ISSN 0790-7753

THE GSI GROUNDWATER NEWSLETTER

NUACHTÁN SCREAMHUISCE SGÉ

- *Exploration*
- *Management*
- *Pollution*
- *News from abroad*
- *Development*
- *Quality*
- *Reviews*
- *Opinion Forum*

- *Taiscéalaíocht*
- *Bainistíocht*
- *Truailliú*
- *Nuacht idirnáisiúnta*
- *Forbairt*
- *Cáilíocht*
- *Athbhreithniú*
- *Tuairimí*

Published by the Geological Survey of Ireland.
Beggars Bush, Haddington Rd.,
Dublin 4. ☎ (01) 609511

Edited by: Donal Daly.

Foilsithe ag an Suirbhéireachta Gheolaíochta Éireann.
Tor an Bhacaigh, Bóthar Hadington,
Baile Átha Cliath 4. ☎ (01) 609511

No. 22 February 1993

IN THIS ISSUE

In the last decade, Wexford County Council has been one of the leading local authorities in **developing groundwater for public supply**. This was not done on an *ad hoc* basis, but rather in a planned way, using modern engineering and hydrogeological techniques both at the exploration and development stages. Yet at first glance, County Wexford does not look to be the most promising area for groundwater - it has only relatively small areas of limestone and gravel (the most productive aquifers in Ireland); although it has volcanic rocks, they tend to have variable permeabilities; much of the county is underlain by low permeability, ancient (more than 400 million years old) sandstones, slates and granites; and iron and manganese are sometimes a problem. On page 2, Don O'Sullivan shows that these disadvantages have not prevented the increasing use of groundwater . His conclusions are worth repeating here "**... large groundwater abstractions have a major part to play in the provision of public water supplies. Groundwater will be the most economic solution to 50 per cent of the public supply needs in County Wexford. Major groundwater schemes should be accompanied by an aquifer protection regime and groundwater modelling as the aquifer is developed**". Although groundwater is not the panacea for public water supply needs - it is not always present in the quantities required, it is sometimes not the most cost-effective source and in parts of the west of Ireland in particular, it is prone to pollution - the example given by Don O'Sullivan highlights the benefits of a modern engineering and hydrogeological approach to groundwater development.

A similar modern engineering approach, this time to the **selection, development and operation of landfills** in Ireland, was described in a recent lecture by Billy Moore (see page 12). Copies of the paper can be obtained from the GSI.

The need to improve **drilling standards** was regarded in the 80's as vital to progress in groundwater development. Undoubtedly much improvement has occurred in recent years. Tom Fogarty, of the well-known Kilkenny drilling family, outlines his approach to drilling on page 6.

Other items in this **Newsletter** include practical advice from Suzanne O'Sullivan on the **use of chemical analyses** (page 7); a summary of recent developments in **water tracing** by Catherine Coxon (page 8); a description of the **flooding that occurred in the Gort-Ardrahan area in 1990** (page 3); and details on a **groundwater protection scheme** that has commenced in County Limerick (page 10).

Editor

THE STATUS AND POTENTIAL OF LARGE GROUND WATER ABSTRACTIONS

Wexford County Council currently supplies 42,720 m^3/d of drinking water, of which 35 per cent is groundwater. Groundwater development has evolved in a fragmented manner in Co. Wexford during the late 1970's and early 1980's as the needs expanded rapidly. To meet public water supply needs to the year 2016, the Council has defined a framework of six regional schemes. The projected demand in the year 2016 is 110,780 m^3/day and the estimated cost is £102.5 million. Three major regional schemes using groundwater are proposed. The schemes, aquifers and projected demands are as follows:

1. Fardystown R.W.S.; South Wexford Limestone Aquifer; 26,400 m^3/day.
2. West Central R.W.S.; Ordovician Volcanic aquifer at Camross; 11,700 m^3/day.
3. Gorey R.W.S.; Ordovician Volcanic Aquifer at Barntown; 14,100 m^3/day.

For a regional scheme source, the following points are relevant:

(i) a wellfield of sufficient yield, located in close proximity to the demand centre is recommended;

(ii) the wellfield size is important in order to enable cost effective collection;

(iii) treatment to meet the Drinking Water Regulations (1988) must be feasible and economic.

(iv) groundwater protection must be assured and saline intrusion controlled.

A typical wellfield would have 10 to 15 boreholes, 400m to 600m apart, and each producing in the range of 900 to 2,000 m^3/day. Boreholes would be drilled to a depth of 90m and finished to an internal diameter of 250mm.

The Fardystown Regional Scheme will serve an area of 23,500 hectares in the South East of the county. The demand of 26,400 m^3/day will be supplied by twenty boreholes located in the north and mid-wellfields situated on a line from Bridgetown - Mayglass - Drinagh.

