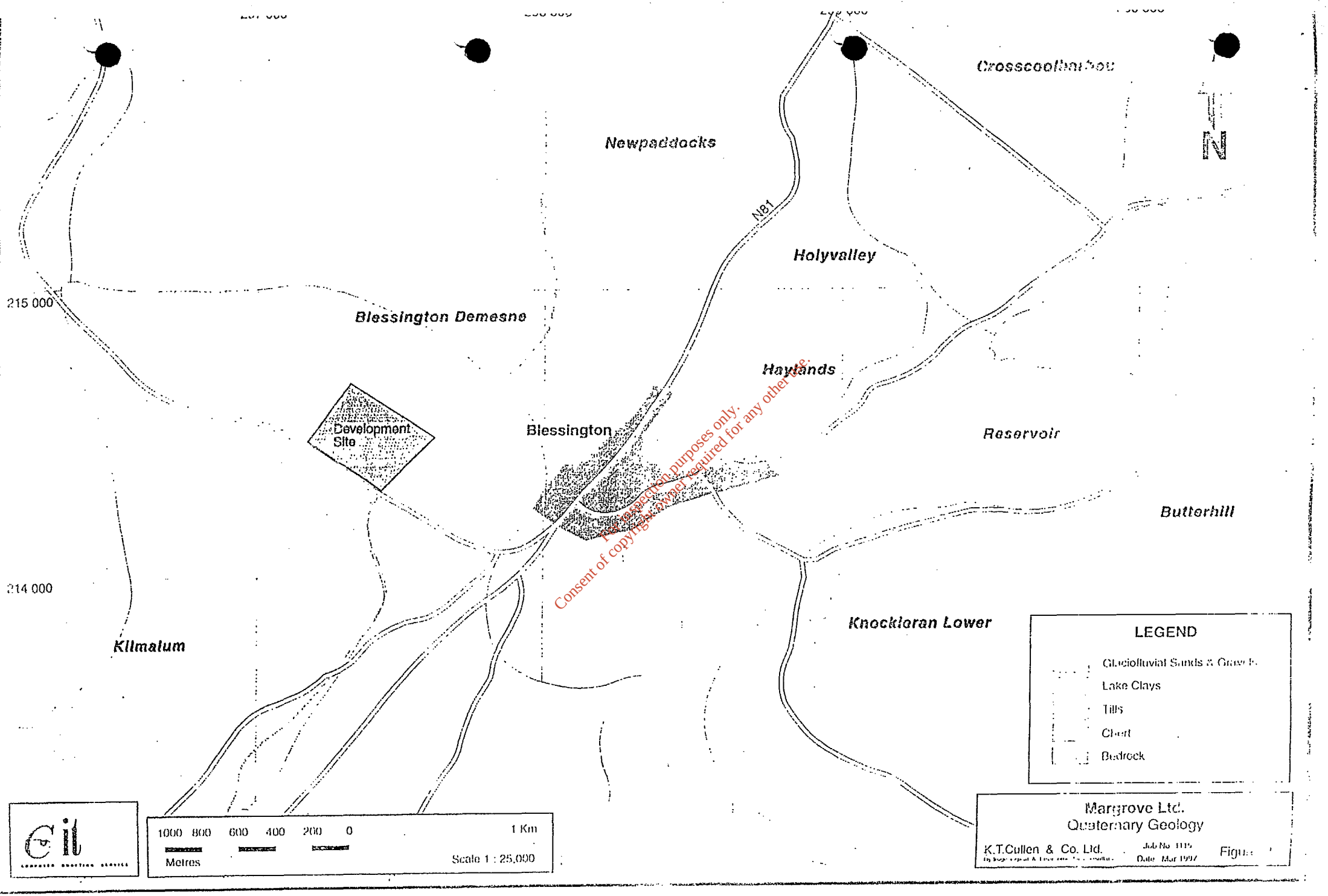
3.2 Trial Pit Excavation.

A series of 5 trial pits were excavated to a depth of 2.5 to 3 metres across the site. The strata encountered was very similar in all the pits excavated. There was a thin layer of topsoil underlain by clayey sandy gravel. The trial pit information shows that the site is underlain by permeable material. Samples were collected for sieve analysis and the permeability was calculated empirically. The average permeability was calculated to be 150 m/day.

4. AQUIFER CLASSIFICATION AND VULNERABILITY RATING.

The well records of the GSI were inspected and there was only limited information available. Records for only 5 wells were found within 800 metres of the site. The data was extremely limited in the fact that only the depth of the well was available and in some cases a description of the material encountered was also available. The details and locations are shown in Figure 1. The quaternary geology is shown in Figure 3 and this shows the site to be underlain by glacial tills. This has been proved to be an incorrect subsoil classification in terms of the site itself. The trial wells and trial pits show that the site is underlain by glacio fluvial sands and gravels. It should be noted that the quaternary maps available from the GSI are general regional classifications based on sparse and diverse information and that individual sites can exhibit contradictory material. The results of the on-site investigations will supersede the information on the GSI maps. The aquifer underlying the site at Blessington would be classed as a **regionally important gravel aquifer (Rg)** and its vulnerability rating would be classed as **high.** There is between 3.1 and 10. 7 metres of unsaturated zone underlying the site.





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5. LOCATION OF DUTY AND STANDBY WELLS.

It proposed to locate the duty and standby wells in the northern corner of the property . This location has been chosen to keep as much of the site down gradient of the well as possible and to avoid any possible plume from septic tanks located on the western boundary of the site. The elevation of the site is an advantage from a distribution perspective.

6. SOURCE PROTECTION AREAS.

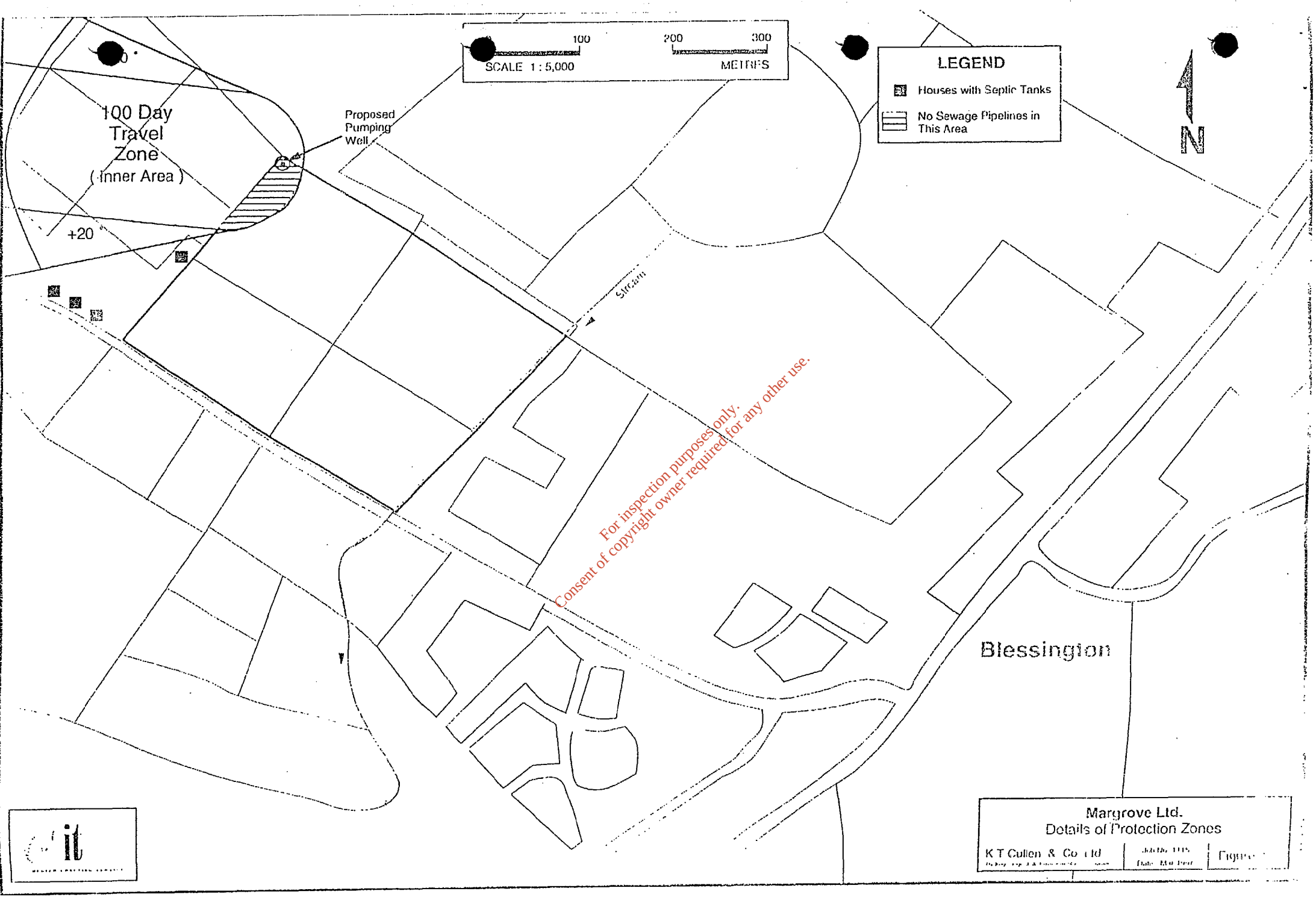
6.1 Outer Protection Area :

This includes the complete catchment area to the source and requires that the groundwater direction is known. The width of the corridor within which all groundwater will be drawn to the well must be calculated.

The recharge was estimated to be 375 mm and the average daily abstraction rate will be 200 m3/day. This is increased to 300 m3/day to allow for dry weather. The area required to recharge this amount 0.29 km^2.

The hydraulic gradient was calculated to be 0.006 from the survey of the water levels in the trial wells. If the permeability is taken to be 150 m/day and the aquifer thickness 8 metres the characteristics of the flow pattern to the well can be calculated. The uniform flow equation is used to determine the characteristics of the changes in groundwater flow to the wells. The distance to the down gradient stagnation point was calculated to be 7 metres and the maximum width of the influx zone is 42 metres. For the purposes of this exercise and to allow for uncertainties the corridor width is taken to be 150 metres. A buffer safety margin of $\pm$ 20% is also included. The down gradient stagnation point is taken as 20 metres. These protection areas are shown in Figure 4 and 5.

The Zone of Contribution is taken back to the catchment divide. The source protection areas are shown in Figures 4 and 5.



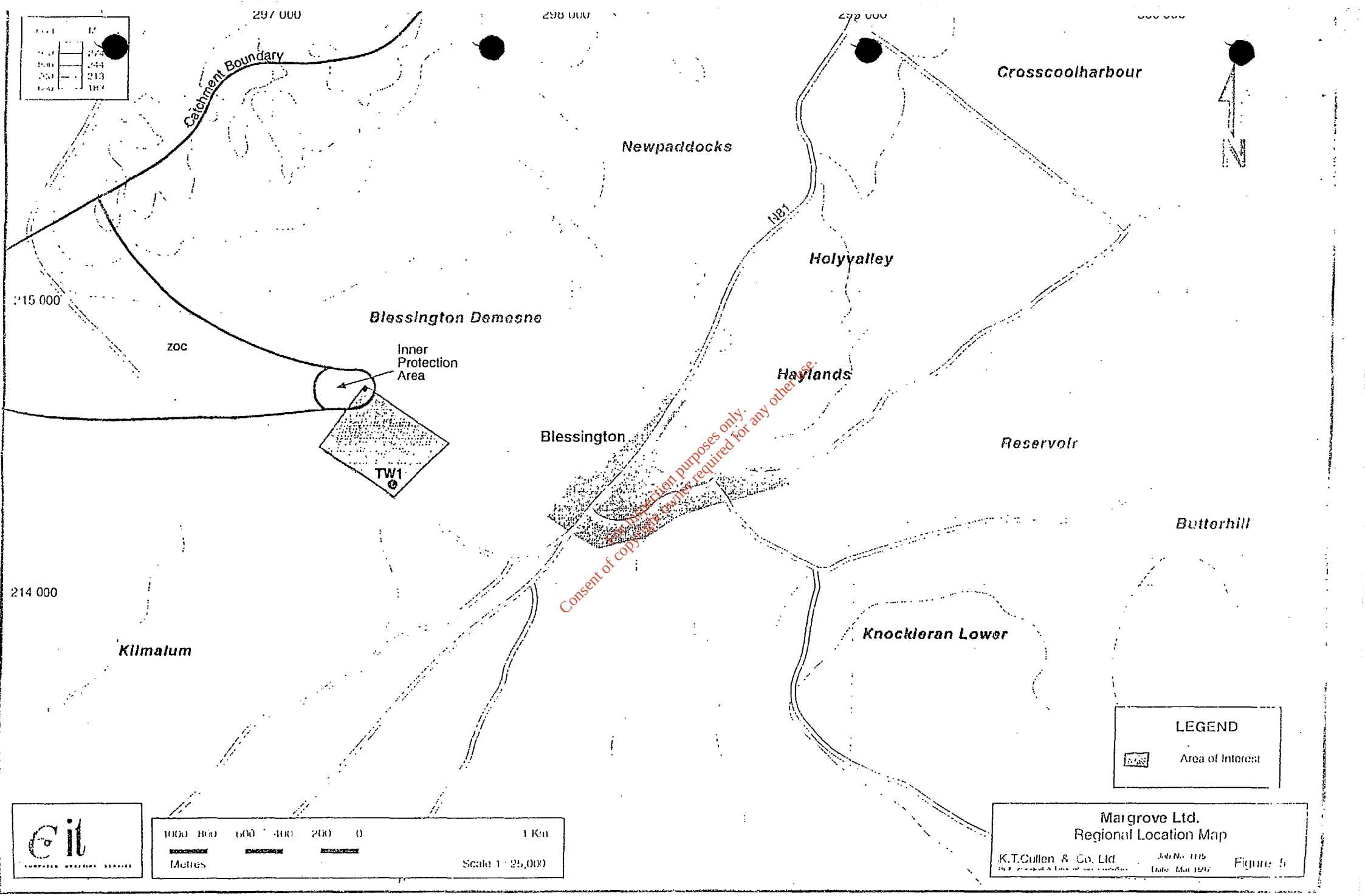


Table 1 Vulnerability Mapping Guidelines (Geological Survey of Ireland)

Vulnerability Rating	Hydrogeological Requirements				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Recharge Type
	high permeability (sand/gravel)	moderate permeability (sandy till)	low permeability (clayey till, clay, peat)	(sand & gravel aquifers only)	
Extreme	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	Point (<30 m radius)
High	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	diffuse
Moderate	N/A	>10.0m	5.0 - 10.0	N/A	diffuse
Low	N/A	N/A	>10.0m	N/A	diffuse

Notes: i) N/A = not applicable

ii) Precise permeability values cannot be given at present.

iii) Release point of contaminants is assumed to be 1-2m below ground surface

Table 2 Draft Groundwater Protection Scheme Matrix for Septic Tank Systems.
(Geological Survey of Ireland)

Vulnerability Rating	Source Protection			Resource Protection					
				Regionally Imp		Locally Imp		Poor Aquifers	
	Site	Inner	Outer	Rk	Rf/Kg	Lm/Lg	L1	P1	Pu
Extreme (E)	R4	$R3^1$	$R3^3$	$R3^3$	$R2^2$	$R2^2$	$R2^1$	$R2^1$	$R2^1$
High (H)	R4	$R3^2$	$R2^7$	$R2^4$	R1	R1	R1	R1	R1
Moderate (M)	R4	$R2^9$	$R2^6$	$R2^3$	R1	R1	R1	R1	R1
Low (L)	R4	$R2^8$	$R2^8$	$R2^3$	R1	R1	R1	R1	R1

Note :

Arrows (→ ↓) indicate directions of decreasing risk.

IMP = Important

Table 3

Responses to the Proposed Location of a Septic Tank System

(Geological Survey of Ireland)

Response Code	Acceptability, Conditions or Exceptions
R1	Acceptable, subject to normal good practice (i.e. compliance with S.R.6:1991).
R2[1]	Probably acceptable, subject to compliance with S.R.6:1991. Particular attention should be given to the depth of subsoil in situations where there are nearby wells and springs.
R2[2]	Probably acceptable, subject to compliance with S.R.6:1991. Special attention should be given to the depth of subsoil over bedrock and to the thickness of the unsaturated zone in free-draining areas.
R2[3]	Probably acceptable subject to compliance to S.R.6:1991. Special attention should be given to the location of karst features, such as swallow holes and collapse features. Percolation areas should not be located within 15m of such features.
R2[4]	Probably acceptable, subject to compliance to S.R.6:1991. Particular attention should be given to the (i) the depth of subsoil over bedrock, (ii) in free-draining areas, to thickness of the unsaturated zone and (iii) to the location of karst features. Percolation areas should not be located within 15m of karst features.
R2[5]	Probably acceptable subject to: (i) compliance with S.R.6:1991and (ii) provision of evidence on the type and depth of subsoil to ensure that the site is not in a higher risk zone that precludes the location of septic tank systems (for instance from nearby wells or local information)
R2[6]	Probably acceptable, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence on the type and depth of subsoil to ensure that the site is not in a higher risk zone (for instance from nearby wells or local information); (iii) taking account of the number of existing houses so that the problem of significant contamination by nitrate does not arise.
R2[7]	Probably acceptable, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence on the type and depth of subsoil to ensure that the site is not in a higher risk zone (for instance, from nearby wells or local information); (iii) taking account of the number of existing houses so that the problem of significant contamination by nitrate does not arise. Engineered preventative measures, such as on-site treatment systems, may be advisable to reduce the risks in some situation (for instance, where the site is close to the limits of the zone-close to extreme vulnerability or the SI zone boundary)
R2[8]	Probably acceptable, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence on the type and depth of subsoil to ensure that the site is not in a higher risk zone (for instance, from nearby wells or local information); (iii) that surface ponding of effluent and/or shallow contaminated groundwater does not pose a significant risk to the source (this would apply particularly where the site is up-gradient of the source and/or the well casing has not been grouted and sealed).
R2[9]	Probably acceptable, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence on the type and depth of subsoil to ensure that the site is not in a higher risk zone (for instance, from nearby wells or locate information); (iii) taking account of the number of existing houses so that the problem of significant contamination by nitrate does not rise; (iv) an assessment that surface ponding of effluent and/or shallow contaminated groundwater does not pose a significant risk to the source (this would apply particularly where the site is up-gradient of the source and/or the well casing has not been grouted and sealed).
R3[1]	Not generally acceptable, unless it is shown by investigation and assessment that the risk to groundwater is reduced by the hydrogeological situation at the site (for instance, if the site is in a lower risk zone where septic tank system are acceptable, subject to compliance with S.R.6:1991). On-site treatment systems should not be seen as an alternative)
R3[2]	Not generally acceptable, unless it is shown by investigation and assessment that the risk to groundwater is reduced by the hydrogeological situation at the site (for instance, if the site is in a lower risk zone or the subsoil thickness is substantially greater that 3m or, in the case of sands/gravels, the unsaturated zone is substantially greater than 3m) or alternatively can be significantly reduced by the use of engineered precentative measures, such as on-site treatment systems. Compliance with S.R.6:1991 or appropriate Agreement Certificate is essential.
R3[4]	Not generally acceptable, unless it is shown by investigation and assessment that the risk to groundwater is reduced by the hydrogeological situation at the site (for instance, if the site is in a lower risk zone) or alternatively can be significantly reduced by the use of engineered preventative measures, such as on site treatment systems. Compliance with S.R.6:1991 or appropriate Agreement Certificate is essential.
R4	Not acceptable

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6.2 Inner Protection Area.

This area is defined by the 100 day travel time from a point below the water table to the to the source and it is delineated to protect against possible microbial contamination. The 100 day travel time is calculated to be 300 metres.

6.3 Source Site.

The source site is delineated as an area 10 m radius around the well.

7. RISK ASSESSMENT.

In order for a risk to the water supply for the proposed development to exist the hazard must be situated within the catchment of the proposed well. There are only three apparent hazards to the water supply and these are the septic tanks in the houses to the west of the site. The other potential hazards are the foul sewers that convey the sewage from the houses to the west of the well. The risk of slurry spreading on the adjoining lands will also be assessed.

7.1 Septic Tanks.

The nearest house with a septic tank is located 150 metres from the well. This tank lies outside the 100 day travel time (i.e. outside the inner protection area).

The Geological Survey has published a matrix for septic tanks and this is reproduced here for discussion purposes. This details the risk and assesses the acceptability of a septic tank in relation to the source. The matrix is reproduced in Table 2. The vulnerability of rating of the Ashton site is "High". No septic tank lies within the catchment of the well and consequently the there will be no risk.

7.2 Sewage Pipelines.

The assessment of the risk created by the sewage pipelines is much more complex. This complexity is caused by the fact that unlike septic tanks pipelines are not designed to leak. A leak will occur as a result of an accident. The degree of the leak can vary from a clean break to a pinhole. In order to eliminate any risk to the source no sewage pipeline will be constructed within 100 days travel time of the source.

7.3 Slurry Spreading.

There is no intensive agriculture carried out in this part of Blessington. No discharge licences for slurry spreading should be granted due to the vulnerable nature of the underlying aquifer. The aquifer classification is a regionally important gravel aquifer with a high vulnerability. No land spreading should be conducted within the Inner Area (100 day travel zone). Individual farmers do not require a licence to spread slurry generated on their own farms. If land spreading is carried out in the ZOC (zone of contribution) then the organic nitrogen loading on the land should not exceed 170 kg/hectare/year.

