CROOM PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

(DRAFT)

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1. SUMMARY OF WELL DETAILS

GSI no.	:	1413NW W201
Grid ref.	:	15080 14118
Owner	:	Limerick Co. Co.
Well type	:	Bore
Elevation (top of casing)	:	27.76 m OD (Poolbeg). Ground level is 27.58 m OD.
Depth	:	47.24 m
Depth of casing	:	18.9 m
Diameter	:	203 mm (8”)
Depth-to-rock	:	18 m
Static water level	:	8.82 m (below top of casing)
Pumping water level	:	13.36 m below top of casing (10 hrs)
Drawdown	:	4.54 m
Abstraction rate	:	790 m^3/d (7,250 gal/hr)
Normal consumption	:	527 m^3/d (116,000 gal/d over 16 hrs)
Specific capacity	:	127 m^3/d/m (1 week)

Pumping test summary:

(i) abstraction rate: 789 m^3/d
(ii) specific capacity : 174 m^3/d/m (10 hours)
(iii) transmissivity: 120 m^2/d [95–145 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 with recovery 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 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 a number of different methods including analytical equations and computer modelling (FLOWPATH) to take a more detailed look at the hydrogeology and to delineate protection zones.

3. WELL LOCATION AND SITE DESCRIPTION

This source is the main public supply well for Croom and is located to the west of the village, at the bottom of a field, off a bye road on the Ballingarry road. The wellhead is sealed, housed and fenced off and the enclosure is well maintained. A second council supply, a large spring lying to the north of the village, is now abandoned due to contamination. In addition there are many private wells in the area, including three to the west of the source, within 500 m.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The Croom area is generally low lying and flat around the 30 m OD (100 ft) contour with a small hill (49 m OD) along the road to the southwest. Overall the topography dips gently to the north-northeast.

The river Maigue flows through Croom in a north-northwesterly direction. There are no surface streams in the area and it is mainly dry with just a few drainage ditches in a slightly wetter area, to the south west.

With the exception of the residential area, the land is used mainly for grazing although there is some market gardening. Sands and gravels are currently being extracted on a small scale and limestones have been quarried out in places.

5. GEOLOGY

5.1 Bedrock geology

The bedrock geology of the area comprises primarily the massive, blue grey limestones of the Waulsortian Bank Formation (Fig. 1), which dip generally to the northeast. A large north-south fault trends through the village parallel to the Limerick/Charleville road and the river. East of this fault, the shaly limestones of the Ballysteen Formation crop out to the south although they are overlain to the north by the Waulsortian limestones. The Ballysteen limestones are reported to be magnesian in places, suggesting that dolomitisation has occurred. To the southwest of the area there are a series of anticlinal folds which bring the Ballysteen limestones closer to the surface, exposing them in places. It is likely that this occurs throughout the area and that it is associated with a degree of fracturing and faulting. There is also likely to be a series of north-south joints and fractures parallel to the major fault.

5.2 Subsoils (Quaternary) geology

The subsoils in the immediate vicinity of the well are classified as till-with-gravel. The tills are limestone dominated and are mainly silty, stony and clayey with patches of silty, sandy gravel in places (Fig. 2). An elongated more permeable sand and gravel deposit lies to the west of the source. The sands and gravels range from fine sands through coarse sands and fine gravels, to cobble gravels. To the west, south and east, bedrock is close to the surface with thin till deposits where there is no outcrop. The wetter area to the southwest is a thicker limestone till deposit. Lake clays occupy a small low lying area to the northeast and there are sandy silty alluvial deposits, with some peaty layers, along the course of the river.

5.3 Soils

Soils of the area are primarily derived from a parent material of glacial drift origin, mainly limestone with some shale, sandstone and volcanics and include members of two of the more common series in Limerick, the Howardstown gleys and the Elton grey brown podzolics. There is also a thin stretch of the Camoge gleys derived from alluvium along the river course. The soils are shown on the published soils map of Co. Limerick (Finch and Ryan, 1966).

