# POULNAGUNOGE PUBLIC SUPPLY

## GROUNDWATER SOURCE PROTECTION ZONES

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March 1996

# POULNAGUNOGE PUBLIC SUPPLY

## 1. SUMMARY OF WELL DETAILS

| | | |
|---|---|---|
| GSI no. | : | 2011NEW001 |
| Grid ref. | : | 22294 12132 |
| Owner | : | Waterford Co. Co. |
| Well type | : | Bored |
| Elevation (top of casing) | : | 144.80 m OD (Poolbeg). |
| Depth | : | 34 m |
| Depth of casing | : | unknown |
| Diameter | : | 127 mm (5") |
| Depth-to-rock | : | Rock close to surface |
| Static water level | : | Approx. 134.38 m O.D. (10.42 m b.g.l.) on 7/8/92<br>Approx. 137.65 m O.D. (7.15 m b.g.l.) on 17/1/96 |
| Pumping water level | : | Approx. 133.75 m O.D. (11.05 m b.g.l.) on 17/1/96 |
| Drawdown | : | 3.90 m on 18/1/96 |
| Abstraction rate | : | 64 $m^3$/d (580 gal/hr) |
| Normal consumption | : | 32 $m^3$/d ( 7000 gal/d on average, over approx. 12 hrs) |

Pumping test summary:

| | |
|---|---|
| (i) abstraction rate | : 50 - 110 $m^3$/d |
| (ii) specific capacity | : 8 $m^3$/d/m (over 2 hours, from general pumping) |
| (iii) transmissivity | : 10 $m^2$/d (calculated from specific capacity) |

## 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 precise locations and any relevant borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the surrounding area. A one hour recovery test was followed by a two hour pumping test in August 1992 in order to examine the aquifer characteristics. Subsequently, field work was carried out in the area encompassing a circle of 1 km radius in order to examine subsoil and bedrock geology, hydrogeology, vulnerability to pollution and current pollution loading. Finally, two raw water samples were taken in September 1992 and June 1993 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 well serves as the public supply for Poulnagunoge and it is located in the centre of the village just off the road (Figure 1). The well is under a manhole cover, behind a small pumphouse. The pumphouse is surrounded by a wooden fence.

## 4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The well at Poulnagunoge lies half way down a steep valley side, 1.5 km to the south east of Clonmel and the River Suir. The well is at an elevation of 144.8 m and the land rises steeply up to a height of 390 m to the south.

A stream 12 metres to the east of the well flows northwards into the River Suir. Another stream flows northwards (200 m east of the well) and joins the first stream further downslope. Both streams are perennial. Several springs and small streams can be observed 500m to the south of the supply.

The land use in the area is a mixture of farming (including silage stores, a piggery and cattle pens), residential buildings and general pasture land.

## 5. GEOLOGY

### 5.1 Bedrock geology

The public supply is located in the Knockmealdown Formation (Old Red Sandstone). The formation consists predominantly of red sandstones, with sandstones and conglomerates towards the base of the sequence. Sandstone outcrops can be seen in the stream closest to the well and in most of the other streams to the east and south. Beds are generally thin (10 cm to 50 cm) and dip steeply to the north ( Figure 1). The Kiltorcan Sandstone overlies the Knockmealdown Formation immediately to the north of the well, although the exact position of the boundary is uncertain. A north - south trending fault is shown immediately to the west of the well (running through the stream) on the G.S.I. bedrock map.

### 5.2 Quaternary (subsoils) geology

The subsoils in the area surrounding the well are very poorly exposed, however in general the stream valleys appear to have rock close to the surface with thin sandstone till covering most of the remaining area (Figure 2). The till in the general area is described, from regional mapping, as red/brown in colour with a sandy matrix.

### 5.3 Depth-to-rock

Outcrops in and around streams in the area indicate that the depth to rock is less than 3 metres over much of the area around the public supply. Evidence from Quaternary mapping in the general area suggests that the depth to bedrock in the remaining areas is generally between 3 and 5 m. Rock is outcropping in the stream immediately adjacent to the well. Outcrops and proposed depth to bedrock contours are shown on Figure 2. The depth-to-rock has been contoured for ease of incorporation into the vulnerability map but it is 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 area around Poulnagunoge are poor. A brief well survey was conducted during the site visit on the 17/1/96, however no wells could be found in the area around the public supply. A 1 hour recovery test was followed by a 2 hour pumping test in August 1992, however the test was restricted because of demand for water at that time. A longer test would have been more preferable.

