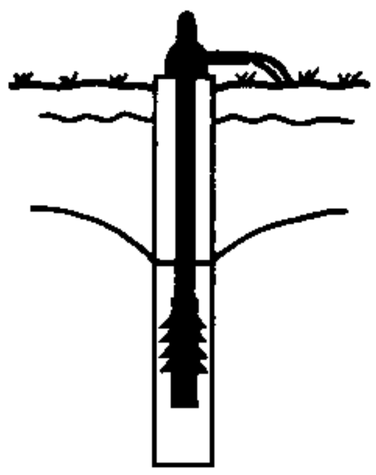
THE GSI GROUNDWATER NEWSLETTER

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



NUACHTÁN SCREAMHUISCE SGÉ

- *Taiscéalaíocht*
- *Bainistíocht*
- *Truailliú*
- *Nuacht idir Náisiúnta*
- *Forbairt*
- *Cáilíocht*
- *Athbreithniú*
- *Tuairimí*

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

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

Edited by: Donal Daly.

No. 10. December, 1988

IN THIS ISSUE

The **Geological Survey of Ireland (GSI)** maintains a **national archive of earth science information.** Although this archive is expanding, a greater return of geological and hydro-geological data would prevent the loss of valuable information andenable the GSI to provide a better service to public bodies consultants and the general public both now and in the future. If you have geological information that could be collated and stored in the GSI's national data bank please send it to us. In **South Australia** (see page 2) they have a very efficient system for ensuring that well data are not lost and in **Washington State** there have also been improve-ments (page 9).

In the U.S. there are now strict regulations (page 9) to safeguard groundwater from **leaking underground storage tanks (UST's).** Is this a topic which we should be consid-ering more here? Have we any pollution problems from UST's and if not why not? Coincidentally we have articles on **scavenger wells** (page 7) and **cone penetration testing** (page 3 which might help in solving pollution problems from leak-ing UST's and other sources.

Infiltration galleries are an important source of water in several counties in Ireland. However they are more vulner-able to pollution than many wells and springs and so, as the risks of pollution increase, local authorities will need to assess the **vulnerability of each infiltration gallery.** Eugene Daly gives advice on the approach to take in the first of two articles on page 4.

Articles for the next issue should reach to Geological Survey before 15th February, 1989.

Donal Daly, Geological Survey of Ireland.

GROUNDWATER DEVELOPMENT

Management of Water Resources in South Australia

The right to the use and flow and to the control of all waters in South Australia is vested in the State under the Water Resources Act (1976). This act is designed to protect South Australia's water resources and is administered by the Engineering and Water Supply Department. Hydrogeologists from the Department of Mines supply technical advice and there is close co-ordination and staff interchange between the two departments.

All water supply wells deeper than 2.5m must have a permit and be drilled by a licensed well driller. The only exception is where a landowner may drill on his/her own property, to a maximum depth of 15m, without a licence, although he/she still needs a permit to abstract the water. It is the permit holder's responsibility to ensure that (a) the driller has an appropriate licence before work is commenced and (b) the well location plan, included with the permit, is completed and given to the driller. It is the licensed driller's responsibility to ensure that (a) work is carried out in accordance with a General Specification (which is part of the Act) and with any special condition on the permit and (b) a Well Construction Report, together with the well location plan and any strata and water samples required, are forwarded to the Department of Mines and Energy. The specifications are overseen by a Drilling Inspector or Underground Water Inspector of the Department of Mines and Energy. Drillers must notify an Inspector at least 24 hours before starting drilling or cementing operations. Also any drilling site is subject to visits from the Inspectors who may order work to be stopped where permit conditions are not being followed, or make modifications to drilling procedures.

Deteriorating groundwater quality is causing increasing concern in South Australia. In particular the clearing of native vegetation has had a dramatic effect on recharge rates in some areas with an increase of two orders of magnitude measured. The consequent rise in the water table causes land salinisation in low lying areas and increasing inflows of saline groundwater to the River Murray (a major source of drinking water) leading to an increase in river salinity. Computer models of the aquifers are being assessed to enable better decision- making by water resource managers.