8. MONITORING PROGRAMME.

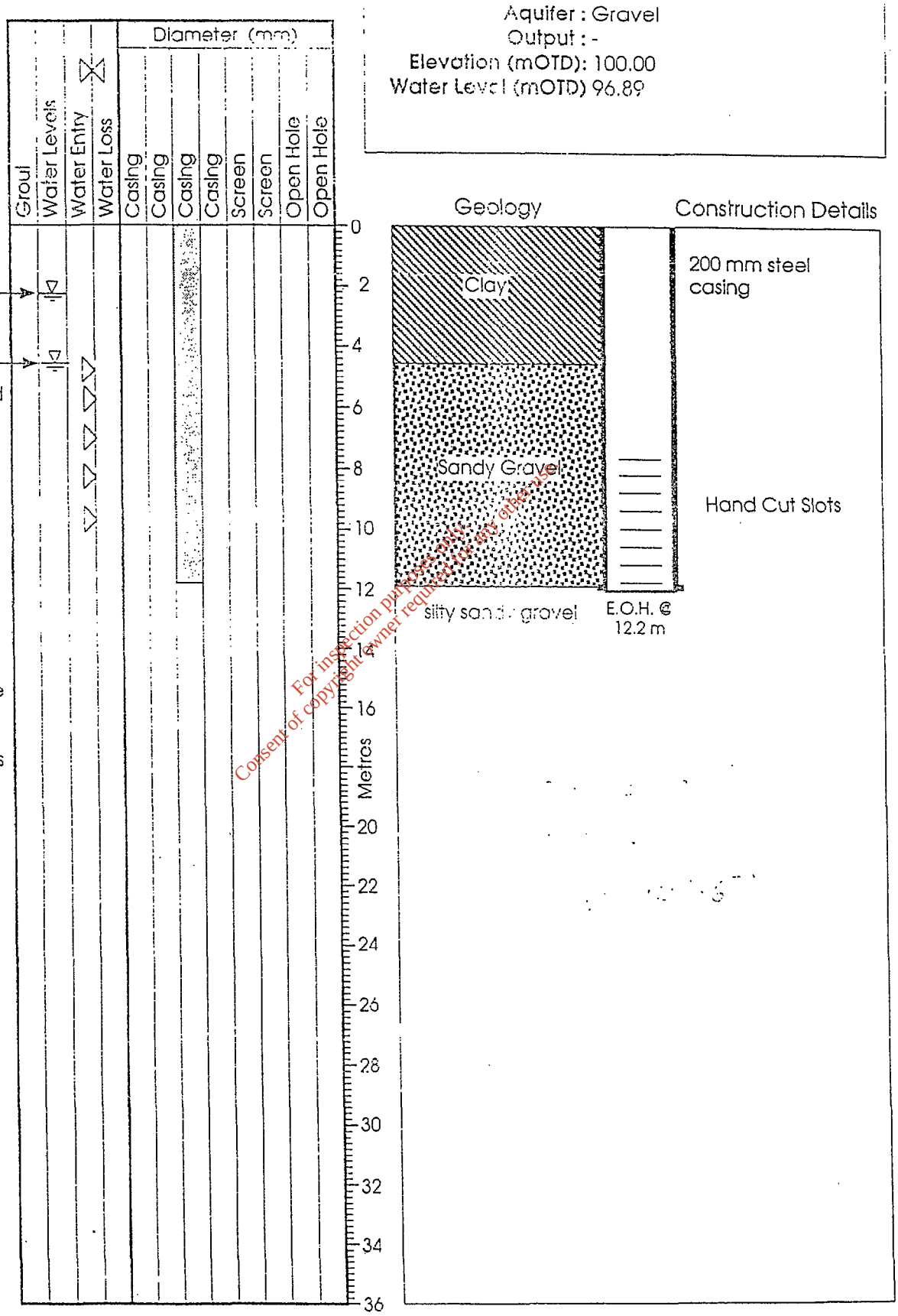
The water from the well should be sampled every month. The sample should be analysed for Faecal Coliforms, Total Coliforms, Faecal Strep, Plate Count at 22° C and Plate Count at 37°C. It is also recommended that a sample be collected every three months and sampled for Nitrate, Nitrite, Ammonia, Sodium, Potassium, Chloride and Sulphate, Iron and Manganese.

APPENDICES

Completed Well Design

Client : Margrove
Project : Groundwater Development
Location : Blessington
County : Wicklow
Date : July 1996
Driller : Tom Connell
Aquifer : Gravel
Output : -
Elevation (mOTD): 100.00
Water Level (mOTD) 96.89

Trial Well No.1



Remarks

Standing water level prior to test 8/7/96

Water level at end of test 12/7/96

Pumping rate at end of test: 340 m3/day

TW 1 was given an arbitritrary level of 100 m and all other levels were taken relative to this temporary Datum

K.T. Cullen and Co. did not oversee the drilling of this well and the construction details are as reportedby the driller.

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Figure No.2

Completed Well Design

Trial Well No.2

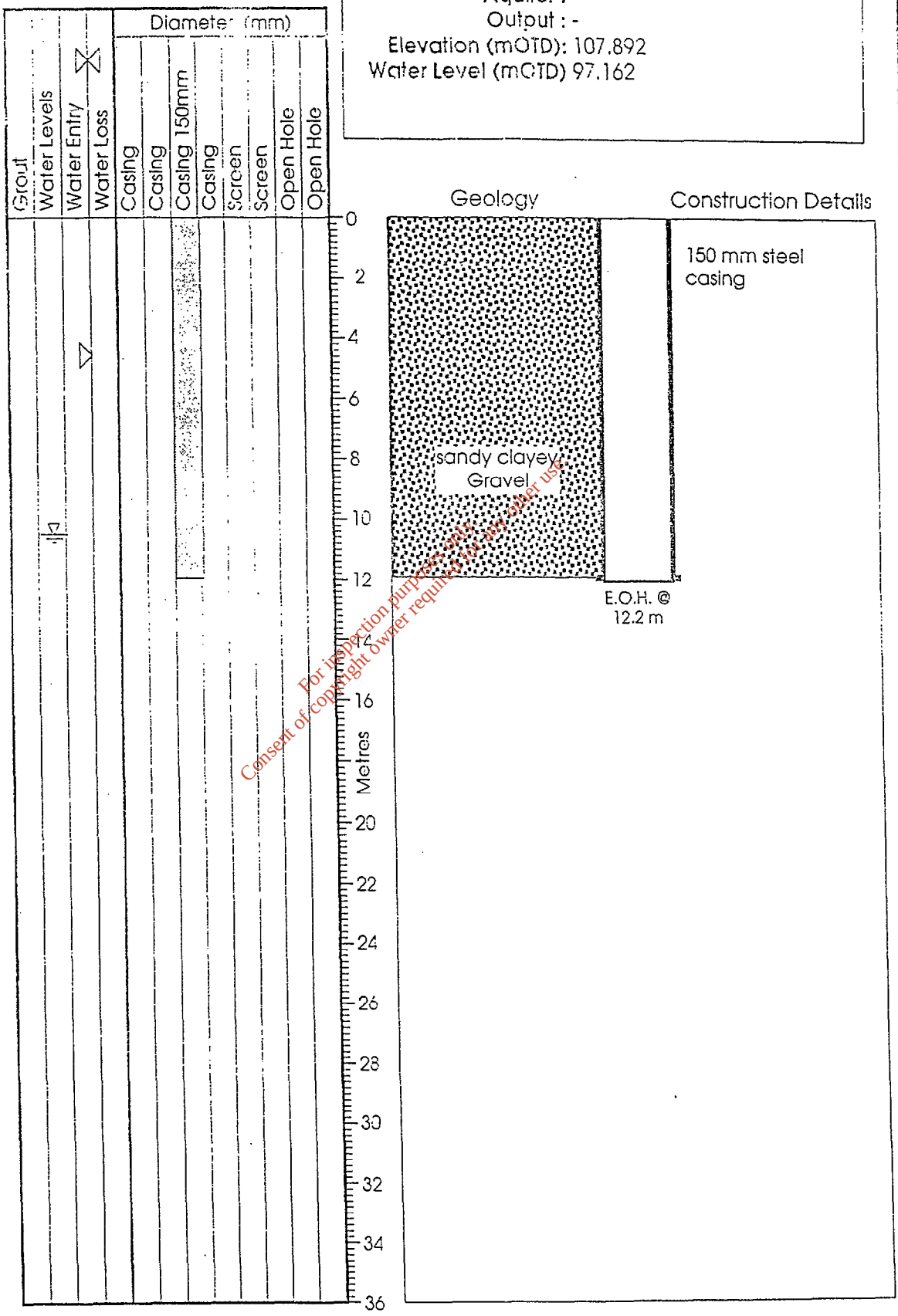
Client : [illegible]
Project : Groundwater Development
Location : Blessington
County : Wicklow
Date : July 1996
Driller : Denis O'Donoghoe
Aquifer : -
Output : -
Elevation (mOTD): 107.892
Water Level (mOTD) 97.162

DRAFT

Remarks

Water strike at 4.8m not measureable. Cased off to 12m Gravels unproductive . SWL after Airlifting 10.7 m.

TW 1 was given an arbitritrary level of 100 m and all other levels were taken relative to this temporary Datum



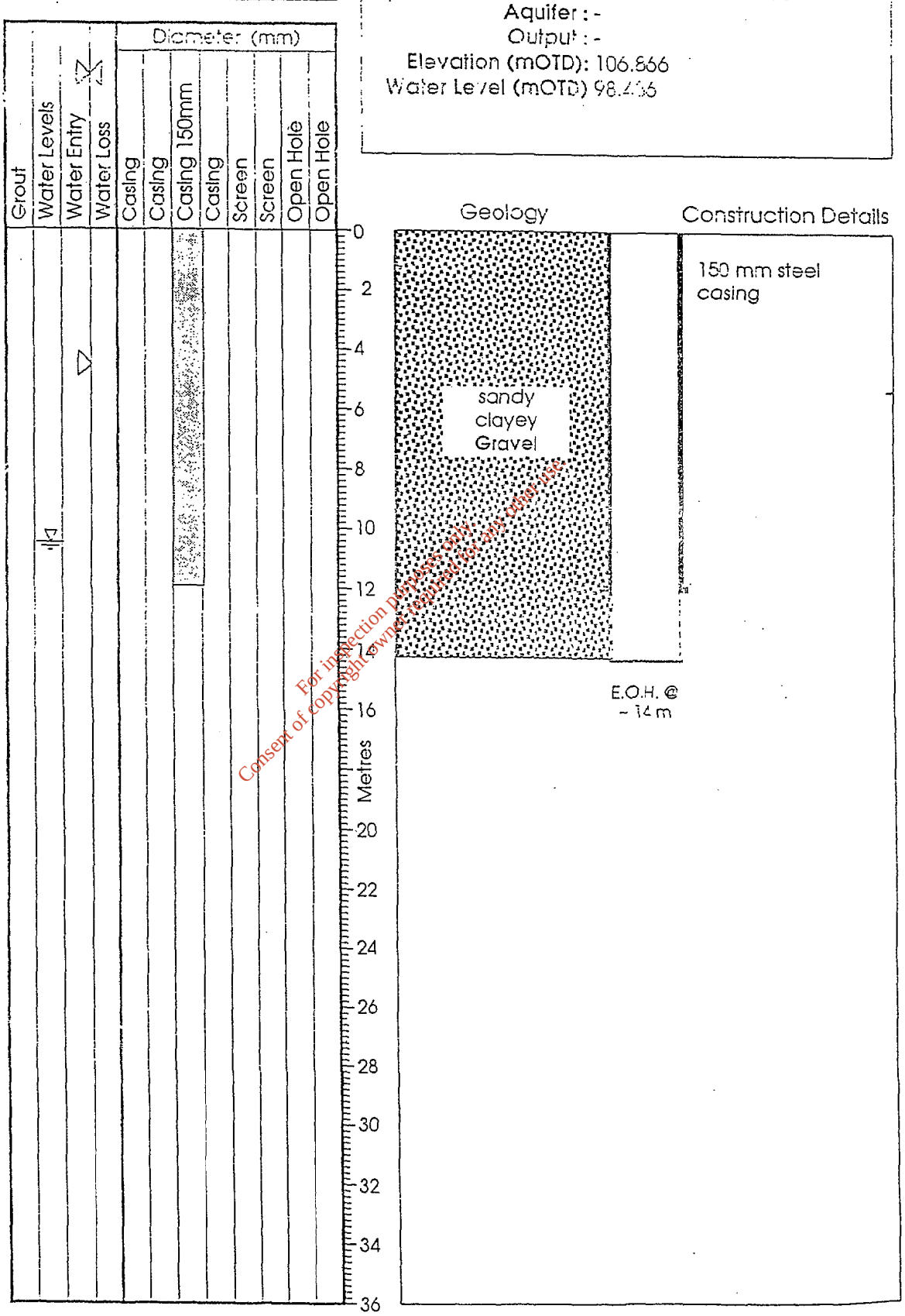
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Figure No.3

Completed Well Design

Trial Well No.3

Client : [illegible]ve
Project : Groundwater Development
Location : Blessington
County : Wicklow
Date : 23/07/97
Driller : Dennis O' Donohue
Aquifer : -
Output : -
Elevation (mOTD): 106.866
Water Level (mOTD) 98.436



Remarks

Water strike at 4.8m not measureable. Cased off to 12m Gravels unproductive . SWL [illegible] airlifting 10.9 m.

TW I was given an arbitritrary level of 100 m and all other levels were taken relative to this. temporary Datum

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Figure No.3

TRIAL PIT RECORDS

Project No: 1115 Location: Ashton, Blessington Date: July 1997

Trial Pit No. 1

Geology: 0.0 - 3.0 Clayey Sandy Gravel

Depth to Rock: -

Rock Type: -

Water entry :

Static Water: -

Total Depth : 3.0

Comments: No water encountered

Trial Pit No. 2

Geology: 0.0 - 3.3 Clayey sandy Gravel

Depth to Rock: -

Rock Type: -

Water entry : -

Static Water: -

Total Depth : 3.3

Comments: No water inflows encountered

TRIAL PIT RECORDS -

Project No: 1115 Location: Ashton, Blessington Date: July 1997

Trial Pit No. 3

Geology: 0.0 - 3.5 Clayey Sandy Gravel

Depth to Rock: -

Rock Type: -

Water entry :

Static Water: -

Total Depth : 3.5

Comments: No water inflow encountered

Trial Pit No. 4

Geology: 0.0 - 3.3 Clayey sandy Gravel

Depth to Rock: -

Rock Type: -

Water entry : -

Static Water: -

Total Depth : 3.3

Comments: No water inflows encountered

TRIAL PIT RECORDS

Project No: 1115 Location: Ashton, Blessington Date: July 1997

Trial Pit No. 5

Geology: 0.0 - 3.0 Clayey Sandy Gravel

Depth to Rock: -

Rock Type: -

Water entry : None

Static Water: -

Total Depth : 3.0

Comments: No inflows recorded

Trial Pit No.

Geology:

Depth to Rock: -

Rock Type: -

Water entry : -

Static Water: -

Total Depth :

Comments:

JAMES REYNOLDS, B.E., C.Eng., M.I.C.E., M.I.E.I.

MANOR KILBRIDE, CO. WICKLOW. (01) 4582683

REPORT on

BORED WATER SUPPLY TREATMENT PLANT
& PUMPHOUSE at
BLESSINGTON, Co. WICKLOW.

CLIENT: Ballymore Homes Ltd.

June 1994.

INTRODUCTION

This report describes the existing water supply plant and boreholes installed by Ballymore Homes Ltd to provide water for the Ashton and Beechdale Estates built at Blessington Co Wicklow,.
The water supply consists of two boreholes with submersible pumps adjacent to a plant room housing a pressure tank, softening plant, chlorination dosing plant and a standby generator.

The attached Drawings:

BH/B1 Bored Water Supply Blessington - Site Location and Layout
BH/B2 Bored Water Supply Blessington - Pumphouse Details

show the location and layout of the site, the pumphouse, the boreholes, and the position of the items of plant within the pumphouse.

BOREHOLES & PUMPS

Borehole Number 1 which is located nearest the plant building is 12.20 metres (40 feet) deep.
It is equipped with a 3 h. p., 4 inch submersible, Lowara DE10. pump.
The Performance Curve for this pump is attached, See Figure 1.
From this Performance curve it can be ssen that the pump has a capacity of over 10 cubic metres/hour against a head of 40 metres.

Borehole Number 2 is 11.66 metres (38.25 feet) deep and is equipped with a 2 h.p. pump.
A Completed Well Design for this borehole prepared by K.T. Cullen & Co. Ltd. is attached, See Figure 2.
This shows the borehole to have a 150 mm. steel casing with a 150 mm. stainless steel well screen 1.4 metres in length..
This borehole was sunk by Mr. S. Kelly, Enniscorthy.

The overall capacity of the boreholes can be determined by a standard pumping test.

PRESSURE TANK

The steel pressure tank has a capacity of 500 litres with a maximum operating pressure of 10 bar.
The pump operation is governed by a pressure switch which limits pressure between 45 p.s.i. and 60 p.s.i.
Water is delivered to the 100 mm. feeder main to the Ashton and Beechdale housing

estates at this pressure.

WATER SOFTENING PLANT

The water softening plant is not presently in use.
The Plant consists of a Duplex Water Softener, Model XLD 240/200, with two fibreglass mixing tanks, a salt storage tank, a brine tank and dosing and control equipment.
The softening salt, Sodium Hexacyanoferrate, is stored in liquid form in the plastic 435 litre capacity Salt Storage and Brine Tanks
The two fibreglass composite tanks, each have a capacity of 310 litres and a maximum operating pressure of 10.5 bar. Dosing and control equipment are included.
The effectiveness of the softening plant can be determined by water quality testing during operation.

CHLORINATION PLANT

Sodium Hypochlorite solution is added to the water after the softening proceess. The Hypochlorite solution is pumped by a Chemtech Dosing Pump from a 100 litre plastic drum into the outgoing watermain.
The Dosing Pump has a maximum output capacity of 113.5 litres/day.
A flowmeter and a sampling point are provided in the outgong 1.25 inch Hydrodare pipework which feeds the 100mm. main. .

WATER QUALITY

K.T. Cullen & Co. Ltd. sampled the water supply on 7th December,1993. Attached is their Chemical Analysis of the water supply from the well and the taps, See Figure 3.
The water softening plant was not in operation at the time of sampling.

STANDBY DIESEL GENERATOR

A standby diesel generator is housed in the annex to the plant building, together with a diesel storage tank and the control panel.
The generator is a 50 Hz, 3000r.p.m., 220V, 8KVA or 10KVA 380V mobile generator.
The annex has front and rear louvred openings to allow air flow.

FIRE FIGHTING WATER STORAGE TANK

A 10,000 gallon cylindrical steel fire fighting tank is provided at Ashton housing estate. The 4 inch diameter tank outlet is about 300 mm above ground level

NOTES/CONDITIONS

- Borehole depth for Borehole Number 2 is as recorded by K.T. Cullen & Co. Ltd.
- Borehole depth for Borehole Number 1 is as recorded by the driller of Borehole Number 2, Mr. S. Kelly, Enniscorthy.
- The existing water softening and chlorination plant is as described, the adequacy of the treatment is to be assessed by water quality analysis.
- Water quality analysis report shown for information only, results to be confirmed with K.T. Cullen & Co. Ltd.
- The watermains layout, and the fire-fighting provisions for the the Ashton and Beechdale Estates is not covered by this report.