Treatment for iron and manganese removal by filtration using a 400mm layer of manganese dioxide media is proposed. The anticipated impact of the abstraction on the aquifer is as follows:

(i) a drawdown of 20 to 30m at the individual boreholes which will reduce to 2-3 metres at 1 kilometre away;

(ii) the groundwater level lowering will result in a landward movement of the saline/fresh water interface by 100m to 500m; and

(iii) the existing spring flows and the river base flows will be reduced and the risk of induced sink-holes will be increased.

The Gorey R.W.S. serves the region to the north east of the county. Preliminary drilling carried out in March 1992 indicates that a major wellfield can be developed in the volcanic aquifer at Clough - Barnadown - Essex Bridge. Yields to date indicate that 6,000 m^3/day could be supplied. It is considered that the projected demand figure of 14,100 m^3/day will be available. The Council proposes to prepare a groundwater model to determine the relationship between the water table, the rate of abstraction and the saline/fresh water interface.

Development of groundwater in Ireland is still at the early stage. Aquifers are rarely pumped at or close their capacity. There is a need for legislation where local authorities can, in the public interest, control the abstraction of groundwater.

In conclusion, large groundwater abstractions have a major part to play in the provision of public water supplies. Groundwater will be the most economic solution to 50 per cent of the public supply needs in County Wexford. Major groundwater schemes should be accompanied by an aquifer protection regime and groundwater modelling as the aquifer is developed.

Don O'Sullivan, Wexford County Council.

FLOODING IN THE GORT-ARDRAHAN AREA: CAUSES AND MEANS OF ALLEVIATION

Introduction

1. Exceptionally bad flooding occurred in the lowland karst limestone area between Slieve Aughty and Galway Bay in 1990. It caused severe disruptions for several weeks with road blockages, school closures and the inundation of large areas of land. At least five houses were flooded.

2. The GSI investigated and prepared a report on the flooding (Daly, 1992)*. David Drew acted as an advisor on the study and Vincent Fitzsimons, a student in Earth Sciences at TCD, carried out most of the fieldwork and compiled the relevant data (Fitzsimons, 1992)**.

3. The main objective of the study was to identify the reasons for the exceptional flooding. A second objective was to give a preliminary appraisal of possible means of flood alleviation.

4. This article summarises the findings and conclusions of the study.

Groundwater and Surface Water Conditions

1. There is an appreciable difference between the water and flow conditions in the higher Slieve Aughty area and the lowlands to the west. Slieve Aughty is composed of Silurian and Devonian sandstones and mudstones, which have a low permeability. In contrast, the Carboniferous limestones between Slieve Aughty and Galway Bay are karstified (dissolved and cavernous) and so have a high permeability. Consequently, water flows on the surface on Slieve Aughty, whereas underground flow is dominant in the lowlands.

2. The limestones have many of the distinctive and unusual features associated with karstification - swallow holes, sparse and intermittent streams, bare rock, caves and turloughs.

3. The streams flowing off Slieve Aughty disappear underground shortly after they reach the cavernous limestones. All the water within a large area - over 500km^2 - must flow underground to Galway Bay. <u>There is no surface outlet to Galway Bay</u>.

4. The underground drainage system consists of swallow holes where the water enters the ground; fissures, caverns and conduits in which the water flows; and risings or springs where the water re-emerges. There are large springs at Kinvarra and in Galway Bay.

5. The capacity of the underground drainage system to allow water to flow to Galway Bay depends on: (i) the size of the conduits and caverns; and (ii) the degree of clogging of the conduits. The size of the underground conduit is fixed and so there is a limit to the amount of water that the swallow hole can take. In periods of heavy rainfall once the limit is reached, the water backs up and floods the area upstream of the swallow hole. Some flooding occurs every year.

6. Coole Lough appears to be the hub of an extensive underground drainage system taking water from a vast area including Slieve Aughty and the limestone area to the south west. The water then flows underground from Coole to Kinvarra.

7. The Gort-Ardrahan area is unusual and even unique in a national and European context in that:

a) it contains a lowland karst limestone landscape with all the typical karst features - swallow holes, springs, turloughs, etc; and

b) it has not been affected by arterial drainage.

Nature Conservation

1. According to the National Parks and Wildlife Service (NPWS) there are 16 wetland Areas of Scientific Interest (ASI's) in the Gort-Ardrahan area. Nine of the ASI's are rated as being of international importance, while four are of national importance. Consequently there are few areas in Ireland with the same degree of nature conservation importance.

2. The wetlands (turloughs, lakes, fens and marshes) and the associated wildlife and landscape features are the characteristics that give the area such a high conservation and natural heritage value.

3. The importance of the area is created by two factors:

a) the geological and water regimes, particularly the large fluctuations in turlough water levels; and

* Daly, D. (1992). A report on flooding in the Gort-Ardrahan area. Internal Geological Survey of Ireland Report. 68pp.

** Fitzsimons, V. 1992. An analysis of the recent flooding problems around Gort, Co. Galway. Dissertation submitted as part of the B.A. Moderatorship in Earth Science at T.C.D.

b) the lack of disturbance of the natural situation by human activities, such as drainage schemes.