(This article is based on a talk given to the Irish Branch of the I.A.H. by Steve Barnett, Geological Survey of South Australia and leaflets published by the South Australian Department of Mines and Energy).

Donal Daly, Geological Survey of Ireland.

The Use of Cone Penetration Testing to Obtain Environmental Data

Since the introduction of the electric cone penetrometer during the 1960's cone penetrometer testing has gained wide acceptance within the geotechnical profession as a rapid, reliable and repeatable method of profiling sub-surface soils and measuring, in-situ, such parameters as shear strength in clays and relative density in granular subsoils. The test utilizes an instrumented probe that is hydraulically pushed into the ground using the thrust capacity of a 20 ton truck. During penetration the resistance of the $10cm^2$ probe tip (the cone) and the skin friction on a sleeve above the tip, is measured by means of internal load cells.

In the past few years an additional range of cones for measuring other parameters have been developed. These developments offer the potential of using cone penetration testing to obtain environmental data.

The 'piezocone' measures the excess pore pressure in the soil, which is generated by the insertion of the cone. This allows the detection of sand layers as thin as 1-2cm. Within the context of a detailed hydrogeological study these sand layers, if continuous, may be significant, for instance as a source of cross-contamination or migration off a contaminated site.

The 'conductivity' cone consists of a conventional cone with two electrodes and associated electronics to facilitate the measurement of the electrical conductivity of the soil or groundwater through which the cone penetrates. Use of the cone at sites of either known or suspected contamination provides a means of mapping the vertical and lateral extent of the contamination plume provided a measureable conductivity contrast exists. The most obvious example is the saline intrusion of a shallow unconsolidated coastal aquifer.

Temperature profiling at landfill sites using the 'temperature' cone can provide valuable data upon which to assess the methane generation potential of a site or can be useful at other sites where knowledge of the spatial distribution of soil temperature needs to be known.

Using the thrust capacity of the cone testing truck, it is possible under the right circumstances to push other probes and samplers into the ground. In general the effectiveness of well screens and monitor wells for recovering groundwater and gas samples will be governed by two main factors:

- the position of the well screen within strata from which a sample is to be recovered (critical if the stratum is thin).
- the degree of contamination resulting from the installation procedure.

In order to instal a well screen, the screen is attached to the core-testing casing and is loosely covered by a protective sleeve. It is pushed to a depth below the required sampling point. As the casing is pulled back the screen is exposed since the protective sleeve is held in place under friction. The installation procedure and the resulting volume expansion in the soil around the casing forms an effective seal above the screen. Groundwater can enter the screened section and is easily sampled using a bailer or small pump. The depth control of cone testing will ensure the correct positioning of the sampler and the installation method reduces contamination.

With a few modifications a similar system can be used to recover gas samples from landfill sites. This method offers the possibility of establishing a monitoring network very quickly on a site together with obtaining other useful environmental data at costs which are competitive with traditional methods.

Jer Keohane, Fugro-McClelland Limited, Hemel Hempstead, England.

Infiltration Galleries (Part I)

An infiltration gallery is a horizontal conduit frequently constructed parallel to a river channel in order to intercept groundwater moving towards it and/or to induce recharge through its bed. These galleries are a very efficient method of tapping thin/shallow aquifers with high water tables.

In Ireland infiltration galleries generally tap groundwater in the narrow sand and gravel aquifers (5-10m thick) which occur in many river valleys. These deposits are normally coarse and poorly sorted with rapid lateral variations in lithology. Supplies of up to 1500 m^3/d of good quality water have been obtained with very little drawdown (less than 4m).

