BALLINGARRY PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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1. SUMMARY OF WELL DETAILS

GSI no.	:	1413SWW009
Grid ref.	:	14165, 13632
Owner	:	Limerick Co. Co.
Well type	:	Spring / dug well
Elevation (top of chamber)	:	80.99 m OD (Poolbeg); ground level is 80.7 m OD
Depth	:	3.24 m (below top of chamber)
Diameter	:	3500 mm
Depth-to-rock	:	estimated at >10 m
Static water level	:	1.8 m below ground level (Co. Co. estimate)
Pumping water level	:	2.7 m below top of chamber (3/10/95)
Average total output	:	550 m^3/d (5,000 gal/hr)
Normal consumption	:	417–458 m^3/d (over 24 hrs)
Specific capacity	:	~785 m^3/d/m

2. METHODOLOGY

There were three stages involved in assessing the area, a detailed desk study, site visits and fieldwork, and analysis of the data. The desk study was conducted in the Geological Survey where the subsoil and bedrock geologies were compiled from the original 6" field sheets. Basic public supply well details were recorded by County Council personnel in the form of a questionnaire which included a precise location and any relevant chamber construction and water chemistry data available.

The second stage comprised site visits and fieldwork. The area encompassing a circle of 1 km radius was mapped with regard to subsoil and bedrock geology, hydrogeology and vulnerability to contamination. Finally, two raw water samples were taken in September 1993 and April 1994 for full suites of chemical and bacterial analyses.

Stage three, the assessment stage, utilised analytical equations and hydrogeological mapping to delineate protection zones.

3. WELL LOCATION AND SITE DESCRIPTION

The Ballingarry source is located close to the town, at the junction of the two roads which join to form the L118 to Croom, and it is marked on the six inch topographic sheets as Sunday Well. The wellhead is housed in a concrete chamber behind the pumphouse and it is fenced off in an enclosure which is owned by the County Council. A Group Water Scheme also abstracts from the source to supply the area between Ballingarry and Knockfeerina.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

Ballingarry lies in the valley between two east-west trending hills, the Knockaderry ridge (216 m OD; 708 ft) to the west and the Knockfeerina ridge to the east (289 m OD; 948 ft). The ground slopes away to a relatively flat and low-lying area to the north while it remains higher than 91.4 m OD (300 ft) to the south.

The Clonshire River, which is part of the River Maigue catchment, flows through the town in a northeasterly direction. There are a few other springs in the area which drain into the river, including John's well in the river valley to the northeast of the site, but generally the area may be described as dry with no drainage ditches and infrequent streams.

With the exception of the village, the land in the area is used primarily for grazing. The large field on the hill to the south of the source was being ploughed on one of the site visits and is now sown with grass. There are also a number of both used and disused quarries on the higher regions of Knockfeerina hill.

5. GEOLOGY

5.1 Bedrock geology

The bedrock geology of the area is dominated by the two east-west ridges which are present as a result of the folding in the area (Fig. 1). The hills are comprised of Kiltorcan Sandstone which may be described as coarse yellow and white sandstones and grits with occasional red shales. To the north and south of the ridges, the rocks move up the succession through the interbedded limestones, sandstones and shales of the Mellon House Beds, the dark shales and thin dark limestones of the Ringmoylan Shales and the dark fossiliferous limestones of the Ballysteen Formation. There are also some Waulsortian Mudbank limestones recorded in drill core further to the north. A major SSW-NNE fault trends through the town and has created the valley between the two ridges. There is also a second major fault trending NNW-SSE which intersects the first in the town centre. Bedding planes generally dip away from the hills in all directions, at angles ranging from 5 to 30°. There are likely to be two series of joints and fractures parallel to the major faults.