Flooded Areas

1. The boundaries and areas of floods in seven locations were estimated - Coole, Ballylee, Blackrock, Cregaclare, Tullaghnafrankagh, Mannin Cross Roads and Pollatoophil. Floods in these locations covered approximately 1570 ha (3870 acres). However this area does not include many smaller floods in other locations.

2. The maximum water level variation at Coole between summer and winter levels is over 9m.

3. The Cregaclare, Tullaghnafrankagh and Mannin Cross floods are not influenced by run-off from Slieve Aughty. They are caused by rainfall in the immediate vicinity of the flooded areas.

4. According to local farmers, major flooding has occurred three times in living memory - 1924, 1959 and early 1990. So major floods have occurred once every 25-30 years.

5. The roles of four factors in causing the exceptional flooding in 1990 and 1991 were considered: (i) Rainfall; (ii) Forests on Slieve Aughty; (iii) Swallow Hole Blockages; and (vi) Drainage from Agriculture.

The Role of Rainfall

1. Rainfall in February 1990 was exceptionally high - 3.6 times normal at the Craughwell rainfall station, with a return period of 70 years. It was also high in the period 18th December 1990- 11th January 1991 - nearly twice normal.

2. Daily rainfall data collection started in the area in 1953. Since then, the worst rainfall event occurred in early 1990, the second worst in 1959/60 and the third in January, 1991. <u>So the worst and the third worst rainfall events occurred in a 12 month period between February 1990 and January 1991</u>.

3. The worst rainfall events in 1990 and 1959/60 correspond with the two worst floods in that period.

4. The main reason for the exceptional flooding in early 1990 and January 1991 was, undoubtedly, exceptionally heavy and prolonged rainfall.

The Role of Forests on Slieve Aughty

1. Many farmers believed that the forests on Slieve Aughty were one of the main causes of the excessive flooding in early 1990 and January 1991.

2. Forests cover about a third of the area of Slieve Aughty.

3. Experience and research worldwide has shown that forests over a certain age - 10 years approx. - enable evaporation of more water than grass or other low vegetation both in winter and summer. Consequently there is less water run-off from forested areas than from corresponding grassland areas. It can be concluded that forests over 10 years old can reduce flooding during extended rainfall events such as those that occurred in 1990 and 1991.

4. Only a tenth of the forests on Slieve Aughty were less than 10 years old at the time of the early 1990 floods.

5. It is considered that the forests on Slieve Aughty are a benefit in that they are likely to reduce rather than exacerbate the flooding. Increasing the areas of forests on Slieve Aughty could be one way of reducing slightly the flood levels during exceptional rainfall events.

The Role of Swallow Hole Blockages

1. Examination showed little significant blockages of the major swallow holes except at Ballylee and Blackrock. It was not possible to be conclusive about the effects of the blockages as they could be occurring underground. However on present evidence, the role of blockages seems to be minor compared to the effect of the exceptionally heavy rainfall.

The Role of Farmland Drainage

1. Although field drainage quickens water run-off, the total quantity from a drained area is likely to be no greater than from an undrained area during an extended rainfall event.

2. Only a small proportion of the Gort-Ardrahan area is affected by land drainage.

3. Land drainage is unlikely to have had any significant effect on flood levels in February 1990 and January 1991.

A Preliminary Assessment of Flood Alleviation Possibilities

1. There are four principal possible ways of alleviating the floods in the Gort-Ardrahan area:

(i) Drainage channels or tunnels;
(ii) Interception dams on Slieve Aughty;
(iii) Planting of forests on Slieve Aughty; and
(iv) Reduction in clogging of the swallow holes.

2. In our opinion, construction of extensive drainage channels or tunnels is not a viable option. The cost would be enormous and the environmental impact would be excessive and it would be difficult to undertake successfully.

3. Interception dams on Slieve Aughty are not

likely to be a viable option - they would be expensive, they would flood other areas and it would be difficult to impound sufficient water to significantly reduce the water levels downstream.

4. The expansion of the area of forests on Slieve Aughty is likely to be an environmentally acceptable way of reducing flooding, provided good forest management practices are followed. However, the effect on flood levels is likely to be small - a few cms -, and it would take over 10 years from the time of planting for the benefits to take effect.

5. Although swallow hole blockages were not considered to be a major factor in causing the excessive flooding in 1990, it would be worthwhile to consider ways of preventing clogging from occurring in the future.

Recommendations

1. In order to prevent the future location of houses and other buildings in areas below or close to the highest flood level, it is recommended that Galway County Council should locate these areas accurately and take steps to ensure that this issue is taken into account in the planning process.

2. It is recommended that the forest management practices used should take account of the need to reduce stream run-off and stream sediment loading from Slieve Aughty.

3. As forests can reduce flooding, it is recommended that increased tree planting on Slieve Aughty should be examined as a means of alleviating future floods.