### 6.2 Groundwater levels

Groundwater levels in the area are variable, depending on the time of year. The static water level in the public supply on the 7/8/92 was 134.38 m O.D. (10.42 m b.g.l.) whereas the static water level on the 17/1/96 was 137.65 m O.D. (7.15 m b.g.l.). Both the 'static' water levels were measured after a relatively short period of time (1 and 3 hours respectively); however the recovery plot during the summer suggests that the water level in the well remains lower than the nearby stream in dry weather. The low 'static' water level is mainly the result of dewatering of the aquifer and therefore does not represent the natural static level. A number of small springs and streams are present 500 m to the south of the well. The stream immediately south of the well was dry on 17/1/96, other small springs and streams are assumed to be seasonal.

### 6.3 Groundwater flow directions and gradients

Groundwater flow to the well will be dominated by flow from the south (upgradient). Due to the lack of groundwater level data it is not possible to obtain an accurate groundwater gradient. However, an approximate gradient (0.1) is proposed. This steep gradient is a reflection of the low permeability of the bedrock and the steep topographic gradient.

### 6.4 Meteorology and recharge

Rainfall data for the area are taken from a contoured rainfall map of Waterford (Duffy, 1993) based on data from the Meteorological Service. For the years 1951 - 1980 the mean annual rainfall for the area was 1100 mm. Evaporation data for the area are taken from a national contoured map as recorded by the Meteorological Service. Potential evapotranspiration (P.E.) is estimated as 500 mm/yr. Actual evapotranspiration (A.E.) is then calculated by taking 95% of the potential figure, to allow for soil moisture deficits for part of the year, so A.E. is estimated as 475 mm/yr. Using these figures the effective rainfall (E.R.) is taken to be approximately 625 mm/yr.

Several perennial streams are present in the area, the bedrock has a relatively low permeability and topography is steep in the vicinity of the well. This suggests that a significant proportion of potential recharge is rejected as surface runoff. Although the proportion of effective rainfall infiltrating to the water table is not known with certainty, it is assumed that 60% is a realistic estimate, consequently the actual annual recharge in the area is therefore approximately 375 mm.

These calculations are summarised below:

| | |
|---|---|
| Average annual rainfall | 1100 mm |
| Estimated P.E. | 500 mm |
| Estimated A.E. (95% P.E.) | 475 mm |
| Effective rainfall | 625 mm |
| Recharge (60% E.R.) | 375 mm |

### 6.5 Hydrochemistry and water quality

Two raw water samples were taken for chemical and bacterial analysis. The hydrochemical analyses indicate a **'soft'** water ( 29 - 45 mg/l $CaCO_3$ ) with a low alkalinity (26 - 32 mg/l $CaCO_3$ ); these values are typical of the Knockmealdown Formation. Conductivities were also low (117 - 127 µS/cm). All the major cations, anions and trace elements are within EC limits, except for faecal coliforms (110 per 100 ml on 30/6/93). A handpump well approximately 50 m south east of the public supply was also polluted 15 - 20 years ago and is now disused. No comprehensive well head analyses were performed, however the temperature and conductivity of the groundwater measured on 17/1/96 were 10.5°C and 137 µS/cm. The temperature and conductivity of the stream adjacent to the well were also measured on the same visit and were 9.4°C and 110 µS/cm.

### 6.6 Aquifer coefficients

The variable discharge during the pumping test means that no analysis is possible from the drawdown test. The recovery test was also very short. A transmissivity of 10 $m^2/d$ is suggested by an examination of the specific capacity of the supply during the pumping test. This value is taken as the most reasonable figure.

The specific capacity calculated from the pumping test was 8 $m^3/d/m$ after 2 hours pumping. More comprehensive pumping tests would be needed to confirm the sustainable maximum yield of the supply.

### 6.7 Conceptual model

The aquifer feeding the Poulnagunoge source is the Knockmealdown Formation. This is overlain by 0 to 5 metres of sandy till that is moderately permeable, therefore the aquifer can be considered to be unconfined.

