PALLASGREAN (NEW) PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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NEW PALLASGREAN PUBLIC SUPPLY

1. SUMMARY OF WELL DETAILS

GSI no.	:	1713NWW078	1713NWW089
Grid ref.	:	17722, 14673	17723, 14673
Owner	:	Limerick Co. Co.	Limerick Co. Co.
Well type	:	Borehole	Borehole
Date drilled	:	Summer 1993 (not now used)	May 1995
Elevation (Poolbeg)	:	55.71 m OD (top of casing)	~55.2 m OD (top of casing)
Depth	:	104 m	82.3 m
Depth of casing	:	9.1 m	7.3 m (well screen 7.3–82.3 m)
Diameter	:	150 mm (6")	200 mm (8")
Depth-to-rock	:	estimated to be between 3 and 7 m	estimated to be between 3 and 7 m
Static water level	:	1.5–3.7 m b.g.l.	~3 m b.g.l.
Pumping water level	:	49 m b.g.l. (after 72 h test)	65 m b.g.l.
Drawdown	:	44.4 m	~62 m
Abstraction rate	:	350 m^3/d (3,200 gal/hr)	273 m^3/d (2,500 gal/h)
Normal consumption	:	not currently used	160–182 m^3/d (over 14–16 hours)
Specific capacity	:	8 m^3/d/m (1 week)	~4 (72 hours)

Pumping test summary (first well drilled in Council yard):

(i) abstraction rate : 350 m^3/d (3200 gal/hr)
(ii) specific capacity : 8 m^3/d/m (73.25 hours)
(iii) transmissivity : 26 m^2/d [20 – 35 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. Two pumping tests were carried out to examine the aquifer characteristics. 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 groundwater protection zones.

3. WELL LOCATION AND SITE DESCRIPTION

The Pallasgrean (New) source is located in the County Council yard to the north of New Pallasgrean. The borehole is not currently fenced off or housed in any way and is adjacent to the newly built pumphouse. This source is the third borehole to have been drilled in the Council yard. The first borehole is located next to the current supply, although it is not now being used as the pump fell in when it was being removed for repair in

early 1995. This borehole is now capped and lies under a manhole cover in the yard. The second borehole was drilled at the back of the yard and it was also abandoned as it was not productive. The current source was drilled in May 1995 and it supplements the shallow well supply, marked on the six inch sheets as Keatings well, which is located closer to Old Pallasgrean. Both supplies are linked to the Cappamore, Doon and Oola pipelines, and the water is pumped directly into the mains as the demand requires.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

Pallasgrean (New) is located in a valley between Knockseefin hill (226 m OD; 743 ft) and a low hill (slightly over 61 m (200 ft high) in the townland of Sunville. The elevation of the top of the casing of the borehole is 55.71 m OD (183 ft).

A small stream flows northwestwards through Pallasgrean village and then northwards to join the Mulkear River. Drainage in the area is generally poor and there are many ditches, marshy areas, small springs and seeps.

With the exception of the village, the land is generally used for grazing for dairy farming.

5. GEOLOGY

5.1 Bedrock geology

The geology of the area is dominated by two suites of volcanic rocks with interbedded limestones (Fig. 1) which lie within the Limerick Syncline. The drillers log from the first borehole describes the geology as: limestone to 5.2 m, limestone/sandstone to 30.5 m, broken rock to 45.7 m, fissured limestone to 76 m and finishing in solid limestone to 104 m. It is likely that the sandstones referred to are dolomitic limestones which are more porous and orange in colour than would be expected of pure limestones. There is also other evidence for dolomitic limestones in a quarry on the southerly border of the townland of Garrane Beg. The rocks are all part of the Herbertstown Limestones which may be generally described as thickly and well bedded, clean, pale blue, medium to coarse grained, oolitic limestones which are often dolomitised. To the northeast and southwest of the site, the volcanic rocks of the Knockroe and Knockseefin Formations crop out. The rocks generally comprise of basaltic lavas with intermediate to basic tuffs, and they are interfingered with the limestones at the contacts. The limestones dip to the southwest at angles of 10–20° and are expected to be well fractured as there are a series of northwest-southeast trending faults throughout the Syncline.

5.2 Subsoils (Quaternary) geology

The dominant subsoils in the area are clayey, silty limestone tills. To the west of Sunville Hill, there is a small area mapped as sandstone till; a section close to this area (NGR 17758, 14762) showed an abundance of sandstone clasts although the matrix was still silty/clayey. The alluvial deposits of the Mulkear flood plain lie further to the west and in a channel along the river valley. These are expected to be dominated by the finer silt and clay fractions. The higher areas generally have rock close to the surface, with thin limestone tills in places (Fig. 2).

