# TOBERGAL (SW REGION) PUBLIC SUPPLY

# GROUNDWATER SOURCE PROTECTION ZONES

(DRAFT)

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## 1. SUMMARY OF WELL DETAILS

| | | |
|---|---|---|
| GSI no. | : | 1111NEW067 |
| Grid ref. | : | 13163 12786 |
| Owner | : | Limerick Co. Co. |
| Well type | : | Springs (Tobergal + 3 other smaller springs) |
| Elevation (top of collection chamber) | : | 61 m OD estimated (Poolbeg) |
| Depth | : | 1.2 m |
| Depth-to-rock | : | unknown |
| Static water level | : | at surface |
| Current consumption | : | ~1195 $m^3$/d (~263,000 gal/d) |
| Average overflow | : | 1255–1855 $m^3$/d |
| Total average spring output | : | 2450–3050 $m^3$/d (4 springs) |

## 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 spring flow, water chemistry and construction data available.

The second stage comprised site visits and fieldwork in the surrounding area. A walk-over survey of the surface water catchment area was carried out which enabled an assessment of the bedrock geology, subsoils, hydrogeology, vulnerability to pollution and current pollutant loading. Two raw water samples were taken in September 1993 and April 1994 for full suites of chemical and bacterial analyses.

Stage three, the analytical stage, relied heavily upon a conceptual model and utilised water balance equations and hydrogeological mapping to delineate the catchment area and hence identify the groundwater protection zones.

## 3. WELL LOCATION AND SITE DESCRIPTION

The Tobergal springs provide a large proportion of the South West Regional Water Scheme. The source is linked to the public supply at Broadford and together they supply a large area stretching from Newcastlewest to Dromcollogher. The springs are located to the northeast of the Mullaghareirk Mountains, approximately 4 miles southeast of Newcastle West, in the townland of Moanroe More. The site is on the western side of the L71 road between Bunoke Cross and Broadford. Three of the springs, including Tobergal, are enclosed in a fenced off area which is owned by the County Council. The fourth lies further to the south and is situated in the corner of an open field. All the springs are surrounded by concrete collecting chambers which are covered and locked. The discharge from all four springs flows by gravity feed to the pumphouse via one pipe and the surplus overflow then discharges from the pumphouse into a small stream (Fig. 1).

## 4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The Tobergal springs are situated in a low lying area to the northeast of the Mullaghareirk Mountains, at an elevation of approximately 61 m OD (200 ft). The land surface is generally quite flat but slopes gently to the northeast where it becomes slightly more hummocky.

The springs lie within the catchment area of the River Deel; one of its tributaries, the Bunoke River, flows in a northerly direction to the east of the site. Surface drainage in the region of Moanroe More is poor and there are many surface streams and drainage ditches. In particular in the immediate vicinity of the springs, the ground is generally heavy and wet, and the vegetation is suggestive of permanently wet conditions. (This is in addition to the currently suspected leaking mains problem). Moving further away from the site to the southwest the land is slightly better drained and the density of surface water channels lessens, while further south again in the townland of Raheenagh, the drainage once again becomes poor and the densities of streams and ditches increases.

The land is primarily used for grazing. There are a number of farms in the area including a large poultry unit approximately 1 km to the east.

## 5. GEOLOGY

### 5.1 Bedrock geology

The springs are located in an area which is underlain by the massive blue-grey limestones of the Waulsortian Bank Formation (Fig. 1). These rocks are overlain to the southwest by the darker muddier limestones and interbedded shales of the Muddy Shelf Limestone Unit. The contact between these two rock types can be seen in the Cloonsherick Quarry to the west of the spring where the rocks dip to the south at angles varying from 20–50°. The sequence in the quarry represents a gradation between the two rock types and the rock there is light grey crystalline limestone with beds varying in thickness from 2 m to 20 cm. Another quarry in Ballintober East exposes the Waulsortian limestones although they dip to the north at angles of 20°. The whole area is therefore likely to be faulted and possibly folded in parts.

### 5.2 Subsoils (Quaternary) geology

The subsoils in the area are predominantly limestone till deposits which are generally clayey. There are also alluvial deposits present along the courses of the Rivers Bunoke and Deel (Fig. 2). A 2 m section through the River Deel deposits to the northeast of the site (NGR 13250, 12858) exposed a silty clayey alluvial deposit overlain by a thin (30 cm) sandy unit. Till-with-gravel deposits are mapped out further to the north of the site.

The Tobergal area lies within the extensive ice marginal deposits in Limerick which stretch from the foot of the Galty Mountains, through south Limerick, and up towards Foynes. The deposits are typically quite thick, (reaching 40 m in places) and they comprise a mixture of sands and gravels, silty sands, various tills and stiff clays. With the extensive thicknesses and the chaotic depositional processes which are known to occur at the ice margin, it is inevitable that the deposits will vary with depth. In particular it is expected that there may be sandy gravelly lenses within the till, and clay-rich sediments within the till-with-gravel deposits.

