ROBERT'S COVE WATER SUPPLY SCHEME

GROUNDWATER SOURCE PROTECTION ZONES

Revised 2002

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1. Introduction

The objectives of this report are:

- To delineate source protection zones for the Robert's Cove Water Supply Scheme(WSS).
- To outline the principal hydrogeological characteristics of the Robert's Cove area.
- To assist Cork County Council (Southern Division) in protecting the water supply from contamination.

2. Location and site description

The Robert's Cove Water Supply is situated in the townlands of Doonavanig and Britfieldstown, just northwest and southwest respectively of Robert's Cove village in South Cork. The water supply comes from 2 boreholes:

- Borehole 1, Doonavanig, on the main road into Robert's Cove from Minane Bridge
- Borehole 2, Britfieldstown, also by a road, near some houses on the road out from Robert's Cove towards Nohoval.

Both bores are well protected inside their respective pumphouses. Neither well is capped and both are protected only by the pumphouse buildings. However the borehole sites are well marked and there are no major activities within a few metres. The water is pumped to a service reservoir in Doonavanig townland, about 700 m northeast of the Doonavanig borehole (Borehole 1)

3. Summary of well details

GSI no.	1705SWW071 (Borehole 1, Doonavanig)
Grid ref. (1:25,000)	17795 05508
Townland	Doonavanig
Owner	Cork County Council (Southern Division)
Well type	Borehole
Elevation (top of casing)	10.71 m OD
Depth	approx. 12 - 15 m
Diameter	0.15 m (6")
Depth-to-rock	Approx. 3-5 m but not exactly known
Pump depth	10 - 10.6 m approx.
Static water level	0.335 m b.g.l. (22/1/99). 1.805 m b.g.l. before pumping test on 7/7/99.
Drawdown	2.675 m
Current Abstraction	approx. 52.4-65.5 m^3/d (intermittently)
Pumping test summary	(i) Abstraction rate: 51.15 m^3/d
	(ii) Transmissivity: about 10-13 m^2/d
Yield test summary	1971 - 131 m^3/d

GSI no.	1705SWW072 (Borehole 2, Britfieldstown)
Grid ref. (1:25,000)	17766 05445
Townland	Britfieldstown
Owner	Cork County Council (Southern Division)
Well type	Borehole
Elevation (top of casing)	approx. 50.5 m OD (from 6" inch map)
Depth	approx. 58.5 m
Diameter	0.15 m (6")
Depth-to-rock	0.5 m (evidence from a nearby auger hole)
Pump depth	48.8 m.
Static water level	5.48 m b.g.l. (22/1/99)
Drawdown	1968 Council file expected ~48 m so pump is at this level
Current Abstraction	approx. 36 m^3/d (dependent on capacity of the pump)
Pumping test summary	(i) Abstraction rate: n/a
	(ii) Transmissivity: n/a
Yield test summary	(i) 93-98 m^3/d over an 8 hour test in 1951
	(ii) 47.5 m^3/d in October 1952

4. Methodology

4.1 Desk Study

Bedrock geology information was compiled from the published Geological Survey of Ireland 1:100,000 Bedrock Series (Sheet 25), (Sleeman & Pracht, 1994) and subsoils were compiled from the limited subsoil information available for the area, and from mapping by Teagasc. Basic public supply well details such as borehole depth, elevation, abstraction and pumping test data were obtained from GSI records and County Council personnel.

4.2 Site Visits and Fieldwork

This included carrying out well surveys, pumping tests etc. to aid in the conceptualisation of the hydrogeology. Vulnerability to contamination and the current pollutant loading in the area were also examined, using depth to bedrock augering and walkover studies.

4.3 Analysis

The assessment stage utilised field studies and a knowledge of the flow regime in the area to delineate protection zones around the public supply wells.

5. Topography and surface hydrology

The Doonavanig borehole is located in a pumphouse at the side of the road, 500 m west of Robert's Cove, at an elevation of approximately 10.7 m O.D. A steep hill behind the borehole rises to about 60-70 m O.D. At the top of this hill stands the service reservoir. The only surface drainage is a very small stream (mostly dry during summer 1999) just across the road from the borehole.

The Britfieldstown borehole lies at an elevation of about 50 m O.D. The land rises very slightly to the southwest behind the well. There are no obvious surface streams in the vicinity.

6. Geology

6.1 Bedrock geology

6.1.1 Geological Succession

Geological Unit	Code	Description
Courtmacsherry Formation	CY	Calcareous mudstone with limestone
Kinsale Formation		
Pigs Cove Member	KNpc	Sand-lensed mudstone
Cuskinny Member	KNcu	Flaser-bedded sandstone & mudstone
Old Head Sandstone Formation	OH	Flaser-bedded sandstone & minor mudstone

6.1.2 Geological Structure

The Robert's Cove area lies on the southern (north-dipping) limb of the small Ringabella Syncline. The rocks generally dip northwards, at an angle of about 40° from vertical, towards the axis of the syncline.

The Doonavanig borehole penetrates the Kinsale Formation (Cuskinny Member). The geological map shows that the borehole lies close to a localised fault zone. This fault runs roughly north-south from the area around the Doonavanig Reservoir to Robert's Head on the coast.

The Britfieldstown borehole abstracts from the same geological formation/member, but no faults are mapped nearby.

6.2 Subsoil Geology

6.2.1 Subsoil types

Two subsoil types can be identified in the area: Till and Alluvium

6.2.1.1 Till

According to Teagasc's map, "till derived from Devonian and Carboniferous age sandstones and shales" covers most of the area around Robert's Cove.

6.2.1.2 Alluvium

Teagasc's map also shows a small deposit of alluvium running along, and either side of, the small stream near Doonavanig borehole. A hole augered about 250 m away from the borehole in this alluvial deposit found 5.5 m of subsoil, comprising 2 m of sandy CLAY with silt, underlain by approximately 3 m of CLAY (using BS 5930 terminology). However, it was not clear whether this latter sample represented the alluvium or the till.

6.2.2 Depth to bedrock

Accurate depth-to-bedrock data are based on outcrop information, well records, subsoil sections and drilling. Outcrop in the Robert's Cove area is mainly restricted to the coastal areas, a road from from Ballyfoyle townland to Ballinvarrig, and one or two other isolated outcrops. 'Rock close' areas (rock within 1 m of ground surface) have also been identified from Teagasc's map, as well as from some borehole and well records. A depth-to-bedrock hole was augered very near to the Britfieldstwon borehole and encountered rock within 0.5 m of the surface. A dug well for domestic use is also found along this road, closer to the village, where it is seen that rock is within 1.7 m of the surface. Areas where rock is within 3 m of the surface have been identified, such as the area northwest of the Doonavanig Reservoir, and along the coast. Over most of the rest of the area, it seems that subsoils are

generally 3 to 5 m thick, but this is hard to confirm without more borehole data, as there may be small areas where the subsoil could be over 10 m thick. More investigation of the area is needed.

