CARRIGKERRY PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

(DRAFT)

Jenny Deakin
Groundwater Section
Geological Survey of Ireland

December 1995

CARRIGKERRY PUBLIC SUPPLY

1. SUMMARY OF WELL DETAILS

GSI no.	: 1113SWW169
Grid ref.	: 14701 12808
Owner	: Limerick Co. Co.
Well type	: Borehole
Elevation (top of casing)	: 195.5 m OD (Poolbeg). Ground level is 195.2 m OD.
Depth	: 12.5 m
Depth of casing	: 12 m (0–6 m blank, 6–12 m 1 mm slot Johnson screen)
Diameter	: 150 mm (8")
Depth-to-rock	: >12.5 m
Static water level	: 2.38 m below top of casing in Nov. 1993; ~6.5 m in Oct. 1995.
Pumping water level	: 2.44 m below casing in Nov. 1993 (3 hrs); 6.93 m in Oct. 1995.
Drawdown	: <0.5 m
Abstraction rate	: 128 m^3/d (1,170 gal/hr)
Normal consumption	: ~60–80 m^3/d (13,000–15,000 gal/d on average, over ~11–15.5 hrs)

Pumping test summary:

(i) abstraction rate: 138 m^3/d
(ii) specific capacity : 2,300 m^3/d/m (3 hours)
(iii) transmissivity: ~400 m^2/d [275–600 m^2/d]

2. METHODOLOGY

The Carrigkerry public supply is a new source which was drilled in 1993 at the request of the County Council. A desk study was conducted in the Geological Survey where the subsoil and bedrock geologies were compiled from the original 6" field sheets. Basic information about the original supply was given by the County Council, including a precise location and the available borehole and water chemistry records. A number of trial holes were dug and a test borehole was drilled by the Geological Survey, at the current site, to investigate the likelihood of obtaining an adequate supply. A short pumping test was carried out to examine the potential of the well and the surrounding area was mapped with respect to vulnerability. The borehole was developed and a raw water sample was taken in November 1993 by the County Council laboratory for analysis for suitability for human consumption. The source protection areas were then drawn up using analytical equations, mapping techniques and computer modelling.

3. WELL LOCATION AND SITE DESCRIPTION

The new source is now the main public supply for the village of Carrigkerry and the surrounding area. It is located to the north of the village, in the bottom of a disused gravel pit and access is via a small road beside a petrol station. The pit area has been levelled and a concreted platform has been put in around the wellhead; the latter is currently covered by a temporary hut which is locked. The original supply is located to the south of the village beside the school but due to its high iron content it is not currently being used.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

Carrigkerry is situated in an upland area, on the northerly slopes of the Knockanimpaha hills, 7.6 km northwest of Newcastlewest. The site lies at a height of approximately 195 m OD (640 ft) with the higher hills lying to the south. On a more local scale, the land surface rises up to the west of the source, where the gravels have not been worked, and gently slopes off to the north and east towards the surface water courses. The land surface slopes more steeply to the south into the small river valley.

Two, small, easterly flowing rivers flow around the area surrounding the site, to the north and south of it. Outside of the area bounded by the rivers there is generally a fairly dense surface drainage network and the vegetation is suggestive of permanently wet conditions. Within the area, however, there is no surface drainage except during the winter months when the water levels rise (refer to Section 6.2) and a small stream flows off to the south-southeast.

The land is fairly poor as a result of the wet conditions but where it is used it is primarily for grazing. Sands and gravels were also excavated in the past, from the area between the easterly flowing rivers.

5. GEOLOGY

5.1 Bedrock geology

The geology of the Carrigkerry area comprises one main rock type, the shales and sandstones of Upper Carboniferous (Namurian) age. Rock outcropping near the source is described as dark grey sandy shale with a few olive grits. Flagstones are also common further to the south of the village. The rocks generally dip to the northwest at angles of approximately 20°, although there is some evidence of small scale folding.

5.2 Subsoils (Quaternary) geology

The subsoils in the immediate vicinity of the source are coarse grained, loose gravels with sands of various grades (Fig. 1). They are bounded to the north by peat deposits and to the south by Namurian sandstone and shale dominated tills, with an area of alluvial deposits along the small river valley to the south. Similar gravel deposits are present in two other small areas to the northeast and east, and they are easily identified on the ground by the sudden change in drainage patterns and surface vegetation. Generally however, blanket bog and till deposits characteristic of the Namurian shales and sandstones are common.