### 5.3 Soils

The soils of the area are all part of the same soil series, the Howardstown Gleys. These soils are derived from glacial drift which is dominantly of limestone origin and they develop under conditions of permanent or intermittent water logging. These conditions may arise from the presence of a high water table or low permeability subsoils. 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

Depth-to-bedrock in the area is difficult to assess as there are few data points. Rock has been quarried out in three quarries to the east, west and southwest of the site (Ahawilk, Ballintober East and Cloonsherick quarries, respectively) and so it is assumed that rock is generally close to surface in these areas (Fig. 2). Borehole data, further to the southwest beyond the quarries, suggest that the subsoils there reach more than 40 m thick. These thicknesses are not uncommon in ice marginal environments (refer to section 5.2). Two boreholes north of the

River Deel (NGR 13247, 12925; NGR 13265, 12870) have recorded depths-to-bedrock of 18.3 m and 5.8 m, respectively. The thickness of the subsoils in the immediate vicinity of the spring is not known although it is estimated, based on the absence of outcrop and the nature of the subsoils, that the deposits are likely to be quite thick. The depth-to-rock has been contoured for use in compiling the vulnerability map but it is based on relatively few data points and may need refining as further borehole records become available (Fig. 2).

## 6. HYDROGEOLOGY

### 6.1 Data availability

The hydrogeology of the Tobergal springs is complex and a number of different data sources have been utilised in trying to understand the hydrogeological regime.

- Daily total spring discharge values for the year 1983 from the caretaker's notebook (the graphs are filed in the GSI).
- Geothermal data from a number of investigations which were carried out at the spring in the 1980s as part of an EC funded study of geothermal springs in Ireland.
- A Geoex (hydrogeological consulting firm) well survey which was carried out in 1975 to evaluate the groundwater resources of the region.
- Hydrographs from two continuously monitored wells in Co. Cork in similar limestone aquifers (the data are filed in the GSI).
- GSI well records, although there are few of any significance in the immediate area.

### 6.2 Spring flow

The daily discharge values have been calculated from daily meter readings on the collection main for all four springs for the year 1983. During 1984 the meter ceased to function properly and it has never worked since; consequently, the 1983 data are the most recent daily data available of the total groundwater discharge at the springs. The data were plotted against daily rainfall for the Castlemahon Rainfall station (refer section 6.5) and against the well hydrographs for two limestone aquifers in Co. Cork. The discharge curve is a relatively smooth curve for a spring with little variability, and there appears to be no correlation with rainfall. However, there is a strong similarity in the seasonal trends between the discharge and the hydrographs from the two wells in Cork. This would suggest that the spring does not respond to individual rainfall events but is a function of the long-term water table fluctuations, implying that groundwater is resident for long periods of time.

### 6.3 Groundwater levels

Groundwater levels in the immediate vicinity of the springs are generally close to surface and this is reflected in the permanently wet conditions in the County Council compound. There are also a number of other smaller springs and several other wells in the area, both drilled and dug, with water levels at or near surface. In particular there is an artesian borehole located to the east of the site (NGR 13212, 12798). Further to the southwest, in the region of the quarries where the subsoil cover thins, groundwater levels become deeper (i.e. 5–10 m below surface) although there is evidence in the Cloonsherick Quarry that, at least during part of the year, water levels reach the surface. Water levels are not known in the area further to the southwest where the subsoil cover thickens once more.

It is reasonable to assume that the River Bunoke and the River Deel are in hydraulic continuity with groundwater; water levels in the streams can therefore be taken as groundwater levels. It is also assumed that the other two smaller streams in the area generally have a poor hydraulic connection with groundwater and that they are essentially perched on the low permeability subsoils.

### 6.4 Groundwater flow directions and gradients

The regional groundwater flow direction is assumed to follow topography, flowing in a northeasterly direction from the Mullaghareirk Mountains towards the River Deel. The groundwater gradient in the Tobergal area, as calculated from the borehole data, is approximately 0.005 which is comparable to the gradient found in the same rock type at Croom.

The groundwater level data would suggest that there is an upward groundwater gradient in the area around the Tobergal springs which is likely to be a consequence of a build up of artesian pressure by confining low permeability clay layers within the subsoils. This upward gradient is likely to account for the large number of small springs and seeps.

### 6.5 Meteorology and recharge

The meteorology and recharge for the Tobergal springs have been calculated from daily Meteorological Service data for the nearby (now closed) rainfall station at Castlemahon. The station was located in a similar topographic setting just over 1 mile to the north of Tobergal and is the closest most suitable one for which records were available. The 1983 rainfall data were selected to enable a comparison to be made with the most recent, available spring discharge data. Total rainfall at Tobergal during 1983 is estimated as 1035 mm. The long-term mean annual rainfall is estimated as 1050 mm using a contoured Meteorological Service map based on the monthly data for the years 1941–1980; 1983 is therefore not considered to be atypical. Potential evapotranspiration (P.E.) is also estimated from a regional Meteorological Service contoured map in conjunction with a ranking scheme with all the other sources, as 500 mm/a. 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 effective rainfall (E.R.) is taken to be approximately 570 mm in 1983.