7. Rainfall, Evapotranspiration and Recharge

7.1 Rainfall

Long term average annual rainfall (P) is estimated at 1100 mm (Met Eireann).

7.2 Evapotranspiration

Long term average annual actual evapotranspiration (AE) is estimated at 486 mm (EPA).

7.3 Recharge

Long term average annual potential recharge is (1100 - 486) 614 mm.

Actual recharge will be a proportion of this, depending on the local runoff coefficient. Considering that the local bedrock is not very permeable, that a significant proportion of the ground is covered with till, and that topographic slopes are fairly steep, we can estimate actual recharge at about half of the potential, i.e. 300 mm/year.

8. Water Quality

8.1 Nitrate

Nitrate has been a problem in the Robert's Cove source for several years. Figure 2 presents the available nitrate data for the source. It is clear that the nitrate content of the water is very variable, from low (around 10 mg/l as NO_3) to unacceptably high (over 70 mg/l). It is difficult to make out any clear overall trend, but there is no sign that the trend is downwards.

Although the data are not conclusive, there does appear to be a pattern: most of the annual maxima are in the winter months, when recharge and water levels are high, whereas the annual minima tend to be in the summer or autumn months, when recharge and water levels tend to be lower. This suggests that the heavy winter recharge is carrying nitrogenous contaminants into the groundwater. Since fertiliser and slurry applications tend to be in the summer, the inference is that some other source of contamination may be to blame.

8.2 Bacteria

No known bacterial problems have been reported although it is unclear whether the values in the historical records are from raw or treated samples.

8.3 Other parameters

Water quality data are available for the Doonavanig borehole from 1991 to date. Sampling of this source was carried out as part of the Groundwater Protection Scheme for South Cork. Results of laboratory analyses of water samples taken in April 1999 suggest that the water from the Doonavanig borehole is typical of a calcium-bicarbonate type water. A total hardness value from the April sampling, of 295 mg/l as $CaCO_3$, indicates a hard water source.

Other parameters measured are shown in Table 1 below. Chloride, at 47.3 mg/l, is quite normal for a coastal area, and does not indicate any saline intrusion into the well, despite the low elevation and closeness to the sea. The caretaker of the scheme has noted problems with iron concentrations in the Britfieldstown borehole, and it is treated with permanganate to relieve the problem. However, detailed water quality parameters for this borehole are not available. There may also be a lot of lime in this well. The supply is chlorinated, so any bacteriological problems are not obvious.

Overall, apart from the nitrate and iron problems discussed above, the chemical quality of the water is generally quite good in the Robert's Cove area.

	Results of Inniscara Laboratory Analyses	
	Average (1991-99)	**14 April 1999**
Conductivity (μS/cm)	637	598
Temperature (°C)	11.5	14
pH	7.0	6.9
Total Hardness (as $CaCO_3$)	281	295
Total Alkalinity (as $CaCO_3$)	255	N/a
Calcium	N/a	97
Magnesium	N/a	12.7
Chloride	43	47.3
Sulphate	24	19.8
Sodium	N/a	24.5
Potassium	N/a	1.7
Nitrate (as NO_3)	32.7	48.6
Iron	<0.05	<0.05
Manganese	N/a	<0.05
Total coliforms (per 100ml)	0	0
E. coli (per 100ml)	0	0

Table 1: Water Quality parameters from Doonavanig Borehole, Robert's Cove WSS.

9. Hydrogeology

9.1 Pumping tests

9.1.1 Doonavanig

A ten-hour pumping test was carried out on 7/7/99. Data are in Appendix 1. The pumping rate was 51.15 m^3/d, and drawdown after 10 hours was 2.675 m. The specific capacity for this shallow borehole is therefore calculated at 19.12 m^3/d/m. Analysis of the pumping test data using appropriate software provided Transmissivity values in the range of 10-13 m^2/day.

9.1.2 Britfieldstown

For operational reasons, a pumping test could not be carried out on the Britfieldstown borehole.

9.2 Aquifer classification

The Kinsale Formation is part of the Cork Group. As outlined in Section 6, the rocks of the Kinsale Formation are a mud-dominant succession of grey mudstones and sand-lensed mudstones with some sandstones. The Cuskinny Member is a more sandstone-dominant facies. Permeability is mostly secondary (i.e. through fractures or fissures and weathered zones). On a QSC graph (Wright, 2000) The Doonavanig borehole falls into the middle productivity category, perhaps because of its proximity to a fault.

The formation is classed as a locally important aquifer, moderately productive only in local zones (Ll).

10. Groundwater Vulnerability

10.1 Subsoil Thicknesses

Subsoil thicknesses are discussed in Section 6.2.2. Bedrock is found at a fairly shallow depth over most of the area. Areas where subsoil thickness is less than 3 m are shown as of Extreme vulnerability on Map 2. Well or borehole data do not allow 5 or 10 m contours to be drawn. Areas of shallow subsoil can be found within the zones of contribution for both boreholes. At Doonavanig, rock is within 3 m of the surface about 150 m north of the well. At Britfieldstown the borehole is in an area of thin subsoil, with slightly thicker subsoil to the east and south. In these areas groundwater is considered as 'extremely' vulnerable to contamination.

10.2 Subsoil Permeabilities

Outside the areas of extreme vulnerability, most of the remaining area is underlain by "till derived from Devonian and Carboniferous age sandstones and shales (Teagasc, 1999). The texture of these deposits has yet to be determined, as an auger hole near the Doonavanig borehole was bored into what was mapped as alluvium, and thus missed the sandstone till. BS 5930 analysis of samples from this hole showed that it penetrated 2 m of sandy CLAY with silt, underlain by 3.5 m of CLAY which could be typical of alluvial deposits. Although these deposits appear to be quite clayey, they are considered to have a moderate permeability.

No samples were collected from the sandstone tills around the borehole, so vegetation and drainage assessments were used to estimate the subsoil permeabilities in this area. At Doonavanig, the land is well drained (fairly steep slope, only one small, intermittent, stream at the bottom) and can support arable farming. At Britfieldstown, the land appears to be fairly well drained also, with good pasture and a lack of surface streams. Both these areas are considered to have a moderate permeability, and, with inferred depths to bedrock of between 3 and 10 m, they fall into the 'high' vulnerability category.