5.4 Depth-to-rock

Depth-to-bedrock in the area is on average less than 5 m, with the exception being to the southeast in the region of the river where subsoils reach a thickness of 12.8 m and at the actual borehole itself where they are recorded as 18 m thick. This deeper deposit around the borehole thins to rock at surface within 500 m to the east and west, creating a north-south trending channel of limestone tills, and sands and gravels. The depth-to-rock has been contoured for use in the vulnerability map but it is based on few data points and may need refining as further borehole records become available (Fig. 2).

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Croom area are better than at most of the sources in Co. Limerick. The following data sources were used in considering the conceptual model:

- A 10 hour pumping test with four hour recovery which was carried out as part of the study in July 1993.
- A Geoex (a hydrogeological consulting firm) report dated 1976 which was commissioned by the County Council to evaluate the groundwater resources of the area.
- A well survey carried out as part of the study to supplement the earlier one by Geoex.
- A measurement of the height of the water in the river when the pumping test was carried out in 1993 from the Office of Public Works.
- A river bed section also from the Office of Public Works.

6.2 Groundwater levels

The static water level taken in the well on 1/7/93, following overnight recovery, was 18.94 m OD (8.82 m below the top of the casing). The level of water in the river on the same day was 17.57 m OD. Two springs to the west of the area imply groundwater is at surface there, while other levels from private wells in the area vary from 12 m below ground level (b.g.l.) in the wells to the west of the source to more than 20 m b.g.l. in the region of the small hill. 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 unsaturated zone therefore is 21 m thick to the southwest thinning to less than 1 m on the banks of the river.

6.3 Groundwater flow directions and gradients

The general assumption that the water table is a subdued reflection of topography is confirmed by the water level data. Consequently, the groundwater flow direction is from southwest to northeast, corresponding to both the gradual slope of the topography and the general dip trend of the bedrock. The average groundwater gradient in the area, calculated from the available spring and borehole data, is approximately 0.005; this corresponds to the gradient assumed by Geoex in their report.

6.4 Meteorology

Rainfall data for the area are relatively good as there was a weather station in Croom until 1983. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1951–1980 was 868 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 490 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 413 mm per annum.

As there are relatively few drainage ditches or streams in the area, a high proportion of the effective rainfall infiltrates to the water table. Estimating run off to be of the order of 15%, recharge to the aquifer is taken to be approximately 350 mm per annum.

These calculations are summarised below:

Average annual rainfall	868 mm
Estimated P.E.	490 mm
Estimated A.E. (93% P.E.)	455 mm
Effective rainfall	413 mm
Recharge (85% E.R.)	~350 mm

6.5 Hydrochemistry and water quality

The hydrochemical properties of the groundwater at Croom are typical of a limestone aquifer in which carbonate dissolution is the dominant chemical process. The analyses show a **very hard** (370–400 mg/l; $CaCO_3$), calcium bicarbonate type water with high alkalinity (330–350 mg/l; $CaCO_3$). The magnesium-calcium ratios are relatively high suggesting that dolomitisation may be an influential factor in the hydrogeological regime.

The water quality in the Croom source is variable and it is considered that there is contamination occurring at times. Chloride levels are usually greater than 30 mg/l; a concentration of 50 mg/l was recorded in the C3 analysis sample taken in May 1993. Nitrates are also often somewhat elevated, reaching 33.4 mg/l (NO_3) in October 1992. Conductivities are variable (720–1100 µS/cm) and are often elevated.

6.6 Aquifer coefficients

The pumping test analyses provided transmissivities ranging from 95 to 145 m^2/d with 120 m^2/d being the best estimate. The shapes of the graphs are not indicative of any major recharge or barrier boundaries. The specific capacity calculated was 174 m^3/d/m after 10 hours pumping.

6.7 Conceptual model

The aquifer supplying the Croom source is the Waulsortian Bank Limestone. The folding occurring in the bedrock, which exposes the less permeable limestones of the underlying Ballysteen muddy limestones, may introduce zones of lower permeability at shallow depth, throughout the area. Conversely, the fracturing in the area, and any dolomitisation which has taken place, may provide high transmissivity zones in a north-south direction.

The aquifer is generally overlain by permeable sands and gravels and thin limestone tills and is therefore unconfined. Aquifer storage is likely to be increased by the sand and gravel deposits although they do not directly contribute to the well as it is lined to bedrock.

The high permeability of the limestone means that slight changes in topography are not reflected in changes to the water table.