4. The only route to Galway Bay for water is through underground channels. Hence the prevention of clogging and blockages is essential. It is recommended that the I.F.A. should publicise the need for farmers to leave swallow holes open and not to leave tree trunks and branches near streams.

5. In order to reduce the risk of future swallow hole blockages, it is recommended that Galway County Council should:

a) publicise the importance of preventing clogging;

b) monitor the major swallow holes, particularly at the end of the low flow period (usually September), to ensure that they are unblocked; and

c) examine the value of constructing gabions (wire baskets filled with rocks) around some of the major swallow holes.

6. The information and data available for this investigation and report was surprisingly sparse. In view of the importance of the area for nature conservation and the degree of disruption caused by flooding, it is recommended that data collection and further research should be carried out. Flow measurements on streams and water level measurements should be initiated. Systematic investigations are needed on the geology and water regime of the area. It is recommended that the OPW and Galway County Council should consider undertaking and funding the proposed data collection and investigations.

Donal Daly (GSI), Vincent Fitzsimons (TCD)* and David Drew (TCD)
(* now with Bernard Murphy and Associates)

GROUNDWATER COURSE

Organic Pollution of Groundwater

A four-day course is offered jointly by the universities of Birmingham, Waterloo (Ontario), Queens (Ontario), and Tübingen (Germany). The course will be held at the University of Birmingham, 19-22 April 1993.

The non-residential fee is £550. For further details, contact Vanessa Chesterton, School of Earth Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK, Tel. 0044 21 414 6751.

A "NOVEL" METHOD OF WELL CONSTRUCTION

This article describes a method of borehole construction that could significantly reduce the cost of the exploration and development of a consolidated aquifer. Despite the use of ever-improving geophysical techniques, the most efficient borehole in a given wellfield may not be located until a number of trial/exploration wells have been completed. This "novel" method of well construction allows the contractor to drill a number of narrower exploration boreholes, which can subsequently be "opened" to the diameter of a typical production well, used to provide additional hydrogeological information or to act as standby wells.

Stage 1 Construction of Trial Well

1. A temporary steel casing, of the same internal diameter as the required production hole, is set (3-5m) into bedrock by standard percussion or rotary drilling techniques.
2. A 6" pilot or "spudding" hole is started at the bottom of the casing and carried a further 3m into bedrock with the hole-opener bit.
3. A temporary standpipe is centred into the borehole and the trial hole is completed to it's required depth with a conventional 6" hammer or tricone bit, followed by a stabiliser to ensure borehole verticality for subsequent casing, (Remember it is easier to stabilise a 6" diameter drill string than a larger size).
4. The trial well undergoes a 72 hour pumping test to establish it's quantitative and qualitative characteristics.

IF the exploration hole is satisfactory;
Develop this borehole as a production well.
Go to stages 2 and 3 below.
OR use this trial hole as a monitoring well.
Go to stage 4.

Stage 2 Construction of Production Borehole

1. Remove the standpipe from the exploration hole and grout in the large diameter steel casing.
2. Ream or open the production hole to it's required diameter with the hole-opener which simply fits onto a conventional drill string in place of a standard bit.
3. The production hole is now finished and after a pumping test to establish it's optimum yield, it can be disinfected and made ready for supply.

Stage 3 Workover of Production Hole

The workover of a production well may frequently be necessary, for a variety of reasons, after it has been in production for some time, for example, in the case of contamination close to the surface, to install a casing string to stabilize part of the borehole walls, etc.

1. The borehole is backfilled with coarse chippings to a depth below ground level, above which there is no significant inflow of water to the well.
2. The backfilled material is capped with 1m of sand and the remaining volume is filled with a cement grout mixture to ground level.
3. A stainless steel casing of suitable diameter containing a 1m concrete plug at it's base is lowered and centred into the borehole.
4. If necessary the large outer casing can be jacked out of the ground whilst the annulus is continually topped up with the grout mixture.
5. Once the grout has set, the concrete plug and backfilled material can be drilled out and the borehole re-developed to remove any fines or grit that remain.

Stage 4 Completion of monitoring hole

1. The trial hole is converted into a monitoring hole by simply fitting a lockable steel cap onto the larger casing and setting a concrete apron around the borehole at ground level.

Tomas Fogarty, Fogarty Drilling, Gowran.

CHEMICAL ANALYSIS OF WATER: USES AND ABUSES

In commercial terms, the most common requirement of a water analysis is to establish if the water is suitable for the intended use. The many uses of groundwater include drinking water, bottled waters, irrigation, process water used in industry and fish-farming, to name the most common. Each use will have its own requirements in terms of water quality, and it is essential to ascertain if these requirements can be met. If they cannot be met, then pre-treatment of the water may be required. Failure to recognise this may result in, for example, a potentially hazardous drinking water supply, or a process water which could adversely affect plant or even the finished product.