11 Conceptual Model

11.1 Doonavanig - Borehole 1

- This shallow borehole, about 12 m deep, abstracts from the sandstones and mudstones of the Cuskinny member of the Kinsale Formation. There is a fault zone quite close to the well as described in Section 6.1.2. It is currently abstracting approximately 52 M^3/d, and although the fault zone could suggest a zone of higher permeability, this well can run dry during the summer months, perhaps due to its very shallow depth.
- Groundwater flow direction in the area around the bore is expected to follow topography and flow from north to south, from the high area around the reservoir and northwest of it, to the stream at the bottom of this small valley just across the road from Borehole 1.
- Groundwater gradients are estimated from topographic gradients, or from water levels in two or more wells if available. The production well and observation well, drilled some 56 m to the north, had their water levels measured just before the start of the July 1999 pumping test. A gradient of 0.053 was calculated using these water levels. However, the topographic gradient is much steeper, in the order of 0.1 to 0.15. The water level in the observation well may not have fully recovered before the pumping test began.
- The transmissivity (T) values calculated from pumping test data range between 10 and 13 m^2/d. This corresponds to a permeability (K) value of 1 m/d. This is a good estimation of the permeability of the upper few metres of this bedrock aquifer. The core recovered from drilling of an observation hole (56 m up-gradient although nearer to the localised fault) seems to confirm high permeability bedrock, with very broken, fractured and fissured grey rock. This local aquifer is therefore considered to be more permeable in this area than the geological description of the Kinsale Formation generally would imply.

- Thin tills cover the bedrock in this area. Teagasc's mapping has found them to be sandstone tills "derived from Devonian and Carboniferous age sandstones and shales". No samples of these tills were available for BS 5930 analysis, but other field observations such as field size, drainage and vegetation suggest that these tills are quite free-draining (Section 10.2). The tills are also quite shallow. Depth to rock of less than 3 m can be found in the north of the ZOC of this well and bedrock is assumed to be within 3 to 5 m of the surface immediately around the well.
- The steepness of the topography around this well, the high average annual rainfall (approximately 1100 mmlyr.) and the inferred high runoff of about 50%, suggest a recharge of approximately 300 mm/yr. This recharge is expected to reach the aquifer through the overlying shallow tills and in some areas of rock close to surface, through direct contact with the rock itself.
- It is assumed that groundwater feeds the small stream to the south of the borehole. However this stream did not appear to be influenced by pumping of the well during the pumping test in July 1999. Electrical conductivity values of the well water measured during the test stayed constant at 650 μS/cm throughout the test. However at that time the stream was very dry and there was no water available to be pulled into the well.
- The groundwater catchment of this well is assumed in part to be coincident with the surface water catchment.
- The water level in the public supply well was about 1.81 m b.g.1 (8.9 m O.D.) on 7 July 1999. In the observation well close by, it was a little higher, about 7.42 m b.g.1 (11.88 m O.D.). The aquifer, namely the Kinsale Formation (Cuskinny member), is thought to be unconfined.

11.2 Britfieldstown - Borehole 2

The aquifer around the Britfieldstown borehole is the same bedrock aquifer as at Doonavanig, but there is no nearby fault zone.

This well is much deeper (58.5 m) and currently abstracts approximately 36 m^3/d. This is quite a low rate but is limited by the capacity of the pump. There are no reported problems with yield during the summer months and in fact yield tests from the 1950s suggest that this well is capable of more.

The groundwater flow direction in this area is from southwest to northeast. There is a lack of any water levels from wells to get a reliable groundwater gradient, so topography has to be used. The topographic gradients in this area are much gentler than at Doonavanig, averaging about 0.04 to 0.05.

With gentler topographic gradients and thinner till cover it is expected that runoff around this well may be a little less than at Doonavanig. The tills are also quite permeable, so recharge is probably in the order of 300 mm/yr. There is no evidence of any surface streams within the ZOC, although there is a small one which rises just 200 m to the east.

The high iron levels found at the Britfieldstown borehole are assumed to be a feature of the rock type this borehole penetrates (Kelly *et al*, 2002).

12. Delineation of Source Protection Areas

12.1 Introduction

This section describes the delineation of the areas that are believed to contribute groundwater to the water supply sources in Robert's Cove (Doonavanig and Britfieldstown), and that therefore require protection. The areas are delineated on the basis of the conceptualisation of the groundwater flow pattern, as described in Section 11. Given the limited amount of calibration data available, a numerical groundwater model was not believed to add significant useful information to the conceptualisation.

Two source protection areas are delineated:

- Inner Protection Area (SI), designed to give protection from microbial pollution;

- Outer Protection Area (SO), encompassing the remainder of the zone of contribution (ZOC) of the well.

12.2 Outer Source Protection Area (SO)

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

i) An estimate of the area size is obtained by using the average recharge and the abstraction rate.

ii) The shape of the area is then derived by both analytical modelling and hydrogeological mapping techniques.

iii)To allow for errors in the estimation of groundwater flow direction and to allow for an increase in the ZOC in dry weather, a safety margin is incorporated by assuming a higher abstraction rate than the current rate.

12.2.1 Doonavanig -Borehole 1

The average abstraction rate for the borehole at Doonavanig was calculated using the rate noted during the pumping test in July. This rate of 51.15 m^3/d matches fairly well with the average pumping rate over longer periods of time. For calculation of the ZOC, a factor of safety is built into this average discharge, and it is increased (typically by 50%) to allow for possible future increases in abstraction and for expansion of the ZOC in dry periods. In this case, a discharge of 77 m^3/d was used. The recharge for the area is thought to be approximately 300 mm/yr, so the required area needed to provide the increased discharge above is 0.094 km^2, or 9.4 ha.

Hydrogeological mapping of the area around the Doonavanig borehole (Borehole 1) was used to delineate the ZOC to the well. The northern boundary of the ZOC is thought to coincide with the surface water catchment. The southern boundary of the ZOC was drawn based on calculations of the down-gradient distance. Using a discharge of 77 m^3/d, a hydraulic conductivity of 1 m/d, (see Section 9) and a groundwater gradient of 0.053, the downgradient distance is calculated as 19.3 m.

Although there was very little flow in the stream south of the borehole during the pumping test in July 1999, it is thought that water from the southern side of the river does not reach the well, and as such this area is not included in the ZOC. The main flow direction of groundwater in the area is towards the south. In order to take account of the heterogeneity of flow, probably in the upper few metres of the aquifer (as seen from the core from the observation hole), a variation in the flow direction of ±20° was included as a safety margin. Although there are nearby faults (within the ZOC), it is not thought that these act as barriers to groundwater flow. As the rock core examined from the observation hole showed, this rock would be quite permeable. Therefore, the eastern and western boundaries of the ZOC can be drawn, based on the flow directions, as is shown in Map 3. The mapped ZOC has an area of approximately 0.089 km^2 (8.9 ha), which compares well with the calculated area outlined above.