5.3 Soils

The soils of the area may be divided into two main types: the gleys of the Cluggin and Darkisland Series, and the grey-brown podzolics of the Ballydoole and Elton Series. The gleys are dominant in the region of the source with the Cluggin Series derived from the underlying limestone-sandstone glacial drift deposits and the Darkisland Series from fine textured alluvial deposits. These soils develop under conditions of permanent or intermittent water logging which may arise from the presence of a high water table or low permeability subsoils. The grey-brown podzolics are present to the southwest of the village on the higher regions where the subsoil cover is thinner. These soils are described as being well to moderately well drained with a heavy texture as the B horizon is clay-rich as a result of downward leaching of fines. 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

The depth-to-bedrock is generally relatively shallow, in particular in the areas higher than the 61 m (200 ft) contours, i.e. Knockseefin Hill and its northeasterly slopes, and Sunville Hill. The thickness of the subsoils in

the public supply borehole is likely to be between 3 and 7 m, based on the depth of casing in the public supply borehole. With the exception of the outcrops, depth-to-bedrock data for the area are poor. The available data have been contoured but the contours may need refining as further records become available (Fig. 2).

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Pallasgrean area include the following:

- The drillers log and accompanying notes from the first borehole drilled.
- An initial 72 hour pumping test carried out on the first borehole by the drillers and the County Council.
- A step test (4 steps of 2 h each) carried out on the first borehole by the County Council on 3/6/93.
- A 10 hour drawdown test with 4 hours recovery carried out on the first borehole as part of the study on 11/9/93.
- A 73.25 hour drawdown test with almost 6 hours recovery carried out on the first borehole as part of the study on 13/10/93.
- Basic data from a 72 hour pumping test carried out on the new borehole by the Council in June 1995.
- The Geological Survey well database.

Most of the data were obtained for the first borehole drilled, but as the current supply is located less than 5 m from it, it is assumed that the aquifer characteristics will be similar for both.

6.2 Groundwater levels

The static water level in the original supply well varies from 52.68 m OD (3.7 m below ground level) taken when the well was first drilled to 54.21 m OD (1.5 m below the top of the casing) which was measured during the pumping test on 13/10/93. A level of 53.6 m OD (10.9 m below the top of the casing) was obtained from another County Council borehole, located next to the housing estate to the south of the village. (This borehole is now abandoned due to problems of silt and sand). Water levels were also available for two shallow groundwater supplies at Sunville House (64 m OD) and at a house on the roadside approximately 320 m to the north of the source (55.5 m OD). There are a number of springs, seeps and shallow wells in the area which indicate that groundwater is generally close to the surface; usually less than 4 m below ground level. It is reasonable to assume that the stream to the south of the source and the River Mulkear are in hydraulic continuity with groundwater and waters levels in these are taken as groundwater levels.

6.3 Groundwater flow directions and gradients

On a regional scale, the groundwater flow direction is generally towards the northwest, flowing from the Knockseefin Hill towards the River Mulkear. On a more local scale however, in the vicinity of the public supply, the flow direction is dependent on the topography of Sunville Hill and diverges in all directions into the stream to the south and into the river valley to the north. Groundwater gradients ranging from 0.012 to 0.015 are calculated using the water levels from the two shallow groundwater supplies to the north of the source, and a water level from the old public supply in the Council yard.

6.4 Meteorology and recharge

Rainfall data for the area are taken from the weather station located in New Pallasgrean. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1941–1980 was 968 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 470 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 531 mm per annum.

There are numerous drainage ditches and streams in the immediate area of the supply and the subsoil deposits and soils are not free draining. The deposits however, are generally quite thin, in particular in the area around Sunville Hill; it is therefore estimated that approximately 65% of effective rainfall recharges to the aquifer, i.e. 345 mm/a.

These calculations are summarised below:

Average annual rainfall	968 mm
Estimated P.E.	470 mm
Estimated A.E. (93% P.E.)	437 mm
Effective rainfall (E.R.)	531 mm
Recharge (65% E.R.)	345 mm

6.5 Hydrochemistry and water quality

The hydrochemical analyses of groundwater at the new source in Pallasgrean indicate that it is a **hard** water (322–350 mg/l; $CaCO_3$), with high alkalinity (294–341 mg/l; $CaCO_3$). Conductivities are also reasonably high at 600–670 μS/cm. These concentrations suggest a bicarbonate type groundwater, which is typically associated with limestone dissolution processes. Magnesium concentrations are relativiely high and the magnesium/ calcium ratio is greater than 0.3, suggesting that dolomitisation may have occurred in the limestones.

The water quality in the Pallasgrean source would appear from the limited analyses (n = 2) to generally good. Nitrate, chloride and potassium are all low and there were no coliforms recorded. The September analysis showed an elevated manganese level of 0.064 mg/l which is higher than the EC MAC but the source was not being harnessed at that time and the pump may not have been running for long enough to get a representative groundwater sample.

