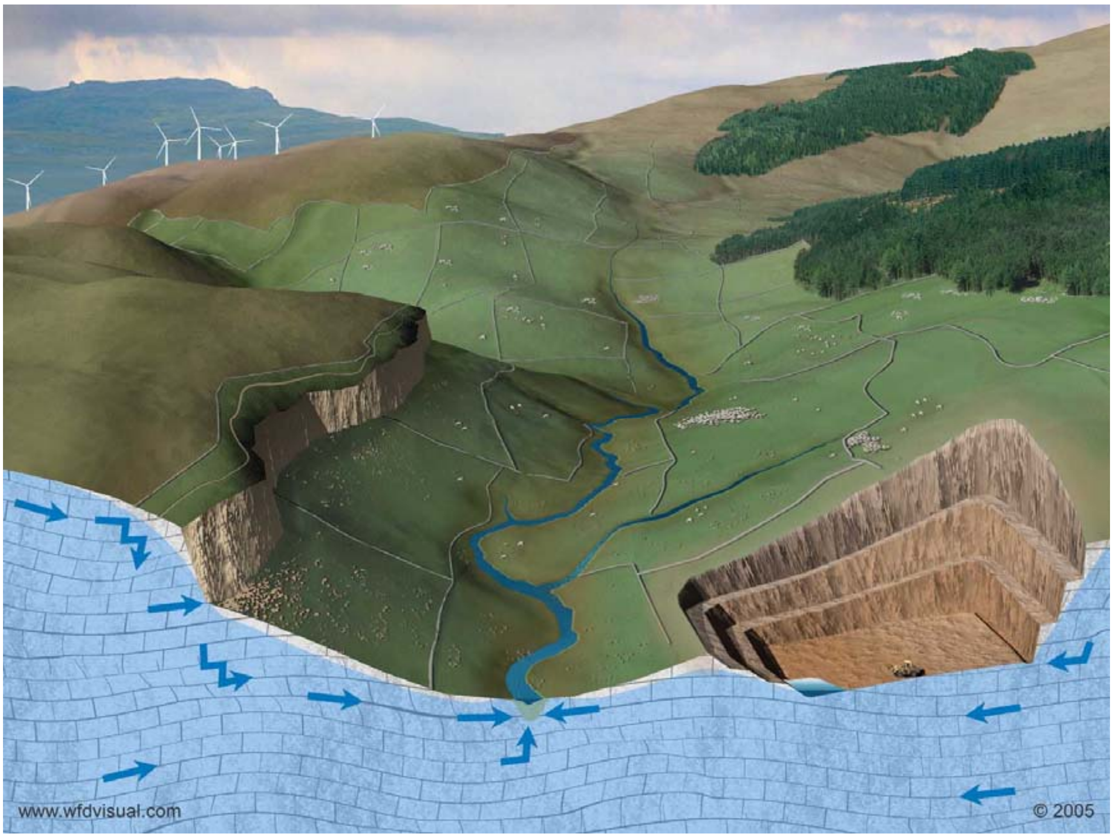
# INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (IRISH BRANCH)

# 2012 ANNUAL FIELD TRIP

**Groundwater Issues in Tipperary, Limerick and Clare**



## Introduction

In keeping with the theme for the successful 2012 IAH, (Irish Group) annual conference the fieldtrip will look at hydrogeological issues associated with quarrying and mining, as well as other issues in the area.

We will be spending most of the first day at Lisheen Mine, in Co. Tipperary. This is one of the largest producers of zinc in Europe. Here, we will be taken through the geological and hydrogeological aspects of the mine, and its large scale dewatering operations. This visit will include an underground tour, but spaces are limited. We will then travel to the sand and gravel spring complex at Moroe in Limerick, where David Ball will explain the groundwater development to increase the yield.

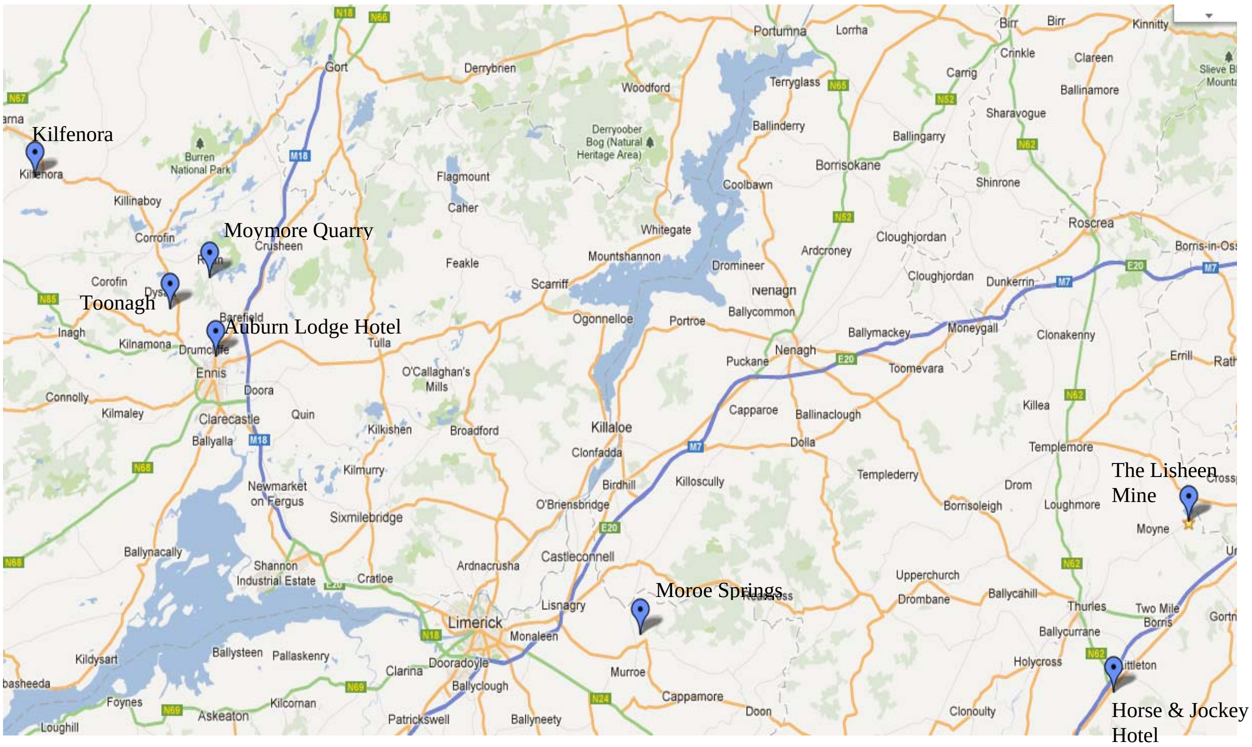
On the second day we start by visiting Moymore Quarry, near Ennis. Ms Mary Burke and Dr. David Drew will discuss some recent investigations into the quarry and its nearby SACs, SPAs and public groundwater sources. We will then move to Toonagh, the site of a major oil spill, where we will discuss groundwater monitoring and clean-up. Patrick Morrissey, of TCD, will discuss some on-going investigations into the impacts of waste-water treatment systems for a small cluster of houses here, also. The second stop of the day will be at Kilfenora waste water treatment plant. We will discuss the fact that the effluent from the treatment works discharges directly into a swallow hole, and examine some recent water tracing that shows the extent of the areas affected.