5.3 Soils

There are two main soil types in the area. The relatively free draining podzols of Knockanimpaha Series occur in the sand and gravel areas, while elsewhere outside the peat areas, the gleys of the Abbeyfeale Series are present. These latter soils are derived from a parent material of glacial drift origin, mainly sandstone and shale, while the Knockanimpaha Series are associated with shale and grit bedrock and colluvium. 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 in the river bed to the south of the source, and in the higher areas to the south of the village. The subsoil thicknesses increase to the north of this, in particular to the northwest where a depth-to-bedrock of 11 m is recorded in a borehole. The new public supply was drilled to a depth of 12.5 m, without reaching bedrock, while the old public supply indicates depth-to-rock on that side of the valley to be 6 m. The depth-to-bedrock data points are shown in Figure 1.

6. HYDROGEOLOGY

6.1 Data availability

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

- Results of the drillers pumping test which was carried out for approximately 3 hours when the borehole was first drilled in November 1993.
- The drillers log and well construction details from the borehole.
- GSI well records, although there are few of any significance in the immediate area.
- A water level and discharge details from the source in October 1995.
- Water levels in the rivers from each of the three bridges.

6.2 Groundwater levels

Groundwater levels within the gravel area are variable, depending upon seasonal climatic variations. The static water level taken in the public supply well, when it was first drilled in early November, 1993, was approx. 193 m OD (2.38 m below the top of casing). The water table came to surface in parts of the gravel pit at this time. During the dry summer of 1995, the water levels were much lower; a level of approximately 189 m OD was estimated in early October. (A pumping water level of 6.93 m below the top of the casing was measured on this date, and with a recovery of just 2 cm in 5 minutes, the static water level is estimated at approximately 6.5 m below the top of the casing.)

It is reasonable to assume that to the southeast of the gravel deposits, the rivers are in hydraulic connection with groundwater and that the river water levels may therefore also be taken as groundwater levels. The river level estimated at the bridge on the Ardagh road is 180 m OD, that at the bridge on the Newcastlewest road is 183.5 m OD, while the water level taken at the bridge in the village is approximately 197 m OD. This implies that the water level in the public supply well is 9–13 m higher than the junction of the two rivers to the southeast of the source.

6.3 Groundwater flow directions and gradients

The groundwater flow within the area of gravels is generally in an east-southeasterly direction towards the junction of the rivers. Groundwater gradients ranging from 0.012–0.02 were calculated using the wet and dry season water levels from the public supply borehole, and the water levels at both bridges to the southeast of the source.

6.4 Meteorology and recharge

Rainfall data for the area are estimated using a contoured map based on the long-term averages for the years 1941–1980 (Meteorological Service). Mean annual rainfall is taken to be in the region of 1250 mm/a. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 530 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 755 mm per annum.

The subsoil deposits around the source are high permeability sands and gravels and within the area bounded by the rivers, there is no surface drainage. It is assumed that there is very little runoff and that most of the effective rainfall will infiltrate. Recharge to the aquifer is therefore of the order of 720 mm per annum.

These calculations are summarised below:

Average annual rainfall	1250 mm
Estimated P.E.	530 mm
Estimated A.E. (93% P.E.)	493 mm
Effective rainfall	~755 mm
Recharge (95% E.R.)	~720 mm

6.5 Hydrochemistry and water quality

There is just one available analysis of groundwater at the source in Carrigkerry as it is new and has not yet been incorporated into the regular monitoring regime. The sample taken had a relatively high conductivity of 775 μS/cm and a pH of 7.6. This would suggest a limestone influence in the source of water although it is not conclusive without further analyses.

The water quality at the source is good with low nitrate (0.73 mg/l; NO_3) and an absence of any coliforms. Chloride had a concentration of 38 mg/l but as the source is located to the west of the county closer to the sea

and the rainfall is high, this is not significantly higher than the background levels to be of concern. Iron and manganese, the problem parameters at the old site in Carrigkerry, were well within the EC limits at 0.014 and 0.018 mg/l, respectively.