Groundwater flow is influenced by topography which rises steeply to the south of the supply; groundwater therefore flows northwards to the supply.

The two streams adjacent to the supply are perennial, therefore groundwater will flow into these streams all year round. However, the static water level in the area immediately surrounding the source is 5 m lower than the nearby stream during summer. Together with the relatively low permeability (approx. 0.3 m/d) and effective porosity of the bedrock, this suggests that the water levels in the vicinity of the source are a reflection of the aquifer being dewatered by the public supply.

The public supply may be drawing water from the nearby stream during the summer, however the available pumping test data and measurements of conductivity and temperature do not allow this to be verified. Controlled measurements of conductivity and temperature a needed during the summer to confirm the relationship between the public supply and the adjacent stream.

A north - south trending fault is shown on G.S.I. geology maps immediately to the west of the well (Figure 1). It is possible that the well is drawing water from the fault which may act as a zone of increased permeability.

### 6.8 Aquifer category

The Knockmealdown Formation is classed as a **locally important** aquifer which is **moderately productive only in local zones.**

## 7. VULNERABILITY

The source at Poulnagunoge is regarded as being high to extremely vulnerable to pollution. Subsoils are moderately permeable and less than 5 m thick throughout most of the area and rock outcrops are common in the stream valleys. Since it is probable that some flow to the well is from the nearby stream during the summer months the water quality in the stream is also very important. The vulnerability is shown in Figure 3.

## 8. DELINEATION OF SOURCE PROTECTION AREAS

### 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 Poulnagunoge is derived from hydrogeological mapping techniques and is controlled primarily by the groundwater flow direction and by the streams to the west and east. A groundwater divide is present 1.5 km to the south of the source, however because of the relatively low yield of the public supply, the low permeability of the bedrock and the presence of springs 500 m to the south of the well the ZOC is not to extended this distance.

The zone of contribution is shown in Figure 4. The size of the zone of contribution is based largely on the Recharge Equation, however in addition the area of the ZOC immediately surrounding the well has been enlarged because the aquifer is dewatered during the summer. Taking the average annual recharge to be 375 mm as previously indicated, the area required to supply an increased pumping rate of 60 $m^3$/d, is calculated to be 0.06 $km^2$ (the pumping rate is increased in order to produce a conservative ZOC). This is equivalent to a circular area with a radius of 136 m. A conservative null point (the distance down gradient after which water is not contributing to the well) of 40m is also taken as a result of the dewatering of the aquifer around the public supply. 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) = 0.3 m/d and porosity = 0.01, the 100 day time of travel distance to the well is calculated to be approximately 300 metres (Figure 4). This relatively large distance is a reflection of the low porosity of the bedrock and the high hydraulic gradient.

### 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 Poulnagunoge is designated the Source Site Area.

## 9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings produces four groundwater protection zones for the source at Poulnagunoge. These are listed here in order of decreasing degree of protection required and are shown in Figure 5 (with the exception of the Source Site):

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

There are several potential pollution sources in the area immediately up gradient of the well. Several houses are present across the road from the well, all of these houses have septic tank systems. Between 50 and 200 m to the west and north - west of the well there is a small piggery, two open cattle pens and a silage store. On visiting the site on 17/1/96 effluent from one of the open cattle pens could be seen running down the road towards the stream adjacent to the well. Other potential pollution sources close to the well include two small farmyards 200 m to the south and south - east of the well. The quality of the water in the stream adjacent to the well may also affect the water quality of the public supply. It is not possible to say with any certainty which source (or sources) of pollution is responsible for the presence of faecal bacteria in the well.

## 11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Poulnagunoge is a poor yielding well which is in a poor location in terms of potential for contamination by pollution. The available water analyses indicated a relatively high faecal bacteria content. The area around the supply is high to extremely vulnerable to pollution and several potential pollution sources occur upgradient of the well, including domestic septic tanks, pig and cattle waste and silage effluent. The well may be drawing some water from the adjacent stream during the summer months and so may also be affected by the water quality in the stream.

It is recommended that the council take raw water samples from the well for chemical and bacterial analyses to check the groundwater quality.

