MORTLESTOWN PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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December 1995

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1. SUMMARY OF WELL DETAILS

GSI no.	:	1411NEW101
Grid ref.	:	16600 12178
Owner	:	Limerick Co. Co.
Well type	:	Borehole
Elevation (top of casing)	:	166.76 m OD (Poolbeg).
Depth	:	63.39 m
Diameter	:	203 mm (6")
Depth-to-rock	:	10 m
Static water level	:	26.39 m below top of casing (summer 1976), 16.07 m on 10/8/93
Pumping water level	:	33.40 m below top of casing (after 10 hours continuous pumping) on 10/8/93
Drawdown	:	17.33 m
Abstraction rate	:	414 m^3/d (3800 gal/hr)
Normal consumption	:	363 m^3/d (80,000 gal/d on average, over approximately 21 hours)
Specific capacity	:	22.0 m^3/d/m (extrapolated to 1 week)

Pumping test summary:

(i) abstraction rate	: 414 m^3/d (17.25 m^3/hour)
(ii) specific capacity	: 23 m^3/d/m (10 hours)
(iii) transmissivity	: 60 m^2/d [39 - 63 m^2/d]

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 borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the surrounding area. A pumping test was carried out to examine the aquifer characteristics. Subsequently, the area encompassing a circle of 1 km radius was mapped with regard to subsoil and bedrock geology, hydrogeology, and vulnerability to contamination. Finally, a raw water samples was taken in September 1993 for a full suite 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 Mortlestown bored well is located approximately 350 metres west of Mortlestown Hill, (immediately adjacent to a minor road) between the villages of Ardpatrick and Kilfinnane. Water from the well is pumped up to a reservoir at the top of Mortlestown Hill. The pump is operational depending on the water level in the reservoir. The well casing is not capped; however, the well is located within a pumphouse which is surrounded by a concrete wall.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The land surrounding the well slopes steeply to the east, up to Mortlestown Hill (225m), but more gently upwards to the south and south west. The area to the north of the Ardpatrick-Kilfinane road is a broad valley marked by several small springs and surface streams (Figure 1).

Several small streams, located to the west of the public supply, are shown on Ordnance Survey maps. These streams flow northwards and originate from small springs located approximately 500 metres to the south of the well. Several streams of a similar size and origin are marked on the eastern side of Mortlestown Hill. However on visiting the site in August (10/8/95) all of these streams were dry except the largest stream on the eastern side of Mortlestown Hill. Several small springs are marked on 6"scale topographic maps to the north of the Ardpatrick - Kilfinnane road.

Agriculture is the principal activity in the area, with most of the land around the public supply being used as pasture. The two fields on either side of the well were being used as pasture at the time of the site visit (10/8/95).

5. GEOLOGY

5.1 Bedrock geology

The well is located in the Devonian Old Red Sandstone (ORS) as shown in Figure 1. This consists of purple/red conglomerates and sandstones with minor shales. The sandstones in this area have a dip of around 45 degrees to the north west. Approximately 500 metres to the north of the well the ORS is overlain by Carboniferous Limestone, while the contact with the Silurian grits and slates lies 1 km to the south.

5.2 Quaternary (subsoils) geology

The subsoils are shown in Figure 2. On the higher parts of Mortlestown Hill (generally above the 600 ft contour) the subsoils consist of a thin cover of weathered till containing some chert and limestone clasts. To the west and south west of Mortlestown Hill (including the area of the well) the bedrock is covered by till with gravels, composed of a combination of limestone and ORS clasts with a variable matrix of clay, silts and sands. Several small disused gravel pits are marked on old 6"scale GSI Quaternary maps. Sand and gravels are present around the largest stream on the eastern side of Mortlestown Hill.

5.3 Soils

The predominant soils in the low lying areas around the public supply are the Elton series (Grey Brown Podzolics derived predominantly from limestone till). Soils of the Knockaceol series occur over the higher ground of Mortlestown Hill. These soils are Podzols derived from sandstone till and associated bedrock.

5.4 Depth-to-rock

A significant area of rock close to surface occurs over the higher parts of Mortlestown Hill. Rock outcrops occur near the top of the hill and in two small quarries on the northern slopes. Other rock outcrops occur 500 metres to the south east and in the major stream east of Mortlestown Hill. Areas where the depth to bedrock is less than 3 metres occur on the lower slopes of Mortlestown Hill and in other areas surrounding bedrock close to surface.