6.6 Aquifer coefficients

The short pumping test carried out when the source was drilled gave a transmissivity of approximately 400 m^2/d [275–600 m^2/d]. The drawdown was very low at ~6 cm and the specific capacity is consequently very high (2,300 m^3/d/m for a 4 hour period). The storage is estimated from studies carried out in the Nore Basin in other similar situations, to be in the range 0.08–0.15.

6.7 Conceptual model

The area of sands and gravels in which the borehole is located is essentially a small isolated groundwater system which is bounded to the south by the relatively low permeability Namurian till and alluvial deposits, and to the north by the till and peat. During the drier periods, groundwater will flow in an east-southeasterly direction towards the junction of the rivers. This area, in particular the stretch where the northerly river runs southwards past the permeable sands and gravels, is considered to be the groundwater discharge zone. Prolonged, heavy rainfall will create a small recharge mound within the gravels with relatively small quantities of groundwater radiating outwards in all directions into the peat to the north, and the alluvium and till to the south, but the majority of flow will still be to the east-southeast towards the discharge zone. The river water to the south and southwest of the source flows on the low permeability bedrock and subsoils and is considerd to be isolated from the gravels by the till and alluvial deposits.

The original well to the south of the village was drilled into bedrock and the shaley lithologies there were responsible for the high iron concentrations in the groundwater. The gravels are limestone dominated and this is reflected in the hydrochemistry of the water analysis. (There are low concentrations of iron and manganese present due to the low percentage of Namurian shale clasts within the gravel.)

6.8 Aquifer categories

The aquifer currently being used to supply the village of Carrigkerry is considered to be a **locally important** sand and gravel aquifer. Under the GSI Guidelines, the areal extent of the deposits (0.3 km^2) should have precluded them from being considered as an aquifer. However, the thickness of the sand and the gravel and the high rainfall in the area means that there is enough storage and recharge to provide the local community with a water supply.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, sand and gravel aquifers with an unsaturated zone of less than 3 m are extremely vulnerable to contamination, while elsewhere they rank as high. During the wet season, the areas in the immediate vicinity of the source at the lower levels of the gravel pit are extremely vulnerable as the water table rises to surface in places. During drier periods and further west where the gravels have been undisturbed, the unsaturated zone is thicker and a classification of highly vulnerable is more applicable (Fig. 2).

8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for a 50% higher output than the current abstraction (i.e. 120 m^3/d) to facilitate an increase in demand and to allow for expansion of the zone of contribution in 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 groundwater recharge.

The zone of contribution for the Carrigkerry public supply has been delineated using a simple computer modelling package (WHPA Code, US EPA) and hydrogeological mapping techniques. The model is suitable for situations such as that which occurs at Carrigkerry where the boundaries of the aquifer are known but where information on the aquifer coefficients is poor. Hydrogeological parameters within the model can be varied and

the resultant effects on the size and shape of the zone of contribution can be easily assessed. In the interests of delineating a conservative zone of contribution, hydrogeological parameters were assigned worst case values as follows:

Parameter	Assigned model value	Comments
Aquifer thickness	5 m	a conservative thickness for dry weather
Transmissivity	275 m^2/d	the lower end of the estimated range
Porosity	0.08	a conservative estimate
Groundwater gradient	0.012	the lower end of the estimated range
Discharge	120 m^3/d	the increased abstraction

Groundwater is also assumed to flow parallel to the southerly river to allow for a proportion coming in from beneath the village, and the zone is delineated to the edge of the sand and gravel deposits on the up-gradient side.

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 increased discharge at the source, on an annual basis, is in the region of 60835 m^2, equivalent to a circular area of approximate radius 140 m. The Outer Protection Area, shown in Figure 3, 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 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 100-day travel time distance is estimated to include the total zone of contribution (Fig. 3). Using the Time of Travel Equation, it is considered that groundwater is likely to reach the well, from the boundary of the ZOC, in less than 100 days.

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 it is designed to maintain good wellhead sanitary protection. This area is not currently fenced off at Carrigkerry.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability rating, delineates a total of three groundwater source protection zones for the Carrigkerry source. These are listed here and are shown in Figure 4 (with the exception of the Source Site):

- Source Site / High SS – H
- Inner Protection Area / High SI – H
- 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 main current threat to groundwater quality at the Carrigkerry source is the domestic refuse which has been tipped in the now disused gravel pits, both down gradient of the source and further to the west on higher ground. Of particular note at the time of visit in October 1995, was an old fridge lying approximately 30 m to the

southeast of the source. In addition, although the petrol station is considered to be outside the zone of contribution, it is located close to the boundary.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Carrigkerry is an efficient shallow water source which is of a high quality. Although the water levels dropped substantially during the dry summer of 1995, the required yield was sustained, indicating that although the resource is limited it is adequate for the local demand.