It is also recommended that the Council try to ascertain whether the public supply is drawing water from the stream (by taking controlled conductivity and temperature measurements during the

summer). If this is the case then it will be necessary to monitor the stream water closely in addition to controlling and monitoring potentially polluting activities within the ZOC of the source. In the event of a pollution scare occurring in the stream, upstream of the well the public supply well should be turned off to prevent the drawing in of possible contaminants into the aquifer between the stream and the source.

If subsequent analysis confirms the well to be polluted it is recommended that a new well (upgradient of potential pollution sources) should be drilled, ideally using a geophysical investigation to locate possible zones of higher permeability.

## 12. ACKNOWLEDGEMENTS

This report is a follow up to original work carried out by Sara Duffy in 1992/1993 for an M.Eng.Sc. entitled 'The Protection of Groundwater Resources in County Waterford'. The M.Eng.Sc. was supervised by Professor Con Cunnane (University College Galway) and Mr Paul Johnston (Trinity College Dublin) in conjunction with the Geological Survey and Waterford County Council.

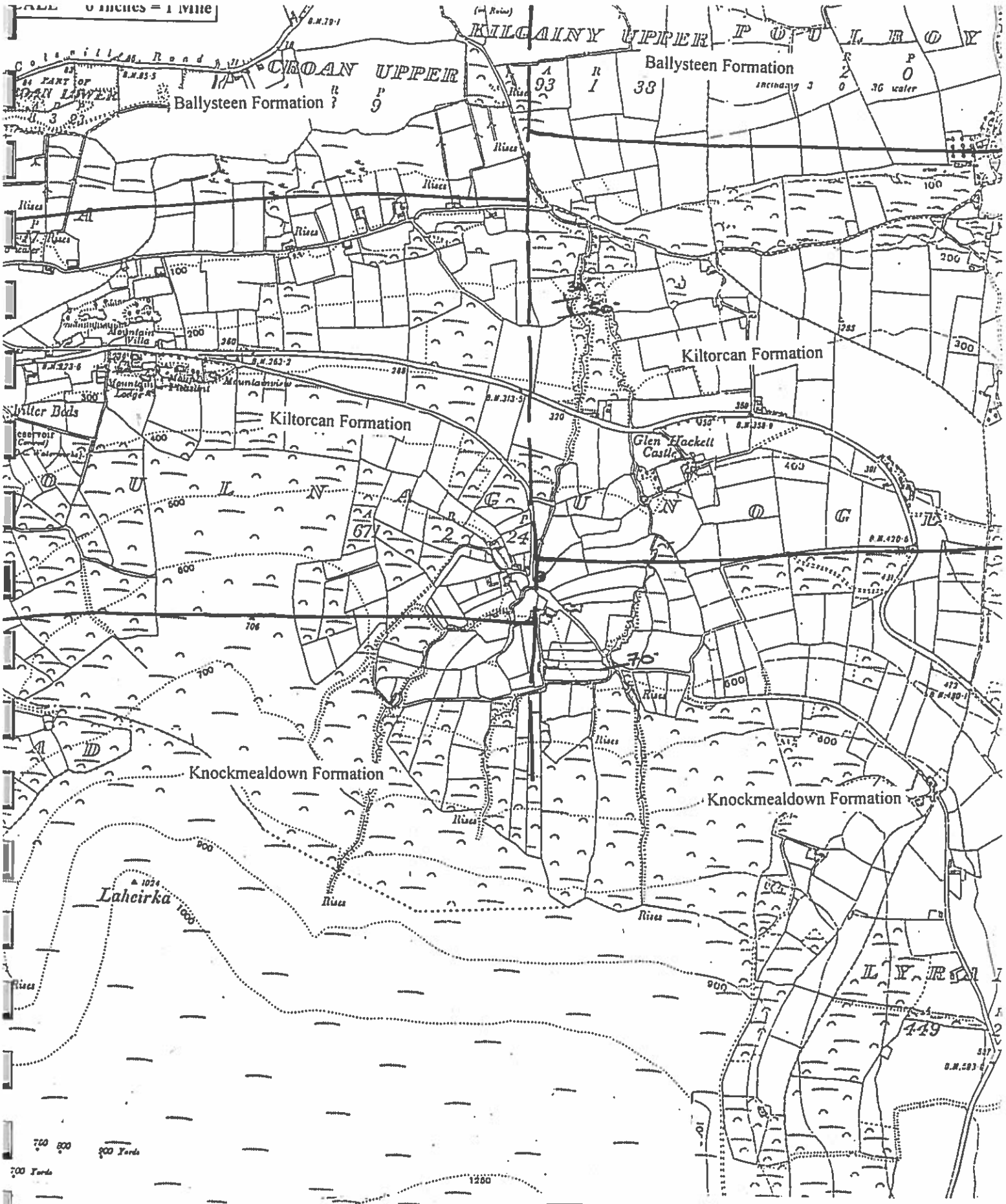
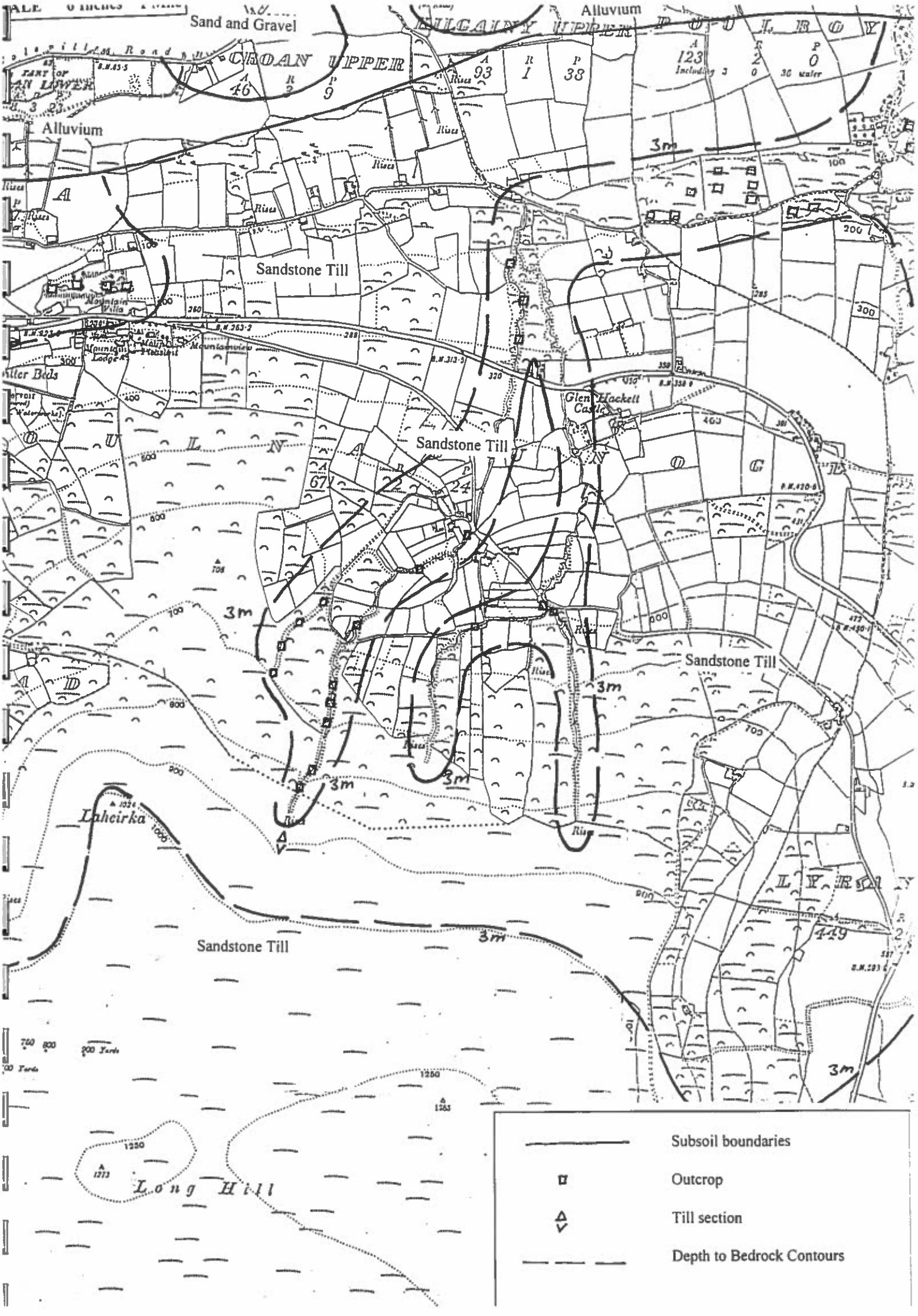