The depth to bedrock at the well location is 10 metres, however depth to bedrock data from other wells in the Mortlestown area and from subsoil sections indicate a variable depth to bedrock in the vicinity of the well. Further to the north west, in the low lying areas, the depth to bedrock is greater than 10 metres. Depth to bedrock contours are shown in Figure 3.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Mortlestown area are poor and in particular are lacking in the area around the public supply. A well survey was conducted during the site visit on the 10/08/95, however only one well was discovered in the area. Although records of four wells exist for the wider area around the well, the location of three of these cannot be determined accurately (only a townland name is available). A 10 hour pumping test with a four hour recovery was carried out on the public supply well in August 1993 as part of the study.

6.2 Groundwater levels

The static water level in the well was recorded at 141 m O.D. (26.39 m below the top of the casing) in the summer of 1976 and at 151 m O.D. (16.07 m below the top of the casing) prior to the pumping test on the 10/08/93. The water level in the well at 'Betteville' (800 m to the south of the public supply) was measured at approximately 182.0 m O.D. (10.90 m below the top of the casing) on the 10/08/95. In addition this well has a recorded water level of 185.6 m O.D. (7.3 m below casing) in July 1970.

There are also a number of springs in the area (as described in section 4). These springs appear to coincide with the ORS - Limestone contact; however the springs are not perennial.

6.3 Groundwater flow directions and gradients

Groundwater flow from the regional viewpoint, is generally towards the NNW, but at a more local scale, it is also influenced by topography. Groundwater flow in the vicinity of the supply is dominated by water moving westwards from Mortlestown Hill and north westwards.

Gradients in the general area are variable with topography. The average gradient (based on the limited data available) between the well at 'Betteville' and the public supply is 0.01.

6.4 Meteorology and recharge

Rainfall data for the area is taken from the nearest weather station (which is located at a similar altitude) in Kilfinnane, 3 km to the north east. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1951 - 1980 was 1195 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking sequence with all the other sources, as 530 mm/yr. Actual evapotranspiration (A.E.) is then calculated by taking 93% of the potential figure, to allow for soil moisture deficits for part of the year, so A.E. is estimated as 490 mm/yr. Using these figures the effective rainfall (E.R.) is taken to be approximately 705 mm/yr.

The presence of thin free draining soils and permeable till with gravels over the area suggests that a high proportion of effective rainfall is infiltrating to the water table. Although there is only one perennial stream present (on ORS outcrop) within 2 km of the well, there is evidence of several smaller streams which flow during the wetter months of the year, suggesting that some runoff does occur. In addition the land surface rises steeply in the vicinity of the well. Although the proportion of effective rainfall infiltrating to the water table is not known with certainty, it is assumed that 75% is a realistic estimate, consequently the actual annual recharge in the area is therefore 530 mm.

These calculations are summarised below:

Average annual rainfall	1195 mm
Estimated P.E.	530 mm
Estimated A.E. (93% P.E.)	490 mm
Effective rainfall	705 mm
Recharge (75% E.R.)	530 mm

6.5 Hydrochemistry and water quality

Most of the analyses carried out on the water supply by Limerick County Council at Mortlestown are derived from water sampled from consumers taps in the Ardpatrick and Kilfinnane area. However this water is already

treated and in addition it represents a mixture of water from more than one source. A raw water sample was taken from the well by the GSI on 15/9/93.

The hydrochemical analyses of groundwater at the source in Mortlestown indicate a '**moderately hard water'** (216 mg/l ($CaCO_3$)), with a moderate alkalinity (191 mg/l ($CaCO_3$)). Conductivities were relatively low at 280 - 350 μS/cm. There was no evidence of contamination; all the major cations, anions and trace elements were well within EU limits.

6.6 Aquifer coefficients

The pumping test analyses provided transmissivities of 63 m^2/d from the 10 hour pumping test and 39 m^2/d - 59 m^2/d from the recovery test. A value of 60 m^2/d is taken as the most reasonable figure for transmissivity.

The specific capacity calculated was 23.0 $m^3/d/m$ after 10 hours pumping. After an initial drawdown in the well of 14 metres during the first 4 minutes, drawdown was only 3.5 metres over the next 10 hours. This suggests that the yield of the well could be increased. However, more comprehensive pumping tests would be needed to confirm the sustainable maximum yield of the well.