In considering the percentage of effective rainfall which will actually recharge to groundwater, the general area is most usefully subdivided into three based on the drainage patterns and the depth-to-bedrock.

- The first is the area around the source in the townland of Moanroe More. Subsoil deposits, being primarily clayey limestone tills, are of relatively low permeability, and will hence inhibit the infiltration potential. There is a high density of surface water streams and ditches suggesting that quite a high proportion of potential recharge runs off in these areas, and there appears to be an upward gradient which will also minimise recharge.
- The second area is the northwest-southeast trending band, further to the southwest of the source in the region of the quarries, where rock is assumed to come close to surface. Till deposits are still of low permeability but are thinner, and there is generally a lower stream density. It is expected that the highest proportion of recharge to the shallow groundwater system occurs in this area.
- The third area is that further again to the southwest where the low permeability deposits are thicker once more and the stream density increases.

It is difficult to assign one figure for the percentage runoff over the whole region. An average of 50% is taken although it is emphasised that this will vary over the three areas. The uncertainties are incorporated in the subsequent catchment area delineation. Recharge to the shallow aquifer system is therefore taken to be *approximately* 285 mm in 1983, while the average long-term annual recharge is approximately 293 mm/a. These calculations are summarised below:

| | **1983 values** | **Long-term mean annual values** |
|---|---|---|
| Annual rainfall | 1035 mm | 1050 mm |
| Estimated P.E. | 500 mm | 500 mm |
| Estimated A.E. (93% P.E.) | 465 mm | 465 mm |
| Effective rainfall | 570 mm | 585 mm |
| Recharge (50% E.R.) | approx. 285 mm | approx. 293 mm |

### 6.6 Hydrochemistry, water quality and temperature

The hydrochemical analyses of groundwater at the Tobergal source are indicative of a calcium bicarbonate type water which may either be a carbonate rich sandstone or which may lie at the softer end of the limestone carbonate water scale. The analyses show a **hard** water (259–273 mg/l ($CaCO_3$)), with moderate alkalinity (255 mg/l ($CaCO_3$)). The hardness would be more typical of the sandstones in Co. Limerick but values this low may also occur in limestones. Conductivities measured for the project are also slightly lower than is commonly found in the limestones, at approximately 540 μS/cm.

The routine analyses carried out by the Council for the purposes of the EC regulations are of limited use in assessing the water quality of the Tobergal springs, as the supply is linked to the borehole at Broadford and the samples are normally taken at the point of consumption rather than at the individual sources. From the raw water analyses taken as part of the study, it appears that the water quality is generally excellent, with all indicator parameters at background levels. This conclusion however, is based on just two samples. The County

Council analyses of the combined sources have indicated the presence of faecal coliforms in the past (e.g. C2 analysis 1992) but it is suspected that this may be attributed to contamination at the Broadford site or may be a localised problem caused by overland flow at the Tobergal springs.

The EC funded study of thermal groundwaters in Ireland showed that the spring has a temperature of 13.4–14.1°C which is considered to be a few degrees higher than normal groundwater. This indicates that at least some of the groundwater issuing at the spring has been thermally heated and is likely therefore to be coming up from a considerable depth.

### 6.7 Permeability

The chaotic depositional environment of the glacial sediments gives rise to a large variability in the deposits with depth and it is expected that there may be some higher permeability sands and gravels beneath the relatively low permeability clayey limestone till at surface.

The Waulsortian limestones are relatively highly permeable and they have been karstified and dolomitised in other areas in Co. Limerick and elsewhere. The Ballysteen Limestones, Ringmoylan Shales and Mellon House beds which lie under these limestones are expected to comprise low permeability shaley limestones and shales, and moderate permeability thin siltstones, shales and sandstones, to a depth of approximately 300 m. The next rock unit beneath them is the highly permeable Kiltorcan Sandstone.

### 6.8 Conceptual Model

The available information is limited and does not permit a definitive conceptual model. It is highly likely that groundwater discharging from the Tobergal springs comes from two sources: (i) the shallow Waulsortian limestone aquifer in the vicinity of the springs, perhaps augmented by lenses of sand and gravel in the till; and (ii) a deep confined aquifer – probably the Kiltorcan Sandstone – which provides the warm water to the springs, probably along a permeable fault zone. The proportions of discharge coming from each source is not clear, but mixing between the two is likely to occur at shallow depth in the vicinity of the springs.

The proportion of the spring discharge arising from the shallow aquifer is estimated, based mainly on the likely catchment area, to be approximately one third of the total discharge. (This may be an overestimate and it is emphasised that the scientific basis for the figure is poor.) The recharge area for groundwater in the deeper aquifer system is likely to be quite distant from the Tobergal area.

### 6.9 Aquifer Categories

Considering the Kiltorcan Sandstones and the Waulsortian Limestones in terms of well yields, specific capacities, lithology and structure over the county, they are both classed as **regionally important aquifers** which are dominated by **fissure flow**. The Muddy Shelf Limestone Unit to the southwest is classed as a **locally important aquifer** which is **generally moderately productive only in local zones**.