In order to obtain an accurate assessment of the water quality, two points should be borne in mind:

1. An analysis can only be as good as the sample that is taken. An amazing number of samples come into laboratories for analysis in old lemonade bottles (and worse!), still retaining a powerful aroma of the original constituent. Most people involved in the water industry are probably accustomed to clean sample containers, but the same attention to detail is not always kept to in filling the sample bottle to the top, to eliminate air, or transporting the sample as quickly as possible to the laboratory, in order to minimise chemical changes which may occur in the intervening period between sampling and analysis. Some parameters, such as sulphate and chloride, are relatively stable, and will not alter appreciably, even when a sample is left unrefrigerated for several weeks. Less stable ions like ammonia, nitrate, or bicarbonate can alter chemically very quickly when exposed to the atmosphere, and often all nitrite in a sample will have oxidised to nitrate by the time analysis has taken place.
2. The results of analysis on a particular sample refer to that sample only, and cannot be freely extrapolated over time and space. We can say only what the quality of the groundwater is at a particular point in the aquifer, on a specific date, and under certain pumping conditions. The more samples taken from different points in an aquifer, or from the same point over a period of time, the more confident we can be of identifying temporal and spatial variations in water quality. However, we still have to be aware, that what lies between point A and point B, be it in time or in space is at best, an estimate.

This leads on to a second use of chemical analysis, and that is continuous monitoring of hydrochemistry during a pumping test. This can lead to an understanding of variations in an aquifer, for instance, as the cone of influence increases during pumping. Differences in chemistry observed at different pumping rates, could highlight the fact that contaminated water was being intercepted at higher pumping rates. This could help in setting safe pumping rates for a particular borehole. Monitoring of conductivity levels during pump testing of a coastal aquifer can indicate if saline intrusion is occurring, and again, this could help in identifying a safe maximum pumping rate.

It is both impractical, and potentially extremely expensive to send multiple samples off to a laboratory for analysis during pumping tests. Field analysis is the only practical way of carrying out continuous monitoring. Several parameters e.g. pH, conductivity and chloride can be measured by data loggers which can record data in a form which can be simply transferred to a computer for subsequent data handling. Less sophisticated techniques can also be employed. The results of field analyses may often be inferior in terms of accuracy to analyses carried out in a laboratory. However, in the field, we are more often concerned with variations rather than precise numbers.

In order to correctly use chemical analyses as a hydrogeological tool, we need to first establish what water quality parameters are important. Sampling technique and sample transport should always take into account the potential instability of the parameters to be analyzed for. The accuracy of the data required is important, it is as wasteful to spend time and money on expensive analyses when approximate figures will give adequate information, as it is to collect inferior data which may result in false or limited interpretations.

Finally, when interpreting chemical analyses, it must be remembered that each result is the best estimate of the true value only, and should be treated as such. Variations in results from one sample to another may reflect lack of precision in the analytical technique rather than any real variation in the chemistry. As with any other analytical tool, a correct interpretation must be based on an understanding of all the factors involved.

Suzanne O'Sullivan, ERA-MAPTEC.

INTERNATIONAL DEVELOPMENTS IN WATER TRACING

The Sixth International Symposium on Water Tracing was held in Karlsruhe, Germany on September 21-26, 1992. This was organised by the International Association of Tracer Hydrology and the Department of Applied Geology of the University of Karlsruhe, and it brought together about 200 research scientists and water managers from a wide range of organisations and from a total of 29 countries.

There is a long tradition of the use of water tracing in the field of karst hydrology, and karst researchers were well represented at the meeting (which was preceded by a field trip of the IAH Karst Commission). However, the conference was not restricted to this area, and it reflected the increasing use of tracers in many areas, particularly in studies of contaminant dispersal. The meeting included sessions on tracer applications in porous, fissured and karst aquifers and in surface water, as well as sessions on methodological developments and on the use of tracers in mathematical modelling.

Modern tracer studies involve the use of a range of substances with different characteristics; conservative tracers to determine water flow rates and non-conservative tracers to mimic the dispersal of contaminants. The most commonly used artificial tracers are still fluorescent dyes such as fluorescein and rhodamine, a new development being fluorometers with fibre optic sensors which can be lowered down boreholes. In continental European karst hydrologic investigations, the use of dyed *Lycopodium* spores or plastic microspheres (detected by a fluorescence microscope) is common, as these enable simultaneous tracing of a large number of routes. Several studies have used bacteriophages (harmless viruses specific to bacterial hosts): for example, one U.K. study* involved the tracing of motorway runoff from a soakaway in the Chalk to a large public water supply three kilometres away by Photine CU (an optical brightener) and two types of bacteriophage.

A major development in tracer studies in the last decade has been an increase in the use of isotopes. A number of studies involved the injection of short-lived radioactive isotopes, but this is not a method likely to be acceptable in aquifers used for water supply. However, the measurement of isotopes already present in the water, such as oxygen-18 and tritium, as environmental or "natural" tracers, has considerable use in evaluating the underground residence times of groundwaters. Indeed, such analyses seem to have become a normal part of a groundwater chemical analysis in most countries. At present, groundwater isotopic analysis is virtually unknown in Ireland, and while it does not provide a solution to all problems, it is certainly an approach which we should consider seriously.