6.7 Conceptual Model

The aquifer feeding the Mortlestown source is the Old Red Sandstone. This is overlain by 0 to 10 metres of till with gravels that is highly permeable, therefore the aquifer can be considered to be unconfined.The thick unsaturated zone (15-25 m) in this unconfined aquifer (in the vicinity of the well) suggests that the aquifer is relatively permeable and this is supported by the yield from the well. Permeabilities within the bedrock will be increased by joints and fractures and at least one major fracture was observed from an observation of inflow during the pumping test (occurring at approximately 144.87 m O.D. (21.9 m below the top of the casing)).

Groundwater flow is influenced by topography and a groundwater mound is present beneath Mortlestown Hill. Groundwater divides are present to the south and southeast of the supply and are shown in Figure 5. The streams to the west of the supply are not perennial and therefore, at least in the summer, groundwater is not discharging to the streams adjacent to the well. Groundwater flow to the public supply is therefore north-westwards.

It is assumed that the groundwater divide nearest the well (beneath Mortlestown Hill) will be displaced eastwards by the effects of pumping, a distance of 100 metres is considered to be a conservative estimate. Groundwater may discharge to the small streams to the west and southwest of Mortlestown Hill during the winter months, when the water table is higher, however the conceptual model is representative of summer groundwater flow which is the "worst case" scenario.The springs located to the north of the public supply are not perennial and therefore do not represent a major component of groundwater flow.

The moderate hardness and alkalinity values from the chemical analyses are not typical of sandstone waters in general, however they are similar to other values from the ORS in Limerick. In this case these values may be due to groundwater reacting with limestone within the overlying soil and subsoil during percolation.

6.8 Aquifer category

The Old Red Sandstone is classed as a **locally important aquifer** which is **moderately productive only in local zones**. The aquifer categories for the adjacent geological units are as follows: the Inchacoombe Sandstones (poor aquifer, generally unproductive except in local zones), the Ballygeana and Assaroola units (poor aquifer, generally unproductive), the Mellon House Beds (locally important, moderately productive only in local zones), the Ringmoylan Shales (poor aquifer, generally unproductive) and the Ballysteen Limestone (locally important, moderately productive only in local zones).

7. VULNERABILITY

The source at Mortlestown is regarded as being high to extremely vulnerable to pollution. Using the GSI vulnerability mapping guidelines, areas where rock is less than 3 m below surface are mapped as having a 'probably extreme vulnerability' and most of Mortlestown Hill falls into this category. Other smaller areas of 'probably extreme vulnerability' are present to the south and west of the supply. The 3 metre depth to bedrock

contours are interpreted using the general trends across the country, aerial photographs and the available data points. A large area around Mortlestown Hill is covered by 3-10 metres of subsoil, however the permeability of this subsoil results in this area being classified as 'probably highly vulnerable'. To the north of the source, subsoils are thicker than 10 metres and the area is classified as 'probably moderately vulnerable'. The vulnerability zones are shown on Figure 4.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source protection areas are delineated for a higher output (545 m^3/d) than is currently abstracted, to facilitate an increase in demand of 50% and to allow for expansion of the zone of contribution during dry weather.

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 recharge. The most accurate zone of contribution at Mortlestown is derived from hydrogeological mapping techniques and is controlled primarily by the groundwater divides to the southeast and south of the source and by the groundwater flow direction. The zone of contribution is shown in Figure 6. The size of the zone of contribution is based largely on the Recharge Equation. Taking the average annual recharge to be 530 mm as previously indicated, the area required to supply the increased pumping rate of 545 m^3/d, is calculated to be 0.37 km^2. This is equivalent to a circular area with a radius of 345 m. The null point (the distance downgradient after which water is not contributing to the well) has been calculated using the uniform flow equation and is approximately 155 metres distant. A buffer (safety margin) is included in the final zone of contribution by incorporating a ±20% error margin in the estimated groundwater flow direction.

8.2 Inner Protection Area

The Inner Protection Area (SI) is the area defined by a 100 day time of travel from a 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 contamination.

Using the following aquifer coefficients: permeability (k) = 1.3 m/d and porosity = 0.015, the 100 day time of travel distance to the well is estimated to be approximately 260 metres (Figure 5).

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) in order to maintain good wellhead sanitary protection. The enclosure around the source at Mortlestown is designated the Source Site Area.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings produces five groundwater protection zones for the source at Mortlestown. These are listed here in order of decreasing degree of protection required and are shown in Figure 6 (with the exception of the Source Site):

- Source Site / High
- Inner Protection Area / Extreme
- Inner Protection Area / High
- Outer Protection Area / Extreme
- Outer Protection Area / High

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, the EPA and the GSI.