Time table*:

| | | |
|---|---|---|
| Saturday 13th October | 8 am | Coach leaves GSI offices |
| | 10 am - 3 pm | Visit to Lisheen Mine, |
| | 4 - 5 pm | Moroe spring complex |
| | 6 pm | Arrive at Auburn Lodge Hotel, Ennis, Co. Clare |
| | 8 pm | IAH Group Dinner at the Auburn Lodge Hotel |
| Sunday 14th October | 9 am | Coach leaves hotel |
| | 9:30 -10:30 am | Moymore Quarry, Ennis |
| | 11:00 - 11:15 | Toonagh, Ennis |
| | 12 -2 pm | Kilfenora WWTS |
| | 2 pm | Lunch in Kifenora |
| | 2:45 pm | Coach leaves for Dublin |

* Please note that timetable may change on the day

## Map of Sites




## Acknowledgements

On behalf of the IAH Irish Group I would like to thank all the contributors and field guides for taking the time to show us around the site and for preparing this field guide document. In particular, I would like to thank Jenny Deakin, David Ball, Patrick Morrissey, David Drew and Mary Burke for all their time and effort. I would like to especially thank the staff of the Lisheen Mine, for facilitating us on a weekend and allowing an underground visit. They were very helpful in the run up to the trip. Finally, I would like to thank the GSI and the Groundwater Section for their support, especially John Carroll, who helped me prepare this booklet.

Caoimhe Hickey 2012

## The Lisheen Mine

The Lisheen Mine is situated in County Tipperary, some 12 km northeast of the town of Thurles, between the villages of Moyne and Templetuothy. Development of the mine started in 1997 and it has been in production since 1999, producing an average of about 165,000 tonnes of zinc and 20,000 tonnes of lead per annum (Water Management Consultants, 2009).

### *Regional Geology*


The Lisheen zinc deposit is located in the Rathdowney Trend. The Lisheen district is underlain entirely by Lower Carboniferous limestones. The most dominant unit locally is the Waulsortian formation (the Waulsortian mud bank complex). Argillaceous Bioclastic Limestone (ABL) dominates the areas to the northwest and northeast of Lisheen. Sequences of Cross Patrick formation and Lisduff oolite are common to the south. The Lisheen deposit owes its existence to the presence of several faults in the district, which played a major role in the formation, morphology and location of the ore bodies. It is believed that these fractures in the strata acted as conduits for the hydrothermal mineralising fluids which carried metals upwards from extreme depths.

### *Mining*

The Lisheen Mine is an underground operation, with an average mining depth of 170 metres. Room & Pillar and Drift & Fill are the main extraction methods employed underground, with blast hole stoping used in thicker areas.

Mining operations are scheduled on a 3 shift rotating basis, 6 days per week basis. Approximately 6,300 tonnes of ore grade material are transported from the mine to surface daily via a conveyor system. The mine is accessed via a 1.5 kilometre long decline, at -15%, 6.3 metres wide by 5 metres high. Underground drilling rigs bore holes in the ore face, which are charged with explosives and fired. The resultant broken ore is removed by large Load Haul Dump (LHD) machines and loaded into trucks which transport the ore to the crusher. The ore is first emptied onto 'grizzly' bars which prevent oversized material from entering the crushing chamber before being fed into the underground crusher. All material is removed by conveyor to the surface, where it is stored in a covered stockpile of approximately 12,000 tonnes live capacity prior to processing in the Concentrator plant.

The mining department workforce comprises 210 people, 130 of whom work in operations; the remaining 80 staff work in Maintenance and Technical services. Production crews operate a 3 shift cycle covering six days per week. A staggered start in each shift facilitates an overall shift length of 10-11 hours. Maintenance crews operate on a 3 and 4 shift cycle.