* Atkinson, T.C. & Price, M. (1992) Tracing the movement of highway drainage in the Chalk aquifer, southern England. In Hotzl, H. & Werner, A. (eds.), Tracer Hydrology (Procs. 6th International Symposium on Water Tracing), A.A. Balkema, Rotterdam, pp. 305-311.

Catherine Coxon, Environmental Sciences Unit, T.C.D.

COST 65: HYDROGEOLOGICAL ASPECTS OF GROUNDWATER PROTECTION IN KARSTIC AREAS

COST (Co-operation in Science & Technology) is a programme originally aimed to encourage co-operation between scientists of the EC, EFTA and the then Yugoslavia. Recently, this has been extended to include other countries in central Europe (e.g. the Baltic Republics, Czechoslovakia, Hungary and the now independent Croatia & Slovenia). Altogether 25 countries participate in the 80 management and technical committees of COST. Brendan Finucane of EOLAS is the senior Cost Official for Ireland.

The projects work on the basis of a memorandum of understanding which is a statement of intent between the participants. EC money is provided to support the secretariate, enable travel by participants and help fund seminars and workshops.

COST 65 was set up to examine the hydrogeological aspects of groundwater protection in karstic areas.

Irish participation in COST 65 consists of projects led by research workers from GSI, Sligo RTC and TCD. The following are the four Irish projects and researchers:

1. To establish the degree of land-use change and the effects of changing agricultural practice in the karstic Burren Plateau. D. Drew, (Geography Dept., TCD);

2. Protection of Groundwater in a karst area of Co. Tipperary. D. Daly (GSI), R. Thorn (Sligo RTC) and M. Keegan (Sligo RTC);

3. Flow and contaminant transport modelling in karst. P. Johnston (Dept. of Civil Engineering, TCD);

4. Study of groundwater vulnerability and aquifer protection in the Lower Fergus catchment, Co. Clare. C. Coxon (Environmental Sciences Unit, TCD).

The COST 65 programme got under way in 1991 and is due to have a concluding workshop in 1995, after which a final report will be prepared. Each year three meetings take place, two of which are field meetings/workshops. Ireland hosted such a meeting in June 1992. Twenty five visitors from fourteen countries and the EC Commission attended. The countries were Austria, Belgium, Croatia, Czechoslovakia, Estonia, France, Germany, Hungary, Italy, Portugal, Slovenia, Spain, Switzerland and UK.

Ireland made a special effort to facilitate the attendance of delegates from the new democracies by covering their expenses within this country. The meeting consisted of a business session held in UCG at which the delegates were welcomed by Minister for Energy, Bobby Molloy. In the afternoon the Irish participants presented papers on the Irish projects and provided a general introduction to Ireland's karst and the subsequent field trip. The field meeting took place during two days in the Burren, South Galway and South Roscommon. Useful discussions and exchanges of views took place. Contacts made during the meeting are expected to lead to collaborative work between Irish participants and those from some of the visiting countries, such as Hungary. The 1993 field meetings are planned for Switzerland/Germany in May and Spain in October.

Bob Aldwell, Coordinator for Ireland, COST 65.

GROUNDWATER PROTECTION SCHEME FOR COUNTY LIMERICK

Increasingly, Irish local authorities are becoming aware of the importance of management and protection of groundwater resources; in recognition of this need, a project has recently been commissioned by Limerick County Council, the aim of which is to draw up a groundwater protection scheme for County Limerick. This will consist of a suite of maps and accompanying reports, to facilitate the management of groundwater resources in the county and their protection from pollution.

The protection scheme will be developed by the Geological Survey of Ireland and the Environmental Sciences Unit Trinity College Dublin, working in cooperation with Limerick County Council. Funding for the project has been provided by the local authority. The project started in October 1992 and will run for two years. The personnel involved are Ms. Jenny Deakin, who is carrying out an M.Sc. thesis on the project, Dr. Catherine Coxon (T.C.D.) and Mr. Donal Daly (G.S.I.), working with Mr. J. Condon and other Limerick county council personnel. Jenny Deakin is a geology graduate from U.C.G. She has recently received one of the two Mark Cunningham Awards for the best geological project reports, submitted by undergraduate geologists in Ireland in 1992.

The work undertaken will include an evaluation of the extent and status of groundwater resources in County Limerick. A series of geological and hydrogeological maps of the county will be produced, leading to the compilation of a groundwater vulnerability map, and based on this, a groundwater protection plan will be developed. In addition to examining aquifer vulnerability and protection at a county scale, the project will involve a detailed examination of the vulnerability of public groundwater supplies, and the delineation of source protection zones. It is hoped that the joint interactive basis on which this project will be carried out will ensure a protection scheme which has both scientific validity and practical applicability.