6.6 Aquifer coefficients

The constant rate pumping test analyses on the old borehole provided transmissivities ranging from 20 to 35 m^2/d, with 26 m^2/d appearing to be the best estimate. The specific capacity in that borehole was low at 8 $m^3/d/m$ (73.25 hours) and as the new borehole has a larger drawdown for a smaller output, the specific capacity is even less (~4 $m^3/d/m$). The step test in the original borehole indicated that it was not capable of yielding more than 320 m^3/d (3000 gph); at higher yields, the drawdown increased dramatically. Even at 320 m^3/d, the well efficiency was only 47%.

6.7 Conceptual model

The aquifer supplying the new borehole at Pallasgrean is the Herbertstown Limestones. The dolomitisation which has occurred has created high permeability zones in places and the productivity of the aquifer will depend on encountering one of these dolomitised zones. This is likely to be the reason for the number of dry boreholes in the area, in particular the second well which was drilled within the Council yard. Water entry to the public supply borehole, as recorded in the drillers report, occurs primarily in two main fractures, above and below a broken rock band (30.5 m and 45.7 m respectively), although a 30 m zone of fissured limestone beneath this is also reported to give small quantities of water. There is likely to be a reasonably good hydraulic connection between the volcanics and the productive zone in the limestones.

It is assumed that the small stream to the south of the source, which is perennial, is a local discharge zone for groundwater flowing from the Sunville hill region. There will be a groundwater divide at the top of the hill, beyond which groundwater will flow in the opposite direction to discharge into the Mulkear River.

6.8 Aquifer category

Considering the Herbertstown Limestones in terms of lithology, permeability, well yields and specific capacities over the county, they are classed as a **regionally important aquifer** which is dominated by **fissure flow**. The volcanic rocks are considered to be **locally important aquifers** which are **generally moderately productive**.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, the area around the new Pallasgrean source is regarded as being highly vulnerable to contamination, as the subsoil cover is generally relatively thin (Fig. 3). The areas to the north and south of the source, above the 61 m (200 ft) contours, are mapped as having a **probably extreme** vulnerability as rock comes close to surface and frequently crops out. Areas outside of this, where rock is more than 3 m below surface, have a **probably high** vulnerability.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for the current output of 270 m^3/d, as the source will not sustain a larger abstraction rate.

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 Pallasgrean public supply is primarily controlled by the topographic contours and the associated likely groundwater flow directions from Sunville Hill, and the groundwater divide (Fig. 4). Using the Uniform Flow Equation, taking an average gradient of 0.0135, the down-gradient distance to the boundary of the ZOC is approximately 125 m. It is not likley that the well will draw water from the stream.

The final zone of contribution includes a buffer area which is delineated by incorporating a ±20° error in the estimated groundwater flow direction. The Recharge Equation estimates that the area required to collect enough recharge to sustain the discharge at the source, on an annual basis, is in the region of 0.29 km^2, equivalent to a circular area of approximate radius 300 m. The Outer Protection Area, shown in Figure 4, is 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. 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 on the up-gradient side. Assuming a pumping water gradient of 0.14, assigning a porosity value appropriate to the limestones of 0.025, and taking the permeability as 0.34 m/d, the 100-day time of travel radius is calculated as approximately 190 m (Fig. 4).

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 Council yard is designated the Source Site Area although it is too small on the western side next to the road.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings, delineates a total of five 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 / Extreme SI – E
- 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 POLLUTION SOURCES

The primary threat to the source at Pallasgrean is any potentially contaminating activities which are carried out in the Council yard. In particular there is an oil storage tank which shows evidence of some leakage and there are frequently Council vehicles parked in the yard. There are also a number of houses with septic tanks in the zone of contribution.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Pallasgrean is a relatively low yielding well which has no potential for further development as the groundwater available for abstraction is limited by the large drawdown. The vulnerability of the area within the zone of contribution is high to extreme but there currently no evidence of contamination in the water quality analyses.

The well should be pumped at as low a rate as practicable for longer periods of time to minimise the drawdown and the well inefficiency. This would be more easily achieved if the supply had a reservoir. The Council should carry out more extensive raw water analyses on the supply, in particular with respect to hydrocarbons. The railway line runs close to the boundary of the ZOC and is not likely to be of consequence, but any major spillages should be monitored closely. The Council should remove the oil storage from the yard and the wellhead should be covered to minimise contamination from Council vehicles.

This source is problematical – it is relatively low yielding, drawdown is large and it is in a poor location. Consequently, it is recommended that a new source should be located, following a hydrogeological investigation.