## 7. VULNERABILITY

In general, groundwater in the Tobergal springs area is considered to be of low vulnerability as a consequence of the thickness and low permeability of the subsoils. In addition, the groundwater residence times appear to be relatively long and there is little response to rainfall which suggests that contaminants may not easily reach the source. The depth-to-bedrock becomes more shallow in the region of the quarries (refer to Section 5.4) and the vulnerability rating increases there through moderate, high and extreme, depending upon the subsoil thicknesses. To the north and east of the site the presence of more permeable till-with-gravel and thinner alluvial deposits, brings the vulnerability rating there up to high (Fig. 3).

## 8. DELINEATION OF SOURCE PROTECTION AREAS

The delineation of the Source Protection Areas is considered with a view to protecting the shallow water system (i.e. the upper limestone beds, and any subsurface sands and gravels) for the following reasons:

- the deeper aquifer is not known with certainty;
- as the deeper aquifer is confined, it is naturally protected by the overlying deposits;

- the likely distant recharge area to the deeper aquifer will be protected by the resource protection scheme;
- the relatively long groundwater residence times will ensure a certain level of attenuation and dilution.

As a conservative guess, it is assumed that not more than one third of the total discharge from the spring is shallow groundwater and that the majority of the flow comes from depth.

### 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 eastern boundary of the zone of contribution is controlled primarily by the river which is considered to be a discharge zone for the subsoils and upper limestones. The western boundary is more tentative and is based on the streamlines associated with the likely groundwater flow direction. The southernmost extent of the zone is constrained by the change in permeability of the bedrock moving from the clean limestones of the Waulsortian Mudbank Limestones to the darker muddier limestones of the Muddy Shelf Limestone Unit, although it includes an additonal 100 m of the lower permeability rocks to allow for error in the current geology map. The final area (as shown) incorporates a ±20° error factor in the estimated groundwater flow direction (Fig. 4).

The Recharge Equation estimates that the area required to collect enough recharge to sustain one third of the current discharge, i.e. the shallow water contribution (refer to section 6.8), on an annual basis, is in the region of 1,179,100 $m^2$, equivalent to a circular area of approximate radius 610 m. The Outer Protection Area, shown in Figure 4, is larger than this and will therefore incorporate an additional safety factor.

### 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 Time of Travel Equation was used to estimate the 100-day time of travel distance to the source. Taking a permeability of 5 m/d, based on analyses at the sources in Fedamore and Croom which occur in the same rock type, assuming a natural water gradient of 0.005 as the springs flow by gravity feed, and assigning a porosity value of 0.025, the 100-day time of travel radius is calculated as approximately 100 m (Fig. 4). The area is delineated to incorporate the 100-day travel time distance to all 4 springs, and will only be valid within the catchment area.

### 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 three main springs at Tobergal, which is owned by the County Council, is designated the Source Site Area. The fourth spring which is separated from the others is not fenced off, but the Source Site will encompases an area of radius 10 m around the collecting chamber.

## 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 Ballingarry source. These are listed here and are shown in Figure 5:

- Source Site / Low (SS – L)
- Inner Protection Area / Low (SI – L)
- Outer Protection Area / Extreme (SO – E)
- Outer Protection Area / High (SO – H)
- Outer Protection Area / Moderate (SO – M)
- Outer Protection Area / Low (SO – L)

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 recharge area for the deep confined aquifer is not known, consequently there is no information on potential pollution sources, and pollution control measures cannot be taken in this area. However, in view of the likely long (probably decades) travel time from the recharge area to the springs, the risk from pollution is probably low. With regard to the shallow limestone aquifer in the vicinity of the springs, the only likely cause for concern at the current time is the occasional slurry spreading which occurs in the fields adjacent to the springs. The permeabilities of the subsoils are quite low and contamination by overland flow may prove to be an issue. There are also a number of farms and houses within the catchment area which are a potential hazard, although the risk is reduced by thick underlying tills.

## 11. CONCLUSIONS AND RECOMMENDATIONS

Overall, the Tobergal springs are a very high yielding group of springs. A substantial proportion of the output is considered to be coming from a deep aquifer, which is probably the Kiltorcan Sandstone. This source of groundwater will have a low vulnerability to contamination as the aquifer is confined. However, groundwater contributed from the shallow limestone aquifer (and sand and gravel lenses, if present) is somewhat vulnerable. The Source Protection Areas are designed to protect the relatively shallow water system which, it is assumed, provides less than one third of the total discharge from the springs.

It is recommended that the Council control and monitor potentially contaminating activities in the immediate vicinity of the source as the subsoil cover is of low permeability and surface runoff down-slope may prove important. In particular the issue of slurry spreading in the adjoining fields should be addressed. The Council should consider fencing in the Source Site around the fourth source. In general however, the source is of a high water quality. The Council should carry out separate analyses on the Broadford and Tobergal raw water sources to ascertain whether the occasional presence of faecal bacteria in the combined supply may be attributed solely to the Broadford supply. If this is the case, usage of the Tobergal source alone should be considered.