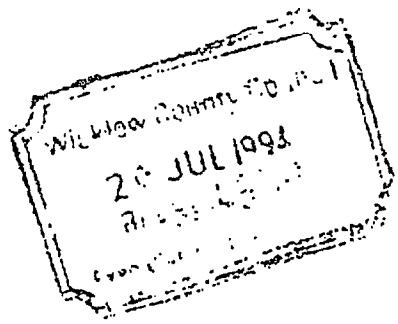
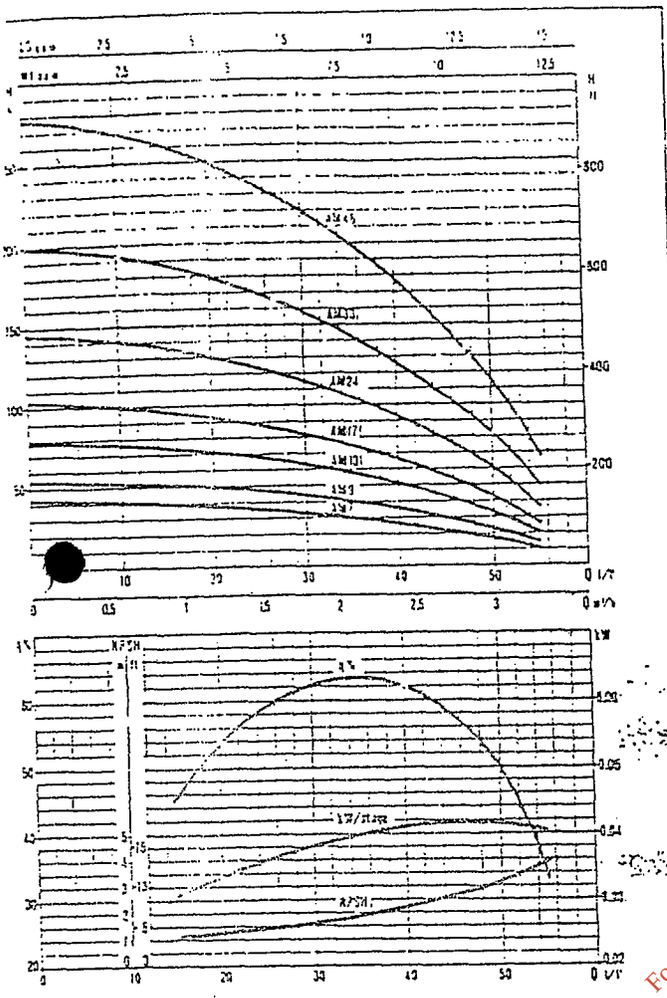
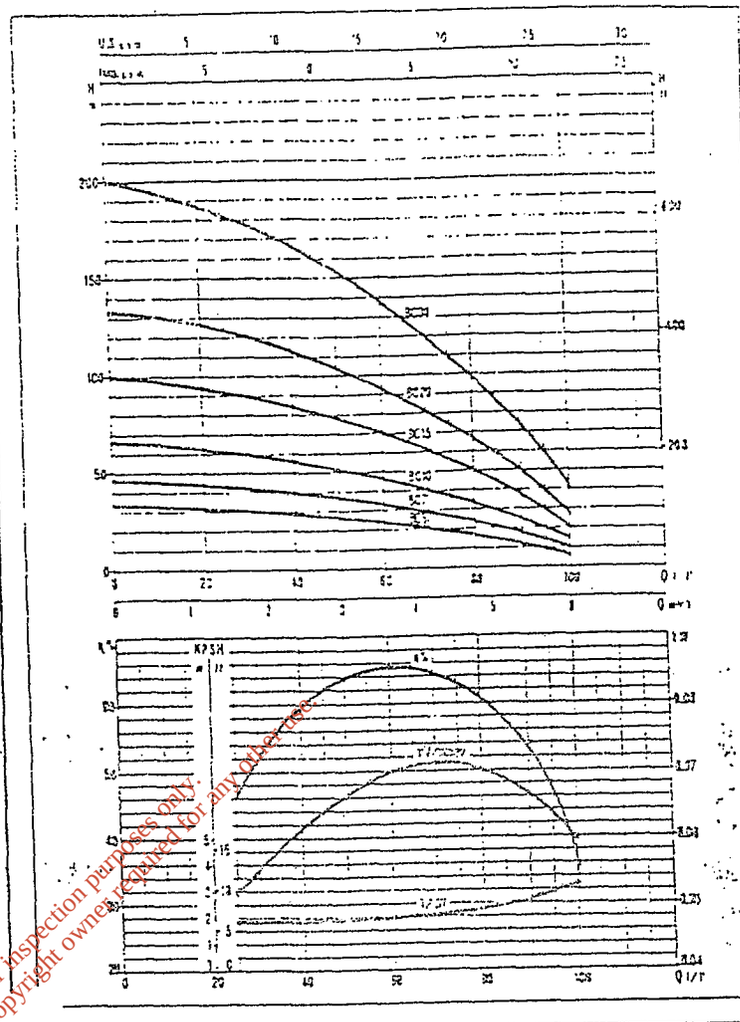
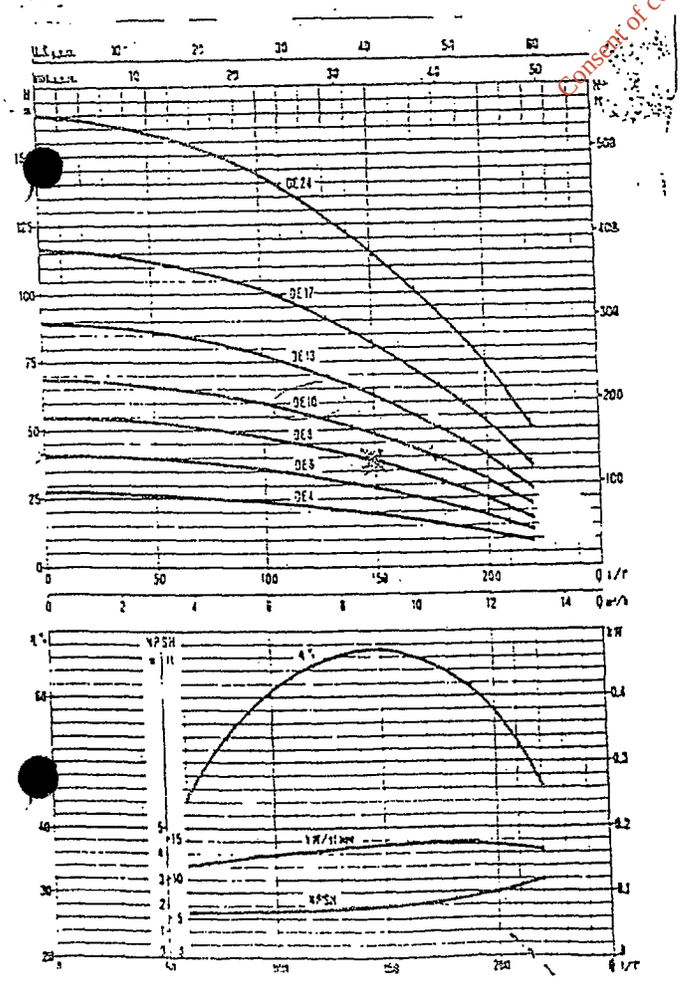
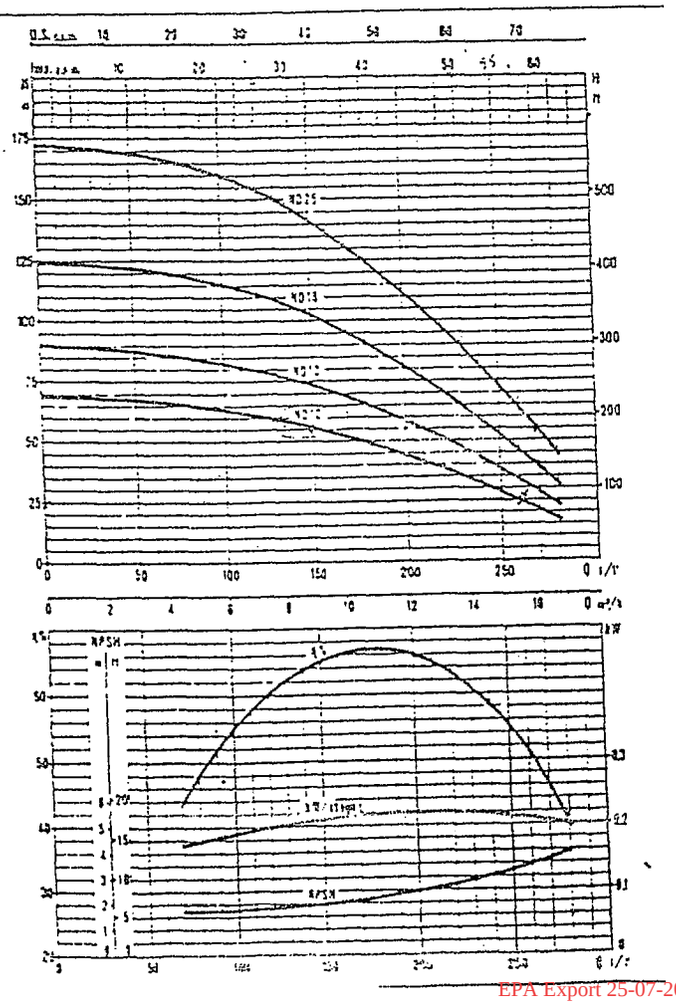


Figure 1 – Performance curves for [illegible] pumps





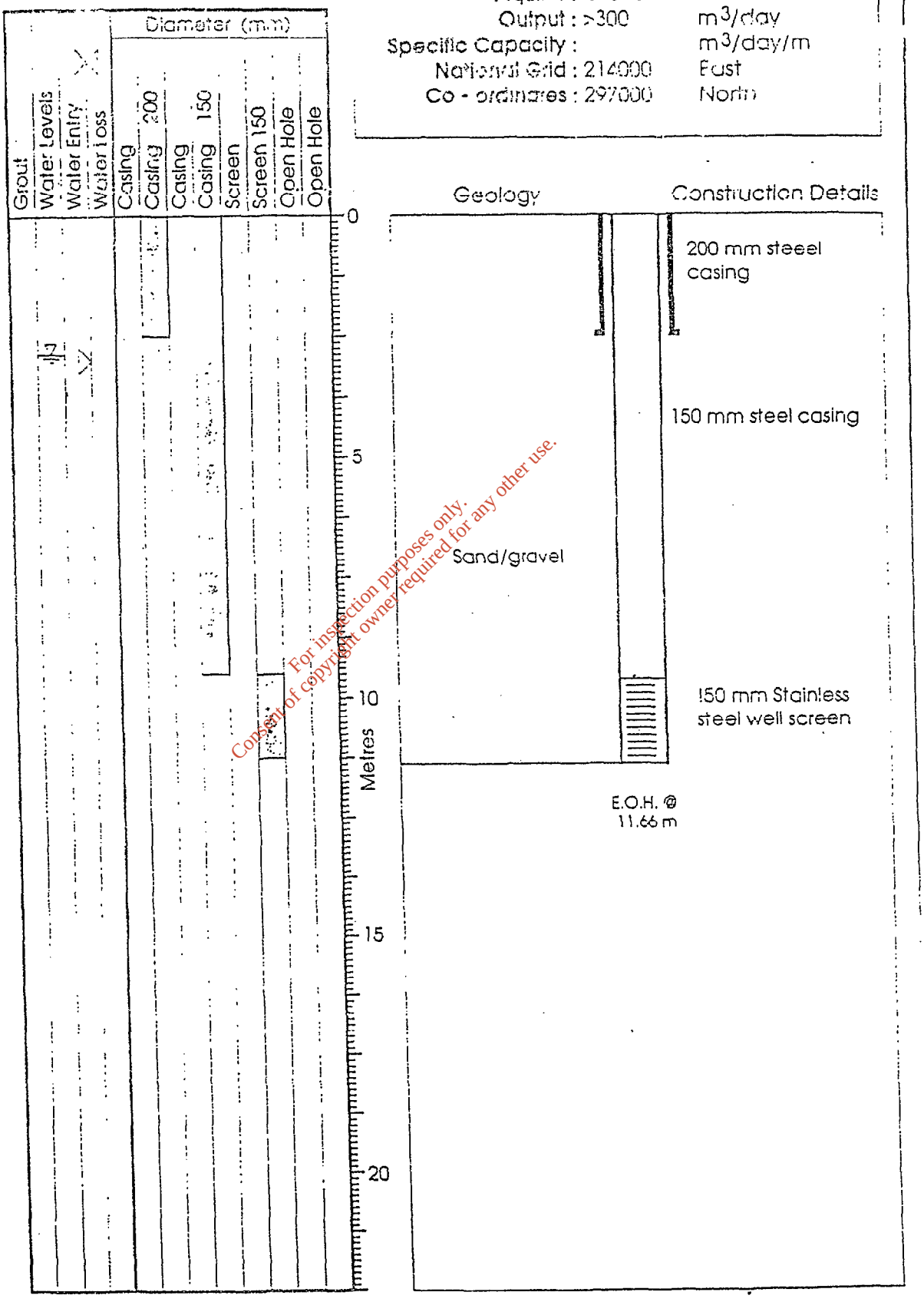




Co...leted Well Design

Well No.2 (new)

Project : Housing Water
Location : Blessington
County : Wicklow
Date : March 1993
Driller : Seamus Kelly
Aquifer : Gravel
Output : >300 m^3/day
Specific Capacity : m^3/day/m
National Grid : 216000 East
Co - ordinates : 297000 North



Remarks

The well was originally drilled to a depth of 21 m and was backfilled to 11.66 m

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Figure No. 2

K.T. Cullen & Co. Ltd.

Chemical Analysis of Groundwater from Ballymore Homes, Blessington, Co. Wicklow.

by K.T. Cullen & Co Ltd., Clonskeagh, Dublin 4.

PARAMETERS	UNIT	Well S1	Tap S2	Tap S3	POTABLE WATER M.A.C.
Colour	Hazen	< 5	< 5	-	20
Turbidity	N.T.U.	< 0.05	< 0.05	-	4
pH	units	7.4	7.4	-	6 - 9
Conductivity	µS/cm	735	735	-	1500
Total Hardness	CaCO3 mg/l	309	303	-	
Alkalinity	CaCO3 mg/l	280	292	-	
Non-carb. hardness	CaCO3 mg/l	29	11		
Calcium	Ca mg/l	113	111	-	200
Magnesium	Mg mg/l	6.6	6.4	-	50
Sodium	Na mg/l	57	56	-	150
Potassium	K mg/l	< 1	< 1	-	12
Sulphate	SO4 mg/l	14	14	-	250
Chloride	Cl mg/l	81	79	-	250
Nitrate	NO3 mg/l	16	18	-	50
Nitrite	NO2 mg/l	< 0.01	< 0.01	-	0.1
Ammonia	NH3 mg/l	< 0.05	< 0.05	-	0.3
Non-Purg Org. Carb.	C mg/l	< 0.5	< 0.5	-	
Aluminium	Al mg/l	< 0.05	< 0.05	-	0.2
Copper	Cu mg/l	< 0.01	< 0.01	-	0.5
Iron	Fe mg/l	0.01	< 0.01	-	0.2
Manganese	Mn mg/l	< 0.01	< 0.01	-	0.05
Residual Chlorine	Cl2 mg/l		< 0.05	-	
Coliforms	MPN/100 ml	Nil	Nil	Nil	0
E - Coli	MPN/100 ml	Nil	Nil	Nil	0
Faecal streptococci	MPN/100ml	Nil	Nil	Nil	
Plate Count @37 C	COL/ml	Nil	3	Nil	No Significant increase
Plate Count @22 C	COL/ml	10	61	20	above background level

LEGEND

M.A.C. = Maximum Admissible Concentration under E.C. directive (No. 80/778/E.C.)

0.12 - Shading indicates value has exceeded M.A.C. concentration

< = Less Than

Figure 3.

BLESSINGTON WATER SUPPLY

BALLYMORE HOMES WELL (No 2) & COUNCIL DEPOT, NAAS ROAD, BLESSINGTON

72 HOUR CONSTANT DISCHARGE TEST ; WEDNESDAY 17/5/95 → SATURDAY 20/5/95

PLOT OF RESULTS.

Q 1166 m³/d.
s 0.3 m.
Sc. 2200 m³/d/m

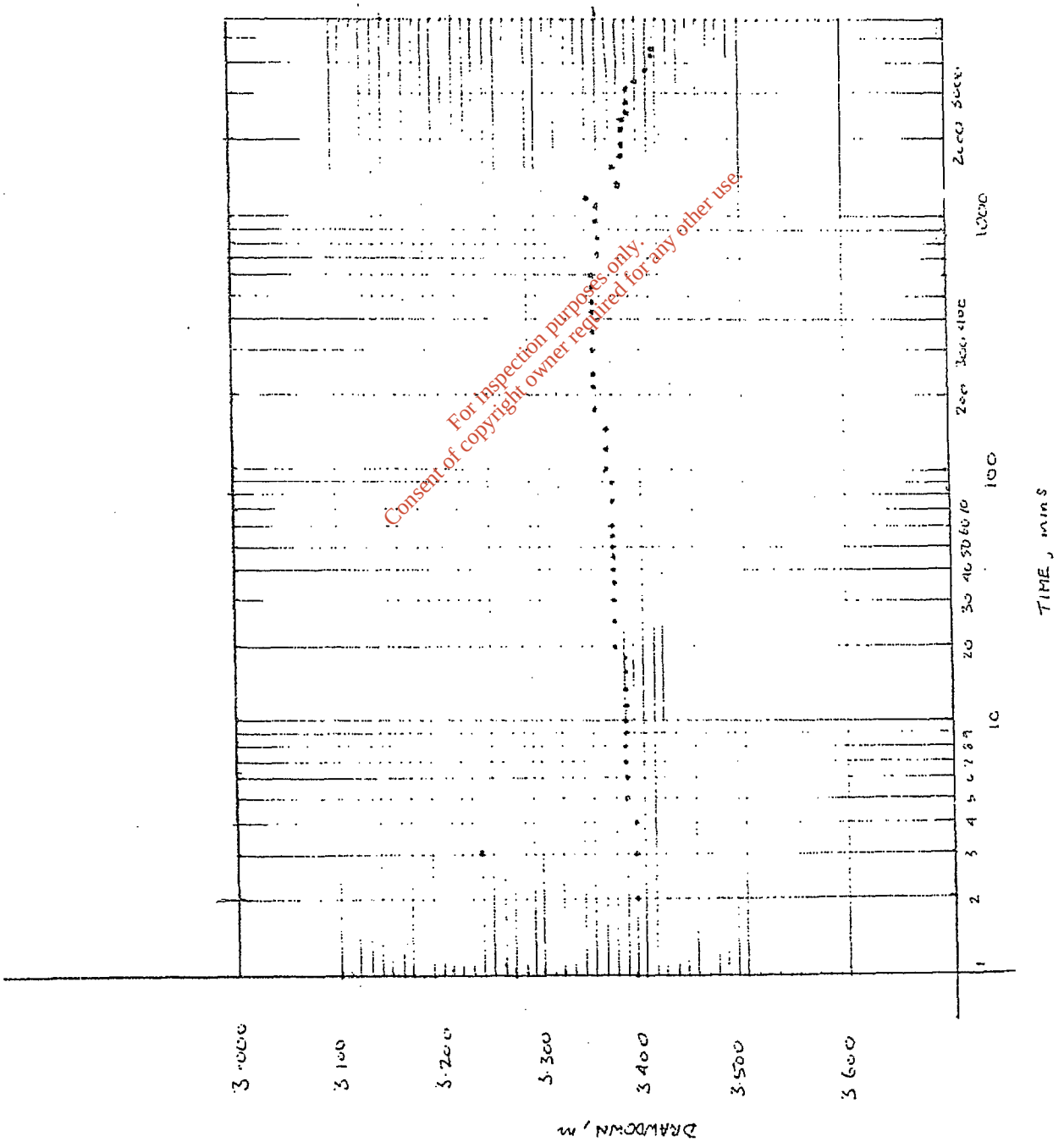


FIGURE 7

Figure 7. Proforma data sheet for pumping test

Borehole at: CALLYMORE HOMES WELL No 2				PUMPING TEST MEASUREMENTS		
No: COUNCIL DEPOT, BLESSINGTON						
County & 6" sheet no: WICKLOW				Drawdown ☑	or Recovery ☐	
Date 17/5/95 → 20/5/95				Pumping well ☑	or Observation Well ☐	
Weather COLD & DRY 17/5/95				Test conducted by D FRANCIS J. DOYLE C MULLEN S BOYLE F KEYNIHAN	Distance from pumping well	
Time	Elapsed time min/hr	Water level m	Draw-down m	Meter reading m^3	Pumping rate m^3/min	Remarks (e.g. pump behaviour, water temp., water quality, etc.)
13.31	0		3.11C	92.78	C.465t	Well 10°C; Stream 12.5°C
13.32	1		3.39C	93.24	0.460	
13.33	2		3.39C	93.70	0.460	
13.34	3		3.39C	94.16	C.460	
13.35	4		3.39C	94.63	0.470	
13.36	5		3.38C	95.09	0.460	
13.37	6		3.39C	95.55	0.460	
13.38	7		3.39C	96.02	0.470	
13.39	8		3.39C	96.48	0.460	
13.40	9		3.39C	96.94	C.460	
13.41	10		3.35C	97.40	0.460	
13.43	12		3.35C	98.32	0.460	
13.45	14		3.35C	99.25	C.465	
13.47	16		3.39C	100.17	0.460	
13.49	18		3.38C	101.09	0.460	
13.51	20		3.37C	102.01	0.460	
13.56	25		3.37C	104.32	0.462	Well 10°C; Stream 12.5°C
14.01	30		3.37C	106.62	0.460	
14.06	35		3.37C	108.92	0.460	
14.11	40		3.37C	111.23	0.460	
14.16	45		3.37C	113.53	0.462	Sample from well
14.21	50		3.37C	115.84	0.462	
14.26	55		3.37C	118.15	0.462	
14.31	60		3.37C	120.45	0.460	
14.46	75		3.37C	127.35	0.460	Well 10°C; Stream 13.5°C
15.01	90		3.37C	134.27	0.461	Sample from well.
15.16	105		3.36S	141.18	0.461	
15.31	2 hrs		3.36S	148.10	0.461	
16.01	2½ hrs		3.36S	161.94	0.461	Well 10°C; Stream 13.5°C

RESTIME 17/5/95

660 m³/d.

FIGURE 8

Figure 8. P[illegible]ms data sheet for pumping t[illegible]

Borehole ac: No:				County & 6" sheet		PUMPING TEST MEASUREMENTS
Time	Elapsed time hours	Water level m	Draw-down m	Meter reading	Pumping rate	Remarks (e.g. pump behaviour, water temp., water quality, etc.)
16·21	3		3355	175 76	0·461	
17C1	3½		3·355	1541 57	0·460	Well 10°C Stream 14°C
17·31	4		3 355	203·41	0·461	
1831	5		3355	231·17	0·463	Well 10°C · Stream 13°C
1931	6		3·355	258·73	0·460	
2031	7		3·355	286·39	0·461	Well 10°C ; Stream 12°C
2131	8		3355	314·06	0·461	
2231	9		3355	341·62	0·459	Well 10°C, Stream 11°C
2331	10		3·355	369·21	0·460	
0131	12		3 360	424·41	0·460	Well 10°C Stream 9°C
0331	14		3 360	481·80	0478	
0531	16		3·360	534·99	0443	Well 10°C ; Stream 8°C
0731	18		3 360	590·23	0·460	
0931	21		3 350	672·98	0·460	Well 10°C ; Stream 10°C
1331	24		3 370	756·14	0·462	Well 10°C ; Stream 10°C
1631	27		3 375	839·77	0·465	
1931	30		3 385	921·55	0·454	
2231	33		3·385	1004·17	0·462	
0131	36		3 385	1086·70	0 455	
0431	39		3 355	1170 00	0 463	
0731	42		3·395	1253 07	0·461	Well 10°C ; Stream 9°C
1031	45		3·390	1335·40	0·457	Well 10°C ; Stream 12°C
1331	48		3·390	1418·19	0·460	Well 10°C ; Stream 15°C
1631	51		3·390	1501·34	0·462	Well 10°C ; Stream 14°C
1931	54		3 400	1583·88	0·458	Well 10°C ; Stream 13°C
2231	57		3 400	1663·49	0·442	
0131	60		3 400	1750·29	0·493	
0431	63		3 410	1830·44	0·445	Well 10°C ; Stream 11°C
0731	66		3 410	1915·26	0·460	Well 10°C ; Stream 11°C
1031	69		3·415	1998 47	0·462	Well 10°C , Stream 10°C
1331	72		3 415	2081·37	0·460	Well 9·9°C ; Stream 10·2°C

THURSDAY LUNCHTIME 18/5/95

FRIDAY LUNCHTIME 19/5/95

SATURDAY LUNCHTIME 20/5/95

Other remarks:

1988 59 m^3 over 72 hours ⇒ 27 62 m^3/hr (ie 6076 gallons/hour)
0 460 m^3/min (ie 101·26 gallons/min)

$D = 0{\cdot}3$ m

Note: Unfortunately the rate of recovery of the well was not recorded. This would have provided useful information.