With regard to maintaining good water quality at Carrigkerry, it is important to control and monitor developments in the area of gravels to the west of the source, and in particular in the zone of contribution. Although it is unlikely that the petrol station is located in the ZOC, caution should be exercised in the event of a serious leak or spill. The Council should get some complete raw water analyses carried out, including parameters such as trace organics and hydrocarbons.

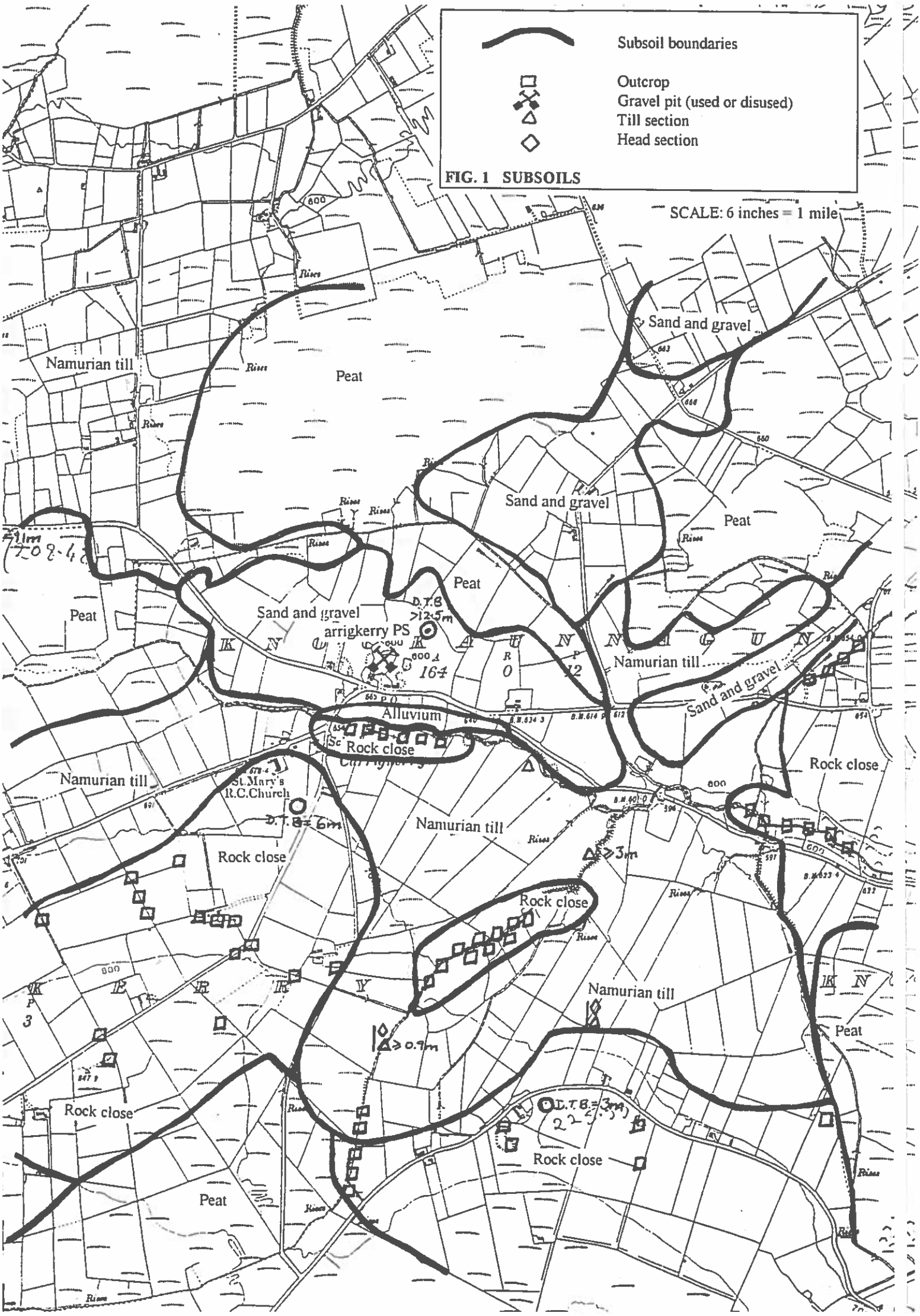