5.2 Subsoils (Quaternary) geology

The subsoils of the area are quite complex. The most common subsoil type is till-with-gravel which is composed of interbedded gravels and tills in varying proportions, although the predominant component would appear to be sands and gravels (Fig. 2). Borehole records to the north indicate that till, where present, is a grey sticky clay with silt, becoming more sandy in places. Interbedded with these, are clean sands and gravels which reach 12 m in thickness to the northeast of the site. A section, which is now covered over, in an old gravel pit to the south of the site (NGR 14175, 13577) showed the sands and gravels to be bedded, indicating that they are fairly well washed and have little of the finer silt and clay fractions. The area to the south of the town is underlain predominantly by limestone till, despite a record of an old gravel pit which is now closed in. In the higher areas, rock is generally at or close to the surface, although there are thin till-with-gravel or head deposits in places. There is also a channel of alluvial deposits along the course of the river bed.

5.3 Soils

The majority of the soils in the area are classed in the Baggotstown Series which are derived from a parent material of glacial gravels and sands of predominantly limestone origin, with some sandstone, shale and volcanics. This suggests that sands and gravels are more common than till in the the till-with-gravel deposits. . The soils are high base brown earths with a gravelly, sandy loam texture and they are well to excessively drained. The area to the southwest of Ballingarry is dominated by the gleys of the Howardstown Series. The soils on the higher regions on the hills are mainly intensely leached podzols (Knockaceol Series) derived from colluvium or head deposits of a sandstone origin. The soils are shown on the published soils map of Co. Limerick (Finch and Ryan, 1966) and so are not reproduced here.

5.4 Depth-to-rock

Rock crops out on both hills although there is a thin subsoil cover in places. Exploration boreholes to the north and northeast of the site have recorded depths of 50 m, 22.3 m and 40 m to bedrock (Fig. 2). These thicknesses are common on the northerly flanks of large rock features in Co. Limerick, such as the Knockfeerina hill, as during the ice ages, the southerly moving glaciers banked up against them and deposited large quantities of sediment. Depth-to-rock around the public supply is unknown but the subsoil cover is likely to be quite thick, as was found to be the case in the rest of the valley. The depth-to-rock contours are based on few data points and may need refining as further borehole records become available.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Ballingarry area are lacking; the following data sources were used in considering the conceptual model:

- The source caretaker's notebook.
- GSI well records.
- GSI Mineral exploration reports for the area.

6.2 Discharge

The average discharge at the source is estimated by the County Council to be of the order of 550 m^3/d (5,000 gal/h), and it is said to reduce slightly during the summer months although it has never failed to sustain the required yield. From the caretakers notebook, it would appear that the monthly average consumption at Ballingarry ranges from 417 m^3/d in February, to 458 m^3/d in August, with daily figures reaching as high as 541 m^3/d at times. The spring has an overflow into the river but as another smaller spring is fed through the same pipeline, the quantity overflowing from the source cannot be estimated.

6.3 Groundwater levels

Groundwater levels will vary over the area depending upon topography, and the permeability of the subsoils and bedrock. The pumping water level in the public supply well on 3/10/95 was 78.29 m OD (2.7 m below the top of the chamber). A static water level was not available but it is estimated as approximately 79 m OD (1.8 m below ground level) by the County Council. It is reasonable to assume that the river is in hydraulic continuity with groundwater and the water level is therefore taken as that of groundwater. The pumping water level in the public supply is estimated from site measurements to be slightly higher than the river level.

A well on the hill to the south of the source, in the townland of Gorteen, has a recorded water level of 12 m below surface; consequently apart from the lowland areas around the river, the unsaturated zone is expected to be more than 10 m thick.

6.4 Groundwater flow directions

Groundwater will generally flow perpendicular to the topographic contours in a northerly direction from the Knockfeerina ridge towards the river. At the western end of the ridge however, in the vicinity of the source, there will also be a westerly component in flow direction before it swings northward and into the river valley.

6.5 Meteorology and recharge

Rainfall data for the area are taken from the nearest, most representative weather station which is located in Kilmeedy. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1941–1980 was 976 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 500 mm per annum. Actual evapotranspiration (A.E.) is then calculated by taking 93% of the potential figure, to allow for soil moisture deficits during part of the year. Using these figures, the average annual effective rainfall (E.R.) is taken to be approximately 511 mm per annum.

As there are no drainage ditches or streams in the recharge area to the spring, and the subsoil deposits and soils are very permeable and free draining, a high proportion of the effective rainfall infiltrates to the water table. Estimating run off to be of the order of 10%, the average recharge to the aquifer is taken to be 460 mm per annum.