* Well is in use

FIGURE 7

Well in use.

Figure 7. Proforma data sheet for pumping test.

Borehole at: CASTLEKELLY HOMES DEVELOPMENT, No: GLENVIEW COURT, NAAS RD, BLESSINGTON				PUMPING TEST MEASUREMENTS		
County & 6" sheet no: WICKLOW				Drawdown ✓		or Recovery ☐
Date 17/5/95 → 20/5/95				Pumping well ☐		or Observation Well ✓
Weather COLD & DRY 17/5/95				Test conducted by D. MANNON J. DOYLE J MULLEN B DOYLE E. MCYNNITAN		Distance from pumping well ~180m
Time	Elapsed time min/hr	Water level m	Draw-down m	Meter reading	Pumping rate	Remarks (e.g. pump behaviour, water temp., water quality, etc.)
13.30	0		4.470			
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	12					
	14					
	16					
	18					
	20					
	25					
	30					
	35					
	40					
	45					
	50					
	55					
13 31	60		4.470			
	75					
	90					
	105					
	2 hrs					
	2½ hrs					

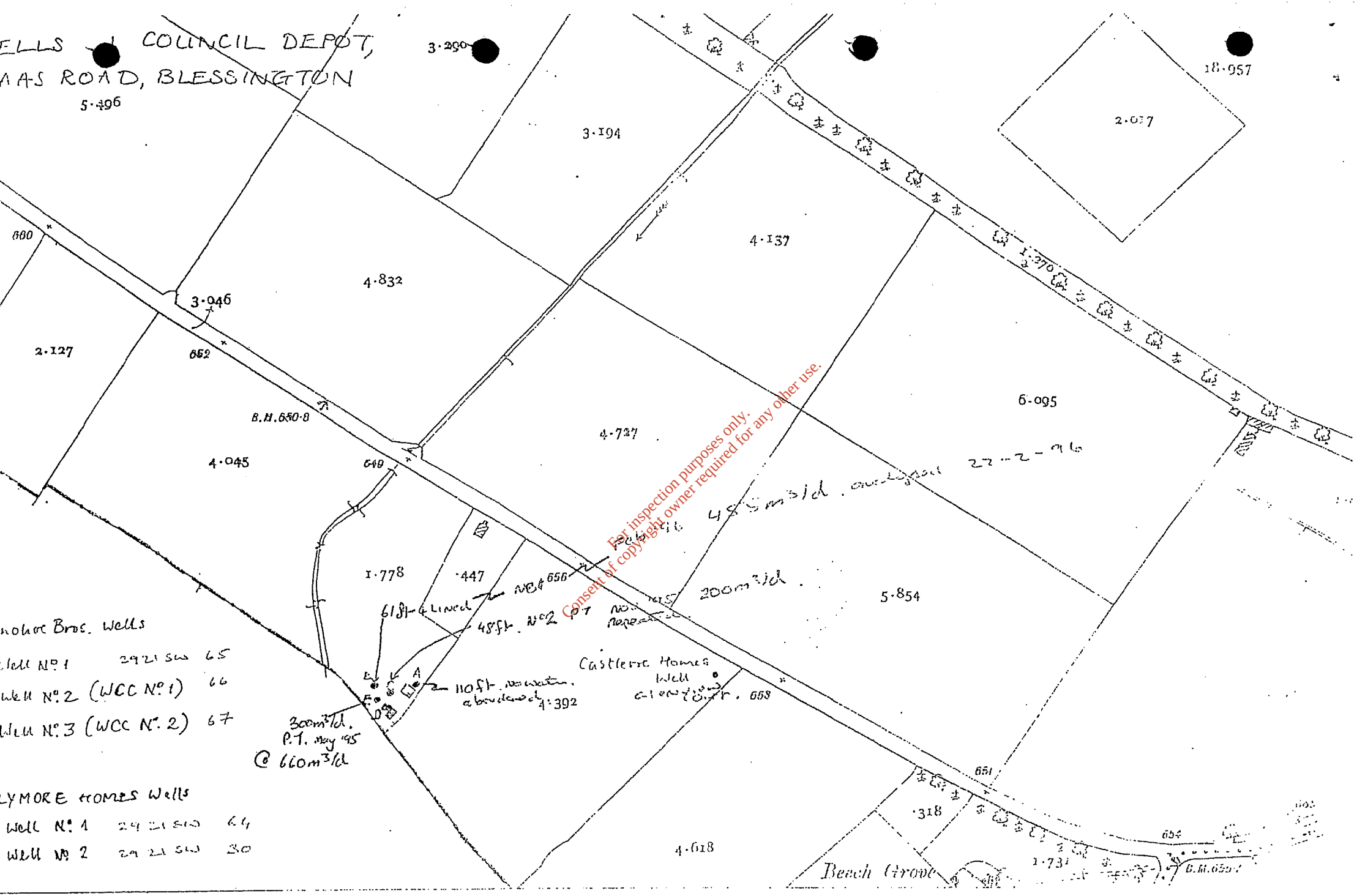
10cms.

FIGURE 9

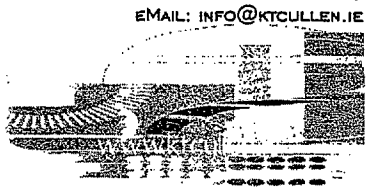
Figure 9. [illegible] ...ing test (continuation sheet).

Borehole at: No:				County & 6" sheet		PUMPING TEST MEASUREMENTS
Time	Elapsed time hours	Water level m	Drawdown m	Meter reading	Pumping rate	Remarks (e.g. pump behaviour, water temp., water quality, etc.)
16.31	3		4.470			
	3½					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
01.31	12		4.500			
	14					
	16					
07.31	18		4.500			
	21					
	24					
16.31	27		4.500			
	30					
	33					
	36					
	39					
07.31	42		4.500			
10.31	45		4.500			
	48					
	51					
	54					
	57					
01.31	60		4.530			
	63					
07.31	66		4.530			
	69					
13.31	72		4.570			

Other remarks:



Bracken Business Park, Bracken Road,
Sandyford Ind. Estate, Dublin 18, Ireland.
V.A.T. Reg. No. IE 6554210 F
Tel. +353 1 2941717
Fax +353 1 2941823
eMail: info@ktcullen.ie



K.T.Cullen & Co. Ltd.

William Mulrooney
Cookehill Ltd.,
Carmichael House,
60 Lower Baggott Street,
Dublin 2.

24th October 2001

Dear William,

Enclosed are the chemical and bacteriological analyses for the trial hole, BH 2, at Blessington. The samples were taken at the end of the 5 day pump test and sent to our usual laboratories for analysis.

Bacteriological

The bacteriological quality of the water is excellent. There are no faecal or total coliforms in the sample. These parameters are used as indicators of other pathogens which may occur in the groundwater but are not as easy to test for. The lack of the indicator bacteria is a good indicator of a bacteriologically clean water.

This result is indicative of the filtering effect of the gravels and also the lack of potential organic polluting sources in the vicinity if the well.

Chemical

The chemical quality of the groundwater is also excellent. None of the parameters exceed their respective MACs. The groundwater is hard (310 mg/l) which may point to a calcareous parent rock derivation for the gravels.

The chloride level is low in comparison with typical Irish groundwater values. This is due to the fact that rainfall, which has low chloride levels, permeates quickly through the gravelly subsurface and does not have time to mix with deeper groundwater which would consequently raise its chloride levels.

The nitrate level (22 mg/l) is well below the MAC of 50 mg/l, but is approaching the EPA/GSI guideline level of 25 mg/l. This is probably due to natural nutrient loading from grazing the grassland. Nitrate is highly mobile especially in gravel aquifers. Future development will have to ensure that sources of nitrate (wastewater treatment systems and landspreading) be carefully controlled.

If you have any queries, please contact myself or Kieran O' Dwyer,

Yours sincerely,

Victoria Conlon

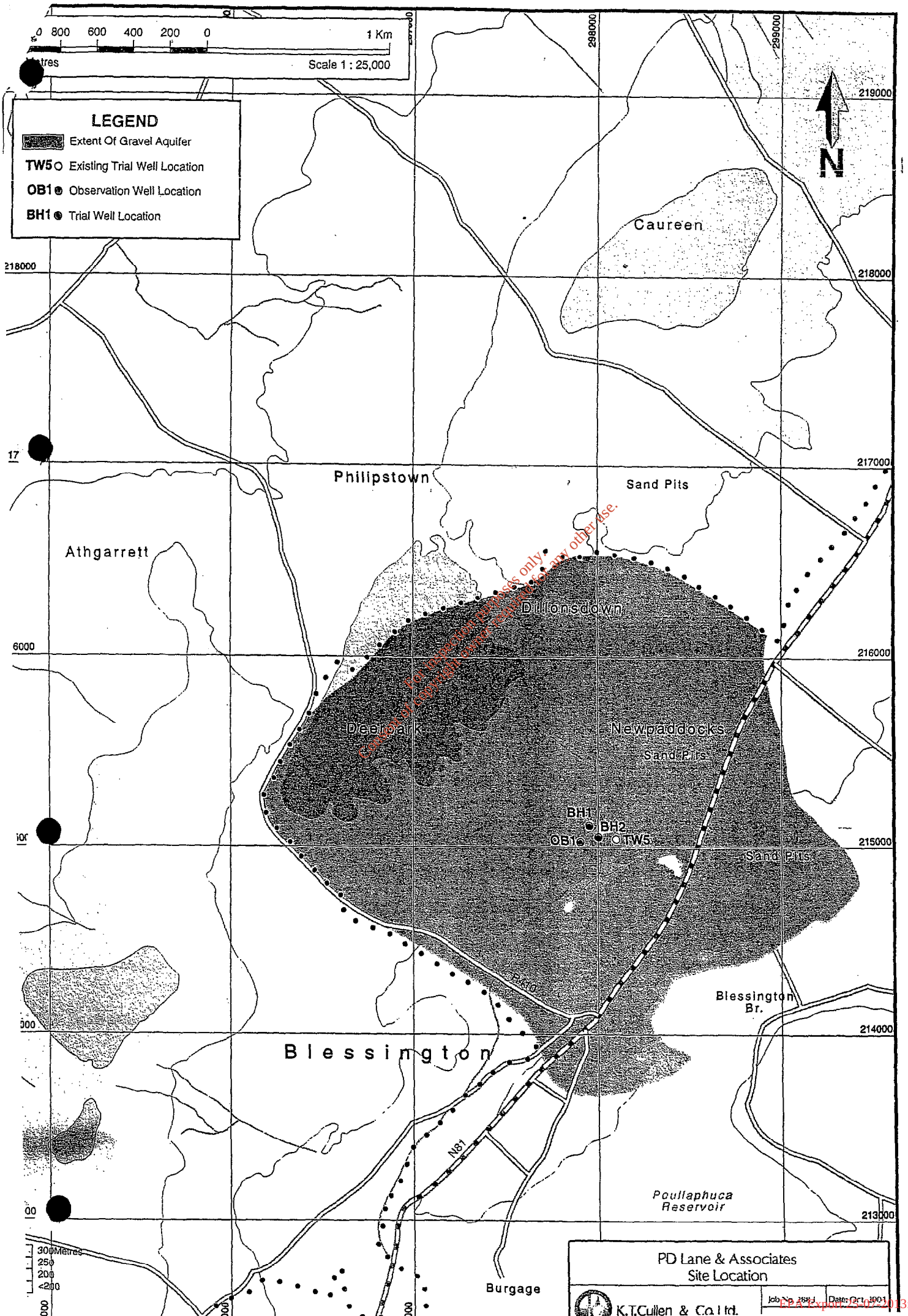
Victoria Conlon B.Sc. M.Sc.

PARAMETERS	UNIT	WELL BH2 Blessington	POTABLE WATER M.A.C.
pH		7.6	6 - 9
Conductivity	µS/cm	510	1500
Total Hardness	CaCO3 mg/l	310	-
Non Carbonate Hardness	CaCO3 mg/l	50	-
Total Alkalinity	CaCO3 mg/l	260	-
Calcium	Ca mg/l	110	200
Magnesium	Mg mg/l	8.7	50
Sodium	Na mg/l	6.0	150
Potassium	K mg/l	0.6	12
Iron	Fe mg/l	<0.01	0.2
Manganese	Mn mg/l	<0.01	0.05
Copper	Cu mg/l	<0.01	0.5
Aluminium	Al mg/l	<0.05	0.2
Nitrate	NO3 mg/l	22	50
Nitrite	NO2 mg/l	<0.01	0.1
Chloride	Cl mg/l	10	250
Sulphate	SO4 mg/l	12.0	250
Ammonia	NH4 mg/l	<0.05	0.3
Non-Purg Org. Carb.	C mg/l	0.5	-

Plate Count (22°C)	T.C.C./ml	17	No significant increase
Plate Count (37°C)	T.C.C./ml	Nil	above background level
Coliforms	CFU/100ml	Nil	Nil
E. Coli	CFU/100ml	Nil	Nil
Faecal Streptococci	CFU/100 ml	Nil	Nil

LEGEND
M.A.C. = Maximum Admissible Concentration under S.I. 81 of 1988.
< = Less Than

Table 1: Chemical Bacteriological Analyses BH2, Blessington, Co. Wicklow, 23/09/01.


0 800 600 400 200 0 1 Km
Metres
Scale 1 : 25,000
LEGEND
Extent Of Gravel Aquifer
TW5 Existing Trial Well Location
OB1 Observation Well Location
BH1 Trial Well Location
N
298000
299000
219000
218000
217000
216000
215000
214000
213000
Caureen
Philipstown
Sand Pits
Athgarrett
Dillonsdown
Deerpark
Newpaddocks
Sand Pits
BH1
BH2
OB1
TW5
Sand Pits
R410
Blessington Br.
Blessington
N81
Poullaphuca Reservoir
Burgage
300Metres
250
200
<200
PD Lane & Associates
Site Location
K.T.Cullen & Co Ltd.
Job No. 8841
Date: Oct. 2001
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GROUNDWATER DEVELOPMENT AND SOURCE PROTECTION PLAN FOR PROPOSED DEVELOPMENT AT BLESSINGTON, CO WICKLOW.

Prepared for:
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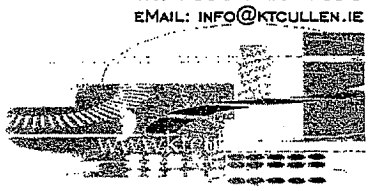


Groundwater Development and Source Protection Plan For Proposed Development at Blessington, Co. Wicklow

1. INTRODUCTION

The works and studies described in this report dated 12/10/01 were commissioned by P.D. Lane Consulting Engineers to Cookehill Ltd. who intend to develop housing on a site in Blessington. This study deals with the establishment of a water supply from a groundwater source together with a source protection study that can be implemented by Wicklow County Council when they take charge of the development. The location of the wells is shown on Figure 1.

2. BACKGROUND

This office undertook a previous trial well drilling and testing programme in 1998, at the site of the proposed development in Blessington. This was carried out for Wicklow County Council on behalf of a third party who intended to develop other lands in the Blessington Area. This study was directed at establishing sources that could be developed in the future to augment the Blessington water supply. 3 of these were shallow wells, drilled on or adjacent to the property that it is proposed to develop. One of the trial wells (TW5) proved to be productive with a safe yield estimated to be 350 m^3/day. The 150 mm diameter of this well limited its value as a production well. There are plans for the new ring road around Blessington to pass close to this successful trial well. The other wells drilled into the overburden in the hope of tapping into productive gravels were disappointing. These are located to the north of TW 5 closer to Glen Ding Wood.

3. SCOPE OF WORK

One of the main concerns of Wicklow County Council is the vulnerability and protection of the source. It was decided to drill a trial well initially at a location up gradient of the development in order to

establish whether productive gravels could be intercepted at location that had less development and potential contamination sources in its catchment. This option is would only be viable if adequate yields are encountered at this location.

The hydrogeological study was undertaken with following objectives.

i) Drill a trial well at the preferred location. Carry out a 24 hour pumping test to confirm yield.

ii) If the trial well drilling at the optimum location was encouraging then a production well would be drilled with a finished internal diameter (casing screen string) of 200 mm in order to accommodate a submersible pump with adequate capacity.

iii) In the event that the trial well at the optimum location was not successful, then the production well would be drilled as close as possible to the proven trial well (TW 5) from the 1998 study but on land that was within the ownership of the developer.

iv) A third borehole will be drilled to provide a triangle of wells from which the groundwater flow direction can be determined.

v) The yield of the production well and the aquifer characteristics will be established by a 5 day pumping test.

vi) Chemical and bacteriological analyses will be carried out on water samples taken from the well at the end of the pumping test.

vii) Undertake a source protection study of the production well, which will investigate the risk of contamination to the well, and will delineate protection zones around the well. In addition, potential sources of pollution can be flagged.

4. TRIAL AND OBSERVATION WELL DRILLING

BH 1 was drilled at what was considered to be the optimum location, (see Figure 2). It was located in an area that was not being developed with housing, (see Figure 1). It was not as far north as the unsuccessful trial wells drilled in 1998. Glovers Site Investigations were retained to carry out the drilling using a shell and auger rig. Drilling of BH1 began on September 2nd, 2001. No water bearing gravels were encountered throughout drilling which was completed at a depth of 25 metres. The well was backfilled to 23.5 metres and fitted with 6" plastic casing in order to serve as an observation well. The geological log is included in Appendix A.

An observation well (OB 1) was drilled on the 7th of September 2001. This was completed to a depth of 21 metres. Water bearing gravelly sands were encountered between approximately 7 and 14 metres. The hole was completed in the soft sands occurring between 14 and 21 metres. 50 mm slotted screen was placed in the hole between 12 and 18 metres in order to allow water ingress from the sands and gravels. The hole was then backfilled and a bentonite seal placed around the top to prevent surface water interfering with the groundwater level. This borehole was drilled solely to provide water level data which taken with the water level in another two wells would establish the groundwater flow direction.

Following the disappointing results of BH 1, A production well BH 2 was drilled close to the location of the existing TW 5. This was drilled at 300 mm (12")-the finished diameter is 200 mm (8"). It was finished at a depth of 21.5 metres. Drilling encountered two main layers of sandy gravels-one from 10.9 to 12.4 metres and the other from 17.3 to the end of the borehole (21.5 metres). Boulder clays were encountered between 3.4 and 10.9 metres and 15.9 and 17.4 metres. The lower sandy gravels were water bearing. 200 mm thermoplastic was placed in the hole, with a screened section from 12 to 15 metres and from 18 to 21.5 metres, to allow water ingress. Once in place the original steel liner was removed and the annulus filled with pea gravel, backfill and a bentonite seal. Logs are shown in Appendix A.

5. TRIAL WELL TESTING

A 120 hour (5 day) pump test was carried out on BH2 between the 19th and 24th of September. During the test BH1, OB 1 and TW 5 were monitored for changes in water levels. The static water level at the start of the test was 10.86 metres. The initial pump rate was 927.4 m^3/d. This dropped over the period of the test to 908.18 m^3/d. The water level dropped gradually over the course of the test until steady state conditions were achieved at a water level of 15.84 metres. This was a total drawdown of 4.98 metres. The long term safe yield of the well is estimated as 650 m^3/d. The quality of the water in the well appeared to be clear at the end of the test.

During the test BH1, OB1 and TW5 dropped by 0.05, 0.02 and 0.35 metres respectively. The distances of these from BH2 are 145, 125 and 7 metres respectively. These drops are negligible and show that the cone of influence of the well is limited and that the available water resources are large in the gravel aquifer. It is important to note that TW 5 is affected even though it is on the other side of the stream to the BH2. The stream is therefore not acting as a constant head boundary. The level of the base of the stream is above the water table at this location.

The pump test data and graphs are shown in Appendix B.

6. SOURCE PROTECTION ZONE DELINEATION

6.1 Introduction

The source protection zone delineation study involved assessing the groundwater flow direction and gradient at the site as well as the aquifer characteristics such as transmissivity and porosity. Source protection zones were then delineated, comprising a 100 day time of travel (TOT) as the inner boundary and the zone of contribution (ZOC) as the outer boundary. Details of the aquifer classification and vulnerability are also given.

These zones were defined using the following information:

Yield (m^3/d)-the amount of water required by the development.
Transmissivity (m^2/d)-the rate at which water flows through a unit area of an aquifer.
Aquifer Thickness (m)-ascertained by drilling.
Porosity of the Aquifer-estimated based on typical gravel aquifer porosity
Hydraulic Gradient-obtained from water levels
Recharge (m^3/d)- Obtained using rainfall data from the closest station to the site-Blessington G.S.

The transmissivity was obtained from the pump test carried out on BH 2. The information relating to the vulnerability of the well was obtained through the present drilling exercise and that carried out in 1998.

6.2 Bedrock Geology

Bedrock was not encountered during the present drilling exercise but according to previous drilling results and the information from the Geological Survey of Ireland Map Number 16, we know that the site is underlain by the Pollaphuca Formation (PO). This consists of coarse grey sandstones and dark shales.