## *The Environment and Water Management*

Water has been a significant challenge in the design and construction of The Lisheen Mine. In the interests of safety and the environment, a sound approach to groundwater management has been implemented and is governed by an Integrated Pollution Control Licence (IPCL) issued by the Environmental Protection Agency (EPA). Initially, surface de-watering wells were placed at the edge of the mining area. Later, a sub-horizontal well field was drilled within the mine, and this remains active.

On a day-to-day basis, a five step approach has been developed for managing water:

1. Pollution is to be prevented at source through:
   - Clean and dirty water separation underground,
   - Maximizing clean water run-off,
   - Preventing contact of clean water with pollutants and mining waste.
2. Improve water use efficiency and minimize wastage.
3. Maximize re-use and recycling of dirty mine water through mill circuits.
4. Treat polluted water in a manner that is sustainable, meets IPCL conditions, and catchment water quality objectives.
5. Abide by licensed discharge requirements of “clean” and treated water, and responsibly handle water treatment waste.

The Water Management System extends across all aspects of the operation, and through the efforts of a full-time Water Crew and the use of Departmental Water Management Programmes, ensures that less than one third of all water entering the mine workings becomes contaminated. This contaminated water goes through a rigorous treatment process that is closely monitored and tested to ensure full compliance with all guidelines and legislation set down by the appropriate Governmental State Bodies.

The treatment process uses lime, coagulants and flocculants to precipitate out metals. The process is closely monitored by continuous water monitors and tested to ensure full compliance.

Following treatment, water from the mine workings is pumped to the on-site conditioning ponds, blended with uncontaminated mine water and then discharged to the Drish and Rossestown rivers. The discharge water meets the legislated Salmonid and Human Consumption water quality guidelines (SI294/89, SI293/88 and The Department of Environment Technical Memorandum No.1 (April '78))

The second most significant aspect is the management of tailings, which is the waste material from the mining process (comprised of finely ground waste rock, zinc & lead minerals and metal sulphides, sand, silt and clay sized particles). It is generated in our concentrator building where metal is extracted from ore. The tailings are piped as slurry to an impoundment created by a water retaining embankment, the Tailings Management Facility, or TMF. Approximately 50% of tailings will be is used for underground backfill and the remaining are stored under a water cover in the TMF, to prevent oxidation of residual sulphides. The TMF has an HDPE lining in place over the in situ peat to prevent seepage of tailings water in groundwater and to maintain water cover, therefore due to the low permeability of peat, the facility is essentially double lined.

A rigorous sampling program is in place to monitor the condition of the TMF and ensure that it does not have any impact on the local environment. An approved closure plan is in place and will progress in consultation with the EPA as the mine approaches closure.

The Environmental department has a complement of seven; four employees carrying out environmental sampling and analysis, two environmental officers are responsible for managing our significant environmental aspects and our management system. The work of the department is co-ordinated by an Environmental Engineer.

In the region of 10,000 individual water samples are analysed every year. Further to this continuous monitors for noise, vibration, weather and water quality generate in the region of 1 million results every year.

Air and water quality are measured, as well as noise and vibration levels in the vicinity of the mining operation. The quality and ecological status of surface water and groundwater soil and vegetation is also regularly monitored.

The mine has a dedicated Environmental Centre, where information can be scrutinised by any member of the public. The Environmental Centre also houses a 'state-of-the-art' laboratory where samples of water, air and soil are tested using the latest analytical equipment. The environmental data collected at the mine site is regularly submitted to the EPA and is available for public inspection at EPA Headquarters, as well as on-site.

*De-watering:*

As was predicted from the outset, the mine has required continuous dewatering to help maintain safe working conditions underground. The original dewatering concept was to install surface dewatering wells to lower groundwater heads in the Waulsortian limestones, prior to the advancing decline reaching the level of the orebodies. It was planned that, once a reasonable amount of underground void space had been opened up, management of water from the underground workings would become progressively more important, and would gradually supersede the surface wells. This proved to be the case (Water Management Consultants, 2009).

Virtually all groundwater movement within the limestone units in the Lisheen area occurs by fracture flow. The structural geology discussed in Section 2.1.5 below exerts a prominent control on the district and local-scale hydrogeology. Because of the high degree of structural control, the drawdown surrounding the mine is anisotropic and is not the same in each direction. Drawdown is locally elongated along the prominent north northwest-south southeast structures.

For the conceptual model, groundwater inflows to the mine can be considered to be derived from: 1) storage removal in the limestone units, and 2) recharge as a result of rainfall and infiltration over the area of drawdown created by the dewatering system. The groundwater predictions developed in 1998 indicated that inflows would rise to 100-140 MLD in the early years, and would gradually reduce to between 54 and 72 MLD once the full mine footprint area had become opened up.

As dewatering has progressed, it has become clear that the main structural geology influence on the overall hydrogeological system is the north northwest-east southeast trending regional faults. Following the early identification of F1, F2 and F3, about seven other major structures are now identified in the Lisheen area. The “zone” of drawdown surrounding the mine is often elongated in a north northwest-east southeast direction. Site-wide, structures of this orientation form the main influence of the groundwater system.

In the early years, storage removal was the main component of the groundwater inflows. However, the actual required amount of storage removal could not be achieved quickly enough, and the early workings were sometimes under residual groundwater heads of 50 m or more. Because of this, the peak dewatering rate was lower than initially modelled. The total inflows to the mine (including F2/F3) reached a peak of 93 MLD in the spring of 2001.

Since the initial Main Zone and Derryville Zone workings were opened up in 1998, the amount of required groundwater storage removal has progressively decreased, and regional groundwater recharge to the area of drawdown has gradually become the main source of the sustained inflows. Overall, groundwater inflows have progressively decreased with time, and reached a minimum of 57 MLD in October, 2004. It should be noted that this “lowend” value was achieved after two consecutive “dry” winters when recharge rates were low.