Although the area to the southwest of the springs overlying the locally important aquifer is not incorporated into the protection zone, the Council should still carefully consider any planning application for a major potentially polluting development.

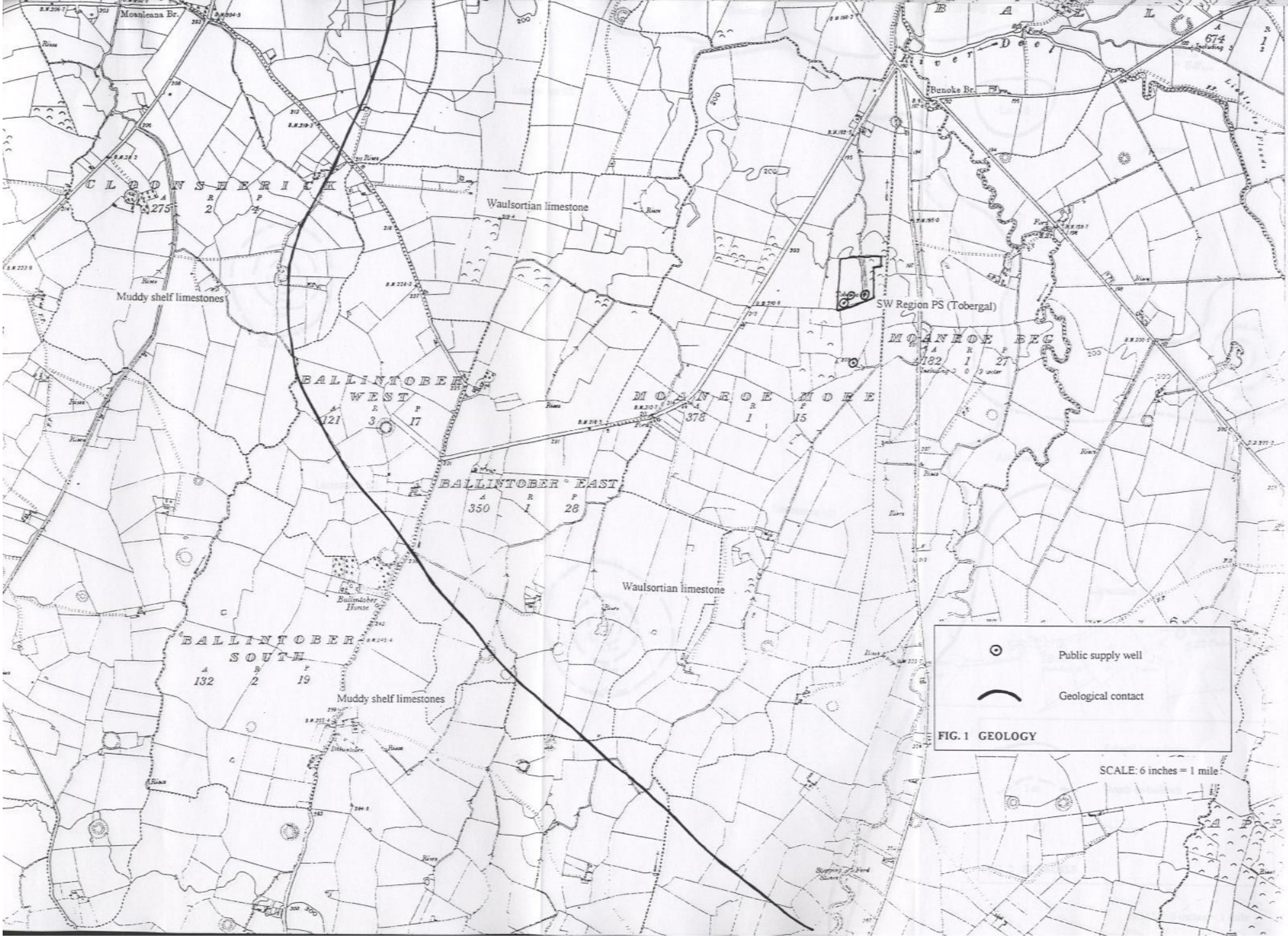


FIG. 1 GEOLOGY

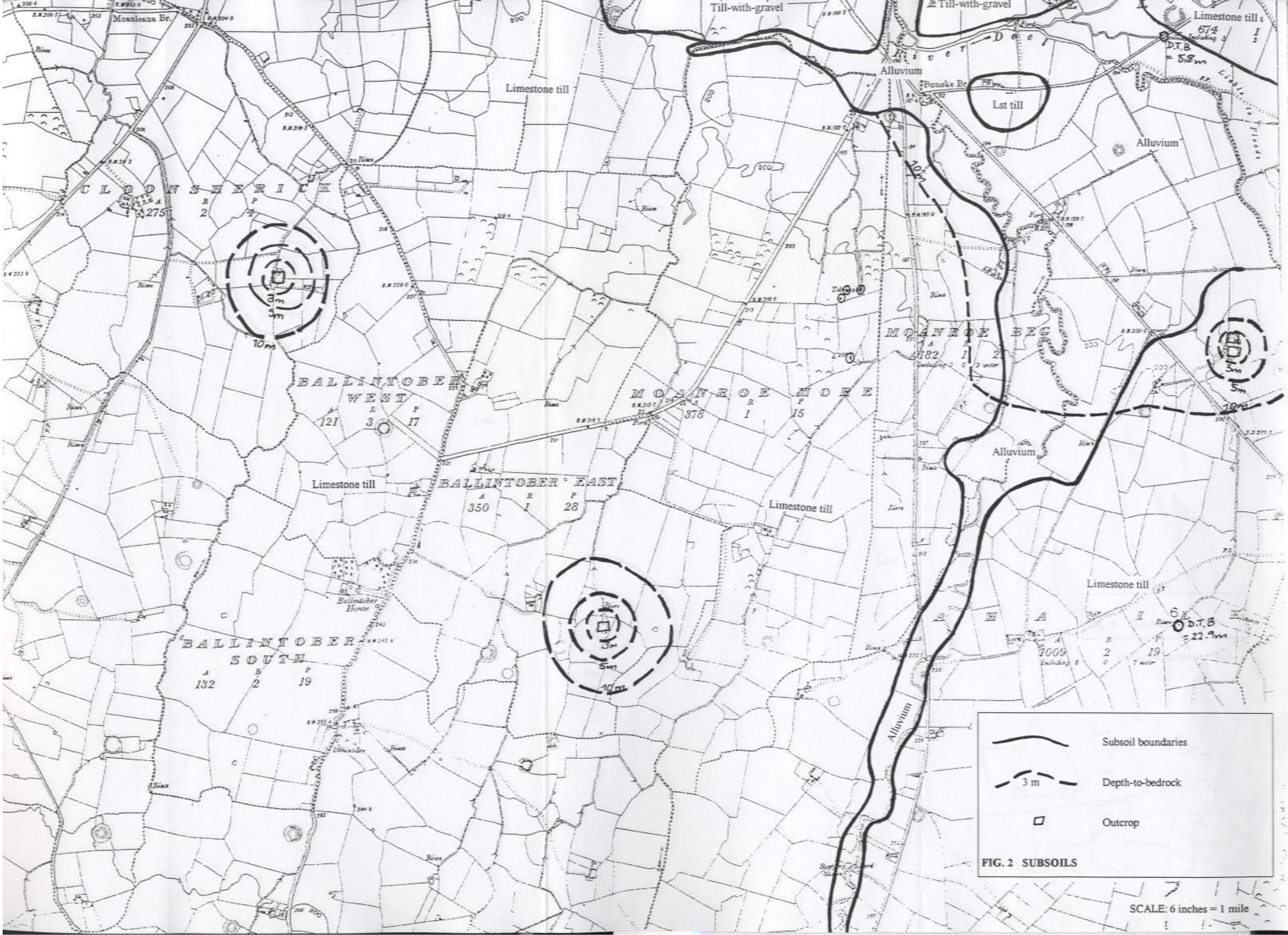