12.2.2 Britfieldstown - Borehole 2

Pumping test data are not available for the well at Britfieldstown. However, it is known to be pumping at a maximum, 36 m^3/d, limited by the capacity of the pump. It is also known that this well could be capable of more, from yield test data from the 1950s. In order to calculate the area of the ZOC for this well, the current discharge was increased by 50% to 54 m^3/d. This figure will allow for any increases in discharge from the well if the present pump is ever replaced.

The mapped catchment for the borehole at Britfieldstown (Borehole 2) has an area of approximately 0.07 km^2 (7 ha), as on Map 3. The southwestern boundary of the ZOC is taken to be the groundwater divide (co-incident with the surface water divide). Using a discharge of 54 m^3/d, a hydraulic conductivity of 0.5 m/d (as discussed in Section 0) and a very gentle gradient (from topography) of 0.04, the downgradient distance can be calculated at 8 m. The groundwater in this area is flowing

generally southwest to northeast. Because of the gentle topography a variation in the flow direction of ±20° was included as a safety margin. This delineates the northwestern and south- eastern boundaries. If the discharge of 54 m^3/d is used and recharge is taken to be 300 mm/yr, (Section 7.3) the calculated catchment would be in the order of 0.066 km^2 (6.6 ha). This figure is comparable with the mapped catchment.

12.3 Inner Source Protection Area (SI)

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

12.3.1 Doonavanig -Borehole 1

Permeability values for the aquifer around this source were derived from pumping test data (see Appendix 1). This estimate of permeability (1 m/d) is an average over the effective 12 m depth of the aquifer. This 12 m is assumed to be within the upper more permeable and fissured zone of the aquifer. Therefore it can be used in the context of creating an inner protection zone based on the time it would take pollutants to reach the well, as a high permeability (representing the zone of greatest and fastest flow) must be taken into account to give maximum protection to the borehole. Therefore, this permeability of 1 m/d was used to estimate the 100 day time of travel zone distance to the well. Using an effective porosity value of 0.02 and a groundwater gradient of 0.053, the 100 day time of travel distance to the well is estimated at 265 m (see Map 3).

12.3.2 Britfieldstown - Borehole 2

The geology of the area around this well is assumed to be similar in rock type but perhaps different in permeability, due to the absence of a local fault zone. As such the permeability for this area of the aquifer is taken to be lower at 0.5 m/d. Using the same porosity and a gradient of 0.04, the 100 day time of travel distance to the wells is estimated at 100 m (see Map 3).

13 Groundwater Protection Zones

The groundwater protection zones are obtained by integrating the two elements of land surface zoning (source protection areas and vulnerability categories) - a possible total of 8 source protection zones (see the matrix in the table below). In practice, the source protection zones are obtained by superimposing the vulnerability map on the source protection area map. Each zone is represented by a code e.g. **SI/H,** which represents an **Inner Protection Area** where the groundwater is **highly** vulnerable to contamination. There are 4 groundwater protection zones present around the Doonavanig Borehole 1 and ? around the wells at Britfieldstown (Borehole 2) (Map 3), as shown in the matrix below.

Matrix of Source Protection Zones

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

The response measures imposing restrictions on certain developments and activities within these zones are included in "Groundwater Protection. Schemes" (DELG, EPA & GSI, 1999). These measures indicate the degree of restriction recommended in each protection zone.

14 Land Use and Potential Pollution Sources

The main hazards within the Zones of Contribution are considered to be landspreading and the application of fertilisers up-gradient of both supplies. There are a number of farms in the area, which have been surveyed by Council staff in late 1998. Intensive arable farming (cereals and sugar beet) is practised up-gradient of the well at Doonavanig, within the ZOC, and could be a potential pollution source. Nitrate levels at this borehole are elevated and have breached the EU MAC (of 50 mg/1) at least 8 times since 1991.

There is also farmland up-gradient of the well at Britfieldstown. There are a number of houses within the ZOC of this well, on both sides of the road. According to Council staff, these houses have their own septic tanks as there is no public sewer system in the Robert's Cove area. There are no water quality records available for this well and it was not sampled by GSI in either April or September 1999. This supply is also chlorinated so bacteriological problems are not obvious.

Other hazards include septic tank systems, as well as possible spillages along the roads up-gradient of the wells. No detailed assessment of hazards was carried out as part of this study.

15 Conclusions and Recommendations

- The Public Water Supply at Robert's Cove consists of 2 wells. One is located in a pumphouse by the road from Minane Bridge to Robert's Cove in the townland of Doonavanig, while the other is also in a roadside pumphouse but on the other side of Robert's Cove on the road to Nohoval, in the townland of Britfieldstown.
- The shallow well in Doonavanig (Borehole 1) is a 'moderate' well, which currently abstracts 52 m^3/d. Pumping test data from July 1999 gave a specific capacity of 19.12 m^3/d/m. Council staff have noted that this well can go dry in summer. The much deeper well at Britfieldstown is less intensively poumped, currently abstracting 36 m^3/d. Yield tests carried out on this well in the 1950s suggests it could be capable of up to 98 m^3/d, but it is limited by the size of its present pump. No data exist on the sustainability of this yield.
- Both wells in Robert's Cove are abstracting from the Kinsale Formation (Cuskinny Member) which is classified as a **locally important aquifer which is moderately productive only in local zones (Ll).**
- The wells are located in areas of sandstone till and are close to areas of rock outcrop or thin subsoil, especially Borehole 2 at Britfieldstown. As such they lie in areas of high and extreme vulnerability as shown on the Vulnerability Map (Map 2).
- Water quality at both these wells is generally quite good, apart from the elevated nitrate levels at Borehole 1 and the reported high iron levels at Borehole 2. The nitrate levels at Borehole 1 seem to peak in the winter months. This suggests that the heavy winter recharge is carrying nitrogenous contaminants into the groundwater. Checks should be carried out to see that fertiliser applications and landspreading are carried out at the appropriate times so as to ensure they are not carried into the ground by high recharge conditions. High iron levels in the Britfieldstown borehole are to be expected considering the rock type tapped by this well, in which high Iron and Manganese levels are not uncommon. Treatment with permanganate should be sufficient, accompanied by closer monitoring of the water quality in this borehole.
- The inner and outer protection zones delineated in the report are based on our current understanding of groundwater conditions and on the available data. Additional data obtained in the future may indicate that amendments to the boundaries are necessary.
- It is recommended that:

- Chemical and bacteriological analyses of raw water rather than treated water should be carried out on a regular basis (every 6 months). The chemical analyses should include all major ions - calcium magnesium sodium, potassium, ammonium, bicarbonate, sulphate, chloride, and especially nitrate.
- Particular care should be taken in allowing any activities or developments which might significantly increase nitrate levels or cause contamination at either of the wells.
- The potential hazards in both ZOCs should be located and assessed;
- Guidelines should be drawn up for dealing with underground storage/transfer, and spillages along the roads in the area.