FIG. 1 SUBSOILS

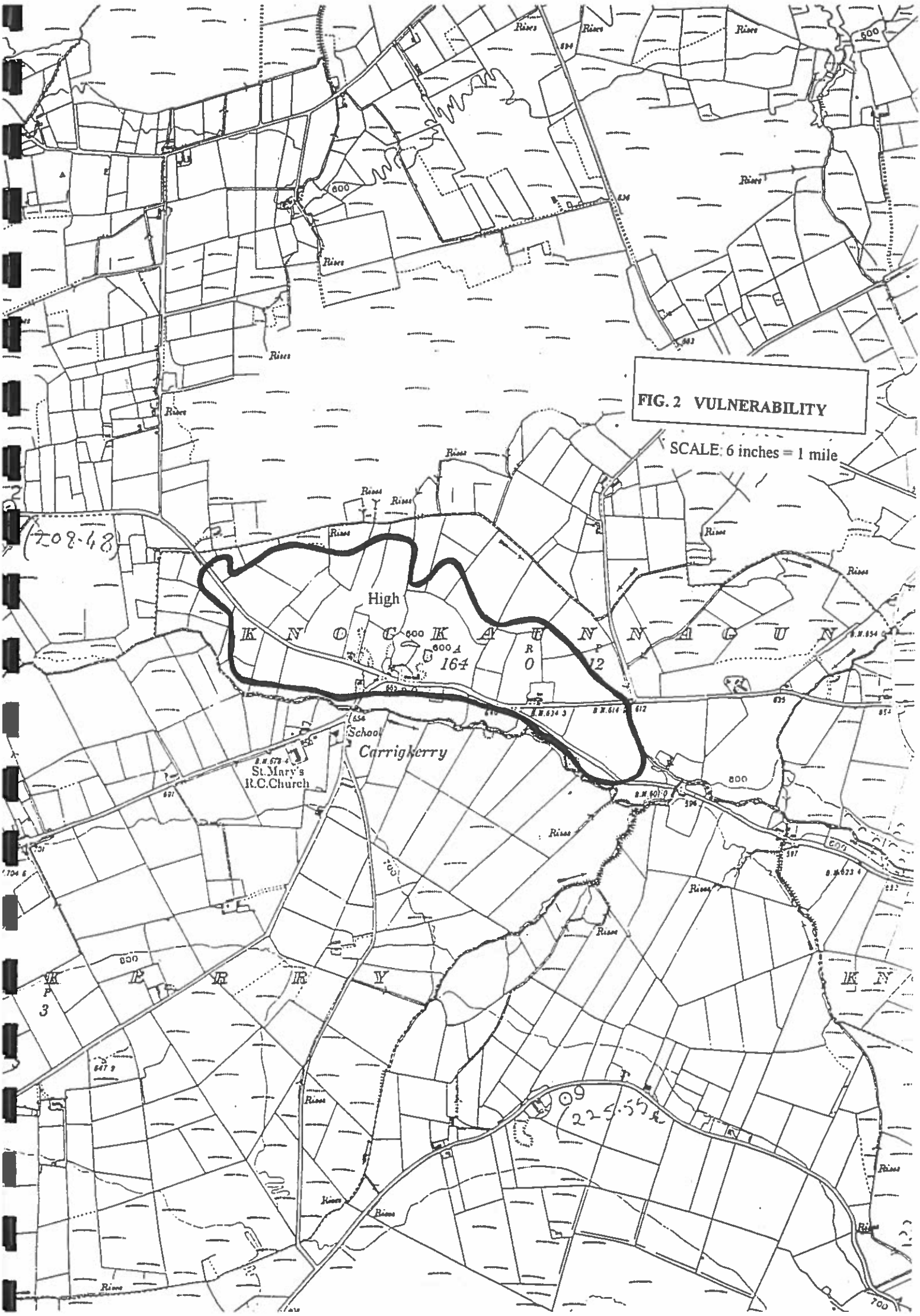
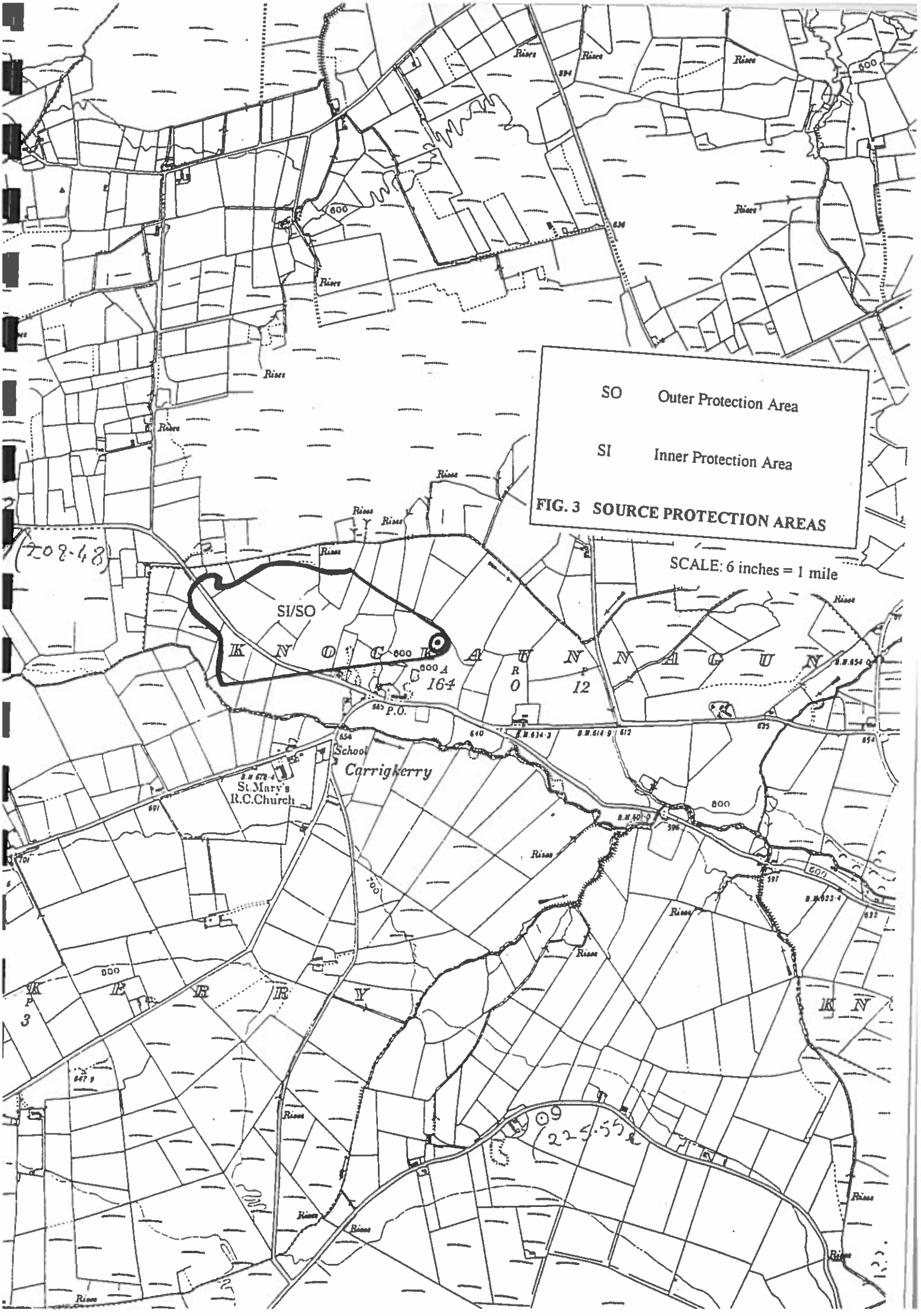


FIG. 2 VULNERABILITY
SCALE: 6 inches = 1 mile
High
KNOCKAUNNAGUN
164
12
School
Carrigkerry
St.Mary's
R.C.Church
KERRY
(208-48)
225-57