6.3 Overburden Geology

The overburden geology of the area is quite complex and variable. The three boreholes drilled on the site (BH1 , 2 and OB 1) as well as TW 5 provide of information on the overburden deposits under the site. TW 3 and TW 4 which were drilled at the same time as TW 5 also provide overburden information. The boreholes show interbedded sands, gravels and clays. The main water bearing gravels appear to be limited to the south-east of the site and are situated at a depth of 17 metres in BH 2 and 12 metres in TW 5. The overlying clay layers appear to be discontinuous and of variable thickness.

6.4 Bedrock Aquifer Classification

The bedrock aquifer is considered to be a locally important aquifer which is productive in local zones-**Pl**. The yields in this formation are mostly moderate (40-100 m^3/d).

6.5 Overburden Aquifer Classification

According to the Draft Wicklow Groundwater Protection Scheme, the gravel aquifer in the Blessington area covers an area of 5.5 km^2 and constitutes a locally important gravel aquifer-**Lg**. Thickness varies over the extent of the aquifer but is on average between 10-35 metres thick. In the Roadstone quarry to the north of the site, overburden thicknesses are up to 40 metres. The gravel aquifer is unconfined and contains many discontinuous clay layers which act as barriers to flow.

Vulnerability

According to GSI guidelines (See Table 1), the site is underlain by what would be considered to be highly vulnerable sands and gravels which have an unsaturated thickness of >3 metres. The water level in BH2 is 10.86 metres below ground level i.e. the unsaturated thickness of the gravel aquifer is 10.86 metres. The thicker the unsaturated layer is, the more protection is afforded to the underlying deposits. The presence of clay layer in between the gravels will reduce the vulnerability but a conservative approach should always be taken with gravel aquifers.

Vulnerability Rating	Hydrogeological Requirements				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Recharge Type
	high permeability (sand/gravel)	moderate permeability (sandy till)	low permeability (clayey till, clay, peat)	(sand & gravel aquifers only)	
Extreme	0-3.0m	0-3.0 m	0-3.0m	0-3.0m	point (>30 m radius)
High	>3.0	3.0-10.0m	3.0-5.0m	>3.0m	diffuse
Moderate	N/A	>10m	5.0-10.0m	N/A	diffuse
Low	N/A	N/A	>10.0m	N/A	diffuse

Notes: i)N/A =not applicable
ii) Precise permeability values cannot be given at present
iii) Release point of contaminants is assumed to be 1-2 m below ground surface

(from Daly & Warren 1997)

Table 1: GSI Vulnerability Mapping Guidelines.

6.7 Topography

The site is situated in a relatively flat area of land, which is backed to the north-west by the sand and gravel ridges of Deerpark and Dillonsdown. The site elevation is approximately 200 metres with a gradual regional slope towards the south-east. On a local scale BH1 is sited on a ridge structure which trends approximately east-west and which slopes gently down to the flat ground where the other boreholes are situated.

6.8 Surface Water

A catchment divide exists to the north-west of the site where the high points of Slieveroe, Athgarrett and Caureen create a ridge separating the north-westerly and westerly flowing streams from those which flow to the south east and east. There are few surface water features in the vicinity of the site which reflects the free-draining nature of the subsoils. The main one is the stream which flows from Dillonsdown south-easterly through the site and into the unnamed pond to the south of the site. This then continues southwards and flows into Pollaphuca at Burgage. This is a shallow stream, approximately 2 metres wide. The stream is perched at the site but is connected to the aquifer downstream near Burgage. At the site the base of the river is above the water table.

6.9 Groundwater Flow and Catchment

The water levels in the wells were levelled in order to ascertain the groundwater flow direction. The resultant flow is towards the south, into Pollaphuca Reservoir, see Figure 2. The hydraulic gradient is calculated to be 0.05.

The catchment divide for the site extends to a local high of over 270 metres at Deerpark. Precipitation falling on the southern side of the sub-catchment divide will flow southerly towards the site and ultimately into the reservoir.

6.10 Land Use

BH 2 is located within tens of metres of the proposed location of a ring road which will encircle Blessington village. The area to the north and south of the site, up to the Roadstone quarry boundary is zoned for housing development. The area to the east of the site is zoned for light industrial development. At present the site is used for cattle.

6.11 Source Protection Zones

6.11.1 Introduction

The groundwater regime in the vicinity of the proposed supply well was defined using the uniform flow equations and the USA EPA's WHPA model. The various inputs to the equation and model were gathered from an analysis of the pumping test together with geological data from the drilling exercise. Values of transmissivity, aquifer thickness, hydraulic gradient, pumping rate, direction of groundwater flow and porosity are input to provide the solution. The 100 day time of travel and width of the zone of contribution are defined by these equations.

The two zones are shown in Figure 3 and in relation to the proposed ring-road in Figure 4.

The length of the Zone of Contribution is not defined by the equations or the model, but is defined by the hydrogeological boundary (groundwater divide) and by using the recharge equation.

6.11.2 Source Site

The source site is delineated as a 10 m radius around the well. This area should be under the ownership and control of the developer. A cordon sanitaire should be maintained within this zone and all potentially polluting activities in this area should be prohibited.

6.11.3 Inner Protection Zone (100 day travel time)

The inner protection zone is usually delineated using a 100 day travel time capture zone and is shown in Figure 3. Faecal bacteria are estimated to have a survival period of 50 days in groundwater. The 100 days is chosen as a conservative period in which no faecal bacteria will survive. The travel time is calculated using the information obtained from the drilling, pump testing and levelling. The estimated 100 day time of travel for BH 2 is approximately 444 metres in a northerly direction. This is based on a transmissivity value of 240 m^2/d, an aquifer thickness of 9 metres. a gradient of 0.05 and an estimated porosity of 0.3. The proposed pumping rate is 650 m^3/d. This zone extends in a northerly direction towards the Roadstone gravel pit and touches on the site of one of the settlement ponds in the quarry.

6.11.4 Outer Protection Zone

This includes the complete zone of contribution to the source (ZOC)/catchment and requires that the groundwater flow direction be known. The Outer Protection Zone is defined as that area of the Zone of Contribution which is outside the Inner Protection Zone.

In this case the northern boundary of the ZOC stretches for approximately 1,000 metres in a northerly direction towards the upland areas of the quarry at Dillonsdown. The width, defined by the area necessary to provide 650 m^3/d of recharge to the well is estimated as 700 metres. This gives a total zone of contribution area of 300,000 m^2. Using the recharge equation and the local precipitation value (948 mm/yr), the effective rainfall is calculated as 391mm/year. Using this value, the area necessary to provide the required 650 m^3/d is just over 700,000 m^2. Therefore the ZOC is conservative.

In addition to a slightly conservative ZOC, a ± 20 degree buffer zone is added to each side of the of the zone. This takes uncertainties of exact groundwater flow direction into account.

6.12 Potential Pollution Sources

6.12.1 Surface water

The main surface water feature in the area-the stream adjacent to BH2 appears to be a perched steam which is not hydrologically linked to the deeper groundwater table. The fact that TW5 which is on the opposite side of the stream to BH2 was affected by the pump test shows that the stream is not acting as a discharge boundary. It is a shallow stream which flows from the quarry, to the northwest. Land-use activities upstream of the river are forestry and quarrying.

6.12.2 Foul Sewer

At the moment there are no foul sewers in the vicinity of the well. This is likely to change with the advent of development of housing in the area. The water supply will be chlorinated which will reduce the risk of bacteriological pollution.

6.12.3 Domestic Wastewater Treatment Systems

There are no upgradient wastewater treatment systems in the area at the moment. The DELG/EPA/GSI response matrix for the siting these facilities is given in Appendix C.

6.12.4 Farmyard Wastes

The site is currently situated on farmland which is under grass and is grazed by cattle. Slurry spreading should be carried out in accordance to Teagasc Guidelines.

6.12.5 Proposed Routeway

BH2 is located close the location of the proposed ring road. The construction and operation of the

motorway has the potential to impact on the quality of the water in the well. The most likely impact will be from motorway run-off which contains hydrocarbons, metals, greases and suspended solids. This run-off should be collected by french drain systems, preferably enclosed in concrete to protect the vulnerable aquifer. Before being discharged to a well-defined surface water body. the discharge should pass through oil interceptors and sediment traps. The road is built up at the site and run-off will be directed away from the well.

7. CONCLUSIONS

- While the location of BH1 would have been more favourable than that of BH2, the trial well drilling exercise has shown that the well yields are not available at that location. Consequently, it was decided to develop the production well at a location where high yields were proven.

- BH 2 is capable of producing a safe yield of 650 m^3/d. Higher yields are possible as was proven by the pump test. 650 m^3/d is chosen as a conservative, sustainable value.

- BH 2 is located in a locally important gravel aquifer which is highly vulnerable to pollution.

- The groundwater flow direction is from the north to the south.

- The well is going to be located close to a proposed ring road and will be surrounded on all sides by housing or light industry. The surface water runoff outfall from the ring road should be located some distance from BH2

- The 100 day time of travel is approximately 444 metres in length, placing it within the boundary of the Roadstone quarry.

- The zone of contribution extends to the high ground of Dillonsdown, approximately 1000 metres north of the well.

This production well will fit in with Wicklow County Council's water supply strategy. There are at least 3 other sources which are well spaced throughout the aquifer. These sources can be operated in such a manner that the supply can be maintained in the other wells if one well becomes contaminated. The spacing of the wells means that it is unlikely that more than one would be affected by the contamination.

RECOMMENDATIONS

Due to its vulnerable location, once the well is commissioned, it is recommended that the water from the pumping well should be sampled every month. The sample should be analysed for faecal coliforms, total coliforms, faecal streptococci, Plate Count at 22° C and Plate Count at 37° C. The supply will be chlorinated which will afford an extra protection to public health. A sample should be collected every three months in order to analyse the major cations and anions.

The most recent guidelines issued by the GSI on the location of Wastewater Treatment Systems are given in Appendix C. As a general rule, the guidelines recommend that septic tank systems should not be allowed within 60 m of the water supply source but are acceptable, subject to normal good practice, in the outer protection zone.

Other potentially polluting activities in the inner and outer zone should be subject to strict planning conditions in accordance with the GSI response matrices

If oil storage tanks are to be used by individual houses then we would suggest that these be constructed with appropriate bunds capable of holding 110 % capacity of the oil tank.

The supply should be chlorinated to provide added security.

Respectfully Submitted

K.T.Cullen & Co. Ltd.

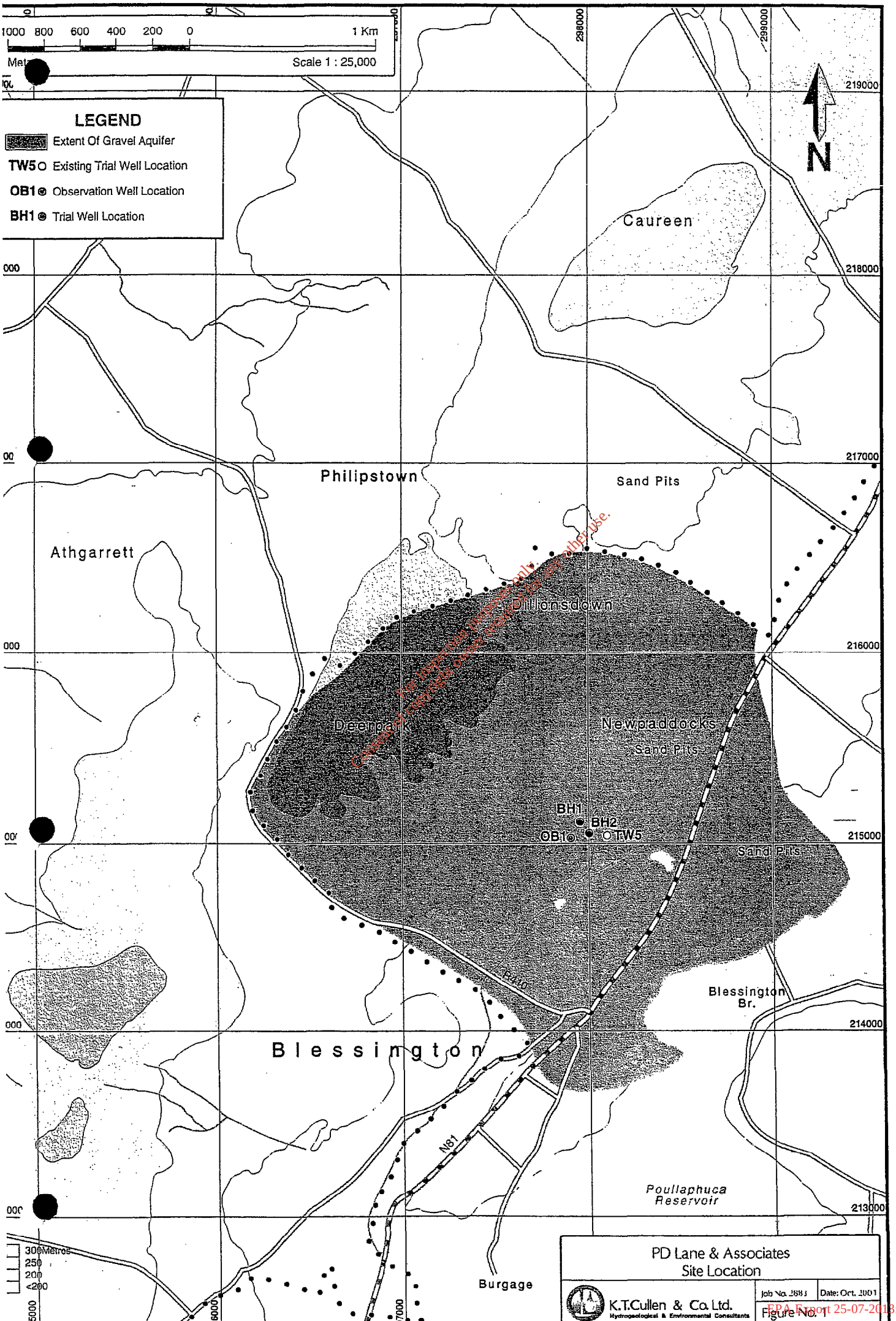
Victoria Conlon

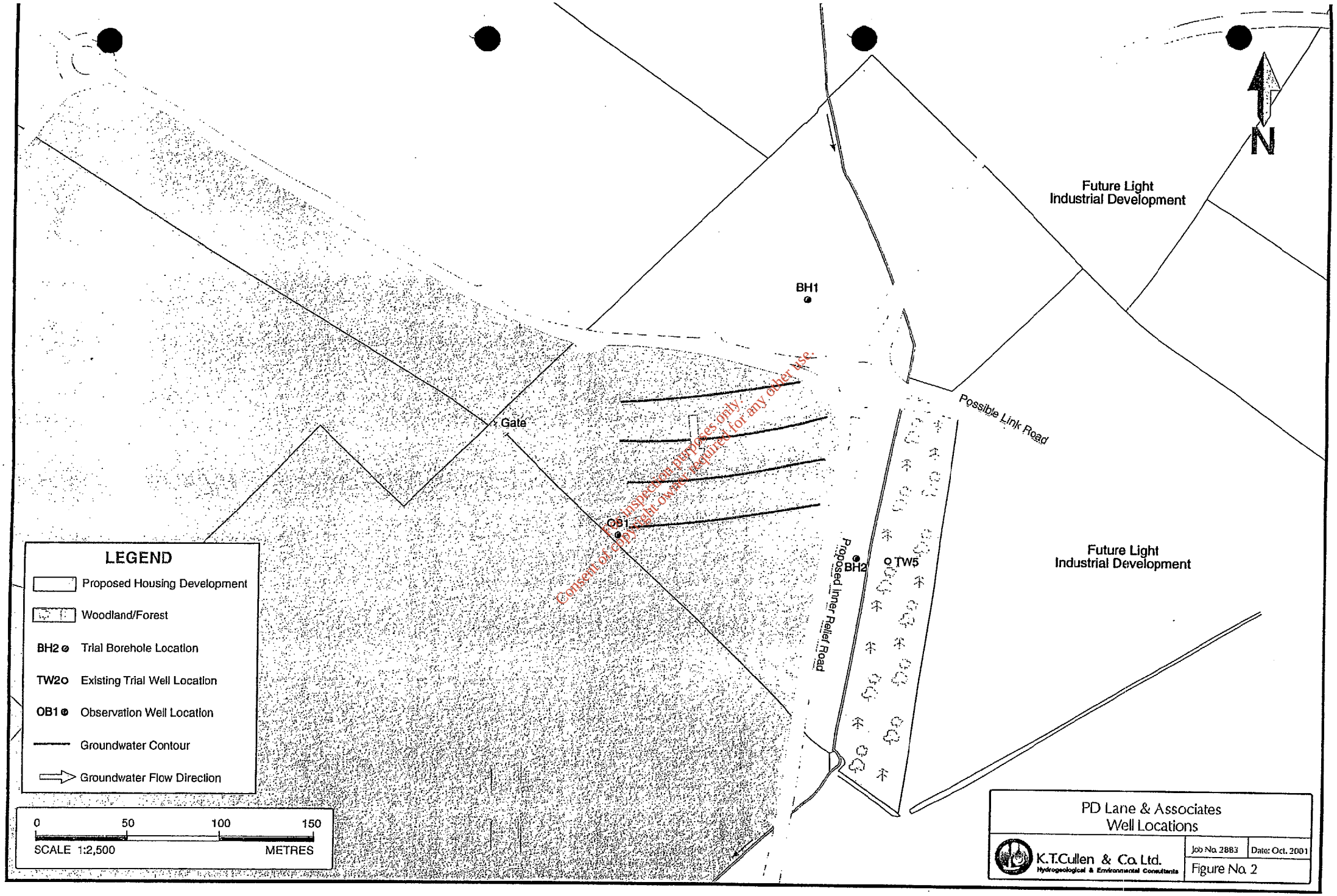
Victoria Conlon B.Sc. M.Sc. Date 30/10/07