FIG. 1 GEOLOGY


Sand and Gravel
Alluvium
Alluvium
Sandstone Till
Sandstone Till
Sandstone Till
Sandstone Till
Glen Hackett Castle
Laheirka
Long Hill
3m
Subsoil boundaries
Outcrop
Till section
Depth to Bedrock Contours

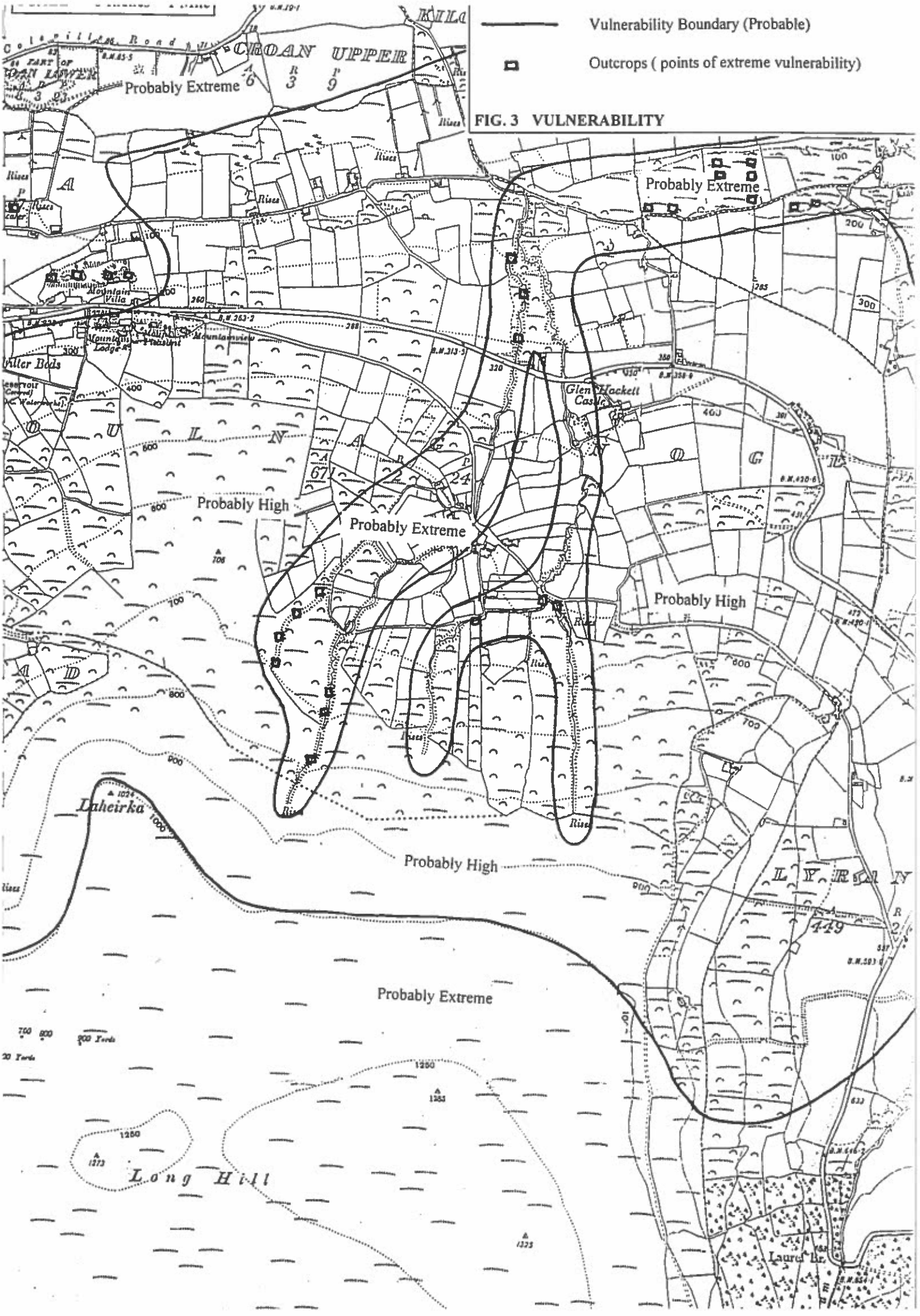



FIG. 3 VULNERABILITY

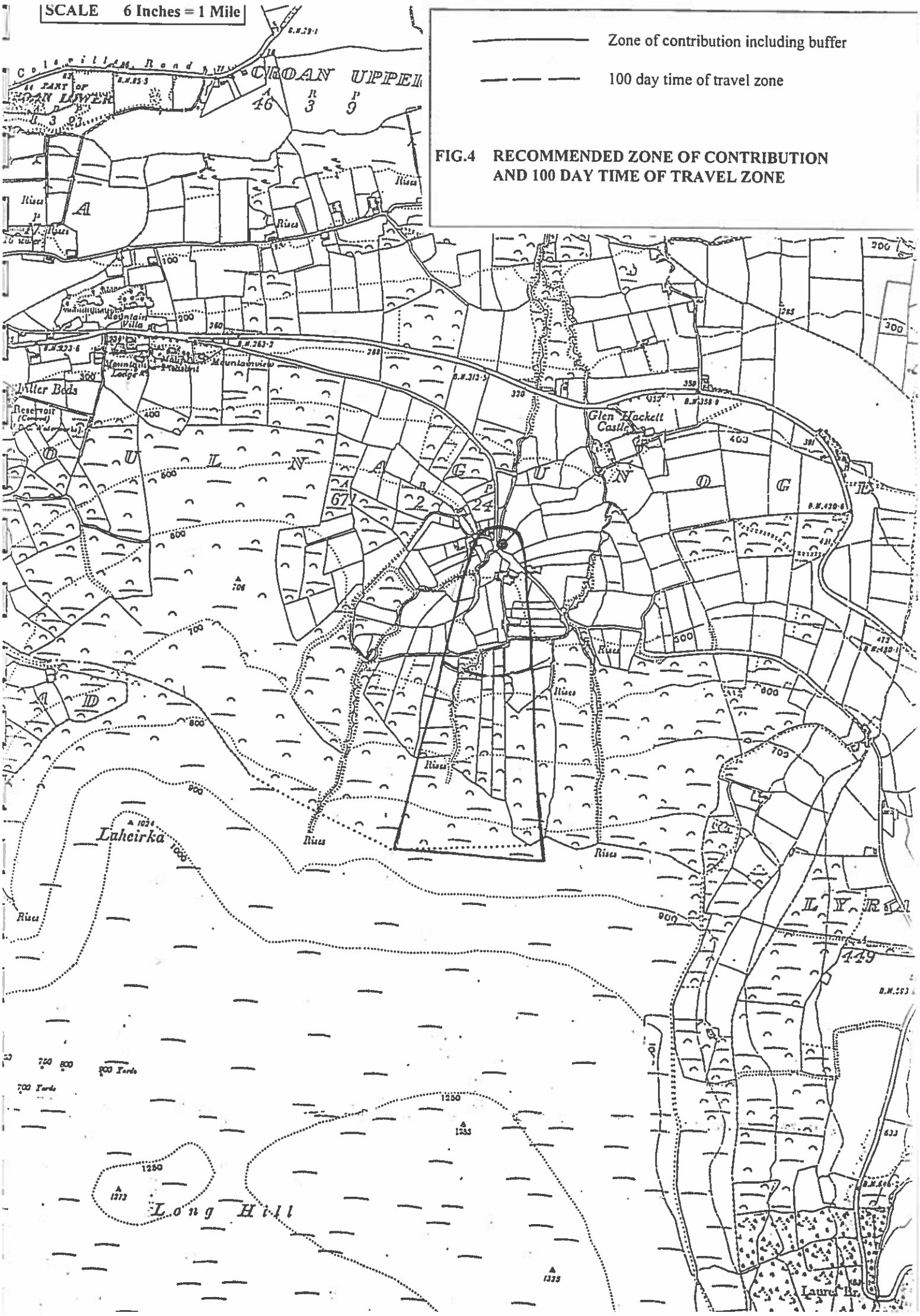