These calculations are summarised below:

Average annual rainfall	976 mm
Estimated P.E.	500 mm
Estimated A.E. (93% P.E.)	465 mm
Effective rainfall	511 mm
Recharge (90% E.R.)	460 mm

6.6 Hydrochemistry and water quality

The hydrochemical analyses of groundwater at the source in Ballingarry indicate that it is a **hard** water (265–289 mg/l; $CaCO_3$), with moderately high alkalinity (229–243 mg/l; $CaCO_3$). Conductivities are in the range 535–610 μS/cm. These analyses are indicative of a calcium bicarbonate type water which may either be a carbonate rich sandstone or which may lie at the softer end of the limestone carbonate water scale. The hardness values would be more typical of the sandstones in Co. Limerick but values this low may also occur in limestones.

The water quality at the source is variable. Nitrate varied from 3.37–29.4 mg/l and was higher than the guide level in four ($n = 10$) samples suggesting that contamination may be occurring at times. Chloride reached 38 mg/l in two of the analyses and this may also suggest that contamination is occurring at times. The analyses from the State Laboratory, taken on raw water samples, show no evidence of faecal coliforms although there was a count of 10 total coliforms/100 ml in the September analysis.

6.7 Conceptual model

The aquifer which is supplying the Ballingarry source is the large area of till-with-gravel to the south, although the underlying Kiltorcan Sandstone may also be contributing. The permeabilities of the subsoils will be variable with the changes in clay content, but from the borehole records to the north and northeast of the site, the permeable soil cover, and the lack of surface water drainage, it would appear that there is quite a high proportion of high permeability sands and gravels throughout. Recharge to the aquifer occurs on the slopes of the Knockfeerina ridge, directly to the southeast of the source. The highly permeable sandstones are likely to have a good hydraulic connection with the sands and gravels, and recharge occurring in the higher areas, where rock is close to surface, may eventually flow to the source. The till lenses in the gravels may be focusing groundwater flow but as the spring is also located close to the contact between the Kiltorcan Sandstones and the less permeable Mellon House Beds, the change in permeabilities may force groundwater to surface, through the till-with-gravel, at the spring.

It is unlikely that the river water contributes to the source as the pumping water level is higher than the river water level and groundwater gradients are likely to be quite steep due to the height of the hill within the recharge area.

6.8 Aquifer category

The gravels at Ballingarry are considered to be a **locally important sand and gravel aquifer**. Till-with-gravel deposits are not usually classed as locally important aquifers, as generally the extent and hydraulic connection between the sand and gravel lenses is not known. In this case however, there is a significant proportion of sand and gravel, and with its extensive thicknesses and the large recharge area, the deposit is more than capable of sustaining a supply for the local community.

The Kiltorcan Sandstone is classed as a **regionally important aquifer** which is dominated by **fissure flow**, while the Mellon House beds and the Ballysteen Limestones are considered to be **locally important / generally moderately productive only in local zones**, and the Ringmoylan Shales are **poor** / **generally unproductive**.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, the area around the Ballingarry source is regarded as being **probably highly** vulnerable to contamination, as the water table in the till-with-gravel deposits is more than 3 m below surface. Further up-slope, rock comes close to surface and this area is designated as having a **probably extreme** vulnerability. There is also a fairly large area of **probably low** vulnerability in the region of the village where there are thicknesses of more than 10 m of limestone till. The vulnerability categories are shown in Figure 3.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for the estimated total spring output (i.e. 550 m^3/d).

8.1 Outer Protection Area

The Outer Protection Area (SO) includes the complete catchment area to the source, i.e. the zone of contribution (ZOC), and it is delineated as the area required to support an abstraction from long-term groundwater recharge.

The zone of contribution for the Ballingarry public supply is primarily controlled by the topographic contours and the associated likely groundwater flow directions (Fig. 4). The size of the ZOC is then given by the Recharge Equation which estimates that the area required to collect enough recharge to sustain the increased discharge at the source, on an annual basis, is in the region of 0.4 km^2 (436415 m^2). This is equivalent to a circular area of approximate radius 375 m. The area delineated using the groundwater flow directions is slightly larger than this and will therefore incorporate an additional safety margin.