FIG. 2 SUBSOILS

SCALE: 6 inches = 1 mile

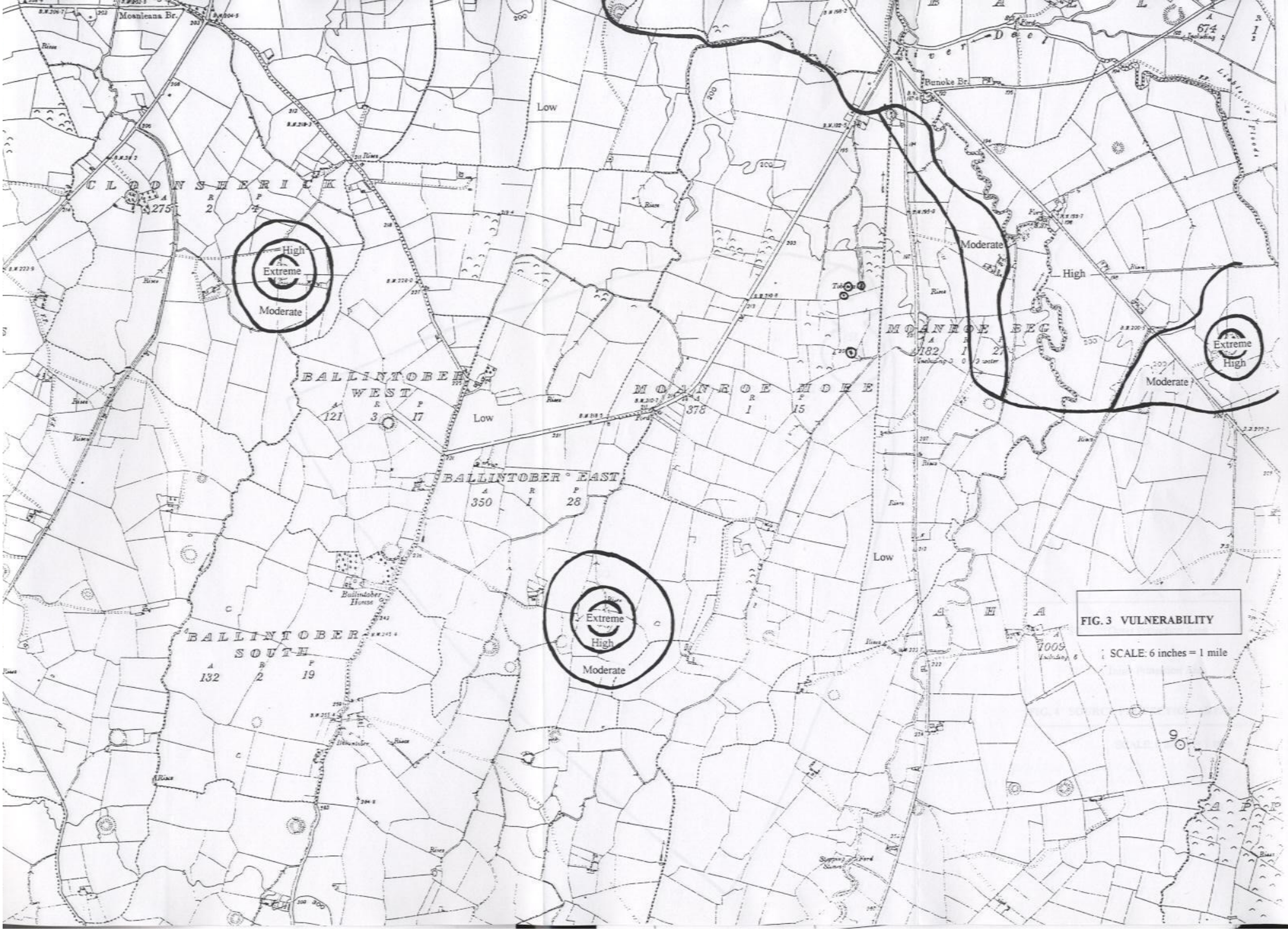


FIG. 3 VULNERABILITY

SCALE: 6 inches = 1 mile

