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THE GSI GROUNDWATER NEWSLETTER

NUACHTÁN SCREAMHUISCE SGÉ

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IN THIS ISSUE

Landfills are a topical issue particularly with the onset of the new EC Landfill Directive. This Directive proposes that all sites should be designed and operated as containment sites in order to prevent pollution. On page 2, it is argued that modern technological means, such as artifical liners, should be used in conjunction with safe geological situations in order to reduce the risks to the environment and to humans, rather than on their own in unsuitable areas geologically. Details on the economics of landfills are seldom available; Patrick Johnston fulfills this need on Page 3. Richard Thorn continues his series of articles (page 5) on toxic wastes in Europe with a description of some of the difficulties that are arising.

Examples of pollution of wells, particularly private wells, are becoming more common. Eugene Daly (page 8) describes the situation in the Nore River Basin and advocates the need for preventive measures. On page 9 John Mulqueen provides a good summary of methods, particularly small scale methods, of measuring permeability; Jer Keohane follows this with a description of the use of core penetration testing in contamination investigations.

Are we due for a drought? Eugene Daly, on page 17, shows that groundwater levels in the south-east are very low for this time of the year. This may have implications for stream flows this summer.

What are the future needs in the areas of groundwater resources development, quality and pollution? An article on page 12 gives one view. If you have any views, send them in for future issues of the Newsletter.

Editor

SELECTION AND MANAGEMENT OF LANDFILL SITES IN IRELAND - GEOLOGICAL AND GROUNDWATER ASPECTS

Wastes are an inevitable consequence of living. In earlier times they didn't pose a significant problem and were assimilated into the environment. However, population increases, congregation into towns and cities and above all the development of a technological and materials-consuming society has led to greater volumes of increasingly complex wastes. These wastes can pose significant risks to the environment. Although reclamation and recycling will undoubtedly play a more important role in reducing and disposing of wastes in the future, landfilling will continue to be the principal means of solid waste disposal in Ireland. However, safe disposal of wastes in landfills is possible although it is at a significant cost.

The water environment is particularly at risk from landfilling. The risk comes from the production of a polluting noxious liquid, called leachate, which results from water passing through the waste. Leachate can cause significant pollution to both surface water and groundwater. The principal aim of good site selection, design and operation is the control of leachate. It is worth remembering that it is not just "toxic" industrial wastes that produce a highly polluting leachate; the leachate produced from domestic refuse - the wastes we all produce - is virtually as bad and sometimes worse!

The only suitable sites in Ireland for the disposal of domestic refuse are so-called "containment sites", i.e. sites which prevent the movement of the leachate. Leachate can be contained either naturally where the underlying rocks have a very low permeability or artificially. These sites have the advantage that they give good control over leachate provided they are operated properly, but have the disadvantage that they are relatively expensive.

The only sites in Ireland where the leachate will be contained naturally is where they are underlain by low permeability clays, glacial tills (boulder clays) or perhaps peat. Artificial containment can be provided by synthetic liners such as HDPE (high density polyethylene) or by bentonite (a natural clay).

Modern landfilling techniques have improved greatly in recent years, particularly with the use of liners. However there is now a danger that these will be seen as a solution to all problems and situations; as a technical fix or "engineering" solution in areas where the natural conditions are completely unsuitable for landfilling, for example, limestone quarries or gravel pits. The likelihood of liner leakage is high, even if it occurs only to a limited degree; we cannot be certain how long they will last for; and problems arise unless there is consistent high quality standards of material, installation and site control. Consequently, we cannot depend on them alone to prevent pollution. We must use modern technological means, but only in conjunction with the natural environment - the rocks - in order to reduce the risks to the environment. **The optimum site in Ireland, in my view, is a greenfield site, underlain by low permeability clays or clayey till which in turn is underlain by a low permeability bedrock.** A liner might be needed depending on the permeability and thickness of the clays. Look at the advantages. In this situation if a leak occurs through the liner, the pollutants will be contained or attenuated in the clays. The clays can be used as cover material and so litter, fires, birds and rats will be minimised. The clays can also be used as binding material around the waste and around the site thus enabling control of the leachate and reducing visual intrusion. Also these sites are easier to engineer and gas control is less of a problem.