10. POTENTIAL POLLUTION SOURCES

A small number of houses and farmyards are present in the general area of the well. One farm yard in particular is located approximately 150 metres immediately up gradient of the well, on the western slopes of Mortlestown Hill. This is being used to store silage and as a cattle feeding yard. This poses a significant risk to the well.

The silage clamp appears reasonably well engineered; however, effluent is discharged to a collecting tank beneath a slatted shed. On visiting the site in October 1995 this tank was full of effluent (albeit very dilute). This would suggest that a close check needs to be kept on the effluent, particularly during winter months.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Mortlestown is a reasonably good yielding well which is likely to be able to support an increased yield. The water analyses indicated that there were no water quality problems at this source, however the supply is high - extremely vulnerable to pollution due to the shallow thickness and permeability of the subsoils in the immediate vicinity of the supply.

It is recommended that the Council monitor the raw water from Mortlestown public supply to examine the effects of the potentially polluting activities near to the well. In addition it is recommended that the council control and monitor potentially polluting activities being carried out on the delineated groundwater source protection zones. In particular, the council should monitor the farmyard uphill from the well.

SCALE 6 Inches = 1 Mile

Public supply well

Unconformity

Geological contact

FIG. 1 GEOLOGY

Ballysteen limestone

Ringmoylan Shales

Mellon House Beds

Old Red Sandstone

Ballygeana Beds

Assaroola Siltstones

Inchacoombe Sandstones

SUNVILLE LOWER A 286 R 2 P 27

UNMORE A 526 R 1 P 39

MORTLESTOWN A 820 R 1 P 20

BALLYGEAGOG A 361 R 1 P 20

SUNVILLE UPPER A 523 R 0 P 5

ARDPATRICK A 121 R 3 P 16

MONEEN A 119 R 2 P 13

CLOVER A 290 R 1 P 32

BALLINLYNA LOWER A 345 R 0 P 10

FIG. 2 SUBSOILS

SCALE 6 Inches = 1 Mile

UNMORE A 526 R 1 P 39

SUNVILLE LOWER 286 2 27 Including 0 3 6 water

MORTLESTOWN A 820 R 1 P 20

BALLYGEAGOGE A 361 R 1 P 20

BALLINLYNA LOWER A 345 R 0 P 10

PATRICK A 121 R 3 P 16

SUNVILLE UPPER A 523 R 0 P 5

MONEEN A 119 R P

Depth-to-bedrock-contours

Outcrop

10m Depth-to-bedrock-at a well location

10m Depth-to-bedrock-at a gravel section

FIG. 3 DEPTH TO BEDROCK

SCALE 6 Inches = 1 Mile

FIG. 4 VULNERABILITY

BALLYGEAGOGE
A 361 R 1 P 20

SUNVILLE LOWER
A 286 R 2 P 27
Including 0 3 6 water

UNMORE
A 526 R 1 P 39

MORTLESTOWN
A 820 R 1 P 20

BALLINLYNA LOWER
A 345 R 0 P 10

SUNVILLE UPPER
A 523 R 0 P 5

MONEEN
A 119 R 2 P 13

CLOVER
A 290 R 1 P 32

PATRICK
A 121 R 3 P 16

Moderate

High

Extreme

Bawnmore House

Sycamore Lodge

Ballygeagoge House

Pillar Stone

Murrin's Cross Roads

Ashbrook

Souterrain

Mortlestown House

Mortlestown Hill

Carrigeen Cross Roads

Carrigeen

Sunvale

Hydraulic Ram

Sluice

Creamery

St. Patrick's Catholic Church

School

P.O.

Ardpatrick

Memorial Stone

Parochial House

Church (in Ruins)

Grave Yard

St. Patrick's Well

Cloghteach (Round Tower) (in Ruins)

Glean-na-gCaorach

Toor House

Tobar Fhionain

Ford

Black Road

Moneen Cross Roads

Carhair na cailligh

Betteville

Bob's Cross Roads

Castle Hill

Oliver's Folly

Rises

Stone

SCALE 6 Inches = 1 Mile

100 day time of travel zone

Buffered zone of contribution

Groundwater divide

FIG. 5 RECOMMENDED ZONE OF CONTRIBUTION AND 100 DAY TIME OF TRAVEL ZONE, WITH BUFFER

SCALE 6 Inches = 1 Mile

SI/E	Inner Zone - Extreme
SI/H	Inner Zone - High
SO/E	Outer Zone - Extreme
SO/H	Outer Zone - High

FIG. 6 GROUNDWATER PROTECTION ZONES