Public supply well

Geological contact

FIG. 1 GEOLOGY

SCALE: 6 inches = 1 mile

Herbertstown Limestone

Volcanics

Herbertstown Limestone

Volcanics

Volcanics

Alluvium

Limestone till

Alluvium

Alluvium

Rock close

Limestone till

Limestone till

Limestone till

Rock close

Limestone till

3m

3m

3m

3m

Subsoil boundaries

3 m — Depth-to-bedrock contours

Outcrop

Clayey till section

FIG. 2 SUBSOILS

SCALE: 6 inches = 1 mile

FIG. 3 VULNERABILITY

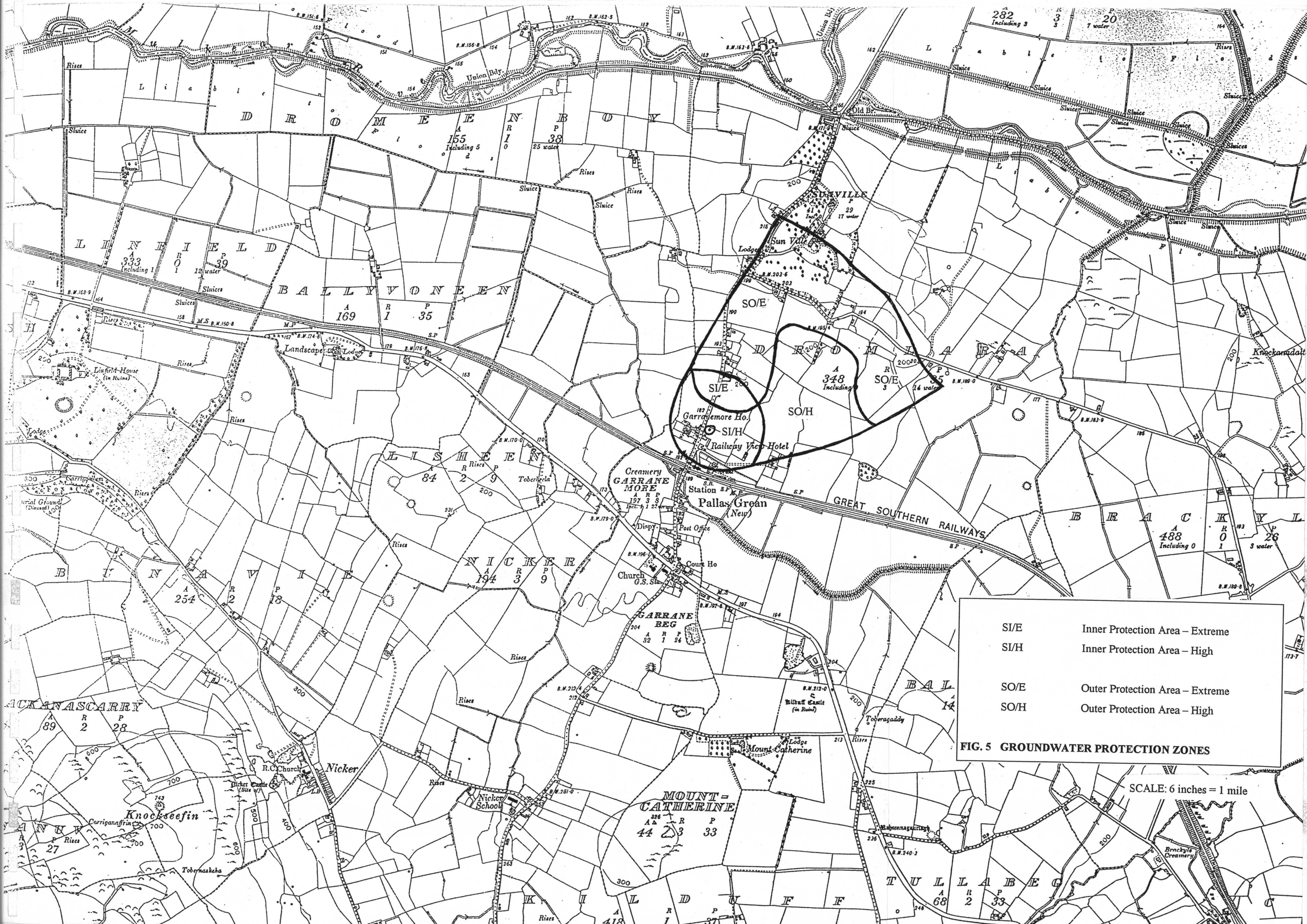
SCALE: 6 inches = 1 mile

SO Outer Protection Area

SI Inner Protection Area

FIG. 4 SOURCE PROTECTION AREAS

SCALE: 6 inches = 1 mile



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

FIG. 5 GROUNDWATER PROTECTION ZONES