16 References

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Appendix 1

Pumping Test Data

SITE Robert's Cove

DATE 1st July 1999

Groundwater Section
Geological Survey of Ireland

Project Title Sth Cork GWPS

PUMPING TEST OBSERVATION WELL

Borehole Name	Robert's Cove Obs Well	Well Depth	~ 20 m	Datum Point	Top of lining
Borehole No.	1705 SW W	Well Diameter	~ 60 mm	Height of Datum	
Well Owner	Cork Co Co / GSI	Pump Depth	n/a	Ground Elevation	
Location	~ 30 m upgradient in field	Aquifer	Kinsale Formation	Datum Elevation	
Grid ref.				Weather	Dull but dry. Rain last night
6" Sheet No.	CORK 113			Observer	Maeve McHugh

Date	Time	Elapsed Time	Water level below datum	Drawdown	Discharge		Discharge	Remarks	
		Mins	(m)	(m)	Meter	Spot	(m3/d)		
########	07:00	0	7.39	0					
		0.25	7.39	0					
		0.5	7.39	0					
		0.75	7.39	0					
		1	7.39	0					
		1.25	7.39	0					
		1.5	7.39	0					
		1.75	7.395	0.005					
		2	7.395	0.005					
		2.5	7.395	0.005					
		3	7.395	0.005					
		3.5	7.395	0.005					
		4	7.395	0.005					
		4.5	7.395	0.005					
		5	7.395	0.005					
		6	7.395	0.005					
		7	7.395	0.005					
		8	7.395	0.005					
		9	7.395	0.005					
	07:10	10	7.395	0.005					
		12	7.395	0.005					
		14	7.395	0.005					
		16	7.395	0.005					
		18	7.395	0.005					
	07:20	20	7.395	0.005					
		25	7.395	0.005					
	07:30	30	7.395	0.005					
		35	7.395	0.005					
		40	7.395	0.005					
	07:45	45	7.398	0.008					
		50	7.398	0.008					
		55	7.398	0.008					
	08:00	60	7.399	0.009					
		70	7.399	0.009					
		80	7.4	0.01					
	08:30	90	7.395	0.005					
		100	7.395	0.005					
		110	7.395	0.005					
	09:00	120	7.398	0.008					
		130	7.395	0.005					
		140	7.395	0.005					
		150	7.395	0.005					
		160	7.391	0.001					
		170	7.39	0					
	10:00	180	7.39	0					

SITE Robert's Cove

DATE 07/07/1999

Groundwater Section
Geological Survey of Ireland

Project Title Sth Cork GWPS

PUMPING TEST OBSERVATION WELL

Borehole Name	Robert's Cove Obs Well	Well Depth	~ 20 m	Datum Point	Top of lining
Borehole No.	1705 SW W	Well Diameter	~ 60 mm	Height of Datum	0.47 m above g.l
Well Owner	Cork Co Co / GSI	Pump Depth	n/a	Ground Elevation	
Location	~ 30 m upgradient in field	Aquifer	Kinsale Formation.	Datum Elevation	
Grid ref.				Weather	Cloudy with sunny spells
6" Sheet No.	CORK 113			Observer	O. Craig

Date	Time	Elapsed Time	Water level below datum	Drawdown	Discharge		Discharge	Remarks	
		Mins	(m)	(m)	Meter	Spot	(m3/d)		
########	07:00	0	7.42	0					
		0.25	7.42	0					
		0.5	7.42	0					
		0.75	7.42	0					
		1	7.42	0					
		1.25	7.42	0					
		1.5	7.42	0					
		1.75	7.42	0					
		2	7.42	0					
		2.5	7.42	0					
		3	7.42	0					
		3.5	7.42	0					
		4	7.42	0					
		4.5	7.42	0					
		5	7.422	0.002					
		6	7.422	0.002					
		7	7.422	0.002					
		8	7.422	0.002					
		9	7.422	0.002					
	07:10	10	7.422	0.002					
		12	7.422	0.002					
		14	7.422	0.002					
		16	7.422	0.002					
		18	7.422	0.002					
	07:20	20	7.422	0.002					
		25	7.425	0.005					
	07:30	30	7.425	0.005					
		35	7.428	0.008					
		40	7.428	0.008					
	07:45	45	7.428	0.008					
		50	7.429	0.009					
		55	7.432	0.012					
	08:00	60	7.432	0.012					
		70	7.435	0.015					
		80	7.438	0.018					
	08:30	90	7.439	0.019					
		100	7.445	0.025					
		110	7.45	0.03					
	09:00	120	7.452	0.032					
		130	7.455	0.035					
		140	7.458	0.038					
	09:30	150	7.46	0.04					
		160	7.462	0.042					
		170	7.462	0.042					
	10:00	180	7.464	0.044					
		195	7.465	0.045					
		210	7.465	0.045					
		225	7.465	0.045					
	11:00	240	7.465	0.045					
		255	7.465	0.045					
		270	7.465	0.045					
		285	7.465	0.045					
	12:00	300	7.465	0.045					
		330	7.465	0.045					
	13:00	360	7.465	0.045					
		390	7.46	0.04					
	14:00	420	7.455	0.035					
		450	7.45	0.03					
	15:00	480	7.447	0.027					
		510	7.44	0.02					
	16:00	540	7.438	0.018					
		570	7.431	0.011					
	17:00	600	7.43	0.01					