So let us combine modern technological advances with the natural geological materials to reduce the risks to the environment. Let us continue to abandon the many atrocious sites that are still present in Ireland and follow standards that are being set at sites such as Ballyguyroe in north Cork, Ballydonagh, near Athlone and Whiteriver in County Louth - the site that led the way in the mid '80's. Landfilling, in my view, should be treated like other major engineering structures such as dams or sewage works. They should be the type of public facility where the County Engineer and County Council Chairperson would be proud to have their names on the plaque opening the site!

(This article was published in Sherkin Comment, the Environmental Quarterly of Sherkin Island Marine Research Station, Issue No. 10 1992. Permission from Matt Murphy to use this article is gratefully acknowledged).

Donal Daly, Geological Survey of Ireland.

LANDFILL ECONOMICS

Landfill will only become an environmentally acceptable means of waste disposal if sufficient financial and human resources are made available to meet the higher standards required by society. The true cost of landfill should include not only development and operational costs but also monitoring and aftercare costs as well as in future a contribution to a landfill aftercare fund. The setting of realistic charges for waste disposal will encourage the avoidance of landfilling of waste that can otherwise be prevented or recycled. This article identifies the key elements in landfill costs and a systematic approach to the assessment of true landfill costs is demonstrated.

The implications of the European Communities Directives on Environmental Impact Assessment and the draft Directive on the Landfill of Waste for landfill economics are assessed and future trends identified.

The True Cost of Waste Disposal

The days of unsightly dumps scattered across the countryside in Ireland are numbered. The European Community draft Landfill Directive will, when implemented next year, put an end to the uncontrolled dumping of waste at a great many of the existing 123 tip heads. Local Authorities will have 5 years to put their house in order, or else be forced to close down the sites. Many of the Authorities and Government bodies are only just realising the true cost of making landfill environmentally acceptable. It is only by raising the standards of landfills that we will prevent pollution, nuisance from flies, litter and vermin, and also by setting realistic waste disposal charges will we achieve a real financial incentive for waste reduction and recycling.

Scale of the Problem

It has been estimated that 28.5 million tonnes of waste is produced annually in Ireland, excluding the north; agriculture alone accounts for 22 million tonnes. Industrial waste, including mining and construction residues, totals 4.86 million tonnes. Special and hazardous waste amounts to about 140,000 tonnes with a further 450,000 tonnes of sewage sludge. Municipal solid waste (msw) disposed of by Local Authorities amounts to about 1 million tonnes annually, or a little over 300kg per head of population.

Almost all municipal solid waste in Ireland is landfilled although standards do vary considerably with many sites continuing to be operated with minimum staff, poor equipment and a lack of leachate and gas control mechanisms.

What are the Alternatives?

The waste disposal management options currently available are wide ranging and including baling, pulverisation, waste derived fuel, composting, recycling and incineration. None of these options represent a complete alternative to landfill as each has a disposal requirement which can only be met by landfill. Although recycling initiatives have been established in Ireland for glass, aluminium, paper and cardboard, it is unlikely that they will make a significant impact on the requirement for landfill capacity (in the UK less than 5% of msw is recycled). Even municipal solid waste incineration, which has been hailed by many environmental pressure groups as being the answer to waste disposal problems, requires landfill sites to dispose of residues. The cost of a modern incinerator with combined heat and power generation to deal with the volume of waste from Dublin alone would cost IR£80 - 100 million to build with operating costs of up to £35 to £45 per tonne.

It is therefore almost certain that landfill will continue to be the only practical and economic option for the majority of unavoidable wastes in Ireland.

The Cost of Improving Standards

The European Community will in future require all waste disposal sites to be designed and operated as containment sites in order to prevent pollution. This will require all new sites to be situated on clay strata or alternatively for the waste to be encapsulated in a high quality plastic membrane possibly in combination with a secondary clay liner for added protection. It is however no use providing high technology solutions to our landfill problems if we are not prepared to also improve the standards of operation, by providing the necessary staffing levels, modern compaction equipment and adequate supplies of daily and final covering materials.