The dewatering inflows were stable between about 2002 and 2006. There was a gradual “tailing-off” of inflows, with a seasonal variation superimposed on the overall declining flow rates. By 2006, it was considered that the hydrogeological system was almost in steady state. Virtually all of the groundwater storage removal had taken place, and the dewatering rate was sustained by regional groundwater recharge over the area of drawdown. Water levels in the footprint area of the mine were drawn down close to the top of the workings. The residual groundwater head above most of the mine footprint area was less than 20 m.

*District drawdown*

Lisheen has prepared an extensive district-wide groundwater well inventory. Groundwater levels in regional wells are monitored by Lisheen staff every 6 months. The drawdown rate is very small (less than 1 m) in most of the outlying regional wells, and is within the magnitude of the normal seasonal variation for most of the regional wells that are monitored. Except in the area immediately surrounding the workings, there has been relatively little impact to the groundwater system.

Monitoring results have shown that a downward hydraulic gradient has developed throughout the district. While the district-wide impacts to groundwater levels at the surface are small to none, the downward hydraulic gradient has created a “zone of capture” for recharge to the mine workings of about 85-90 km2. In the original modelling work, the predicted recharge rate to the zone of capture was about 25% of mean annual rainfall, or about 0.7 MLD per square kilometre. The natural recharge rate to the Waulsortian limestone outside the influence of dewatering is about a third of this value.

Development of the Bog Zone commenced in 2006 by driving an access ramp eastwards from the main area of mining. At that time, the available groundwater monitoring data for Bog Zone indicated that little drawdown had occurred in the area, primarily because Bog Zone is located perpendicular to the main strike direction of the west northwest-east southeast structures. Although they enhance groundwater flow along the direction of their strike, these structures tend to form hydrogeological barriers to groundwater flow perpendicular to their strike direction.

Therefore, it was clear that Bog Zone would require additional groundwater storage removal and would cause higher sustained inflows. Modelling was carried out and predicted that short term overall inflows during mining of Bog Zone would increase to 82-89 MLD. Once groundwater storage removal had taken place around Bog Zone, the overall groundwater inflows to the mine would reduce to a steady state value between 68 and 75 MLD.

*Closure monitoring plan*

Closure of the Lisheen mine site will require a monitoring plan to ensure that actual conditions and potential impacts are roughly as predicted. Details of the monitoring plan will be prepared once the timing and exact conditions for closure are known with more certainty that at present. However, it is likely that the closure plan will include the following elements:

• **Monitoring of recovering water levels in workings.** This may include water level measurements in the Fresh Air Shaft and in one drill hole in each orebody. Monitoring of the F2/F3 inflows would also be carried out for as long as access allows.

• **Monitoring of recovering regional groundwater levels.** This would be carried out in available shallow boreholes, and also in TMF piezometers and monitoring wells. The monitoring of regional wells would also be continued for a reasonable period of time following shut down of the dewatering system.

• **Monitoring of the chemistry as the workings flood.** This would be carried out by sampling the available drill holes into the ore horizon. A selection of shallow holes would also be monitored to ensure upward mixing of the water was not occurring.

• **Establishment of downgradient compliance point.** This is yet to be determined, but could potentially be the existing Colleeny well or a new purpose-drilled well to the south of the Killoran fault zone. Actual water quality compliance levels would be established following more detailed modelling nearer to the time of closure. The establishment of compliance levels would also use the available baseline monitoring data as a reference.

• **Post-closure monitoring of Drish and Rossestown rivers.** This would be carried out as per the current schedule for the first 12 months, decreasing to an annual low flow sample at the downstream bridges following full recovery of the groundwater system.

(The Lisheen Mine 2008-2012 / Water Management Consultants 2009).

Water Management Consultants, 2009. Preliminary Hydrogeological Study of the Tailings Management Facility Under Closure Conditions. 1501/R6. Water Management Consultants Ltd (A Schlumberger Company). Shrewsbury, United Kingdom.

## The Moroe Spring Complex and Groundwater Development

Moroe is a story. It is not a remarkable story when viewed with hindsight. Its outcome now appears obvious and simple.

The source for the water supply for Moroe and a large part of adjacent rural east Limerick was the springs at Moroe. There was a problem. People were moving out of Limerick in the 1990's. They worked in Limerick city but did not want to live there. Many 'one off' houses were being built along the roads radiating from the City beyond the suburbs. People were also settling in, and around, the village of Moroe because of its facilities and the attractive amenity of Glenstal Abbey and its grounds. The demand for water was increasing. The springs at Moroe had a finite yield, and a yield that decreased in summer, at a time when the demand usually increased.

Springs have a strong hold over communities and the people who serve them. There is an emotional attachment to springs, often fostered by folklore and the Church. A copious good quality spring is seen as an endowment or blessing on a community. Springs are seen as a miracle of nature. It is a cause of wonder, to pump from a spring and see the water taken magically restored by nature.

The Local Authority needed to increase the yield from the springs, but realised that they could not increase the yield of the main spring. They realised that they were dependent upon what nature gave them. They had no control over the volume of water that they could take.

They knew that a small amount of water seeped out of the bank of a ditch below the springs and they decided to construct a well or spring chamber at this site, and pump the water back to the main spring chambers, then to be pumped up to the reservoir on the hill. To begin with, it gave them a small amount of extra water in summer, but after a year, as demand increased further, they found that they were using this supplement everyday and still the demand continued to outstrip the supply.