SITE Robert's Cove

DATE 7/7/99

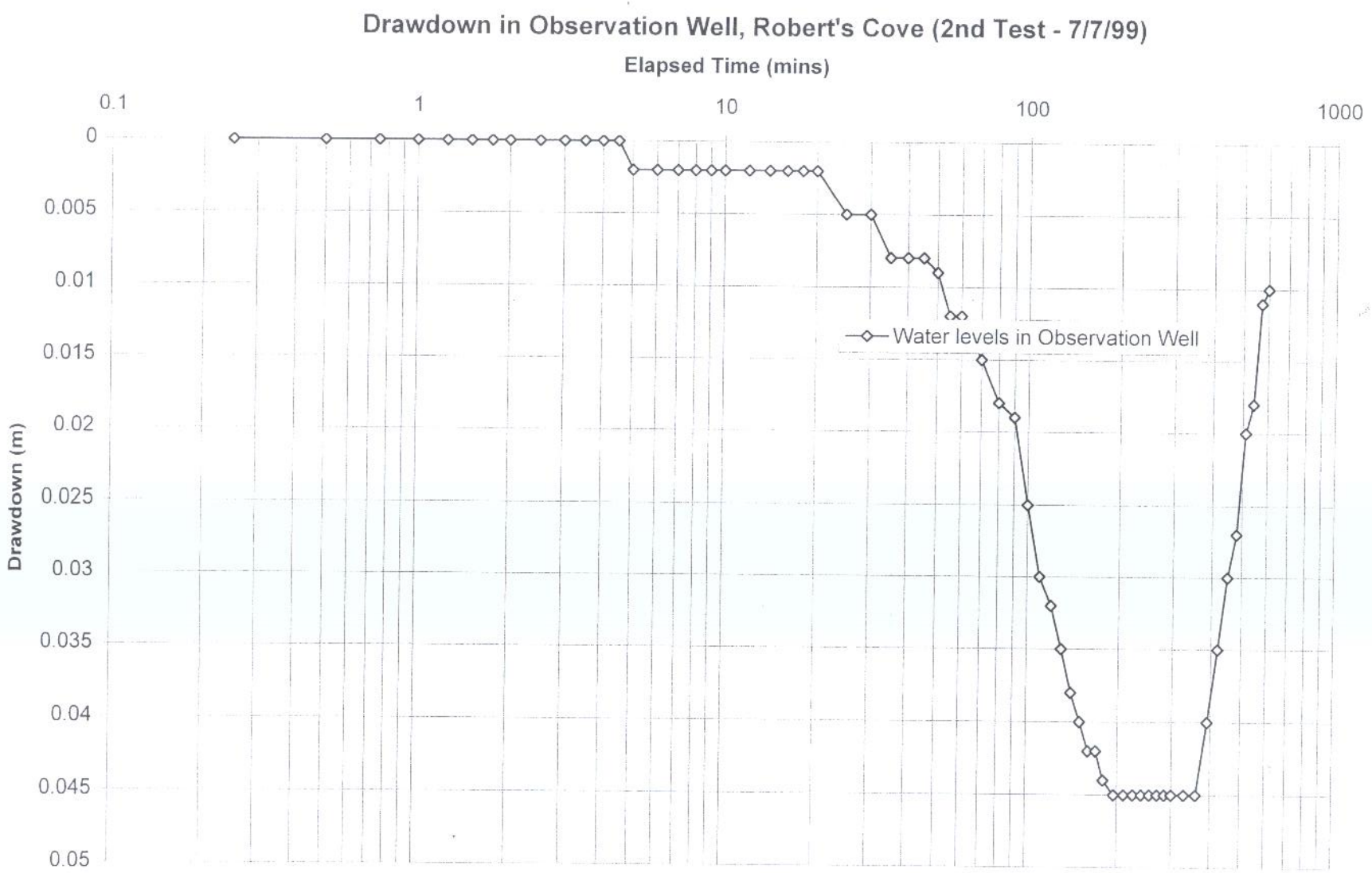
Groundwater Section
Geological Survey of Ireland

Project Title Sth Cork GWPS

RECOVERY TEST OBSERVATION WELL

Borehole Name	Robert's Cove Obs Well	Well Depth	~ 20 m	Datum Point	Top of lining
Borehole No.	1705SW W	Well Diameter	~ 60 mm	Height of Datum	0.47 m above g.l
Well Owner	Cork Co Co / GSI	Pump Depth	n/a	Ground Elev.	
Location	~ 30 m upgradient in field	Duration of Pumping		Datum Elev.	
Grid ref.		Average Discharge		Weather	cloudy with sunny spells
6" Sheet No.	CORK 113	Aquifer		Observer	O. Craig

Date	Time	Time since Pumping Began (t)	Time since Pumping Ended (t')	Water level below datum	t/t'	Residual Drawdown	Recovery	Remarks
		Mins	Mins			(m)	(m)	
07/07/1999	17:00	600	0	7.43				
		600.25	0.25	7.43	2401.00			
		600.5	0.5	7.43	1201.00			
		600.75	0.75	7.43	801.00			
		601	1	7.43	601.00			
		601.25	1.25	7.43	481.00			
		601.5	1.5	7.43	401.00			
		601.75	1.75	7.43	343.86			
		602	2	7.43	301.00			
		602.5	2.5	7.43	241.00			
		603	3	7.43	201.00			
		603.5	3.5	7.43	172.43			
		604	4	7.43	151.00			
		604.5	4.5	7.43	134.33			
		605	5	7.43	121.00			
		606	6	7.43	101.00			
		607	7	7.43	86.71			
		608	8	7.43	76.00			
		609	9	7.43	67.67			
	17:10	610	10	7.43	61.00			
		612	12	7.43	51.00			
		614	14	7.43	43.86			
		616	16	7.43	38.50			
		618	18	7.43	34.33			
	17:20	620	20	7.43	31.00			
		625	25	7.43	25.00			
	17:30	630	30	7.43	21.00			
		635	35	7.43	18.14			
		640	40	7.43	16.00			
	17:45	645	45	7.43	14.33			
		650	50	7.43	13.00			
		655	55	7.43	11.91			
	18:00	660	60	7.43	11.00			
		670	70	7.43	9.57			
		680	80	7.43	8.50			
	18:30	690	90	7.43	7.67			
		700	100	7.43	7.00			
		710	110	7.43	6.45			
	19:00	720	120	7.43	6.00			
		730	130	7.43	5.62			
		740	140	7.43	5.29			
	19:30	750	150	7.43	5.00			
		760	160	7.43	4.75			
		770	170	7.43	4.53			
	20:00	780	180	7.43	4.33			
		795	195	7.43	4.08			
	20:30	810	210	7.43	3.86			
		825	225	7.43	3.67			
	21:00	840	240	7.43	3.50			


Drawdown in Observation Well, Robert's Cove (2nd Test - 7/7/99)
Elapsed Time (mins)
0.1
1
10
100
1000
Drawdown (m)
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05
Water levels in Observation Well