The cost of developing and operating a modern landfill site to an environmentally acceptable standard with an input rate of about 25,000 tonnes per annum has been estimated to be about £16.74 per tonne, approximately three times the cost of a similar sized poorly operated tip head in Ireland. The largest element of these costs are operational costs amounting to about £9.71 per tonne or 58% of total costs and this relates to improvements in staffing, machinery, and environmental control on litter, vermin, monitoring etc. The development costs form the next largest group at £4.52 per tonne or 27% of the total. The cost of restoration of the landfill to a beneficial after-use such as agriculture or public open space amounts to only £0.12 per tonne (0.7%). A new element for many Local Authorities is the requirement to continue monitoring and the completion of the landfill for a period of at least 10 years. These aftercare costs at £0.24 per tonne (1.4%) are insignificant in overall terms but are an essential element in the proper management and aftercare of landfill sites.

Local Authorities responsible for waste disposal must brace themselves for a dramatic increase in waste disposal costs if standards are to improve and landfill is to become an acceptable form of waste disposal. Typically initial site development costs for a modern landfill are likely to be at least IR£0.5 million with ongoing development costs throughout the life of the landfill of between IR£1 and 3 million for a site of 25,000 tonnes per annum.

Economy of Scale

There are however considerable benefits to be achieved through the economy of scale of operating larger landfill sites where the required environmental standards can be achieved at reasonable cost. Typically a landfill with an input rate of 50,000 tonnes per annum will have operational costs of IR£5.50 per tonne compared with IR£9.70 per tonne for a site receiving 25,000 tonnes per annum. The small rural landfill sites in Ireland are relatively expensive to operate to a reasonable standard with input rates as low as 5,000 tonnes per annum and operational costs of IR£20-IR£25 per tonne. The reduction in the number of landfill sites will however entail greater haulage costs, possibly in conjunction with transfer stations and greater co-operation between Local Authorities in operating joint facilities if these economics of scale are to be achieved. The future of landfill is promising with a number of Authorities having established modern containment landfills which with adequate financial funding throughout the life of the sites will achieve the environmental standards now required by society.

(This article was first published in Sherkin Comment; permission by Matt Murphy to use the article is gratefully acknowledged. It is a summary of a more extended paper that will be published by the Sherkin Island Marine Research Station).

Patrick Johnston, Waste Management Consultant.

TOXIC WASTES IN EUROPE - PARLIAMENT, PEOPLE, POLITICS, PRODUCTION AND POTENTIAL

5 - Problems

Toxic waste incinerators, the handling of small quantities of dangerous waste, contaminated land, transfrontier shipments of hazardous waste - take your pick. Each one of these, and many other issues, assumes importance in certain places at certain times. In my experience, however, the issue that crops up time and time again around the EC as a whole are the lack of facilities for the treatment and disposal (usually incineration and landfill) of hazardous wastes and the problems of contaminated land.

The lack of treatment and disposal facilities is well exemplified by the situation in Germany. A report by the Federal Government on the implementation of their Waste Avoidance and Waste Management Act (Anon., 1987) notes that

"...managing the wastes produced by an industrial nation such as the Federal Republic of Germany raises significant problems. Crises can already be expected very soon in some sectors such as hazardous waste management if concerted action by industry, the State and politicians does not remedy the situation very quickly".

The author of the report expressed the belief that the situation would get worse because:

(i) the separate management of many wastes, with, in some cases, compulsory pretreatment before deposition, would lead to a rise in the number of hazardous waste landfill sites and incineration facilities;

(ii) increasing quantities of hazardous waste which were being disposed of outside Germany would in future have to be disposed of in Germany; and

(iii) there would be increasing quantities of contaminate soil requiring treatment as a result of the clean-up of abandoned waste sites.

It is interesting to note that in relation to (i) above a recent (December, 1990) report by the European Parliament Committee on the Environment, Public Health and Consumer Protection called for a complete ban on the disposal in landfill of untreated or unneutralised hazardous wastes. Concerning (ii) and (iii), the report was prepared before the unification of Germany; between 1981 and 1991 the former GDR imported 650,000 tonnes of toxic waste and more than 200,000 tonnes of sewage sludge from the former FRG (Welford, 1991). With unification, the problems faced by Germany in relation to contaminated land have increased dramatically.

If the situation described above is the case for Germany, which has a well regulated and organised waste management industry, it is also certainly the case for other countries in the European Community.

The problems of contaminated land and abandoned landfills should be of particular concern to hydrogeologists since their skills are in demand when it comes to the clean-up of such sites. We tend to think that the abandonment of hazardous wastes is a North American phenomenon e.g. "Love Canal". We have our own difficulties. As a result of the "Love Canal" affair and the European equivalent - Lekkerkerk in Holland - some European countries decided to make a systematic inventory of contaminated sites. The results were disturbing as is shown in Table 1.