C. Coxon (T.C.D.), D. Daly (G.S.I.) & J. Condon (Limerick County Council).

NEWS FROM ABROAD

England: Cutbacks in Triazine Herbicide Usage

The triazine herbicides atriazine and simazine account for 40% of consumption of non-agricultural herbicides in Britain. They are mobile in soils and rocks, and are detected more frequently in surface water than any other pesticides.

The EC limit - 0.1 microgram/l - is frequently exceeded in Britain according to the ENDS Report. In the River Ouse in Yorkshire, atrazine concentrations of 0.55, 0.66 and 0.8 microgram/l were recorded recently upstream of a drinking water intake, while the maximum level of simazine detected was 0.17 microgram/l. "Significant" increases in triazine levels were found in streams following spraying operations by British Rail on the line between York and Thirsk.

Thames Water is now trying to reduce the problem by writing to local herbicide users and asking them to avoid or cut back on atrazine, simazine and diuron. British Rail now plans to reduce the use of atrazine and to completely phase it out. One of the difficulties is that while triazine herbicides are pre-emergent and need to be applied only once, the alternatives are post- emergent and need to be applied two or three times a year.

Source: The ENDS Report No. 194; March 1991. Published by (Environmental Data Services Ltd).

Vermont, U.S.: Licensing of Drillers.

A new law in Vermount has established four classes of drillers' license: water well driller, monitoring well driller, well servicer, and pump installer. The bill authorizes the Department of Environmental Conservation to order the closure of abandoned wells.

Source: The Groundwater Newsletter of Water Information Centre Inc., Vol. 19, No. 19. 1990.

U.S.: Increased Geological Mapping

On May 18 1992, President Bush signed the National Geological Mapping Act, authorising $184 million over four years for a new geological mapping programme to be administered by the United States Geological Survey (USGS). Only 20% of the US is mapped at the standard scale of 1:24,000. According to the Act the "lack of proper geologic maps has led to the poor design of such structures as dams and waste disposal facilities". The maps are used in virtually all basic and applied earth science investigations, such as land-use evaluations and site screening for toxic and nuclear waste disposal.

Source: The Groundwater Newsletter of Water Information Centre Inc., Vol. 21, No. 13, 1992.

U.S.: Environmental Clean-up Creates Jobs

About two million people now earn their living doing same kind of environmental clean-up according to the President of Environmental Economics (Philadelphia). The 65,000 - 70,000 environmental firms accumulated about $130 billion in sales last year, making the industry arguably the most dynamic element of the entire U.S. economy.

Source: The Groundwater Newsletter of Water Information Centre Inc., Vol. 21, No. 13, 1992.

U.S.: Model for Virus Transport in Unsaturated Zone

A model - VIRTUS - has been developed to describe the transport of viruses in unsaturated soil. Although complete data sets from field transport experiments could not be found to test VIRTUS, it could play an important role in assessing the impact of effluent and sludge spreading on land, now that there is increasing interest in viruses as groundwater pollutants.

Source: The Groundwater Newsletter of Water Information Centre Inc., Vo. 21, No. 10, 1992.

Scotland: Spent Sheep Dip Contaminates Rivers

According to a survey by the Tweed River Purification Board, sub-standard sheep dipping operations have caused pesticide contamination in 17 out of 20 river catchments. The organophosphorus insecticides diazinon and propetamhos were the main chemicals found. Levels were generally in the nanogram/l range, but some reached the microgram/l range. In one incident the concentration found was 90 microgram/l. Damaging effects on aquatic invertebrates were detected in several rivers. The survey found that 21% of the sheep dips were likely to cause pollution.

Source: The ENDS Report No. 194: March 1991. Published by Environmental Data Services Ltd.

Editor

LECTURE

"An Approach to the Site Selection, Development and Operation of Landfills in Ireland" by Mr. B. Moore, Tipperary (SR) County Council, at GSI, 1st December, 1992.

An audience of 70-80 people - the largest at an IAH (Irish Branch) Technical Discussion meeting to-date - were treated to an excellently presented and informative lecture by Billy Moore. This was the best lecture I have heard summarising the engineering aspects of landfill site selection, development and operation in Ireland. Billy dealt with the topic not just as a practical engineer with the everyday problems of local authorities, but also as an engineer with a knowledge of the principles and practice of environmental protection. He outlined the recent changes in the operation of landfills; gave his views on future trends; described the criteria for site selection, including aspects such as aquifers, overburden on site, presence of nearby residential properties, access, visual aspects, site sizes, land availability; described the different liners and the means of dealing with leachate; and considered landfill gas, settlement and restoration. As a GSI hydrogeologist, I was pleased to see that he encompassed many of the hydrogeological points in the recommended GSI approach to landfill site selection (see Issue No. 21 of Newsletter) into the broader decision-making process. As a means of implementing the polluter pays principle, improving standards of waste disposal and encouraging waste reduction, Billy strongly and convincingly advocated the need for service charges for the disposal of household rubbish.