Analysis of the available data suggests that the river is not contributing to the source.

6.8 Aquifer category

Considering the Waulsortian Bank Limestones in terms of well yields, specific capacities, lithology and structure over the county, they are classed as a **regionally important aquifer** which is dominated by **fissure flow**. The Ballysteen Limestones are classed as **locally important aquifers** which are **generally moderately productive only in local zones**. The gravels in the area are too small in areal extent to merit aquifer status.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, the area around the Croom supply is regarded as being **probably highly vulnerable** to contamination, due the large proportions of high permeability sand and gravel, and till-with-gravel in the immediate area of the supply (Fig. 3). Areas where subsoils are less than 3 m thick are mapped as having **probably extreme vulnerability**. There is not sufficient evidence to assume a 5 m depth-to-rock contour and the majority of the remaining area falls into the **probably high vulnerability** category. There is however, likely to be an area of **moderate** to **low vulnerability** to the south of the townland of Croom where two borehole records indicate subsoil thicknesses of more than 10 m.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for a 50% higher output than the current abstraction (i.e. 790 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.

Using the Uniform Flow Equation, taking the average gradient of 0.005, the down-gradient distance to the boundary of the ZOC is approximately 210 m (Fig. 4).

As there is no local groundwater divide to which the ZOC could be extended, the shape delineated by the Uniform Flow Equation was amended to account for the regional curvature of the water table contours. This curvature creates a 'fanning out' in the groundwater flow pattern with the consequent narrowing or pinching out of the zone of contribution on the upstream side. The size of the zone is then reliant on 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 0.82 km^2, equivalent to a circular area of approximate radius 510 m.

FLOWPATH, a modelling package (see section 8.2), was used to help in delineating the ZOC.

The final ZOC includes a safety margin, which is delineated by incorporating a ±20° error in the estimated groundwater flow direction. The ZOC, shown in Figure 4, is significantly larger than the area calculated by the Recharge Equation; this is necessary to take account of uncertainties in the conceptual model. As more data become available, the ZOC can be amended.

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 Inner Protection Area is delineated using the groundwater modelling package FLOWPATH. The boundary conditions used in the model were as follows: i) constant head along the river, calculated using river bed gradients for above and below the village; ii) constant head along the 100 m OD groundwater contour, which is taken to be far enough away from the source to remain unchanged during pumping; and iii) two no flow boundaries along groundwater streamlines on each side of the expected zone of contribution. The model was calibrated using the public supply well and the springs in the area.

The data input was as follows:

Discharge	790 m^3/d
Bottom elevation	-19.48 m OD
Permeability	4.2 m/d
Porosity	0.025
Infiltration	0.0010055 m/d

The particle tracking facility of the model produced a 100-day travel time of approximate upstream radius 235 m on the upstream side (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 fenced off enclosure around the source at Croom, which is owned by the County Council, is designated the Source Site Area.

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 Croom 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 POLLUTION SOURCES

The area enclosed within the 100-day travel time radius appears to be currently free from danger of bacterial pollution. There are however, one or two farms just outside this boundary, but within the zone of contribution. From the analysis of the water quality data (refer to section 6.5), despite the absence of bacteria, it appears that one or more of the farms are having an adverse effect on the well.

There are two disused quarries within the zone of contribution and the additional buffer zone which pose a threat to groundwater quality in the public supply. The first lies to the west of the source, off the bye-road which provides access to the well and the nearby three farms. It is overgrown and is currently, or has been in the past, used as a tip site. The second is also a disused quarry located at the south-western end of the zone which currently stores oil or diesel products. These environments provide easy access by contaminants into the aquifer. In the case of the latter quarry the contaminants are likely to be hydrocarbons which are not curently monitored for in the water quality analyses.

The remainder of the area within the zone of contribution does not pose any immediate cause for concern with the exception of a machinery yard with scrap cars and metals on the opposite side of the road to the GAA grounds, which may need some investigation.

The planned Croom by-pass could pose a significant risk to the source, if it passes through the Zone of Contribution. Measures to reduce the risk would need to be considered.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Croom is a high yielding well which taps a large resource and has potential for further development if required. It is however, highly vulnerable to pollution and shows signs of significant contamination. The source of this contamination is likely to be of farmyard origin, possibly one or more of the nearby farms, although it may also be due to fertiliser application or landspreading.