The rivers in Ireland are generally effluent over most of their length (i.e. the stream receives water from the aquifer). Hence most of the water abstracted from infiltration galleries has a groundwater origin. However the relative proportions of surface water to groundwater will vary depending on the hydrogeology at each particular location, the abstraction rate and the distance of the gallery from the river. Furthermore with most of these structures the proportion of surface water to groundwater will vary throughout the year. Generally speaking the largest proportion of river water is likely to be pumped at peak/flood flows and at low flows.

Owing to their proximity to rivers (many of which are of questionable water quality) these structures can be more vulnerable to pollution than other types of groundwater abstraction systems. They are likely to be most vulnerable in the summer when groundwater and river levels are low, dilution is poor and the demand for water is high. Nevertheless the degree of risk can be minimised with adequate hydrogeological information on the location, detailed monitoring of both river and gallery and the possible use of other temporary/standby sources during the summer.

The vulnerability of an infiltration gallery is also a function of the hydrogeology at the individual location, the distance of the gallery from the river and the abstraction rate. Obviously the water quality of the adjacent river has an important bearing on the vulnerability of a gallery particularly as there are natural variations throughout the year and there may be intermittent or persistent pollution problems.

The normal river valley environment in Ireland contains two natural conditions which help to prevent pollutants gaining access to infiltration galleries.

(1) Owing to the effluent conditions and the shallow drawdowns the hydraulic gradient from river to aquifer will reverse quite quickly after the pumps are switched off and the river water (and any pollutants it contains) is pushed back out of the aquifer.

(2) The natural filtration afforded by the sands and gravels will generally eliminate suspended solids and bacterial pollutants if the gallery is a sufficient distance from the adjacent river. However, these strata will generally not restrict the movement of many ions found in solution in surface water.

In order to assess the degree of vulnerability at a particular gallery the hydrogeological environment at the site must be established in some detail. The type and frequency of monitoring of a gallery that is required to ensure the security of supply, to provide some advance warning of pollution and evaluate abnormal occurrences, is dependent on its level of vulnerability.

The information required to assess the degree of vulnerability at infiltration galleries and the monitoring required will be discussed in the next issue of the **Newsletter.**

Eugene Daly, Geological Survey of Ireland

Letter from Oman

Greetings from the Sultanate of Oman, where I arrived in July to work for the Ministry of Environment & Water Resources!

The Sultanate of Oman occupies the SE corner of the Arabian Pensinsula, bordered by South Yemen (PDRY), Saudi Arabia, and the United Arab Emirates. The MEWR has five District Offices, one of which is in my charge - the Muscat District, which covers about 11,000 sq. km. centred on the main urban areas of Muscat, Muttrah, Ruwi and Seeb. The area includes an extensive coastal plain and a lot of mountainous terrain, with some very spectacular scenery.

The main aquifers are gravels (on the coastal plain and in the wadis) and limestones (mainly Permo-Triassic dolomites). Annual rainfall averages 100-300mm but is very variable. Irrigation from groundwater is essential for agriculture. Traditionally, most upland farms depended on a spring or a falaj (like the Persian Qanat), but increasingly wells and boreholes are taking over. On the coastal plain, numbers of wells have multiplied in recent years.

Normal groundwater temperature here is about 30°C! We have some warmer springs - several at about 39°-44° and a few others at 50°-67° - pretty hot! We also have some interesting alkaline springs.

Our main technical problems are: (a) recharge assessment - rainfall records are short and so variable; (b) overabstraction, and resulting saline intrusion at the coast; (c) competition for scarce water resources. New wells require a permit, and much of our work involves evaluation of permit applications. A recent Royal Decree has declared groundwater to be a National Resource, and I hope that we will move toward a system of licensing all groundwater abstractions, beginn- ing with the worst areas of overabstraction. Monitoring of water levels and salinities is an important part of our work.

When rain does come, runoff can be very intense, causing severe floods; some runoff can be lost to the sea, so there is much interest in constructing recharge dams, which will retain flood flows and allow them to infiltrate rather than flow out to sea.