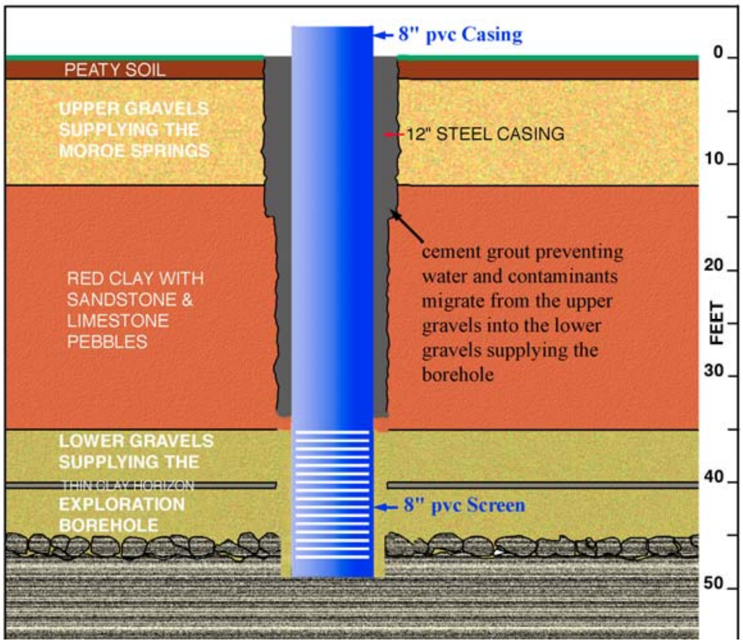

The problem was obvious, and the obvious solution was proposed. It was obvious that one or more boreholes should be drilled to draw upon the groundwater flow feeding the springs. There was the possibility of drawing water from the shallow sand and gravel aquifer that, it was believed, fed the springs. There was the second possibility of drawing water from the bedrock that might, at this site have been broken by a large fault.

The hydrogeological argument for exploration and perhaps production borehole drilling was put forward, but nothing was done. Locally important people would not countenance anything that might interfere with the springs. There was a fear that the water coming up at the springs might disappear if a hole penetrated the aquifer feeding the spring. It was argued that the borehole might act like a plughole in a bath. The water feeding the springs would all drain away, never to return. The 'holy well' would be lost forever. Logical hydrogeological arguments were used to explain that water does not disappear under ground if it has nowhere to go, but still the fear of losing the springs prevailed.

Eventually, there was a catastrophe, and it coincided with the recent appointment of a new Area engineer, who had just returned from working with a UK Water Company that depended, in part, on groundwater. He realised that the science of hydrogeology was an applied science, just like engineering. He didn't believe in water diviners and he didn't believe in the inviolable integrity of holy wells.

Photographs from the airlift pumping (D. Ball)

The visit to the site will include a description of the successful exploration and development of production boreholes. The design of the boreholes and the difficulties of carrying out pumping tests adjacent to existing springs that were being used to maintain supply to a village and a large area around. Pumping tests cause a drawdown. This could cause the springs to dry up.




Mr. David Ball.

Moroe Production borehole design (D. Ball)

## Moymore Quarry

**Quarry Ref:** QY166

**Grid Ref:** N 133,430 E 185,498

**Address of Subject Site:** Moymore, Ruane, Co. Clare.

### *Site Description*

The quarry is located in the townland of Moymore, Ruan, approximately 1.4 km to the south of Ruan village and approximately 5 km to the north of Ennis. The site is located off a local county road and there is an existing gated entrance and access road to the site from the adjoining public road. Dromore Lough is located approximately 350 meters to the east of the site and Lough Reagh is located approximately 750 meters to the west of the site.

Relevant SPA and SAC sites within catchment

The quarry is located approximately 3 km to the north of SPA site Ballyalla Lough SPA Site Code 004041.

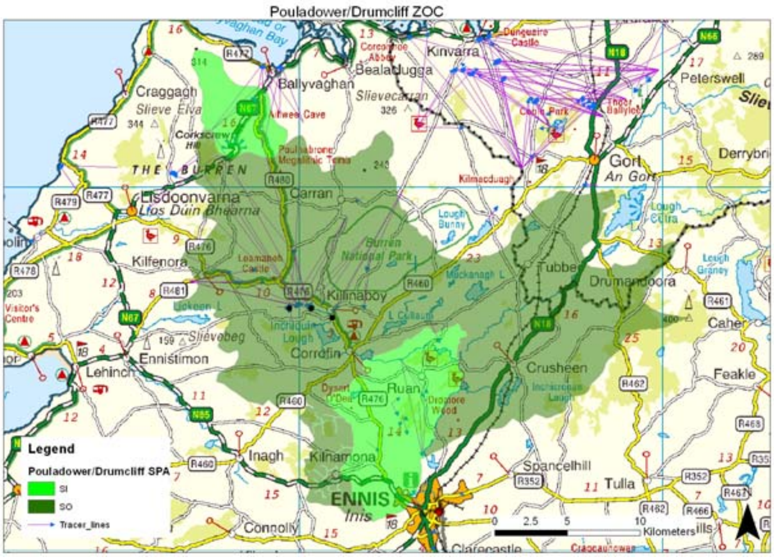
The quarry is located adjacent to SAC site Dromore Woods & Loughs Site Code 000032.The quarry is located approximately 3 km to the north of SAC site Ballyalla Lake Site Code 000014, and is connected by underground channel to this lake.

**Planning history (P99-2189);** permission granted for land reclamation at **Moymore, Co. Clare.** Su**bsequent** P00-776, application to retain existing entrance to quarry, upgrade existing road and install ancillary facilities for quarry operations- refused permission. Subsequent P01-2383 application **for blasting at existing quarry" was refused. Subsequent application** P04-560 for the "retention of a puraflo peat filter waste water treatment system" was lodged and then not progressed.