It is recommended that the potential sources of contamination in the two quarries be removed. The County Council should conduct their own, more detailed, pollution surveys in the given protection zones to investigate the current source(s) of groundwater contamination.

It is recommended that, as a general policy, a comprehensive suite of hydrochemical and water quality analyses, including all the major anions and cations, be carried out on a more regular basis (at least twice a year) to monitor changes in groundwater quality and to forecast any further deterioration. Good aquifer management in the zone of contribution will be crucial in the not too distant future to prevent further contamination.

FIG. 1 GEOLOGY

SCALE: 6 inches = 1 mile

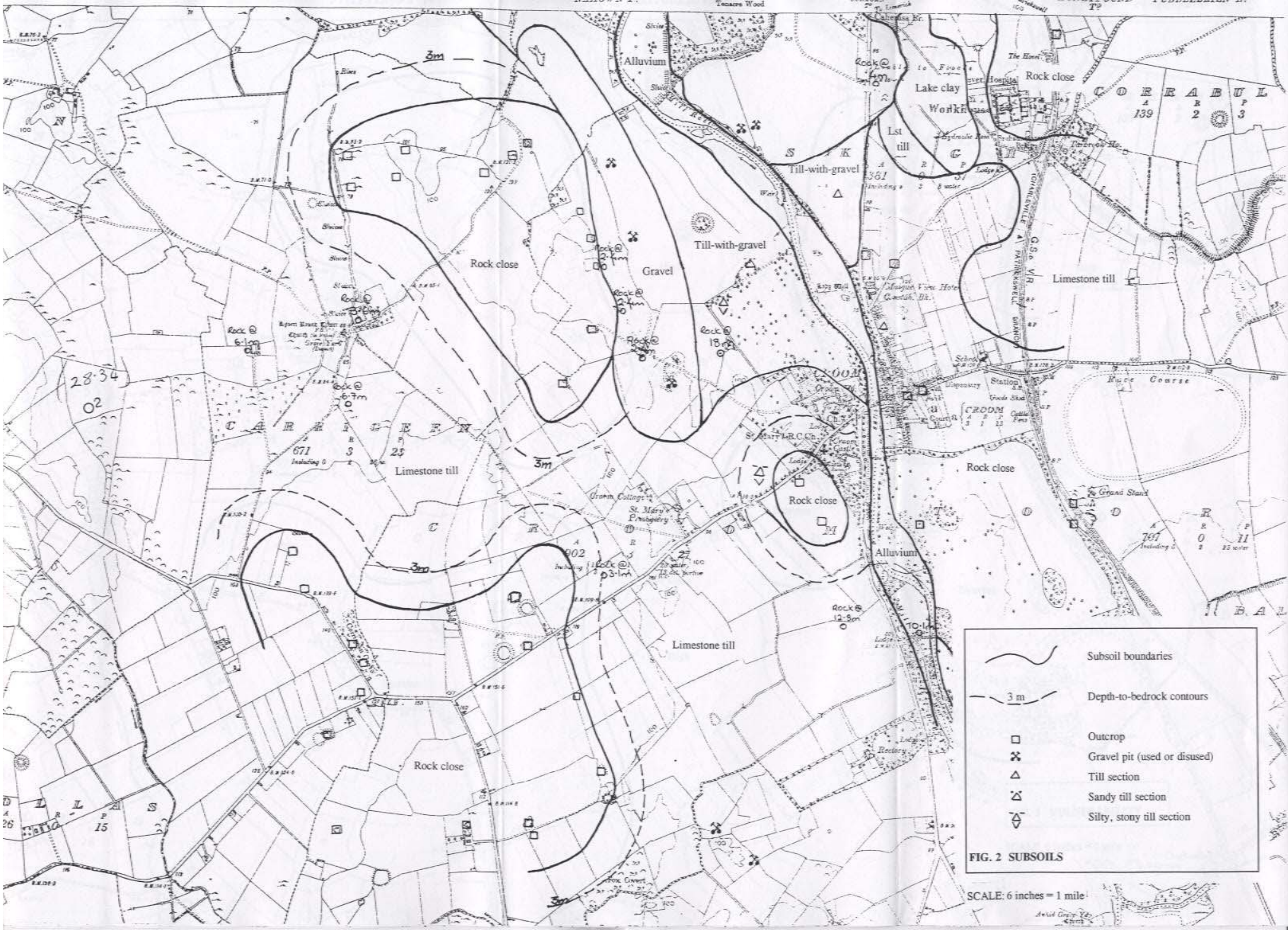


FIG. 2 SUBSOILS

SCALE: 6 inches = 1 mile

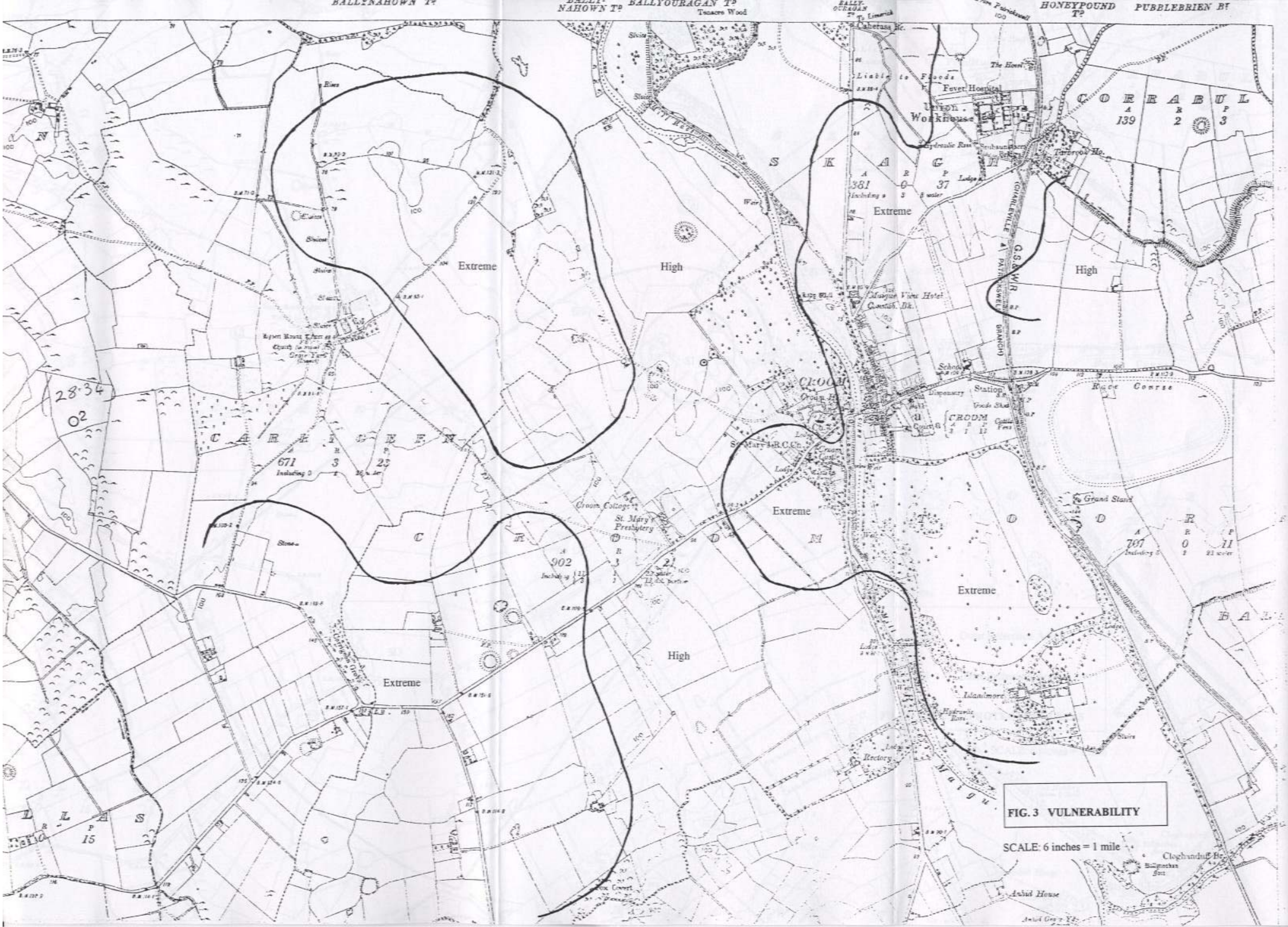