Cavers may be interested in our impressive cave systems, including the world's second largest recorded cave - about 4 million cu. m. in volume! Unfortunately, a helicopter is almost essential to approach the entrance, and access is via a 118 metre free drop by rope!

Working conditions are very pleasant. The intense heat of July has now abated and the winter climate is superb. There is a good network of primary roads, and even the dirt roads are well maintained. So a day's fieldwork can easily encompass 300+ Km of driving without too much strain. The Omani people

are very hospitable and there is a large and varied multi-national expatriate community. However, as yet I have met few Irish people.

I hope to write again for the **Newsletter.** Meanwhile, I wish a successful New Year to all my friends in Ireland.

Geoff Wright

Scavenger Wells

A novel groundwater project is nearing completion in Pakistan. Its aim has been to test the principle of scavenger wells by field trials.

The scavenger well principle has been developed to allow maximum exploitation of relatively shallow, fresh groundwater overlying more saline water. The technique involves the use of two pumps within a well, the upper pump extracting fresh water and the lower pump discharging saline water to prevent it moving into the upper aquifer.

The project, carried out jointly by Groundwater Development Consultants and the British Geological Survey, has included extensive studies of aquifer permeability and groundwater quality stratification, the installation, testing and operation of four scavenger well systems, surrounded by piezometers, and computer simulation modelling to represent the behaviour of both a single well and full wellfield.

The results of the field trials have confirmed that the concept of skimming fresh groundwater by scavenger wells is valid. It is now proposed to install some 400 scavenger wells in the Lower Indus Valley, as part of major on-going drainage projects: these wells will be used for water-level control, with the fresh water component of discharge being recovered for irrigation and the saline water disposed of via drains.

The scavenger well principle could obviously be applied to any situation where fresh groundwater floats on saline, a common occurrence in coastal aquifers, small islands and in some arid inland regions such as the Indus Valley in Pakistan. The principle may also have application to other situations where groundwater quality is stratified, for example in dealing with nitrate pollution in certain parts of Britain, where the high nitrate levels are restricted to the upper part of the aquifer.

Bruce Misstear, Groundwater Development Consultants Ltd.

NEWS ON IRISH HYDROGEOLOGISTS ABROAD

Bruce Misstear

Bruce, a Dubliner, gained his first experience of hydrogeology while working as a temporary field assistant with the GSI during the university vacations from his geological studies at TCD. After graduation in 1975 Bruce went on to do the M.Sc. course in hydrogeology at the University of Birmingham.

In early 1977 Bruce joined a small consultancy firm based in Northern Nigeria, and remained there for three years. His work mainly involved geophysical investigations in the Basement Complex to locate borehole sites.

Bruce joined the Cambridge-based firm Groundwater Development Consultants in 1979 (then a joint venture between Hunting Technical Services and Sir M. MacDonald & Partners, now a wholly-owned subsidiary of MacDonalds). His first posting was in Burma, working on the UNDP Groundwater Exploration and Pilot Development Project, and this was followed by short assignments in Sudan, Saudi Arabia and Bahrain.

In 1981 he went to Oman, where he stayed for four years as the firm's resident hydrogeologist. (Geoff Wright, another well-known, voluble Irishman has now followed in his footsteps!). Amongst the most interesting jobs were several rural water supply projects in the Dhofar Mountains, which involved constructing boreholes to depths of up to 1,000m.

Since 1985 Bruce has been responsible for developing and supervising GDC's work in the UK. Current projects range from a major landfill site development in the West Midlands, through a study of industrial solvent pollution of a public water supply source in East Anglia, to an investigation of the water resources of the Spilsby Sandstone aquifer in Lincolnshire. Perhaps we will be able to benefit from his experience here in Ireland sometime in the future.

Editor.

REVIEW

Book : **Waste Disposal in Ireland: A Discussion of the Major Issues.**
Author : Owen C. Boyle.
Publisher : An Foras Forbartha, 1987 (Price: £3.50).