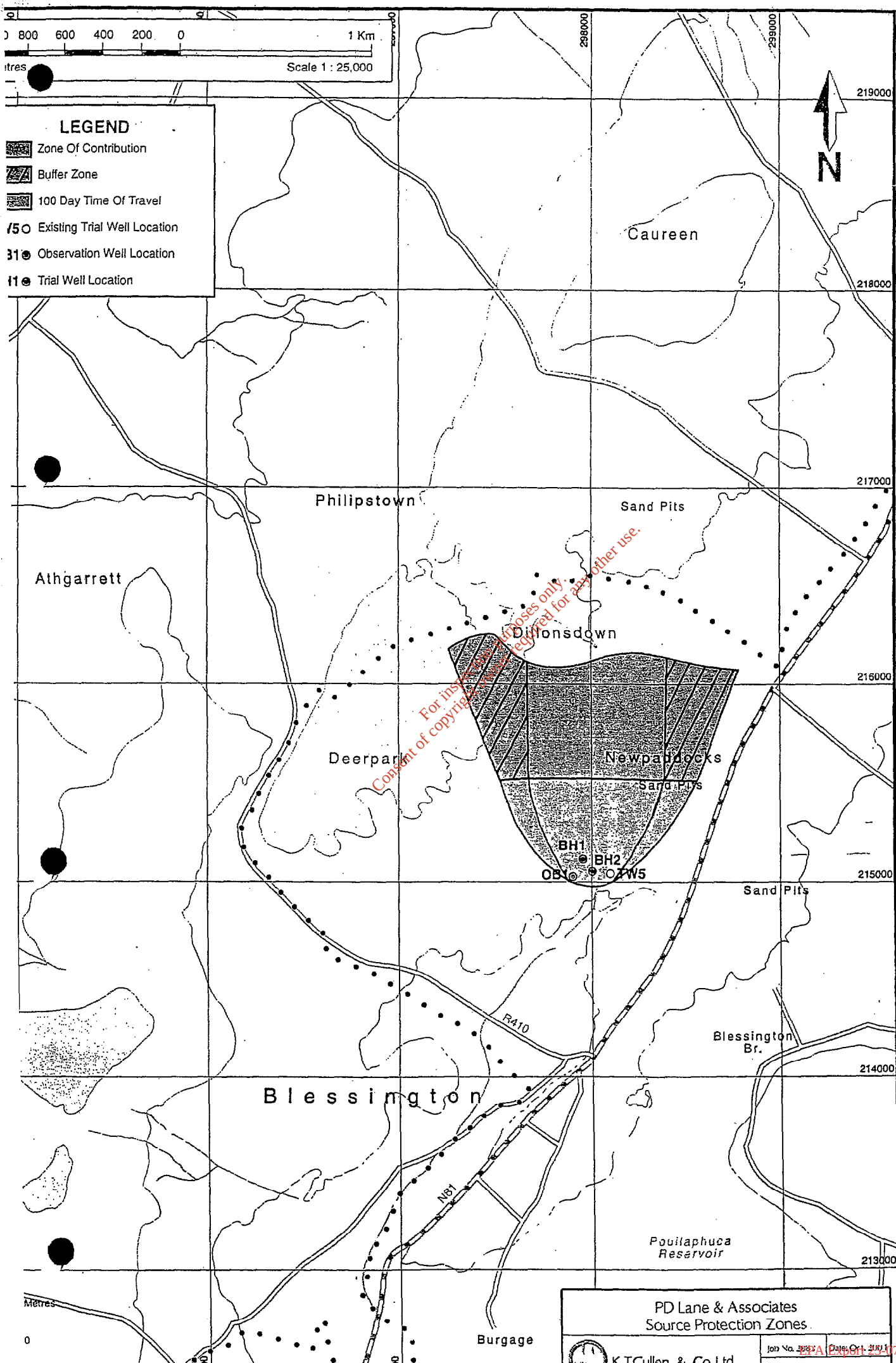
pp Marie Ryan

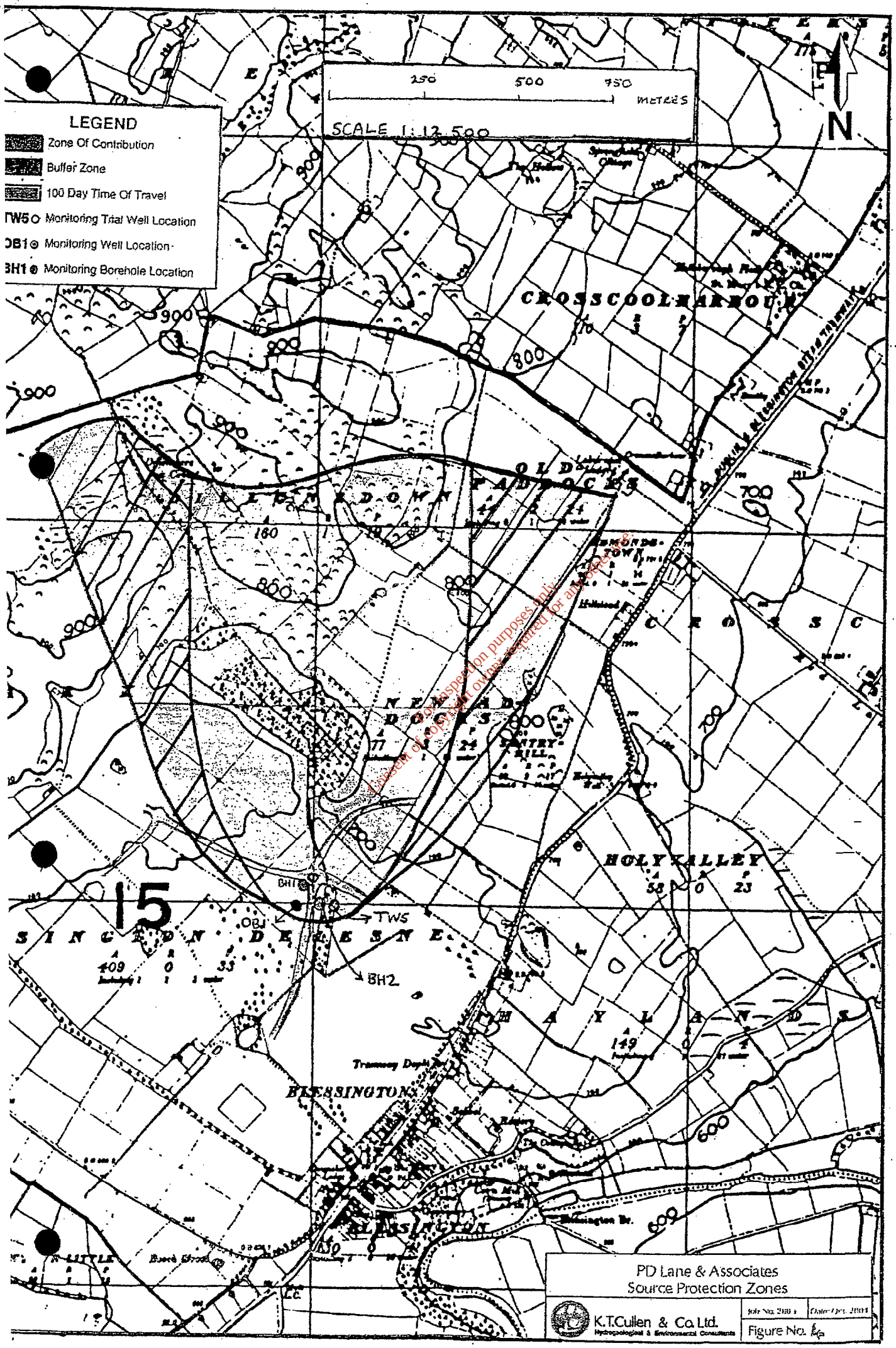
Kieran O Dwyer BE MIEI. Date 30/10/07

FIGURES









PD Lane & Associates
Source Protection Zones

K.T.Cullen & Co.Ltd.
Hydrogeologist & Environmental Consultants

Job No. 2188 s | Date Oct. 2001

Figure No. 6

APPENDIX A

Well Log Glovers

Well No. BH1 **Grid Reference** 98001 15118

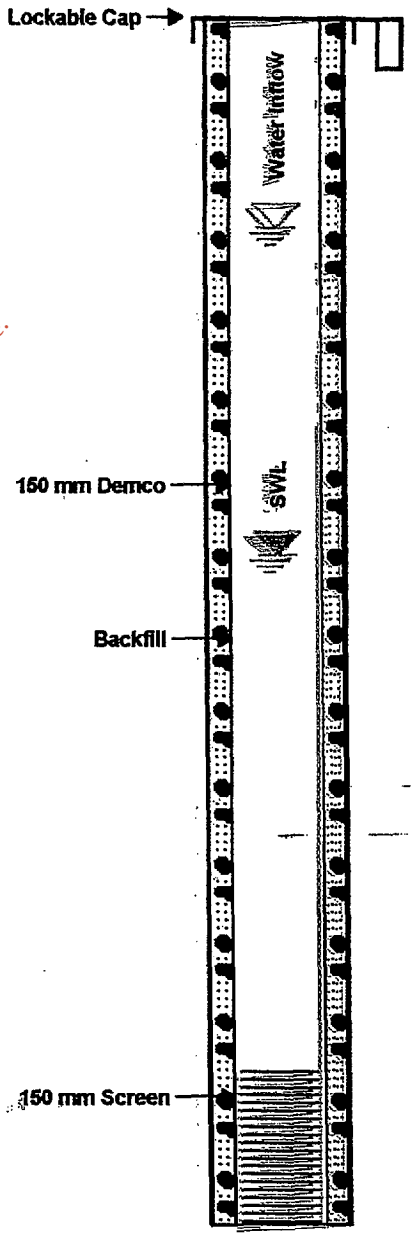
Project No. 2883 **Client** PD Lane & Associates **Drill Date** 2/9/01

Well Type Bored **Location** Blessington **Geologist** Garrett Connell

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface	0	
Top Soil		
Dense Gravel		
Sand Gravel		
Medium Dense		
Loose Sand	5	
Dark Sand/Silt		
Brown Sand Silt	10	
Boulder Clay		
Soft, firm, grey boulder clay	15	
	20	
Backfilled	25	

Well Construction



Drill Method Shell and Auger **Hole Size (mm)** 150

Casing Length (m) 23.5 **Ground Level (mOD)** ~170

Driller Glovers **Static Water Level (bgl)** 10.38

K.T.Cullen & Co. Ltd.

Well Log

Well No. BH2 **Grid Reference**

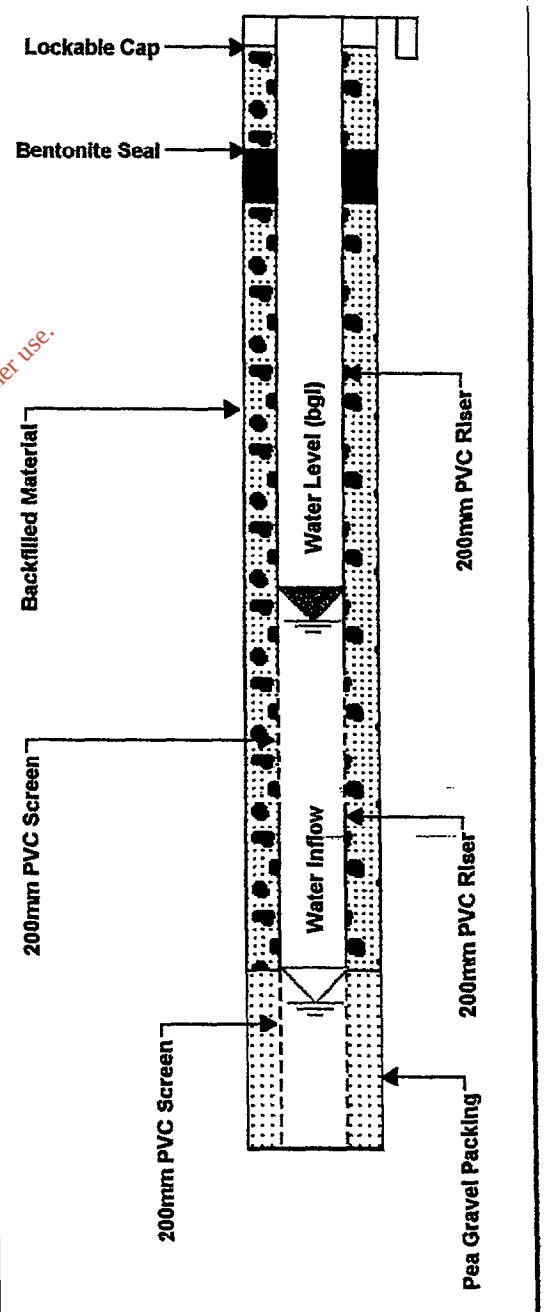
Project No. 2883 **Client** P D Lane **Drill Date** 10/9/01

Well Type Trial Well **Location** Blessington, Co. Wicklow **Geologist** Garrett Connell

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface		
Topsoil	0	
Gravel and Silt		
Medium/Coarse Sand and Silt		
Boulder Clay	5	
	10	
Medium/Dense Gravel		
Medium/Dense Sand and Silt		
	15	
Boulder Clay		
Medium/Dense Silt and Gravel		
Dense Sand and Silt	20	

Well Construction



HYDROGEOLOGICAL & ENVIRONMENTAL CONSULTANTS

K.T.Cullen & Co. Ltd.

Drill Method Shell and Auger **Hole Size (mm)** 200mm

Casing Length (m) **Ground Level (mOD)**

Driller Glovers **Static Water Level (bgl)** 11.15

Well Log

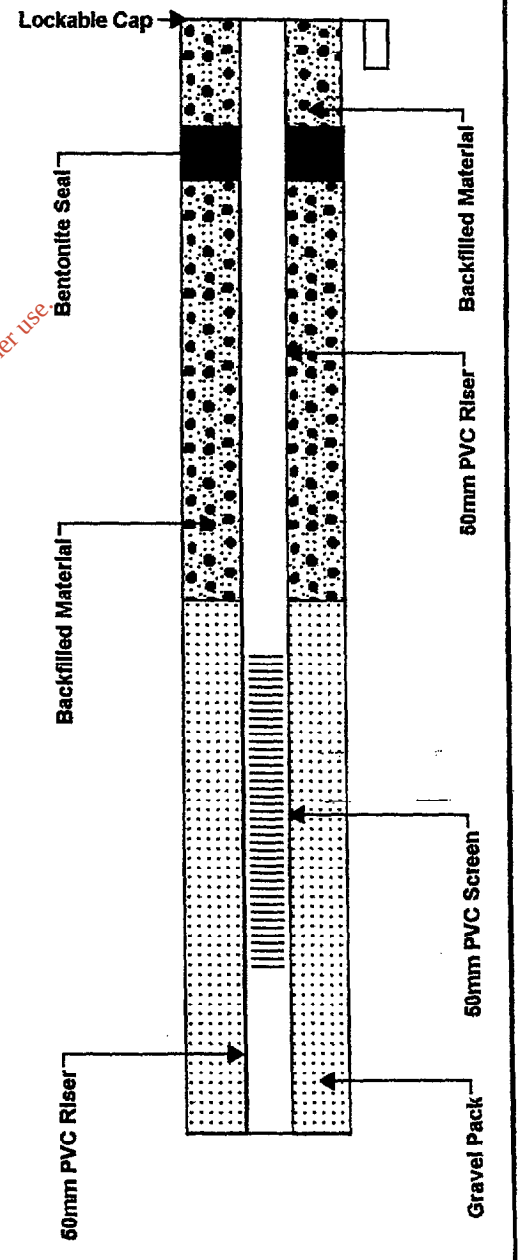
Well No. OB1 **Grid Reference**

Project No. 2883 **Client** PD Lane **Drill Date** 7/9/01

Well Type Observation Well **Location** Blessington, Co. Wicklow **Geologist** Garrett Connell

SUBSURFACE PROFILE

Description	Depth (m)	Symbol
Ground Surface		
Clayey Topsoil	0	
Gravel		
Boulder Clay	5	
Dense Gravelly Sand	10	
Soft Sand	15	
Soft Fine Sand	20	



HYDROGEOLOGICAL & ENVIRONMENTAL CONSULTANTS

K.T.Cullen & Co. Ltd.

Drill Method Shell and Auger **Hole Size (mm)** 50

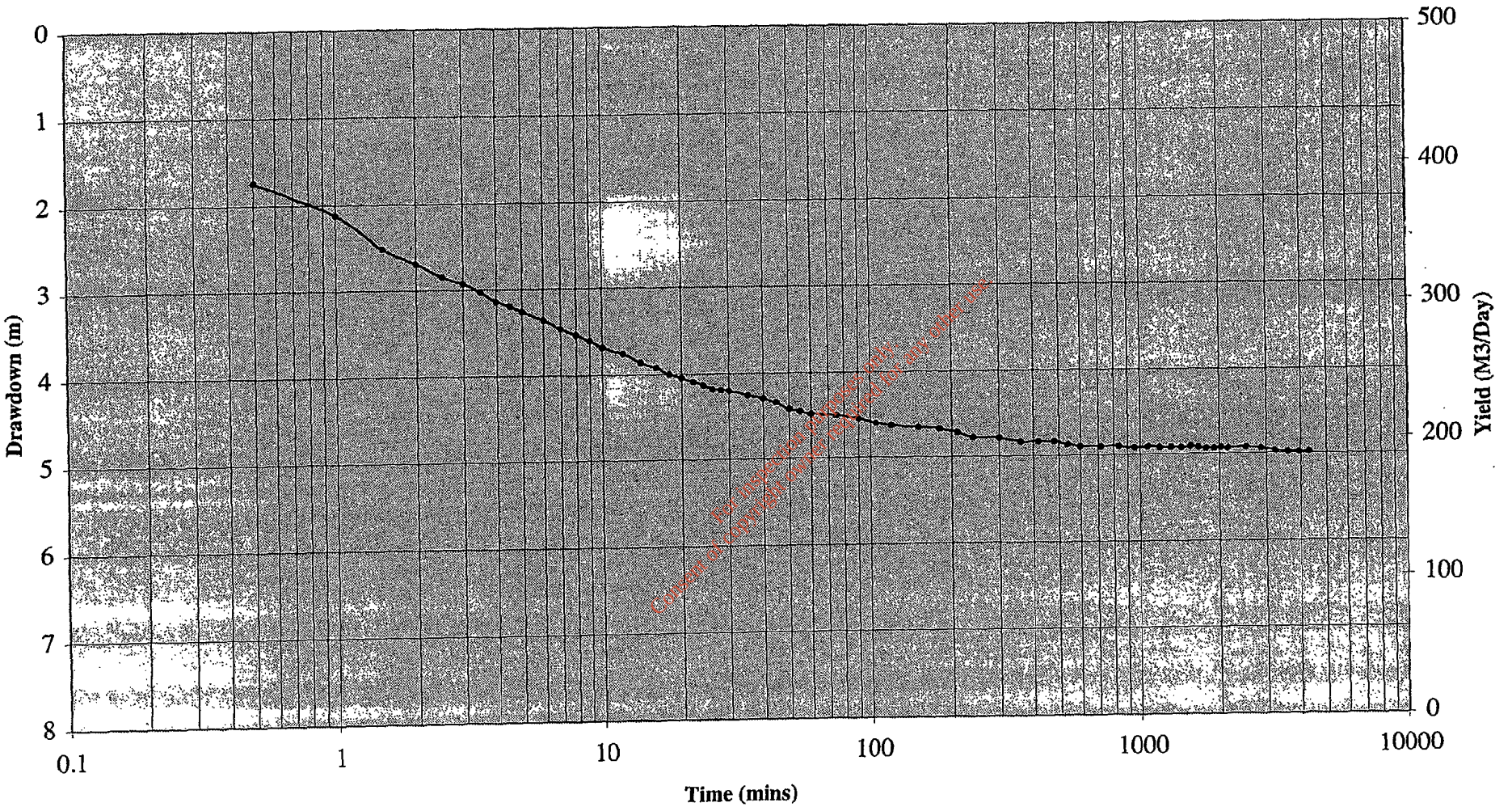
Casing Length (m) **Ground Level (mOD)**

Driller Glovers **Static Water Level (bgl)**

APPENDIX B

Actual Time	Time (mins)	FIELD DATA (METRES)	Water Level below g.l.	Drawdown (metres)	Yield (m3/day)
19-07 11:00:00	0	10.86	10.36	0	927.3
19-07 11:00:30	0.5	12.6	12.1	1.74	
19-07 11:01:00	1	12.96	12.48	2.12	
19-07 11:01:30	1.5	13.38	12.88	2.52	
19-07 11:02:00	2	13.55	13.05	2.69	
19-07 11:02:30	2.5	13.71	13.21	2.85	
19-07 11:03:00	3	13.79	13.29	2.93	
19-07 11:03:30	3.5	13.89	13.39	3.03	
19-07 11:04:00	4	14	13.5	3.14	
19-07 11:04:30	4.5	14.06	13.56	3.2	
19-07 11:05:00	5	14.12	13.62	3.26	
19-07 11:06:00	6	14.22	13.72	3.36	
19-07 11:07:00	7	14.33	13.83	3.47	
19-07 11:08:00	8	14.4	13.9	3.54	
19-07 11:09:00	9	14.47	13.97	3.61	
19-07 11:10:00	10	14.55	14.05	3.69	
19-07 11:12:00	12	14.62	14.12	3.76	
19-07 11:14:00	14	14.73	14.23	3.87	
19-07 11:16:00	16	14.78	14.28	3.92	
19-07 11:18:00	18	14.86	14.36	4	
19-07 11:20:00	20	14.91	14.41	4.05	
19-07 11:22:00	22	14.95	14.45	4.09	
19-07 11:24:00	24	14.99	14.49	4.13	
19-07 11:26:00	26	15.04	14.54	4.18	
19-07 11:28:00	28	15.05	14.55	4.19	
19-07 11:30:00	30	15.06	14.56	4.2	
19-07 11:35:00	35	15.11	14.61	4.25	
19-07 11:40:00	40	15.15	14.65	4.29	
19-07 11:45:00	45	15.2	14.7	4.34	
19-07 11:50:00	50	15.28	14.78	4.42	
19-07 11:55:00	55	15.31	14.81	4.45	
19-07 12:00:00	60	15.34	14.84	4.48	908.2
19-07 12:15:00	75	15.36	14.86	4.5	
19-07 12:30:00	90	15.4	14.9	4.54	
19-07 12:45:00	105	15.46	14.96	4.6	
19-07 13:00:00	120	15.48	14.98	4.62	
19-07 13:30:00	150	15.51	15.01	4.65	900.1
19-07 14:00:00	180	15.53	15.03	4.67	
19-07 14:30:00	210	15.58	15.08	4.72	
19-07 15:00:00	240	15.64	15.14	4.78	912.5
19-07 16:00:00	300	15.65	15.15	4.79	
19-07 17:00:00	360	15.7	15.2	4.84	
19-07 18:00:00	420	15.7	15.2	4.84	905.3
19-07 19:00:00	480	15.7	15.2	4.84	
19-07 20:00:00	540	15.73	15.23	4.87	
19-07 21:00:00	600	15.76	15.26	4.9	900.1
19-07 23:00:00	720	15.76	15.26	4.9	
20-07 01:00:00	840	15.76	15.26	4.9	
20-07 03:00:00	960	15.78	15.28	4.92	
20-07 05:00:00	1080	15.77	15.27	4.91	
20-07 07:00:00	1200	15.78	15.28	4.92	
20-07 09:00:00	1320	15.78	15.28	4.92	900.1
20-07 11:00:00	1440	15.78	15.28	4.92	
20-07 13:00:00	1560	15.77	15.27	4.91	915.5
20-07 15:00:00	1680	15.78	15.28	4.92	
20-07 17:00:00	1800	15.79	15.29	4.93	908.2
20-07 19:00:00	1920	15.79	15.29	4.93	
20-07 21:00:00	2040	15.78	15.28	4.92	
20-07 23:00:00	2160	15.79	15.29	4.93	
21-07 05:00:00	2520	15.78	15.28	4.92	
21-07 11:00:00	2880	15.79	15.29	4.93	915.5
21-07 17:00:00	3240	15.83	15.33	4.97	908.2
21-07 23:00:00	3600	15.84	15.34	4.98	
22-07 05:00:00	3960	15.84	15.34	4.98	900.1
22-07 11:00:00	4320	15.84	15.34	4.98	
22-07 17:00:00	4680	15.84	15.34	4.98	
22-07 23:00:00	5040	15.85	15.35	4.99	905.3
23-07 05:00:00	5400	15.86	15.36	5	915.5
23-07 11:00:00	5760	15.86	15.36	5	900.1
23-07 17:00:00	6120	15.84	15.34	4.98	
23-07 23:00:00	6480	15.84	15.34	4.98	900.1
24-07 05:00:00	6840	15.85	15.35	4.99	
24-07 11:00:00	7200	15.84	15.34	4.98	908.2

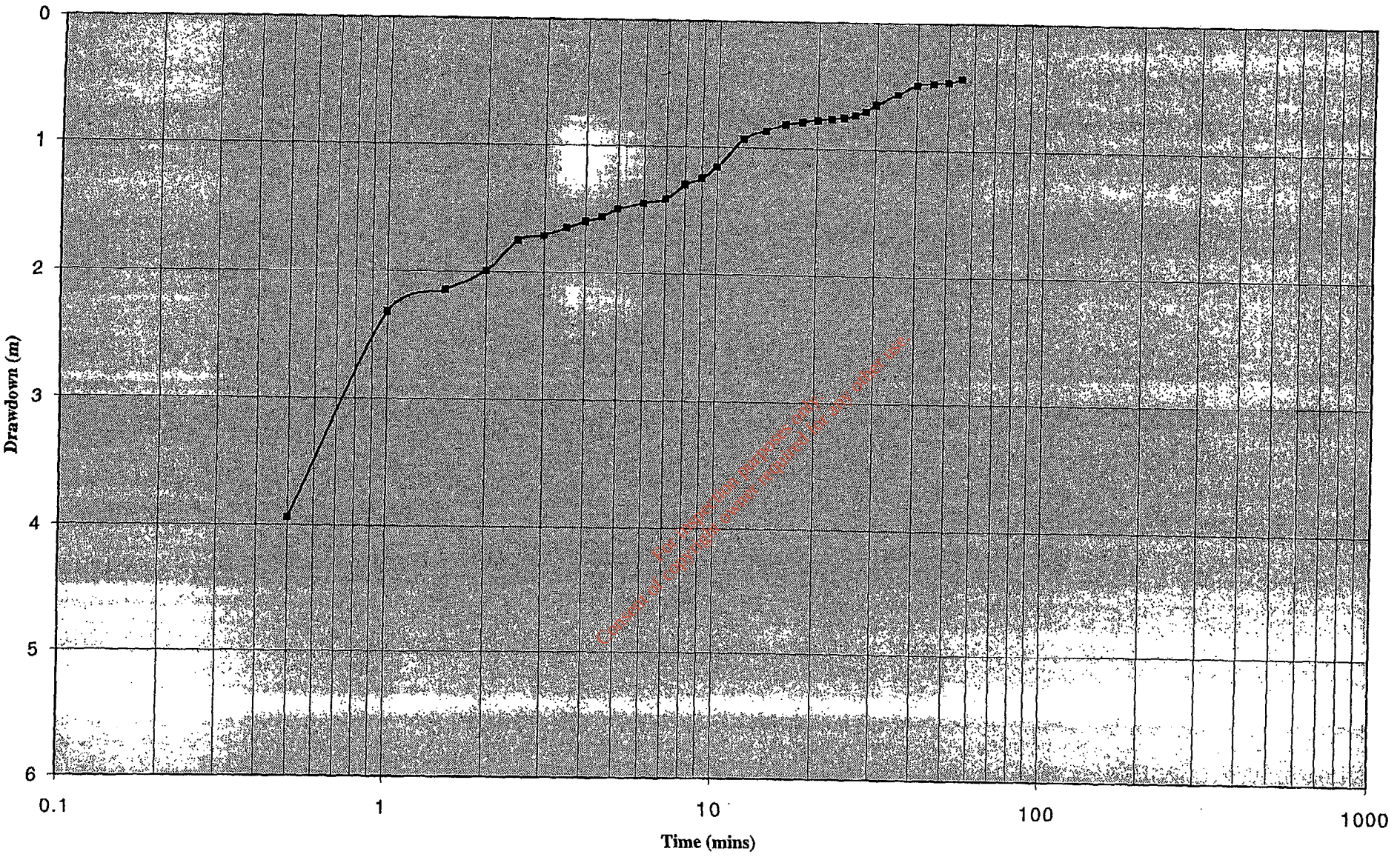
Time Drawdown Data for 120hr Pump Test on BH2 at Blessington on 19th to 24th September 2001.