The lecture was followed by a lengthy questions and answers session with important and sometimes provocative contributions. One in particular, by Mr. P.J. Rudden, M.C. O'Sullivan and Co. Ltd., deserves attention, in my view. Mr. Rudden suggested that the various aspects that need to be considered in site selection - access, groundwater protection, site size, transport costs, etc. - should be ranked into, perhaps, three classes, depending on their importance. This methodology would firstly, draw attention to the broad-ranging aspects that need to be considered and secondly, and most importantly, would help in the decision-making process by ranking the different aspects. I hope that Mr. Rudden or someone else will develop and put this concept in writing.

Copies of the paper can be obtained by contacting me.

Donal Daly, Geological Survey of Ireland.

REVIEW OF THE GEOLOGICAL SURVEY OF IRELAND

During 1991 a major review of GSI was carried out with the purpose of clarifying its role and mission, considering its organisation and establishing specific outputs and targets. The review process, managed by Price Waterhouse, involved extensive participation by the staff of the Geological Survey and took account of the results of a client survey.

Under the review findings, the Geological Survey functions as a line division of the Department of Energy. The Survey is recognised as the national earth science agency whose mandate is the provision of earth science information and advice as they relate to Ireland and the acquisition of data for this purpose.

The Minerals Exploration and Development Division (MEDD) was another independent line division of the Department of Energy and its role was to formulate and implement minerals policy and to administer the State mining lease and prospecting licence system. The review recommended that all functions regarding the regulation of the minerals industry which were being discharged by the Geological Survey be amalgamated with MEDD functions in a new division the Exploration and Mining Division (EMD).

The review proposed that the Geological Survey organisation consist of two operating divisions, in addition to a support services division. One operating division would link bedrock mapping and minerals. The other (Environmental Geology) would group groundwater with Quaternary mapping/geotechnical services and marine geology.

The first priority in the Geological Survey will be to service the requirements of the Minister for Energy in relation to the minerals industry. Five priority programmes are recognised in the Geological Survey, based on client responses, and resources will be allocated on a priority basis. In order of priority these programmes are as follows:

1. **Bedrock Mapping.** The proposed seven year work programme will include full country coverage (21 sheets) at a scale of 1:100,000, a national 1:500,000 scale map and 40% country coverage (193 sheets) at a scale of 1:25,000. The 1:100,000 scale maps will be completed in the first three years and the national map in the fourth. Minimal production of accompanying reports is envisaged, as well as limited database and advisory work.

2. **Quaternary Mapping and Geotechnical Services;** A seven year Quaternary Mapping programme is proposed in which a total of 129 sheets at a scale of 1:25,000 will be produced, representing 27% coverage of the country. Geotechnical services will be provided to the public and the Groundwater Programme will be appropriately supported.

3. **Groundwater.** The top priority for this programme will be the provision of advice to MEDD in relation to mining developments. Apart from the completion of projects which are currently advanced, a well database and advisory service will be maintained and three Groundwater Newsletter per annum will be published. One or two county projects on groundwater vulnerability and protection will be completed each year.

4. **Minerals.** This programme will involve specific project work undertaken for EMD as well as the maintenance of a database (including the Open File data). In addition public awareness of Irish mineral potential will be advanced through newsletters, exhibitions, lectures and publications. Applied geological and geochemical studies will be undertaken as appropriate.

5. **Marine Geology.** The Marine function will be maintained and its future will be reviewed in the light of developments regarding the Marine Institute.

All activities in the Geological Survey, other than the five priority programmes, comprise support services whose allocation must be guided by the priority functions themselves. The support services are: Cartography; Administration; Central Technical Services; Information Services; Drilling; Geophysics.

Following the outcome of the review, the posts of Director, Principal Geologist and four Senior Geologists were filled in early 1992 by confined competition in the Geological Survey. The Director, Dr. Peadar McArdle, will have responsibility for implementing the findings of the review.

(This article was previously published in the GSI Industrial Minerals Newsletter No. 18).

IAH NEWS

IAH Technical Discussion Meetings

There are informal discussion meetings and lectures held at the GSI at 5.30 pm.

The future topics, dates and speakers are as follows:

2nd March Hydrometric data - quality control and processing. Introduced by Tim Joyce, OPW.

4th May Barrow valley groundwater quality. Introduced by Catherine Coxon, TCD.

For further information contact either Kevin Cullen (01) 2697082 or Donal Daly (01) 609511.

IAH Portlaoise Seminar

The topic for this years April seminar is "Groundwater data management and information technology".

CONTRIBUTIONS FOR THE NEXT ISSUE OF THE NEWSLETTER

The **GSI Newsletter** aims to improve communication among the many scientists and engineers involved in groundwater. It includes news, developments, reviews and opinions on all aspects of groundwater - exploration, development, water quality, pollution and energy. It is published at four monthly intervals.

Your contributon to the dialogue would be welcome. These should reach the Geological Survey before 30th April.