Appendix 2

Water Quality Data

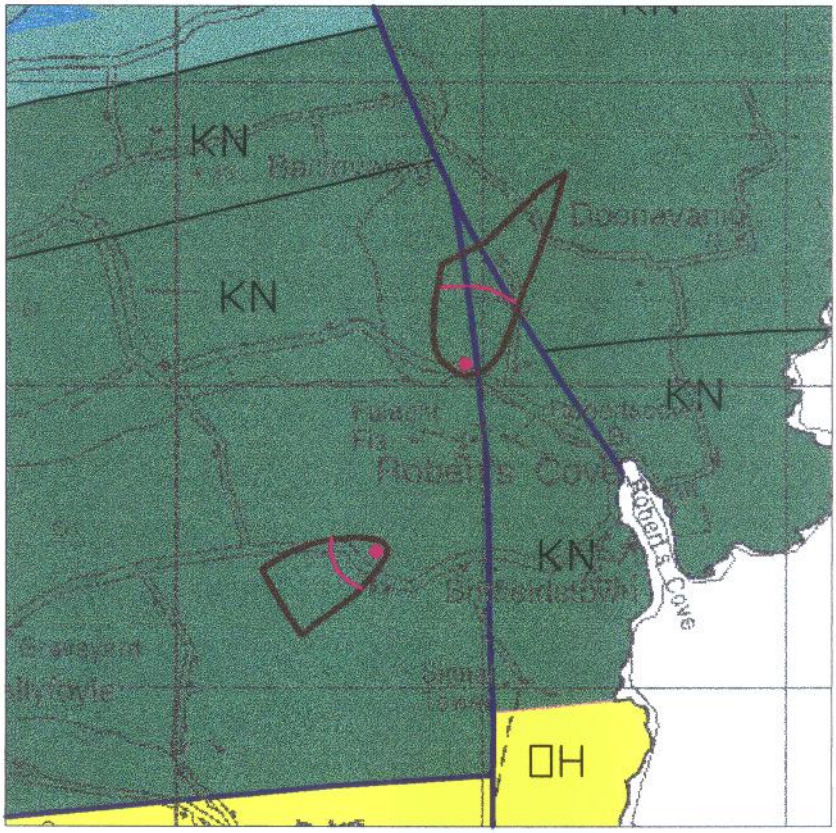
Robert's Cove WSS Water Quality

Greater than Guide levels
Greater than MAC levels

Hydrochemistry and Water Quality Database

Groundwater Section, Geological Survey of Ireland.

									Ratios		Other Commonly Analysed Parameters									Bacteria		pH	Temp		EC (20 oC)			
	Lab	Date	Ca	Mg	Na	K	SO4	Cl	K:Na	Mg:Ca	Alk	TH	Fe	Mn	Nitrite		Nitrate	NH4	Al	E-Coli	TC	Lab	Lab	Field	Lab	Field	F	Zn
Units			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l			mg/l CaCo3		mg/l	mg/l	N	NO2	NO3	mg/l	mg/l	no/100l	no/100l		oC	oC	uS/cm		mg/l	mg/l
MAC			200	50	150	12	250	250					0.2	0.05	0.03	0.1	50	0.23	0.2	0	0				1500		1	1
	Inniscarra	15/01/1991													0.003		17.89	0.016		0	3	7.1	6		622			
	Inniscarra	24/04/1991																		0	0							
	Inniscarra	26/08/1991													0.012		0.04	0.01		0	5	7	16		593			
	Inniscarra	30/09/1991																		9	?9999?				529			
	Inniscarra	14/10/1991																		5					547			
	Inniscarra	06/11/1991													0.004		13.73	0.004		0	0	6.8	10		594			
	Inniscarra	13/01/1992																		0	0		7.5		569			
	Inniscarra	27/01/1992													0.005		70.64	0.058		0	0	7.2	8.2		798			
	Inniscarra	06/04/1992																		0	0		9.5		778			
	Inniscarra	06/07/1992													0		7.05	0.013	0	0	0	6.8	18.5		718			
	Inniscarra	18/08/1992																		0	0		16.5		709			
	Inniscarra	14/09/1992																		0	0		15		785			
	Inniscarra	05/10/1992																		0	0				865			
	Inniscarra	22/02/1993													0.003		16.99			0	0		9		655			
	Inniscarra	23/03/1993																		0	0				631			
	Inniscarra	05/04/1993																		0	0		9.5		687			
	Inniscarra	03/05/1993																		0	0		10		709			
	Inniscarra	10/05/1993																		0	0				711			
	Inniscarra	18/05/1993																		0	0				700			
	Inniscarra	02/06/1993																		0	0				658			
	Inniscarra	14/06/1993													0.003		41.99	0.02		0	0	7			716			
	Inniscarra	22/06/1993																		0	0				717			
	Inniscarra	28/06/1993													0.007		53.49	0.01		0	0	6.9	11		712			
	Inniscarra	22/07/1993																		0	0				707			
	Inniscarra	26/07/1993																		0	0		17		581			
	Inniscarra	20/09/1993																		0	0				552			
	Inniscarra	05/10/1993																		0	0				602			
	Inniscarra	24/01/1994																		0	0				610			
	Inniscarra	23/02/1994										332	0	0.034	0.01		76.27	0.01		0	0	7.1	7		725			
	Inniscarra	16/05/1994																		0	0				628			
	Inniscarra	26/09/1994																		0	0				701			
	Inniscarra	25/10/1994																		0	0				681			
	Inniscarra	22/02/1995																		0	0				625			
	Inniscarra	07/03/1995					24	43			255	217	0.1	0.025	0.006		43.78	0.01	0.03	0	0	7.1	7		615			0.05
	Inniscarra	24/04/1995																		0	0				431			
	Inniscarra	24/07/1995																		0	0				516			
	Inniscarra	07/11/1995											0	0	0.002		??11.29	0.01		0	0	7.1	12		494		0.5	
	Inniscarra	01/02/1996																		0	0				573			
	Inniscarra	05/02/1996											0	0	0.01		29.9	0 01		0	0	6.8	7		581			
	Inniscarra	24/06/1996											0	0	0.016		37.5	0.013		0	0	7.2	16		587			
	Inniscarra	07/10/1996																		0	0				472			
	Inniscarra	29/01/1997																		0	0				595			
	Inniscarra	19/03/1997															55			0	0							
	Inniscarra	08/04/1997															54			0	0				607			
	Inniscarra	06/05/1997																		0	0				608			
	Inniscarra	11/06/1997															10											
	Inniscarra	26/08/1997											0	0	0.013		21.18	0.026		0	1	7	18		552			
	Inniscarra	17/11/1997															23											
	Inniscarra	10/12/1997															63											
	Inniscarra	17/02/1998															59											
	Inniscarra	24/03/1998															60											
	Inniscarra	15/09/1998														0.039	25.54	0 02		0	0	6.7	13		539			
	Inniscarra	14/04/1999	97	12.7	24.5	1.7	19.8	47.3	0.069	0.131		295	<0.05	<0.05		<0.013	48.6	<0.026		0	0	6.9		14	598	554		