8.2 Inner Protection Area

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

The Time of Travel Equation was used to estimate the 100-day time of travel distance to the source. In view of the lack of definitive hydrogeological information however, conservative estimates were used for each of the relevant aquifer coefficients. Taking the permeability as 50 m/d and the hydraulic gradient as 0.004, and assigning a porosity value of 0.07, the 100-day time of travel radius, for the increased pumping rate, is calculated as approximately 285 m (Fig. 4). The radius will only be valid within the ZOC and so the shape of the area is amended accordingly.

8.3 Source Site

In addition to the Inner and Outer Areas there is a third protection area, the Source Site (SS), which is delineated as the area in the immediate vicinity of the source (minimum 10 m radius), and is designed to maintain good wellhead sanitary protection. The fenced off enclosure around the source at Ballingarry, which is owned by the County Council, is designated the Source Site Area although it is slightly too small.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings, delineates a total of four groundwater source protection zones for the Ballingarry source. These are listed here and are shown in Figure 5 (with the exception of the Source Site):

- Source Site / High (SS – H)
- Inner Protection Area / High (SI – H)
- Outer Protection Area / Extreme (SO – E)
- Outer Protection Area / High (SO – H)

It is not within the scope of this report to delineate the protection zones in the surrounding area and this is dealt with at the regional resource protection scale. The accompanying code of practice imposing restrictions on developments will follow when discussions as to the degree of restriction necessary in each protection zone have been carried out between the Council and the EPA, with assistance from the GSI.

10. POTENTIAL CONTAMINATION SOURCES

The village is not expected to pose a serious threat to the source as, for the most part, it is located outside the source protection area and there is a sewerage scheme in operation. The sewer line however, appears to run through the zone of contribution to the sewerage works located to the east of the source. During one site visit in early October 1995, fertiliser was to be applied to ploughed land in the fields to the south of the site. As infiltration rates are estimated to be high in this area, excess nitrogen applied may reach the water table relatively quickly. There is also a farmyard located at the western edge of the boundary of the zone of contribution, which may be contributing.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Ballingarry is a reasonably high yielding well which is being supplied by a till-with-gravel aquifer to the south of the source. The aquifer is highly vulnerable to contamination and this is being highlighted by the currently variable water quality. The main threats are the agricultural practices within the zone of contribution, in particular with respect to nitrate contamination, and possibly any leakage occurring from the sewerage line. It is recommended that the Council investigate the sewerage line, and control and monitor potentially contaminating activities carried out within the zone of contribution.

Kiltorcan Sandstone

Ballysteen limestone

Ringmoylan Shales

Red Beds

Mellon House Beds

Kiltorcan Sandstone

Ballysteen limestone

Ringmoylan Shales

Mellon House Beds

Kiltorcan Sandstone

Mellon House Beds

Kiltorcan Sandstone

Mellon House Beds

F

F

Public supply well

F Fault

Geological contact

FIG. 1 GEOLOGY

Scale: 6 inches = 1 mile

Subsoil boundaries

3 m — Depth-to-bedrock contours

Outcrop

Gravel Pit

FIG. 2 SUBSOILS

Scale : 6 inches = 1 mile

Limestone till

Sand and gravel

Till-with-gravel

Alluvium

Rock close

Limestone till

Sand and gravel

Till-with-gravel

Till-with-gravel

Till-with-gravel

Till-with-gravel

Rock close

Till-with-gravel

Limestone till

Sand and gravel

Till-with-gravel

Limestone till

Till-with-gravel

Rock close

Till-with-gravel

Limestone till

SO Outer Protection Area

SI Inner Protection Area

FIG. 3 SOURCE PROTECTION AREAS

Scale: 6 inches = 1 mile

Enquiry 179/76

SI/H	Inner Protection Area – High
SO/E	Outer Protection Area – Extreme
SO/H	Outer Protection Area – High

FIG. 4 GROUNDWATER PROTECTION ZONES

Scale: 6 inches = 1 mile