For those who have not already purchased it, this is a belated recommendation for a concise, well-written illustrated booklet which contains a summary of various aspects of waste disposal in Ireland including the following: statistics on quantities of waste generated; information on waste reuse and recycling; incineration; waste collection and transport; disposal in tip sites; and litter prevention.

Editor

NEWS FROM ABROAD

Leaking Underground Storage Tanks: U.S. EPA Regulations.

The U.S. EPA have announced final federal regulations to safeguard groundwater from leaking underground storage tanks (UST's). More than 95% of the nation's two million UST's hold petroleum products. An estimated 80% of these have unprotected bare-steel construction, the type most likely to corrode and leak. New tanks must include cathodic protection and there must be certification of proper installation as well as leak monitoring systems. The tank's age, size, type, location and use must be notified to the State authorities.

Owners of existing petroleum tanks will have to provide corrosion protection within ten years and a variety of leak detection methods, ranging from daily tank measurements to the placement of monitor wells, will have to be installed. Devices to prevent spills and overfills are also required.

A leak detection system may cost a typical petrol station with three 5,000-gallon tanks up to $8,000, while retrofitting existing tanks with cathodic protection may cost up to $48,000. Violators of the new rules can be fined up to $10,000 per violation per day for each tank.

Farm and residential tanks storing less than 1,100 gallons of motor fuel for non-commerical purposes are excluded from these regulations, as well as tanks storing heating oil for on-premises use.
(Source: The Groundwater Newsletter of the Water Information Centre, Inc., Vol. 17, No. 18).

Washington State, U.S.

A recent revision of this State's construction and licencing law includes provisions which set minimum well construction standards and provide for minimum education/experience requirements for drillers. In the last year the number of people becoming licensed to drill has almost trebled and well report submissions have increased by 100%.
(Source: The Groundwater Newsletter of the Water Information Centre, Inc., Vol. 17, No. 20).

Editor

I.A.H. NEWS

The 21st I.A.H. Congress, Guilin, China, October, 1988.

"Karst Hydrogeology and Karst Environment Protection" was the theme of the 21st Congress of the International Association of Hydrogeologists, held in Guilin, in southern China, from 10th to 15th October 1988. The meeting was attended by 451 delegates from thirty-seven countries, and among them were three from Ireland: Breda Naughton, Richard Thorn and myself. Over 160 papers were presented over five days, and the proceedings (including three papers and one abstract by Irish researchers) have been published by the I.A.H.

The themes of the paper sessions included general karst hydrogeology, the use of geophysics and remote sensing, computer modelling of karst aquifers, engineering geology problems, karst water chemistry and water pollution, and karst aquifer management and protection. I found the last two themes of particular interest; papers which raised points relevant in an Irish context included a discussion of groundwater quality and land use in the Mid-West U.S.A., and work by Quinlan on water quality monitoring in karstic aquifers. One gap in Irish research and knowledge which became apparent was the issue of trace organics in groundwaters: many projects are under way in this area, and one paper highlighted the particular vulnerability of karst aquifers to such contamination. While our lack of major industrialisation or highly intensive agriculture lessens the risk, the growing list of problems documented elsewhere would suggest that the time has come for some basic investigations here.

The Congress was held in the new Geological Academic Exchanges Centre in Guilin, attached to the Institute of Karst Geology (which is the national centre for karst geological research, employing 172 geologists). It is situated in the heart of a classic region of tower karst (fenglin karst); besides being of hydrogeological interest, this is very spectacular scenically, with steep limestone hills occurring in clusters or rising as isolated peaks from an alluvial plain. A series of field trips after the Congress provided an opportunity to study the geology and hydrogeology of other parts of China. Each of the Irish participants attended a different trip: I visited the karst of the Kunming area, in south-western China, including the famous "Stone Forest" of pinnacles developed in Permian limestones and dolomites.

Overall, the Congress was of great value, both for keeping abreast with international karst hydrogeological research, and for learning about Chinese karst geology and hydrogeology at first hand.

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