Roberts Cove Water Supply Scheme

Map 1. Geology

0 500m 1 km

CY Courtmacsherry Formation

KN Kinsale Formation

OH Old Head Sandstone Formation

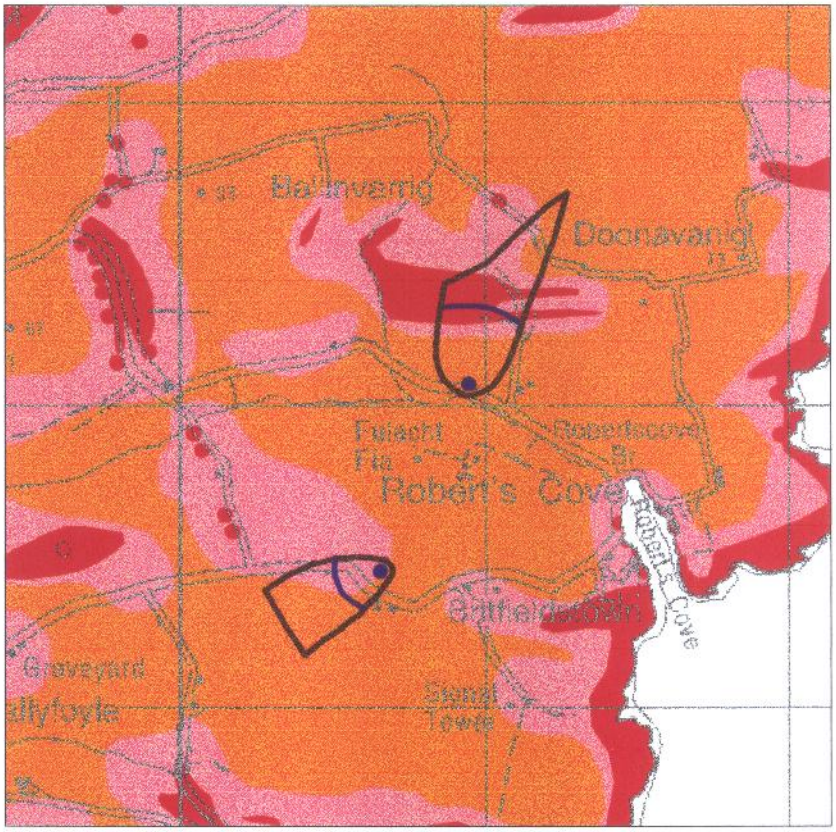
Fault

Public Supply Well

Inner Protection Zone

Zone of Contribution

This Bedrock Map is designed for general information and stragegic planning usage. The boundaries are based on the available evidence and local details have been generalised to fit the map scale.
Evaluation of specific sites and circumstances will normally require further and more detailed assessments, and will frequently require site investigations.



0 500m 1km

Roberts Cove Water Supply Scheme

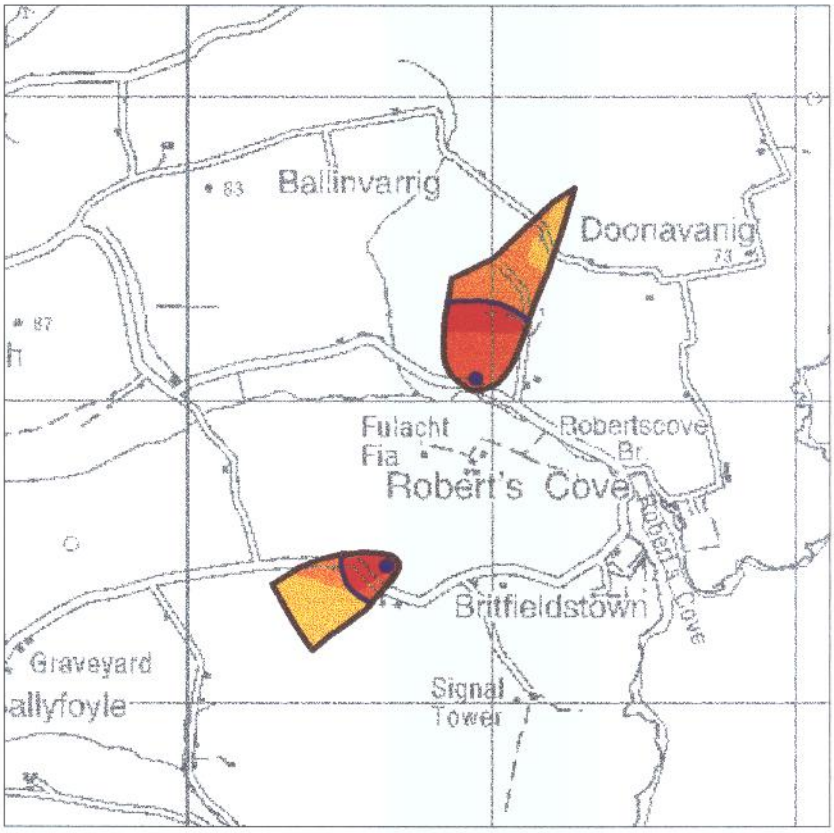
Map 2. Groundwater Vulnerability

- Extreme (E)
- Outcrop/Shallow rock (E)
- High (H)
- Moderate (M)
- Low (L)
- Public Supply Well
- Zone of Contribution
- Inner Protection Zone

Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The map shows the vulnerability of the first groundwater encountered (in either sand/gravel aquifers or in bedrock) to contaminants released at depths of 1-2 m below the ground surface. Where contaminants are released at significantly different depths, there will be a need to determine groundwater vulnerability using site-specific data. The characteristics of individual contaminants have not been taken into account.

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



0 500m 1km

Roberts Cove Water Supply Scheme

Map 3. Source Protection Zones

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

Public Supply Well

Inner Protection Zone

Zone of Contribution

This **Source Protection Map** is designed for general information and stragegic planning usage. The boundaries are based on the available evidence and local details have been generalised to fit the map scale.
Evaluation of specific sites and circumstances will normally require further and more detailed assessments, and will frequently require site investigations.
The map is intended for use in conjunction with groundwater protection responses for potentially polluting activities, which lists the degree of acceptability of these activities in each zone and describes the control measures necessary to prevent pollution.