SO Outer Protection Area
SI Inner Protection Area
FIG. 3 SOURCE PROTECTION AREAS
SCALE: 6 inches = 1 mile
SI/SO
KNOCKAUNNAGUN
164
R 0 P 12
P.O.
School
Carrigkerry
St.Mary's R.C.Church
KERRY
Rivers
600
(208-48)
225.55 R

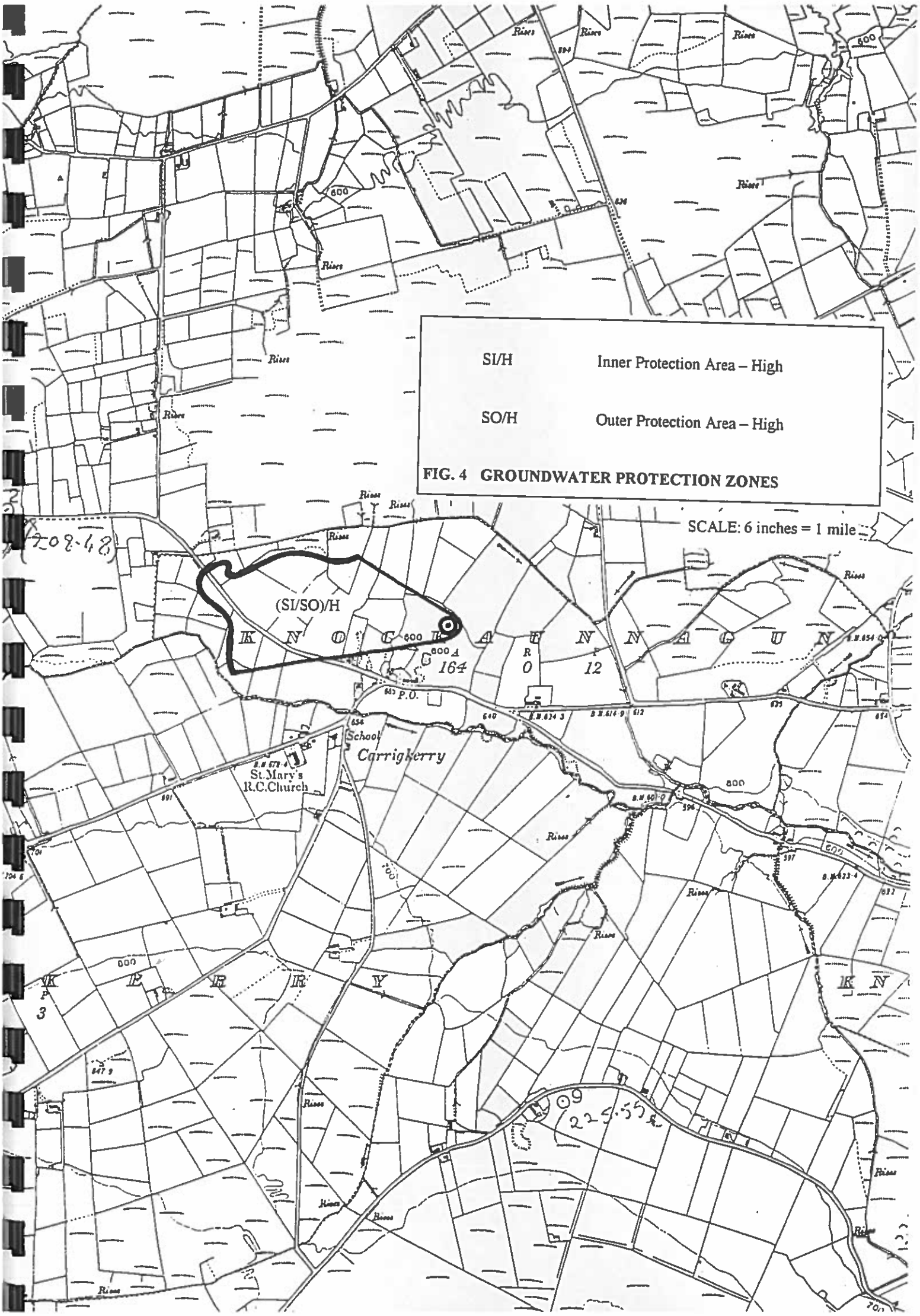


FIG. 4 GROUNDWATER PROTECTION ZONES