**FIG.4 RECOMMENDED ZONE OF CONTRIBUTION AND 100 DAY TIME OF TRAVEL ZONE**

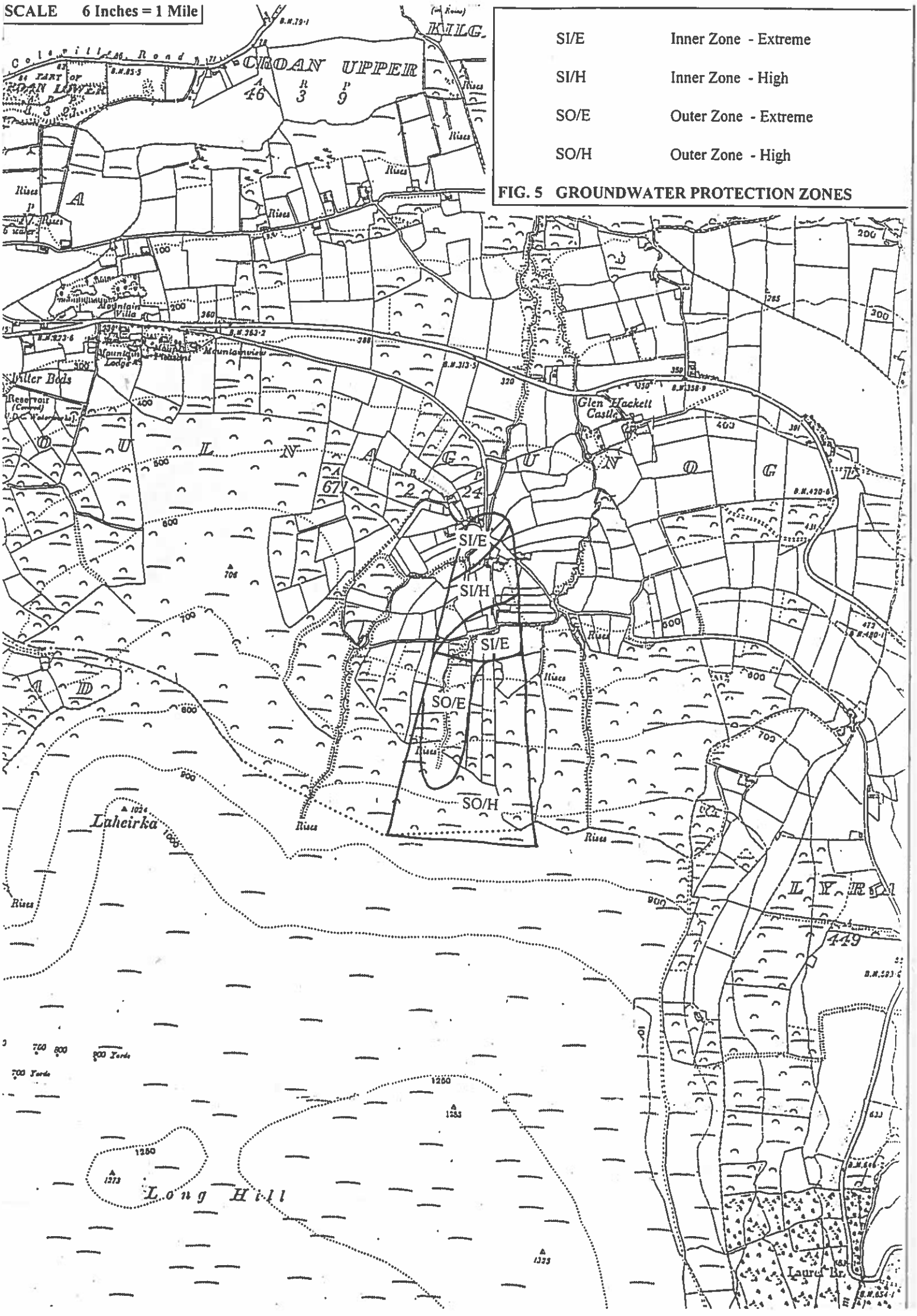



**FIG. 5 GROUNDWATER PROTECTION ZONES**