Time Drawdown Graph for 120hr Pump Test on BH2 at Blessington on 19th to 24th September 2001.

Elapsed Time (mins)	Field Data (metres)	Water Level below g.l.	Drawdown (metres)
0	15.84	15.04	4.98
0.5	14.8	14	3.94
1	13.18	12.38	2.32
1.5	13	12.2	2.14
2	12.85	12.05	1.99
2.5	12.61	11.81	1.75
3	12.57	11.77	1.71
3.5	12.5	11.7	1.64
4	12.45	11.65	1.59
4.5	12.41	11.61	1.55
5	12.35	11.55	1.49
6	12.3	11.5	1.44
7	12.26	11.46	1.4
8	12.15	11.35	1.29
9	12.1	11.3	1.24
10	12.01	11.21	1.15
12	11.8	11	0.94
14	11.73	10.93	0.87
16	11.68	10.88	0.82
18	11.66	10.86	0.8
20	11.64	10.84	0.78
22	11.63	10.83	0.77
24	11.62	10.82	0.76
26	11.6	10.8	0.74
28	11.57	10.77	0.71
30	11.52	10.72	0.66
35	11.43	10.63	0.57
40	11.35	10.55	0.49
45	11.34	10.54	0.48
50	11.33	10.53	0.47
55	11.3	10.5	0.44

Time Drawdown Recovery Data for 120hr Pumping Test on BH2 in Blessington from the 19th to 24th September 2001.



Time Drawdown Recovery Graph for 120hr Pumping Test on BH2 in Blessington from the 19th to 24th September 2001.

APPENDIX C

Groundwater Protection Responses for On-site Wastewater Systems for Single Houses

Background

The primary responsibility for groundwater protection rests with any person who is carrying on an activity that poses a threat to groundwater. Groundwater in Ireland is protected under European Community and national legislation. Local authorities and the Environmental Protection Agency (EPA) have responsibility for enforcing this legislation. The Geological Survey of Ireland (GSI) in conjunction with the Department of Environment and Local Government (DELG) and the EPA have issued guidelines on the preparation of groundwater protection schemes to assist the statutory authorities and others to meet their responsibility to protect groundwater (DELG/EPA/GSI, 1999). A groundwater protection scheme incorporates land surface zoning and groundwater protection responses.

This document is concerned with groundwater protection responses for the siting of on-site wastewater treatment systems for a dwelling house of up to 10 people with facilities for toilet usage, living, sleeping, bathing, cooking and eating. These responses should be used in conjunction with the EPA guidance document *Wastewater Treatment Manual: Treatment Systems for Single Houses* (EPA, 2000). The groundwater protection responses outline acceptable on-site wastewater treatment systems in each groundwater protection zone (as described in *Groundwater Protection Schemes* DELG/EPA/GSI, 1999) and recommend conditions and/or investigations depending on the groundwater vulnerability, the value of the groundwater resource and the contaminant loading. It will be noted that these responses relate to discharges to groundwater. Less stringent responses may be appropriate for discharges to surface waters.

In Ireland, wastewater from approximately 400,000 dwellings is treated by on site systems. On-site systems can be subdivided into two broad categories: septic tank systems and mechanical aeration systems.

A conventional septic tank system consists of a septic tank followed by a soil percolation area. As an alternative to a conventional percolation area the effluent from a septic tank can be treated by filter systems such as:

- a soil percolation system in the form of a mound;
- an intermittent sand filter followed by a polishing filter;
- an intermittent peat filter followed by a polishing filter;
- an intermittent plastic or other media filter followed by a polishing filter; or
- a constructed wetland or reed bed, followed by a polishing filter.

Mechanical aeration systems include: biofilm aerated (BAF) systems; rotating biological contactor (RBC) systems; and sequencing batch reactor (SBR) systems. The effluent from a mechanical aeration system should be treated by a polishing filter.

On-site systems are the primary method used for the treatment and disposal of domestic wastewater in rural areas. These systems are also used in urban areas, which are not connected to public sewer systems. On-site systems are often located close to private or public wells.

When choosing the location and type of on-site system, developers should have regard to any nearby groundwater source, the groundwater as a resource and the vulnerability of the underlying groundwater. The groundwater protection responses in this guidance combine these factors to produce a response matrix.

The objectives of these groundwater protection responses are:

- to reduce the risk of pollutants reaching drinking water supplies;
- to reduce the risk of pollution of aquifers;
- to minimise pollution of domestic wells; and

- to provide advice where it is proposed to locate domestic wells in the vicinity of existing wastewater treatment systems and vice versa.

The risk from on-site wastewater treatment systems is mainly influenced by:

- its proximity to a groundwater source;
- the groundwater vulnerability;
- the value of the groundwater resource;
- the height of the water table;
- the groundwater flow direction; and
- the type of on-site system and the quality of the final effluent.

The use of these groundwater protection responses allows decisions to be made on the acceptability or otherwise of on-site wastewater treatment systems from a hydrogeological point of view.

These groundwater protection responses should be read in conjunction with *Groundwater Protection Schemes* (DELG/EPA/GSI, 1999). Other published responses in this series are *Groundwater Protection Responses for Landfills* and *Groundwater Protection Response to the Landspreading of Organic Wastes.*

Effluent from On-site Wastewater Treatment Systems for Single Houses: a Potential Hazard for Groundwater

The characteristics of domestic wastewater are outlined in Table 1.

Table 1: Characteristics of Domestic Wastewater.

Parameter	Typical concentration mg/l unless otherwise stated
COD (as O_2)	400
BOD_5 (as O_2)	300
Total solids	200
Total Nitrogen (as N)	50
Total Phosphorus (as P)	10
Total coliforms (MPN/ 100 ml)*	10^7 - 10^8

* Most probable number (MPN/100 ml).

Particular contaminants of concern are pathogenic organisms and nitrates.

Pathogenic organisms

Pathogenic organisms can cause gastro-enteritis, polio, hepatitis, meningitis and eye infections. Organisms such as *E. coli*, *streptococci* and faecal coliforms, with the same enteric origin as pathogens, indicate whether pathogens may be present or not in wastewater.

Nitrates

Nitrate in excess concentrations in water may constitute a risk to human health and the environment. Nitrogen enters on-site wastewater treatment systems mainly as organic nitrogen, which means the nitrogen is part of a large biological molecule such as a protein. Bacteria and other microbes oxidise or mineralise the organic nitrogen to ammonia, which is further oxidised to nitrites and nitrates.

Groundwater Protection Response Matrix for Single House Systems

The reader is referred to the full text in *Groundwater Protection Schemes* (DELG/EPA/GSI, 1999) for an explanation of the role of groundwater protection responses in a groundwater protection scheme.

A risk assessment approach is taken in the development of this response matrix. A precautionary approach is taken because of the variability of Irish subsoils bedrock and the possibility that the treatment system may not function properly at all times. Where there is a high density of dwellings in the vicinity of public group scheme or industrial water supply sources, more restrictive conditions may be required or the development may need to be refused. The density of dwellings and associated treatment systems may impact on the groundwater because of the cumulative loading, particularly of nitrate. This should be taken into account especially where the vulnerability of the groundwater is high or extreme.

The potential suitability of a site for the development of an on-site system is assessed using the methodology outlined in *Wastewater Treatment Manual: Treatment Systems for Single Houses* (EPA, 2000). This methodology includes a desk study and on-site assessment (visual, trial hole test and percolation tests). The groundwater protection responses set out in Table 2 below should be used during the desk study assessment of a site to give an early indication of the suitability of a site for an on-site system. Information from the on-site assessment should be used to confirm or modify the response. In some situations site improvement works may allow a system to be developed. In such situations site improvement works followed by reassessment of the groundwater response, may allow a system to be developed. Site improvements are dealt with in Section 3.2.2 of the *Wastewater Treatment Manual: Treatment Systems for Single Houses* (EPA, 2000).

Where groundwater protection zones have not yet been delineated for an area, the responses below should be used in the following circumstances:

- where on-site systems are proposed in the vicinity of domestic wells;
- where on-site systems are proposed in the vicinity of sources of water with an abstraction rate above 10m³/d (e.g. public, group scheme and industrial supply wells and springs);
- where groundwater is extremely vulnerable (based on the visual assessment and trial hole test), and
- where there are karst features such as swallow holes, caves etc.

The appropriate response to the risk of groundwater contamination from an on-site wastewater treatment system is given by the assigned response category (R) appropriate to each protection zone.

Table 2 Response Matrix for On-site Treatment Systems

SOURCE PROTECTION AREA	RESOURCE PROTECTION AREA							
	Inner (SI)	Outer (SO)	Regionally Important Aquifer		Locally Important Aquifer		Poor Aquifer	
VULNERABILITY RATING			Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu
Extreme (E)	R3	R3	R2	R2	R2	R2	R2	R2
High (H)	R2	R2	R2	R1	R1	R1	R1	R1
Moderate (M)	R2	R2	R1	R1	R1	R1	R1	R1

and subject to the following conditions:

1) The authority must be satisfied that, on the evidence of the groundwater quality of the source and the number of existing houses, the accumulation of significant nitrate and/or microbiological contamination is unlikely.
2) No on-site treatment system should be located within 60˚m of the public, group scheme or industrial water supply source.
3) A management and maintenance agreement is completed with the systems supplier.

R3[2] Not generally acceptable unless:

A treatment system other than a conventional septic tank system, as described in EPA (2000), is installed with a minimum thickness of 1.2˚m unsaturated soil/subsoil with P/T values from 1 to 50, (in addition to the polishing filter which should be a minimum depth of 0.6 m) beneath the invert of the polishing filter (i.e. 1.8 m in total for a soil polishing filter).

and subject to the following conditions

1) The authority must be satisfied that, on the evidence of the groundwater quality of the source and the number of existing houses, the accumulation of significant nitrate and/or microbiological contamination is unlikely.
2) No on-site treatment system should be located within 60˚m of the public, group scheme or industrial water supply source.
3) A management and maintenance agreement is completed with the systems supplier.

The responses above assume that there is no significant groundwater contamination in the area. Should contamination by pathogenic organisms or nitrate (or other contaminants) be a problem in any particular area, then more restrictive responses may be necessary. Where nitrate levels are known to be high or nitrate loading analysis indicates a potential problem, consideration should be given to the use of treatment systems which include a de-nitrification unit. Monitoring carried out by the Local Authority will assist in determining whether or not a variation in any of these responses is required.

Ponding may occur in areas of low permeability subsoils (T >50) and thus safeguards for surface waters should be put in place.

Additional Requirements for the Location of On-site Treatment Systems Adjacent to Receptors at Risk, such as Wells and Karst Features

Table 2 above outlines responses for different hydrogeological situations, which may restrict the type of on-site treatment system, and must be satisfied in the first instance. Once a response has been determined for a site, the next step is to manage the risk posed to the features identified during the desk study and on-site assessment. These features include water supply wells and springs (public and domestic), and karst features that enable the soils and subsoil to be bypassed (e.g. swallow holes, collapse features).

Table 3 below provides recommended distances between receptors (see also Figure 1) and percolation area or polishing filters, in order to protect groundwater. These distances depend on the thickness and permeability of subsoil. The depths and distances given in this table are based on the concepts of risk assessment and risk management, and take account, as far as practicable, of the uncertainties associated with hydrogeological conditions in Ireland. Use of the depths and distances in this table does not guarantee that

pollution will not be caused; rather, it will reduce the risk of significant pollution occurring.

Where an on-site system is in the zone of contribution of a well, the likelihood of contamination and the threat to human health depend largely on five factors:

- the thickness and permeability of subsoil beneath the invert of the percolation trench;
- the permeability of the bedrock, where the well is tapping the bedrock;
- the distance between the well or spring and the on-site system;
- the groundwater flow direction; and
- the level of treatment of effluent.

Table 3 Recommended Minimum Distance between a Receptor and a Percolation Area or Polishing Filter

T or P Value[1]	Type of soil/subsoil *	Depth of soil/subsoil (m) above bedrock (see note 1,2,3,6)	Minimum distance (m) from receptor to percolation area or polishing filter ****				
			Public Water Supply	*Karst feature*	*down-gradient domestic well or flow direction is unknown (see note 5)*	*Domestic well alongside (no gradient)*	*up-gradient domestic well*
>30	CLAY; silty, sandy CLAY (e.g. clayey till); CLAY/SILT.	1.2 >3.0	60	15	40 30	25	15
10 -30	Sandy SILT; clayey, silty SAND; clayey, silty GRAVEL (e.g. sandy till).	1.2 >8.0	60	15	45 30	25	15
<10	SAND; GRAVEL; silty SAND.	2.0** 2.0*** >8.0***	60	15	60 40 30	25	15

* BS5930 descriptions
** water table 1.2-2.0°m
*** water table >2.0°m
**** The distance from the percolation area or polishing filter means the distance from the periphery of the percolation area or polishing filter and not the centre.

Notes:

1. Depths are measured from the invert level of the percolation trench.
2. Depths and distances can be related by interpolation: e.g. where the thickness of silty, sandy CLAY is 1.2°m, the minimum recommended distance from the well to percolation area is 40°m; where the thickness is 3.0°m, the distance is 30°m; distances for intermediate depths can be approximated by interpolation.
3. Where bedrock is shallow (<2°m below invert of the trench), greater distances may be necessary where there is evidence of the presence of preferential flow paths (e.g. cracks, roots) in the subsoil.
4. Where the minimum subsoil thicknesses are less than those given above, site improvements and systems other that conventional systems, as described in EPA (2000), may be used to reduce the likelihood of contamination.
5. If effluent and bacteria enter bedrock rapidly (within 1-2 days), the distances given may not be adequate where the percolation area is in the zone of contribution of a well. Further site specific evaluation is necessary.
6. Where bedrock is known to be karstified or highly fractured, greater depths of subsoil may be advisable to minimise the likelihood of contamination.

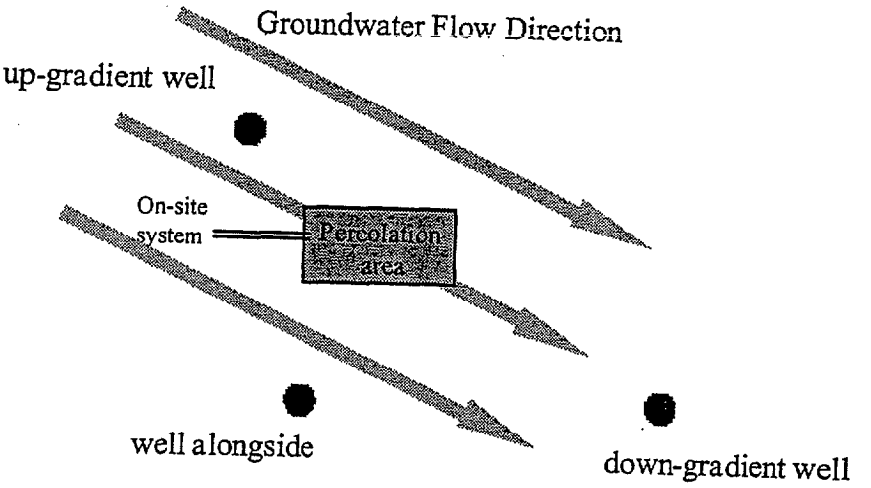


Figure 1. Relative location of wells

References

DELG/EPA/GSI, 1999. Groundwater Protection Schemes. Department of Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland.

EPA, 2000. Wastewater Treatment Manuals: Treatment Systems for Single Houses, Environmental Protection Agency.

Groundwater and Surface water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

June 2002

1. Background

White Young Green Ireland were requested by Brady Shipman Martin, Consulting Planners to comply with a request for further information from Wicklow County Council dated 6th March 2002. Roadstone Dublin Ltd., plan to construct a sand-washing facility across the road from their existing Doran's Pit washing facilities. As part of the planning application for the facilities an EIS was carried out, including a description of the groundwater and surface water regime of the site. Wicklow County Council requested that additional ground and surface water sampling be carried out and that a monitoring programme be put in place.

2. Groundwater Sampling Procedure and Analysis

Four groundwater and two surface water samples were taken at Roadstone Dublin Quarry at Blessington Co Wicklow on the 4th of June 2002. Roadstone further requested that sampling programme be designed to include analysing the EPA list of baseline parameters for landfill monitoring in order to ascertain the possible presence of decaying organic matter beneath a section of the quarry.

Groundwater samples were taken from the four boreholes at the Roadstone site as indicated on Figure 1. Two of the boreholes were drilled specifically for the purposes of sampling (BH1 and BH2). BH1 is located upgradient of the proposed facility and BH 2 is located downgradient. BH2 is situated at an area which is the subject of debate over the possible presence of illegally dumped waste. TW1 was drilled as a water supply on private property downgradient of the quarry. BH4 was drilled as part of the original quarry EIS in 1996 and is located upgradient of the proposed sand-washing plant. BHs 1 and 2 and TW 1 are drilled into the gravel aquifer to depths of 18, 17 and 21.5m respectively. BH 4 is drilled to 38.3 m into the bedrock aquifer beneath the gravel. BH4 is also on the other side of the catchment divide and may not be indicative of groundwater flow through the gravel aquifer beneath the site for both of these reasons.

The groundwater samples were sent to an accredited laboratory for analysis. The results are shown in Table 1. The groundwater analyses are compared against:

- Drinking Water Standards, SI 81 of 1988
- Typical Leachate Composition, EPA 1992

2.1 Drinking Water Standards

The overall groundwater quality is very good. The only parameters which exceed the Maximum Admissible Concentrations (MAC) for Drinking Water are nitrite in BH 1 and BH 2 and ammonia (as ammonium) in BH 1.

Nitrite exceedences are generally indicative of recent organic pollution from either land-spreading or animal slurry. Nitrite rapidly breaks down to nitrate therefore the fact that nitrate is not elevated in BH 1 would indicate that there is not a long-term pollution source in the vicinity of the borehole. This borehole is located in the centre of the quarry area, removed from sheep and any form of land-spreading so the source of the nitrite and ammonia is not obvious.

BH 2's nitrite content only slightly exceeds the Drinking Water MAC of 0.1 mg/l. This is located near to an area which is grazed by sheep and may be linked to the animal slurry.

Both BH4 and TW1 display excellent groundwater quality which regard to chemical parameters is suitable for consumption.

2.2 Leachate Composition

BH2 is the closest borehole to the proposed are of illegal dumping. As such it would be expected that if leachate was being generated in this area, then the chemical signature of the groundwater in this borehole would reflect this. BH2's chemical parameters are significantly less than the typical leachate composition values.