Ms Mary Burke, 2012

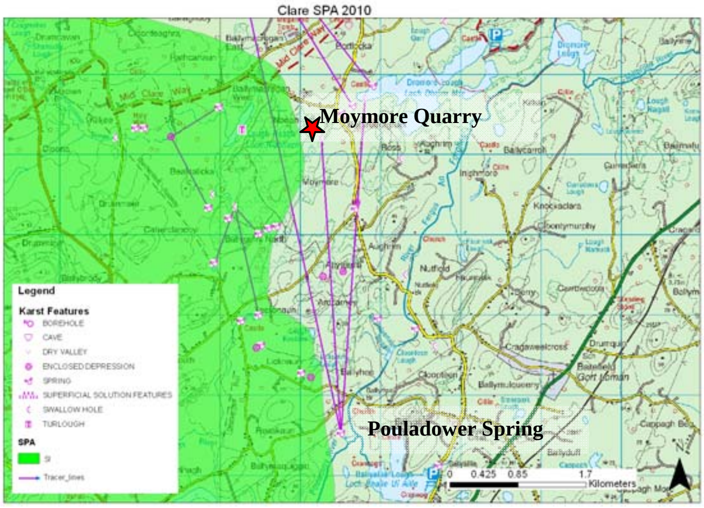
### *Tracing Experiments*

Two tracing experiments were undertaken from the water flowing in Moymore quarry. Quarrying intersected a karstic flow channel with a discharge estimated at 50-70 litres/second apparently flowing from north to south (GR 33262 85205). The quarry is believed to be located within the catchment for Pouladower spring (Deakin 2000(a)) – based on the results of tracings from the sink on the southern side of Dromore Lough and from the sinking waters of the River Fergus in Lough Keagh to the north of Ruan. Deakin presumed that the Pouladower catchment was distinct and had no connection, with



the contributing area for Drumcliff spring, a cherty rock unit forming a barrier to groundwater flow between the springs.

Tracing was conducted to determine where the underground stream intersected by the quarry at Moymore resurges and to relate the underground flow route to the known hydrogeology of the Dromore-Pouladower-Drumcliff area.




An initial test using optical brightener indicated that the quarry water did not flow to the nearby spring flowing into Dromore Lough. A subsequent tracing using sodium fluorescein showed that the quarry water drains to Pouladower spring with an underground flow rate greater than 100m/h. These findings in conjunction with earlier work allow the Pouladower water budget and zone of contribution to be established with considerable confidence.

Dr. David Drew, July 2012

## Toonagh Lime Works

The Toonagh Lime Works site is located about six kilometres North West of Ennis Town in Co. Clare. The site is located in a rural setting adjacent to an existing quarry operated by Roadstone. The bedrock in the area is classified by the Geological Survey of Ireland (GSI) as a regionally important karstified limestone aquifer. The aquifer vulnerability is classified as high to extreme vulnerability and the site lies within the inner protection zone of the Drumcliff Water Supply Scheme which supplies drinking water to Ennis town.

A leak of diesel occurring on the evening of Thursday the 28th of October 2010 from a fuel hose coming from the bunded above ground storage tank (AST) located towards the centre of the Toonagh Lime Works site. The spill was identified very early in the morning of the 29th and the extent of the loss quantified later that day. The Environmental Protection Agency (EPA), Clare Co. Council (CCC) and the Inland Fishers Board (IFB) were notified of the spill on the October 29th. Clogrennane Lime also appointed contractors to commence the excavation and a removal of any accessible shallow contaminated unconsolidated fill and soil material from the spill location on Friday the 29th. Approximately 50 tonnes of material was removed by ENVA to their licensed disposal facility at Portlaoise WYG were notified of the spill on Saturday 30th of October 2010 and attended the site on the same day.

Diesel fuel was observed in ducting down gradient of the spill location and potential for hydrocarbon contaminated was reported from the water ponding at the lower level (Bench 4) of the adjacent Roadstone Quarry and few hundred metres north of the spill location and at a surface water feature known as O’Sullivan’s Hollow located about 2.5 kilometres east of the spill location.

Given that the Toonagh Lime Works site lies within the Inner Source Protection Zone catchment of the Drumcliff spring, which is part of the Ennis town water supply, and that the bedrock is a karstic limestone with high to extreme vulnerability, there was a need to quantify the potential extent of the spill and instigate any necessary remediation works as promptly as possible.

WYG Environmental & Planning Ireland Ltd. (WYG) were appointed by Clogrennane Lime Ltd to undertake an environmental contamination assessment following a diesel fuel spill at their Toonagh Lime Works site at Ballybrody near Ennis in Co. Clare. The purpose of the assessment was to determine, as far as possible, the nature and extent of any contamination in the underlying subsoil/fill material, bedrock and groundwater and to propose a program of works to monitor and if necessary remediate any diesel contamination. A volume of up to an estimated 2,800 litres of fuel was thought to have been lost in the incident which occurred on the night of the 29th of October 2010.

As part of the initial assessment works WYG supervised the completion of trial pits, soil excavations, borehole drilling, soil and groundwater sampling and also undertook a hydrogeological study. An environmental assessment report was produced by WYG and issued to the EPA on the 26th November 2010 outlining the details of the diesel spill, the completed investigations and remediation works undertaken up to that time. The full report was entitled ‘Incident report – Diesel Spill at Toonagh Lime works’ and the WYG report was titled ‘Environmental Assessment Report’ and was dated 26th November 2010 and should be read in conjunction with this report. The report recommended the installation of an additional monitoring borehole to be located between the existing drinking water production well and the diesel spill area, further sampling and analysis of all monitoring boreholes on site, including the drinking water well and medium to long term visual assessment monitoring of the groundwater and surface water at chosen locations both on site and in the locality.