FIG. 3 VULNERABILITY

SCALE: 6 inches = 1 mile

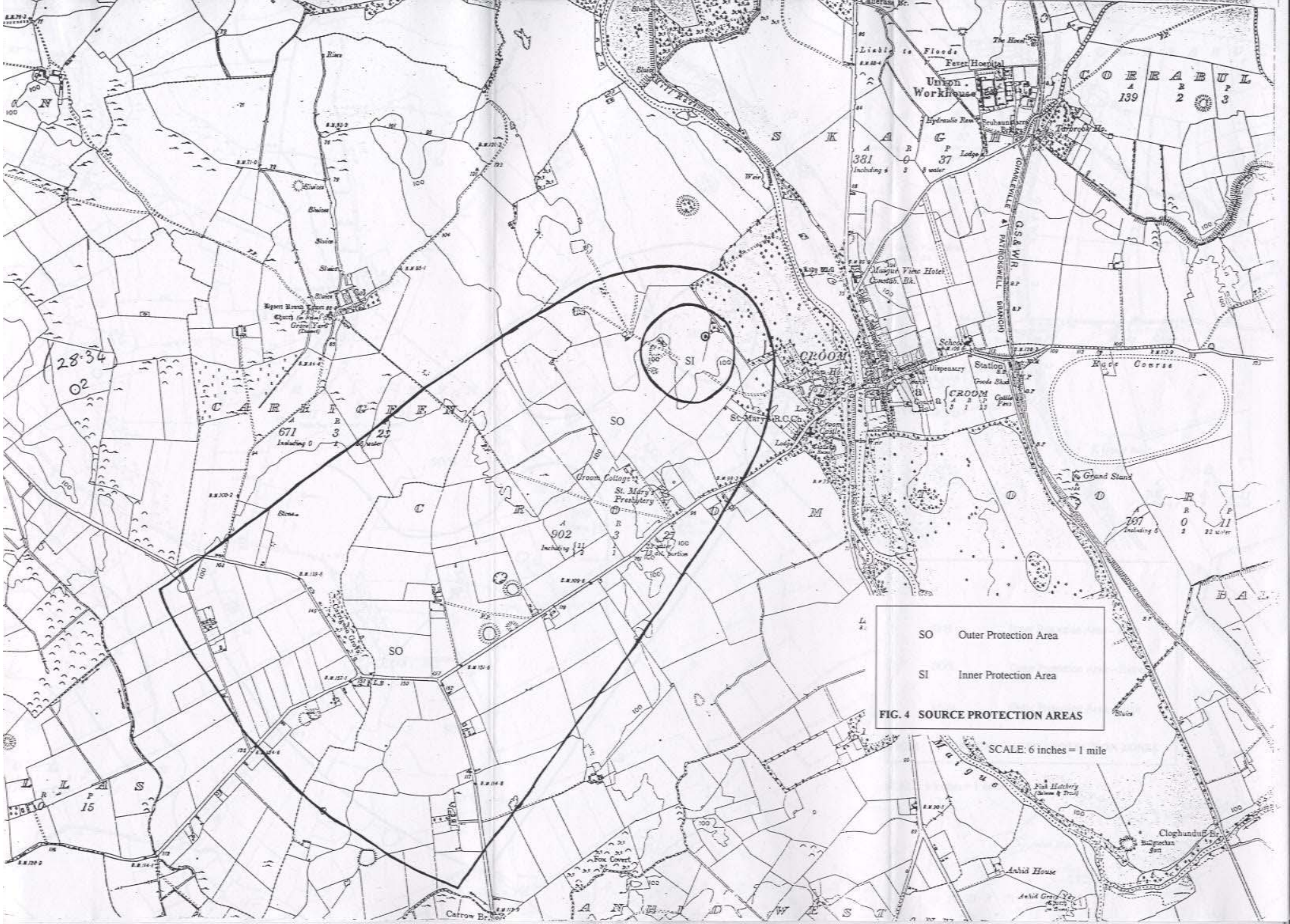
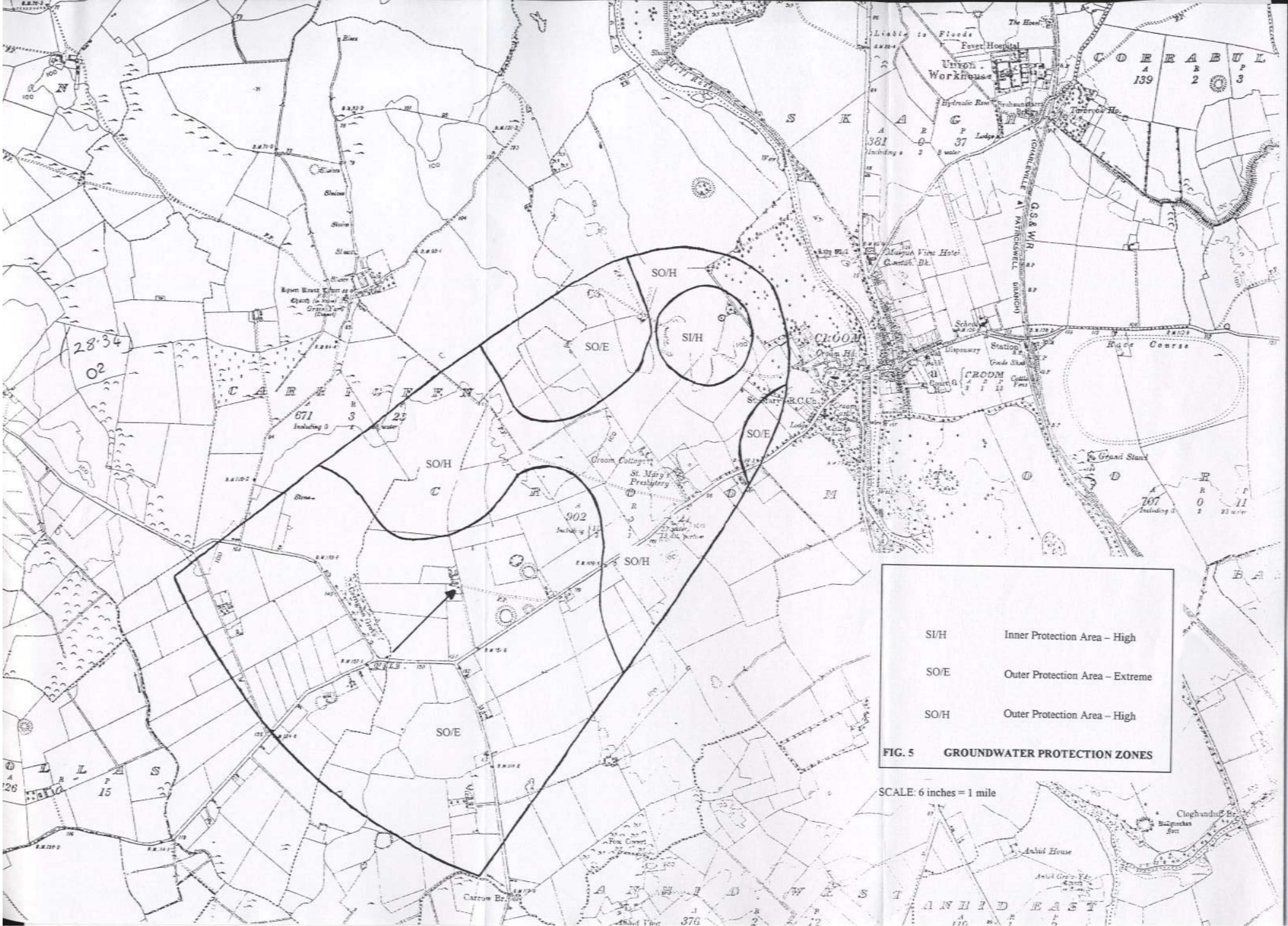


FIG. 4 SOURCE PROTECTION AREAS



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

FIG. 5 GROUNDWATER PROTECTION ZONES

SCALE: 6 inches = 1 mile