The most common indicator parameters of pollution from leachate are chloride, ammonia and conductivity. Chloride is possibly the most useful as it is it the most mobile ion in groundwater. Typical background chloride levels in Irish groundwaters are between 15 and 30 mg/l. Values higher than 30 mg/l in areas which are not close to the coast can be indicative of organic pollution. The chloride levels at the site range from 17 to 21 mg/l, indicating that the groundwater in the four wells is not impacted by leachate. The conductivity levels are quite variable in the four wells, ranging from 330 mg/l to 630 mg/l in BH 2. These levels relate directly to the calcium and bicarbonate (alkalinity) levels in each sample and are indicative of the calcium carbonate in the overburden deposits.

2.3 Organic Analyses

The samples were sent to an accredited laboratory for organic analyses, consisting of Diesel Range Organics, Petroleum Range Organics, Mineral Oils and BTEX compounds. The results are show in Table 2. All of the analyses are below the detection limit of 10 µg/l, indicating the absence of organic pollution for diesel or petroleum products.

3. Surface water Sampling Procedure

Two surface water samples were taken from the stream which runs along the south-western boundary of the quarry (SW1) and from the main area of open water within the quarry (SW2). Both of these locations were sampled previously on the 6th of March 2001. The recent samples were analysed according to the EPA baseline parameters for surface waters (apart from dissolved oxygen).

The surface water values were compared against:

- Surface Water for Human Consumption Standards for A1 waters SI 294 of 1989
- Typical Leachate Composition, EPA 1992.

3.1 Surface Water Standards

The quality of the surface water is very good with all parameters meeting the requirements for A1 surface waters. Incidentally, the surface water is of a similar quality to the groundwater, indicating the close link between the two within the quarry environment.

3.2 Comparison with Typical Leachate Composition

Both surface water samples show no evidence of leachate contamination. The most obvious indicators are chloride, conductivity, and ammonium in addition to BOD and COD. None of these parameters are elevated.

4. Summary

Four groundwater samples were taken at the Roadstone quarry site: two upgradient of the proposed sand-washing facility and two downgradient. All of the samples are of good chemical and organic quality. Levels of nitrite above the MAC for Drinking Water are found in BH1 and BH2 and elevated ammonium in BH1. These values are not found in conjunction with other indicators of organic pollution i.e. chloride, sodium and potassium are slightly anomalous.

BHs 2, 4 and TW1 show no evidence of leachate contamination. BH1 shows slightly elevated nitrite and ammonia levels but sodium and potassium are all at background levels indicating that the groundwater is not impacted by leachate.

Surface water quality is also good with values similar to those of groundwater and no exceedences of either the Drinking Water and Surface water Standards. The surface water values are all lower than the leachate levels.

The groundwater upgradient and downgradient of the sand-washing facility and in the location of the possible area of illegal dumping is of good quality and shows no evidence of leachate contamination.

5. Recommendations

The results show no indication of the presence of leachate in the groundwater or surfacewater systems. If decaying matter is present at the site and has not yet leached contaminated water into the groundwater system, then trial pitting may be necessary to ascertain the physical presence of decaying material. This would involve the use of a JCB over the period of one day to excavate 3 metre deep pits at intervals over the site. The trial pits would be logged by White Young Green personnel and any waste material would be identified and photographed. The trial pits may be inspected by Wicklow County Council representatives. If a less invasive survey is required by Roadstone then shallow monitoring boreholes can be drilled with a window sampling rig and a landfill gas analyser can be used to assess the presence of landfill gases.

Respectfully Submitted

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Table 1 : Groundwater and Surface Water Sample Analyses Roadstone Blessington

Sample Reference		BH1	BH2	BH4	TW 1	SW1	SW2	Drinking water	Surface Water	Typical
Sample Type		Groundwater	Groundwater	Groundwater	Groundwater	Surfacewater	Surfacewater	MAC value	MAC Value	Leachate composition
		Upgradient	Downgradient	Upgradient	Downgradient	Stream	Quarry			
Sample Date	Units	4/6/02	4/6/02	4/6/02	4/6/02	4/6/02	4/6/02	SI 81/1988	SI 294/1998	EPA 1992
pH Value In Water	mg/l	8.0	7.4	8.0	7.7	7.9	8.2	6 to 9	6 to 9	7.2
Sulphate as SO_4	mg/l	44	8.4	18	8	11	26	250	200	136
Nitrate as NO_3	mg/l	9.2	15	20	6.8	2.4	4.4	50	50	10.6
Nitrite as NO_2	mg/l	**0.84**	**0.16**	<0.01	<0.01	<0.01	<0.01	0.1	-	0.66
Total Oxidised Nitrogen as N	mg/l	2.3	3.4	4.5	1.5	0.54	1	-	-	-
Ammonium as NH_4	mg/l	**0.32**	0.07	<0.05	<0.06	<0.05	0.06	0.3	0.2	614
Chloride as Cl	mg/l	18	17	21	17	11	14	250	250	1256
Conductivity	µS/cm	330	630	350	485	485	300	1500	1000	7789
Alkalinity	mg/l	120	345	140	250	265	130	-	-	3438
Non Purgeable Organic Carbon	mg/l	1.4	1.4	<0.5	2.1	1.3	1.4	-	-	-
Mercury as Hg	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.001	0.001	0.1
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.05	0.07
Zinc as Zn	mg/l	0.02	0.07	0.06	<0.01	<0.01	0.21	1	3	0.58
Cadmium as Cd	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.005	<0.01
Lead as Pb	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.05	0.1
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	-	0.1
Iron as Fe	mg/l	<0.01	<0.01	0.13	<0.01	0.04	0.06	0.2	0.2	54.5
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	0.03	0.02	0.05	0.05	1.99
Magnesium as Mg	mg/l	8.7	19	7.1	5.6	9.7	9.4	50	-	151
Calcium as Ca	mg/l	42	110	57	96	96	52	200	-	250
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	0.05	0.04
Sodium as Na	mg/l	19	11	11	9.3	6.0	7.4	150	-	904
Potassium as K	mg/l	1.6	0.8	0.5	2.2	<0.5	0.8	12	-	491
Residue on Evaporation	mg/l	464	1817	2224	505	n/a	n/a	-	-	-
Cyanide as CN	mg/l	<0.1	<0.1	<0.1	<0.1	n/a	n/a	0.05	0.05	<0.05
Phenol as C_6H_5OH	mg/l	<0.1	<0.1	<0.1	<0.1	n/a	n/a	0.005	0.005	-
Fluoride as F	mg/l	0.25	<0.2	<0.2	<0.2	n/a	n/a	1	1	-
Arsenic as As	mg/l	<0.05	<0.05	<0.05	<0.05	n/a	n/a	0.05	0.05	0.008
Phosphorus as P	mg/l	<0.05	<0.05	<0.05	<0.05	n/a	n/a	2.2	0.22	-
Boron as B	mg/l	<0.1	<0.1	<0.1	<0.1	n/a	n/a	2	2	7
Barium as Ba	mg/l	0.08	0.26	0.18	0.04	n/a	n/a	0.5	0.1	-
Selenium as Se	mg/l	<0.05	<0.05	<0.05	<0.05	n/a	n/a	0.01	0.01	-
Silver as Ag	mg/l	<0.01	<0.01	<0.01	<0.01	n/a	n/a	0.01	-	-
BOD	mg/l	n/a	n/a	n/a	n/a	<2	<2	-	5	>834
COD	mg/l	n/a	n/a	n/a	n/a	<20	<20	-	-	3078

Notes:

n/a-not analysed

MAC=Maximum Admissible Concentration

Block digits=Exceedences of MAC

Derek Luby

From: Malcolm Doak [m.doak@epa.ie]
Sent: 24 July 2003 12:18
To: 'dluby@csa.ie'
Cc: tpaul@csa.ie; MPrendergast@Roadstone.ie; 'cchappell@parkman.co.uk'
Subject: RE: Information on Wicklow County Council Wells

MKeegan.xls (40 KB)

National Groundwater Monitoring Programme

Two groundwater sources have been monitored in the Blessington area as part of the National Groundwater Monitoring Programme (Plot 33 and 48). The raw groundwater has been monitored in both cases. The samples were taken in the 1995 - 1998 period for the general analyses and additional nitrate monitoring data was obtained until 2000. The results are found in the attached spreadsheet.

EPA monitoring of Groundwater in Blessington area (28/01/03) EPA staff carried out sampling of three groundwater wells (CRH BH X, CRH BH Y, Carnegies BH 1A) and a groundwater source (Blessington Depot) on the 28th January, 2003 in the Blessington area. Results of analyses are with Alan Stephens c/o EPA Dublin 01- 268 0113.

EPA monitoring of Drinking Water in Blessington area (06/03/03) The EPA conducted a round of sampling of drinking water in the Blessington area on the 6th March 2003. The results are attached.Please note that the description of sample type on the results sheet should read 'drinking water' and not 'effluent'.
<<MKeegan.xls>>

Hydrogeology of the Area

Geological Survey of Ireland records were viewed on the Blessington area for groundwater information on 28/1/03 by Malcolm Doak. The entire area is underlain by sands and gravels to depths of >20m and up to 74m but with patchy permeability. The GSI class the sand and gravel aquifer as a Locally Important Aquifer. Watertable deepens moving north and northwest of Blessington village. The following reports provide useful information and show well locations south of the CRH holdings (all available from GSI; Mr Geoff Wright):

* Blessington Gravel Aquifer - Groundwater Potential and Vulnerability. GSI 2001
* Margrove, Ashton Blessington Housing Estate Groundwater Report. KT Cullen 1997
* Ballymore Homes Bored Water Supply Report. KT Cullen 1994
* EIA CRH. Water and groundwater chapter. KT Cullen 1997

Malcolm Doak
Inspector
> Environmental Management & Planning Division,
> Environmental Protection Agency,
> An Ghníomhaireacht um Chaomhnú Comhshaoil,
> Johnstown Castle Estate,
> Co. Wexford
> e-mail: m.doak@epa.ie
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>
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County	Plot No.	Location	Easting	Northing	Date	Year	pH	Conductivity	Ammonia	O-Phosphate	TON
Wicklow	33	Ashtown GWS / Blessington	297460	214046	30-Nov-95	1995	7.3	710	<0.005	0.014	4.501
Wicklow	33	Ashtown GWS / Blessington	297460	214046	22-Aug-96	1996	7.43	1015	<0.01	0.017	4.982
Wicklow	33	Ashtown GWS / Blessington	297460	214046	19-Nov-96	1996	7.54	1010	<0.01	0.013	5.452
Wicklow	33	Ashtown GWS / Blessington	297460	214046	4-Nov-97	1997	7.43	865	<0.01	0.015	5.463
Wicklow	33	Ashtown GWS / Blessington	297460	214046	12-Feb-98	1997	7.58	970	<0.01	0.14	6.07
Wicklow	48	Blessington	297500	214000	4-Nov-97	1997	7.41	671	<0.01	0.014	5.465
Wicklow	48	Blessington	297500	214000	12-Feb-98	1997	7.47	575	<0.01	0.13	6.092

NO3 (mg/L N)	Nitrate (mg/L NO3)	Alkalinity (mg/L)	Cl (mg/lCl)	SO4(mg/l S	Na (mg/l Na)	K mg/l	Mg(mg/l)	Ca(mg/l Ca)	Fe (ug/l Fe)	Mn(ug/l
4.5	19.926	259	44.9	15	41.12	1.68	6.36	101.99	812	< 2.0
nda	nda	340	142.28	17.11	86.75	2.27	6.09	116.34	76	< 2.0
nda	nda	270	143.98	20.84	83.4	3.8	3.06	115.2	<50.0	< 2.0
nda	nda	274	133.488	16.265	89.713	0.832	6.354	110.315	<50.0	< 2.0
nda	nda	264	195	14.3	139.6	1	5.8	95.3	<50.0	< 2.0
nda	nda	238	91.225	9.935	54.458	0.031	5.013	97.227	<50.0	< 2.0
nda	nda	220	51.4	10.1	48.9	0.7	5.2	87.5	<50.0	< 2.0

County	Plot No	NGR	Easting	Northing	Scheme Name	Date	Nitrate (mg/l NO3)
Wicklow	33	N975140	297460	214046	Ashtown GWS / Blessington	21-Nov-00	22.79
Wicklow	33	N975140	297460	214046	Blessington	09-Feb-00	24.53
Wicklow	33	N975140	297460	214046	Blessington	08-Sep-98	31.17
Wicklow	48	N975140	297500	214000	Blessington	12-Jan-99	27.54
Wicklow	48	N975140	297500	214000	Blessington	11-Oct-99	27.81

FORWARDED BY ALAN STEPHENS EPA (DUBLIN) 13/03/03

Environmental Protection Agency

Richview
Clonskeagh Road, Dublin 14.

Telephone 01 2680100
Fax 01 2680199

SITE INVESTIGATION RESULTS
Blessington, Co. Wicklow 29/01/03

Blessington town water plus samples from Boreholes on Carnegies and CRH sites

			(GW 4/2)	(GW 4/1)	(GW 6/4)
Date Sampled	29/01/03	29/01/03	29/01/03	29/01/03	29/01/03
Time Sampled	10:50	11:30	13:30	13:00	
Location of Sample	**Blessington Depot 1 GW**	**Carnegies BH 1A**	**CRH BH X**	**CRH BH Y**	**CRH BH Z**
Description	Tap in shed			beside pond	behind site office
GPS coordinates		97935E 16445N	97554E 15839N	97526E 16046N	78795E 15295N
Sampled by	C Ruane	C Ruane	C Ruane	C Ruane	C Ruane
Accompanied by	A Stephens	A Stephens	A Stephens	A Stephens	A Stephens
Sample Type	grab	grab	grab	grab	
Date received in lab	**29/01/03**	**29/01/03**	**29/01/03**	**29/01/03**	
Richview Sample No.	**409**	**410**	**411**	**412**	**dry no sample**
Parameters					
pH	7.4	7.7	7.2	7.6	
Conductivity µs/cm	563	377	690	445	
Alkalinity mg/l CaCO3	264	218	402	280	
Total Oxidised Nitrogen mg/l N	5.5	2.5	4.8	2	
Ammonia mg/l N	<0.01	0.06	<0.01	<0.01	
Total Phosphorous µg/l P	<10	57	14	20	
Fluoride mg/l	<0.5	<0.5	<0.5	<0.5	
Chloride mg/l	15	6	12	7	
Sulphate mg/l	19	9	7	12	

Location of Sample	Blessington Depot 1 GW	Carnegies BH 1A	CRH BH X	CRH BH Y	CRH BH Z
Richview Sample No.	409	410	411	412	dry no sample
Metals					
Na mg/l	15	5	9	13	
Mg mg/l	8	9	18	11	
K mg/l	<1	<1	<1	<1	
Ca mg/l	204	90	127	102	
Be µg/l	<1	<1	<1	<1	
B µg/l	<50	<50	<50	<50	
Al µg/l	<50	<50	315	2420	
V µg/l	<1	3	2	23	
Cr µg/l	10	14	17	23	
Fe µg/l	92	<50	734	6120	
Mn µg/l	<1	<1	266	2170	
Ni µg/l	<1	<1	7	57	
Co µg/l	<1	<1	3	32	
Cu µg/l	11	4	3	19	
Zn µg/l	9	<1	12	74	
As µg/l	<1	4	<1	4	
Se µg/l	<1	1	<1	<1	
Mo µg/l	<1	9	<1	<1	
Ag µg/l	<50	<50	<50	<50	
Cd µg/l	<0.10	<0.10	0.7	4.4	
Sn µg/l	<50	<50	<50	<50	
Sb µg/l	<1	<1	<1	<1	
Ba µg/l	93	<50	142	245	
Pb µg/l	<1	<1	7	50	
Volatile Organic Compounds					
Toluene	<0.5µg/l	<0.5µg/l	<0.5µg/l	<0.5µg/l	
all other VOC's tested for (see Table 1.)	<0.5µg/l	<0.5µg/l	<0.5µg/l	<0.5µg/l	

Dr Ciaran O'Donnell
Regional Chemist

Table 1.
VOC tested for

1,1-Dichloroethene	Bromochlorormethane	p-Xylene	Styrene
o-Xylene	4-Chlorotoluene	Trichloroethene	tert-Butyl benzene
1,2-Dichloroethane	1,3-Dichloropropene*	1,4-Dichlorobenzene	Tetrachlororethene
1,3-Dichlorobenzene	1,1-Dichloropropene	Chlorobenzene	cis-1,2-Dichlororethene
trans 1,2-Dichloroethene	Carbon tetrachloride	n-Propyl benzene	2-Chlorotoluene
Isopropylbenzene	sec-Butyl benzene	Dibromomethane	p-Isopropyl toluene
1,2-Dichloropropane	1,1,2-Trichloroethane	Methylene chlroride	1,1,1,2-Tetrachloroethane
Hexachlorobutadiene	Bromodichloromethane	m-Xylene	1,1,1-Trichloroethane
2,2-Dichloropropane	Benzene	1,3,5-Trimethyl benzene	1,2,4-Trimethylbenzene
Bromobenzene	1,2-Dichlorobenzene	Toluene	n-Butyl benzene
1,3-Dichloropropene*	Dibromochloromethane	1,1-Dichloroethane	Ethylbenzene
Chloroform			

Environmental Protection Agency
Regional Water Laboratory
Butts Green,
Kilkenny

FAXED BY ALAN STEPHEN
EPA (DUBLIN) 16/6/03

Report of: VOC Analysis
Report to: EPA Richview
Report date: 07/03/03

Location sampled:
Date sampled: 06/03/03 Date received: 07/03/03

	Laboratory Ref:	2301415	2301416	2301417	2301418	2301419	2301420	
	Type of sample:	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	
	Sampling point:	Downshire Hotel	Hennessy's Pub	Depot (Town Supply)	SW Stream beside depot	Deerpark Estate Supply	Statoil Garage	
	Sampled by:	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	
	Time Sampled:							
	Start/End - Dates of Analysis:							
	Status of results:	**Final Report**	**Final Report**	**Final Report**	**Final Report**	**Final Report**	**Final Report**	
Parameter	**Units**	**Limits**						
Dichlorodifluoromethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Vinyl Chloride	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromomethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Trichlorofluoromethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Methylene Chloride	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,2-Dichloroethene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	

	Laboratory Ref:	2301414	2301416	2301417	2301418	2301419	2301420	
	Type of sample:	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	
	Sampling point:	Downshire Hotel	Hennessy's Pub	Depot (Town Supply)	SW Stream beside depot	Deerpark Estate Supply	Statoil Garage	
	Sampled by:	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	
	Time Sampled:							
	Start/End - Dates of Analysis:							
	Status of results:	Final Report	Final Report	Final Report	Final Report	Final Report	Final Report	
Parameter	Units	Limits						
c-1,2-Dichloroethene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
2,2-Dichloropropane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromochloromethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Chloroform	µg/l		<0.5	<0.5	<0.5	<0.5	0.6	<0.5	
1,1,1-Trichloroethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloroethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloropropene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Benzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Carbon Tetrachloride	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Trichloroethene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloropropane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dibromomethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromodichloromethane	µg/l		<0.5	<0.5	<0.5	<0.5	2.8	<0.5	
c-1,3-Dichloropropene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Toluene	µg/l		<0.5	0.7	<0.5	<0.5	<0.5	<0.5	
t-1,3-Dichloropropene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,2-Trichloroethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3-Dichloropropane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	

	Laboratory Ref:	23014	2301416	2301417	2301418	1419	2301420	
	Type of sample:	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	
	Sampling point:	Downshire Hotel	Hennessy's Pub	Depot (Town Supply)	SW Stream beside depot	Deerpark Estate Supply	Statoil Garage	
	Sampled by:	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	
	Time Sampled:							
	Start/End - Dates of Analysis:							
	Status of results:	Final Report	Final Report	Final Report	Final Report	Final Report	Final Report	
Parameter	Units	Limits						
Dibromochloromethane	µg/l		<0.5	<0.5	<0.5	<0.5	5.4	<0.5	
Tetrachloroethene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dibromoethene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Chlorobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,1,2-Tetrachlorethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Ethylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
m,p-Xylene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Styrene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
o-Xylene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromoform	µg/l		<0.5	<0.5	<0.5	<0.5	3.2	<0.5	
1,1,2,2-Tetrachloroethane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Isopropylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2,3-Trichloropropane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
2-Chlorotoluene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
n-Propylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
4-Chlorotoluene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3,5-Trimethylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	

		Laboratory Ref:	23014[illegible]	2301416	2301417	2301418	[illegible]1419	2301420
		Type of sample:	Effluent	Effluent	Effluent	Effluent	[illegible]nt	Effluent
		Sampling point:	Downshire Hotel	Hennessy's Pub	Depot (Town Supply)	SW Stream beside depot	Deerpark Estate Supply	Statoil Garage
		Sampled by:	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens	Alan Stephens
		Time Sampled:						
		Start/End - Dates of Analysis:						
		Status of results:	**Final Report**	**Final Report**	**Final Report**	**Final Report**	**Final Report**	**Final Report**
Parameter		**Units**	**Limits**					
	tert-Butylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,2,4-Trimethylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,2-Dichlorobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,4-Dichlorobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	sec-Butylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	4-Isopropyltoluene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,3-Dichlorobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	n-Butylbenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,2-Dibromo-3-Chloropropane	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,2,4-Trichlorobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	Naphthalene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	Hexachlorobutadiene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
	1,2,3-Trichlorobenzene	µg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	

Comments:

1) *Results highlighted and in bold are outside specified limits.*
2) All Metals Analysed in the EPA Dublin Laboratory,
   Cyanide Analysed in the EPA Cork Laboratory.
   Phenols Analysed in the EPA Castlebar Laboratory.
3) **nm** "Not measured"
4) **nd** "None detected"
5) **nt** "No time" - Time not recorded
6) **tntc** "Too numerous to count"
7) **F** "Field measured parameters"

Signed: _____ Date: 7/8/03

Michael Neill, Regional Chemist