The environmental assessment and monitoring works completed to date has shown that there is no evidence that any contamination has migrated from the immediate area of the spill location. The spill occurred over five months ago and at time of writing there has been no evidence of any environmental impact from the diesel spill incident.

The presence of massive bedrock with limited fracturing and naturally occurring clay horizons in the site area appears to be naturally impeding the vertical and horizontal migration of diesel contamination. The absence of karstified limestone has reduced the rate at which the contamination could migrate to and impact the underlying groundwater.

The occurrence of the spill in a built up area of the Toonagh Lime works resulted in some of the diesel plume moving through the shallow permeable man made fill material and electrical piping ducting which acted as a preferential flow path.
It is likely that the majority of the diesel would have migrated into natural undulations or man made depressions occurring in the surface of the bedrock due to excavations completed during the construction of foundations of the lime kiln, the lime silos and/or foundations for the conveyor system. Given the nature of the infrastructure in this part of the site it is not possible to investigate or excavate in these areas.

The findings of the site investigations and sampling works completed to date indicate that the potential migration of the diesel has been reduced and confined by the massive bedrock underlying the site. There is no evidence that diesel has migrated away from the spill area as evidenced by the sampling results within the groundwater monitoring wells located around the spill location, the site boundary or any of the potential surface water receptors in the general locality.

It is likely therefore that the migration of any diesel plume from the top of the bedrock would be extremely slow and its potential movement to the groundwater would be over a very long period of time and at much lower concentrations than if it was migrating through open conduits and fissures. Given that the site is over laid by a thick continuous layer of concrete in this area it is considered that there would be very low risk to site users by any diesel contamination contained on the rock surface. There are no buildings in this part of the site are fully enclosed or occupied by staff on an ongoing basis. It is not considered that the contamination would pose any structural risk to the concrete foundations given their large scale and extent.

WYG, May 2011

## Trinity Research in Toonagh

Research is currently being carried out at Trinity College Dublin which aims to investigate the effects of cluster developments incorporating private on-site wastewater treatment systems on groundwater quality. As part of this research four study areas have been identified across the country incorporating the range of aquifer vulnerabilities. Groundwater chemistry and bacterial levels have been monitored upstream and downstream of these study areas over an extended period of time. In addition a further study area has been identified in order to access the effects of clusters of these systems in karst areas. The study area was identified with the assistance of Clare County Council and is situated at Toonagh near Ennis, Co Clare.

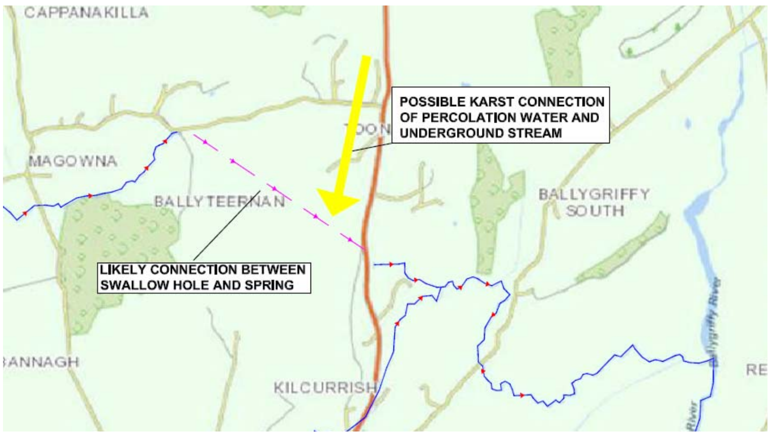



Fig. 1 - Sketch illustrating features in the area

The Toonagh area is underlain by karstified limestone bedrock with many outcrops and karst features clearly visible. The study area consists of approximately 10 No. dwellings discharging their wastewater effluent to a secondary treatment plant. Treated water from the plant is then discharged into a swallow hole.

This study aims to identify the effects of these discharges on groundwater quality in the area. A tracer study has been completed in the area previously by David Drew et al. which identified a connection between a swallow hole draining a local stream upstream of the study area and the Kilcurrish Spring downstream of the site. It was thought that there may be a connection between the swallow hole into which the treatment plant at Toonagh discharges and the Kilcurrish Spring.

A tracer study was carried out in the area using Rhodamine WT dye injected into the treatment plant outfall. The dye was observed at the Kilcurrish Spring downstream after approximately 36 hours and so the connection verified. A study is now on-going whereby water quality is being monitored upstream and downstream of the study site. Results to date indicate that groundwater in the area is not being significantly negatively impacted due to the cluster development probably due to the large volumes of dilution taking place underground. However, monitoring is on-going and a final outcome is expected early next year.