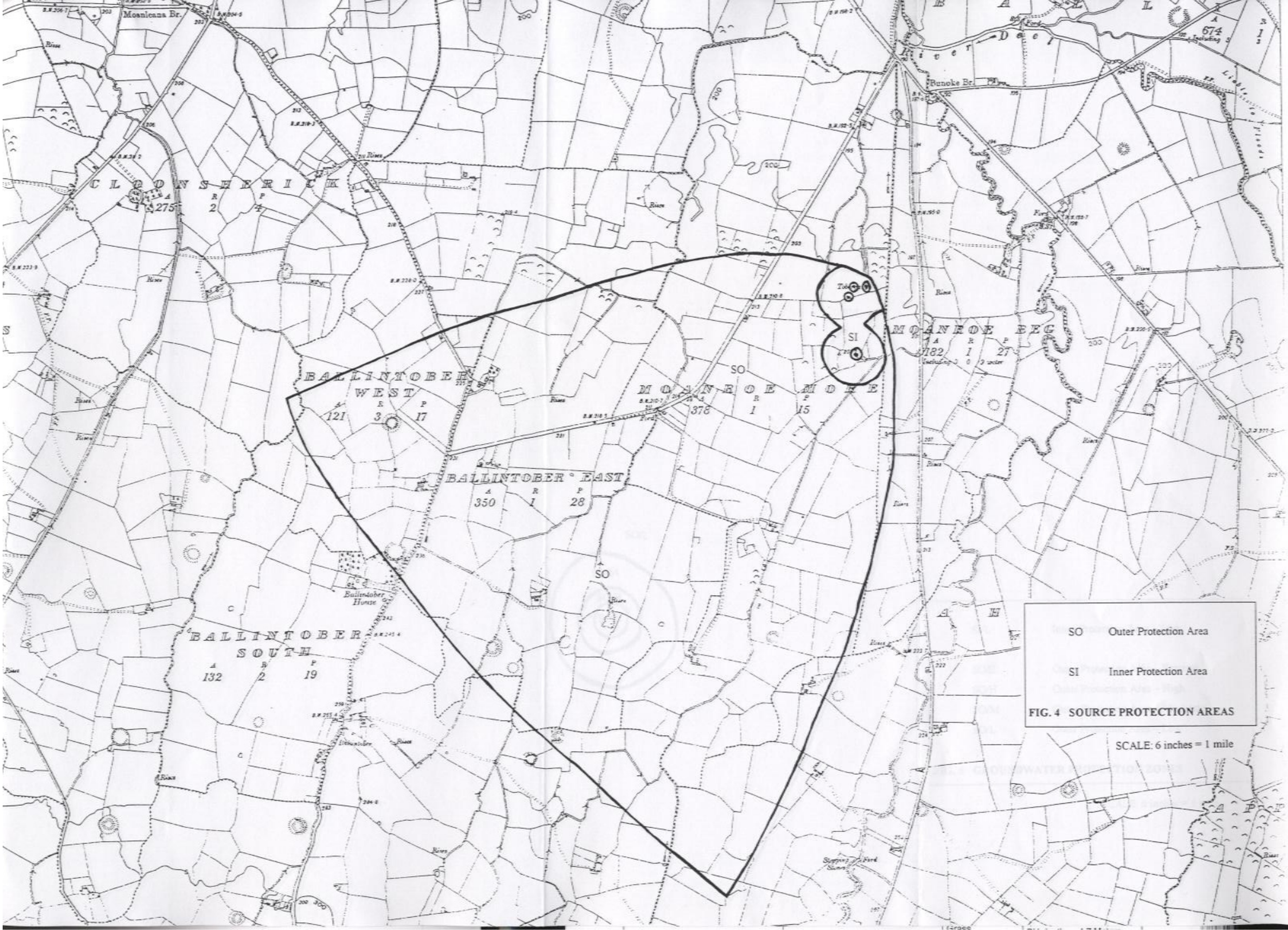


FIG. 4 SOURCE PROTECTION AREAS

SCALE: 6 inches = 1 mile

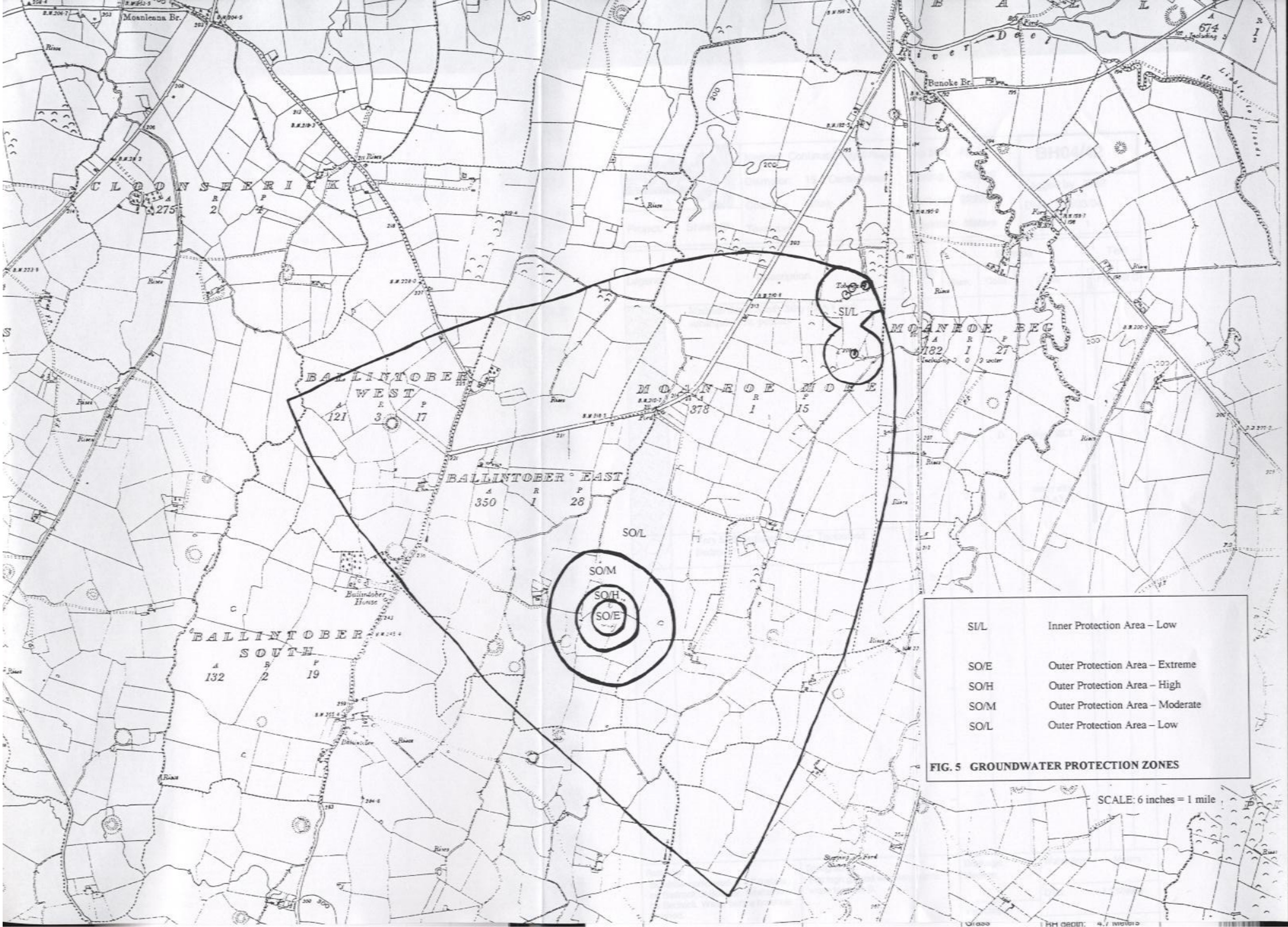


**FIG. 5 GROUNDWATER PROTECTION ZONES**