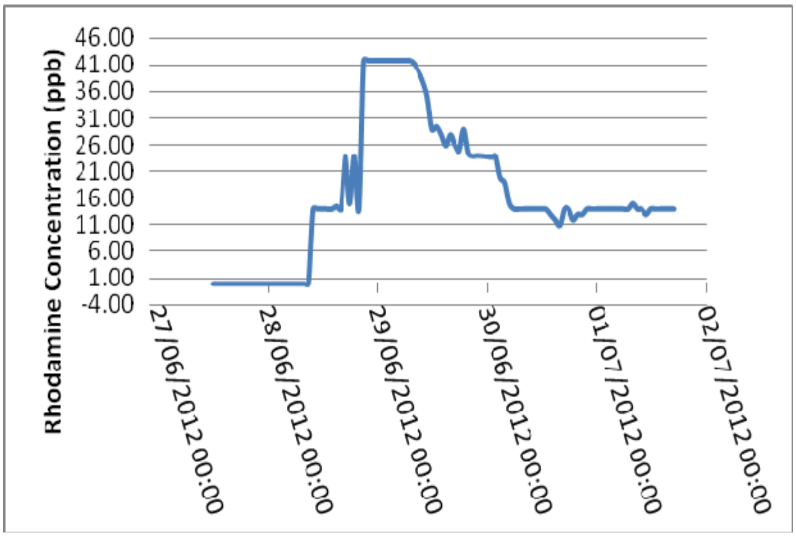



Fig. 2 – Breakthrough curve for tracer study

Patrick Morrissey, PhD Research Student
Dept. Civil, Structural and Environmental Engineering
Trinity College

## Kilfenora Wastewater Treatment Plant

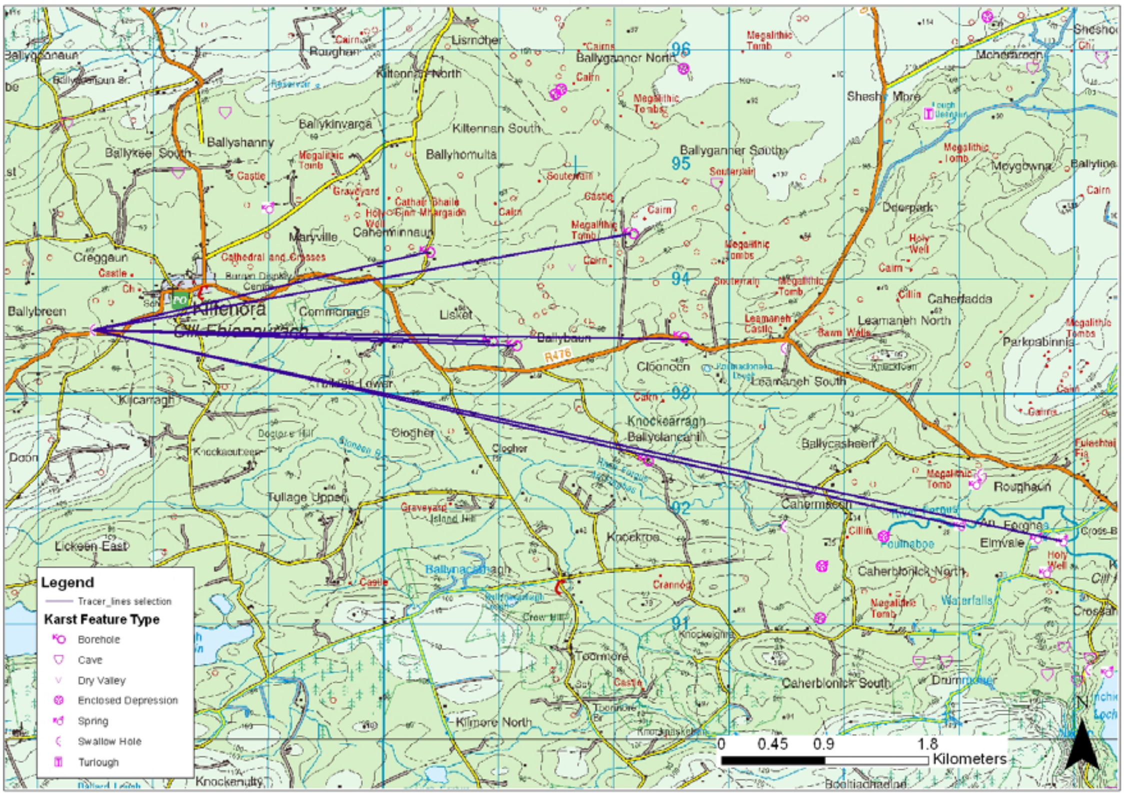
Clare County Council is continuing to provide an alternative water supply to householders in North Clare who have been affected by the alleged contamination of a group water scheme and private wells by treated effluent from its sewerage treatment plant in Kilfenora.

Since the council became aware of this issue a few months ago, the Ennistymon Area has been providing a surface-run pipe, a standpipe and tankers as required to households in Ballygannor, Kilfenora, who are dependent on the Cluneen, Ballygannor, Ballybane and Liskett Group Water Schemes in North Clare.

Clare County Council commissioned a tracer study by Dr. David Drew, to determine the path(s) of flow from the Ballybreen swallow hole, into which treated effluent from Kilfenora wastewater treatment plant is directly discharged.

The aim of the experiment was to determine the underground flow-path of water sinking at Ballybreen swallowhole, en-route to its known reappearance at the Elmvale springs in the valley of the River Fergus upstream of Lough Inchiquin and in particular it was important to determine whether water from the Ballybreen swallowhole flows to any of the boreholes used for water supply in the area between Kilfenora and the springs feeding into the River Fergus further east.

The tracing experiment demonstrated that water sinking at Ballybreen swallowhole ultimately re-appears from springs feeding the river Fergus upstream of Lough Inchiquin. Enroute, water from the swallowhole diffuses laterally from a straight-line sink-spring route as was shown by the presence of tracer, in very low concentrations, at the five boreholes used for water supply located to the west of Leamaneh, including the Lemanagh-Roughan Group Water Scheme.  No tracer was detected at the Kilnaboy G.W.S. source. All tracer had been evacuated from the system within 280 hours (12 days) of tracer input.




Dr. David Drew 2012, The Clare Champion