At present only some European Countries have legislation dealing specifically with the problem of contaminated sites viz Germany and the Netherlands. Few countries are providing the resources necessary to deal with the problem. From the data available (Table 2 and 3) it appears that only the Netherlands has been providing sufficient financial resources to deal with the problem of contaminated sites.

Ultimately the only solution to the problem of hazardous waste treatment and disposal is to eliminate the wastes entirely and this will be the subject of the final article in this series.

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Richard Thorn, Sligo R.T.C.

Table 1
Some Statistics on Contaminated Sites in Europe

Country	**No. of sites Requiring Clean-Up/Immediate Attention**	**Date**
Denmark	1,007	1985
The Netherlands	1,000	1987
Federal Republic of Germany	5,400	1987
France	140	1987

Table 2
Current Expenditure on the Treatment of Contaminated Sites
(in ECU)

Country/Region	**Annual Expenditure**	**Per head of Population**	**% of GNP**
Denmark	5,000,000	1.0	0.01
The Netherlands	88,000,000	6.6	0.07
North Rhine-Westphalia	48,000,000	2.5	0.03
United Kingdom	222,000,000	4.0	0.05
Nord Pas de Calais, Lorraine, Rhone-Alps	13,000,000	1.2	0.02

Table 3
Estimate of Annual Expenditure Required over 15 years for the Decontamination of Sites
(in ECU)

Country	**Annual Expenditure**	**Per head of Population**	**% of GNP**
United Kingdom	476,000,000	8	0.10
Germany	377,000,000	7	0.07
France	214,000,000	4	0.04
Italy	134,000,000	3	0.06
The Netherlands	56,000,000	4	0.04
Belgium	62,000,000	7	0.08
Denmark	13,000,000	3	0.03
Greece	11,000,000	1	0.04
Luxembourg	3,000,000	7	0.07
Ireland	10,000,000	3	0.06

Tables 1, 2 and 3 after European Parliament (1987).

LOCAL GROUNDWATER QUALITY IN IRELAND.

The Geological Survey has been carrying out hydrochemical and water quality investigations in the Nore River Basin (>2500km^2) since the early 1970's. Over 500 boreholes, dug wells and springs have been sampled. The analyses (mainly chemical) have been carried out by the State Laboratory. The principal objective of our investigation is to establish the background hydrochemistry of the groundwaters in the different geological strata in the catchment. Information on water quality and potability is obtained as a by-product of the hydrochemical study.

It has been found that about 20% of the samples taken show significant levels of contamination, at the time of sampling, on the basis of chemical analysis. It is felt that this proportion underestimates the full extent of the water quality problem as in most instances an effort was made to avoid sampling wells that were likely to be contaminated.

In July and August 1990, an investigation (Woods 1990) was carried out in the Nore River Basin to look specifically at water quality at a number of different locations, in varied geological conditions and in a couple of instances in areas where contamination could be expected. At each sampling site possible sources of contamination were identified. Of the 42 wells sampled 45% showed the presence of E.Coli and a further 31%, on the basis of chemical analysis, showed evidence of significant contamination at the time of sampling. The principal sources of contamination were considered to be local point sources i.e. septic tank effluent and farmyard waste etc. Most of the sources were only sampled on one occasion hence it cannot be assumed that all of these wells are permanently contaminated. Nevertheless, it does suggest that there are local water quality problems in many parts of this area.

These results are not surprising as the Geological Survey and other investigators have got similar results elsewhere in the country. In the early 1970's Tom Spillane of AFT (now Teagasc) repeatedly said that about 80% of the water samples he received from farm wells showed evidence of contamination. In the most recent edition of the Newsletter (No.19) Jennifer Browne reports similar conditions in Montana. Hence it can be taken that a significant proportion of low yielding wells in Ireland show some degree of contamination for some or all of the time. In some areas this proportion may be up to 50% of all low yielding wells.

The contamination, indicated by elevated levels of certain chemical parameters such as chloride, nitrate and potassium may not exceed the MAC concentrations of the EC Drinking Water Directive. However they do suggest that human activities are having a significant impact on groundwater quality in the immediate area.

In a previous edition of the Newsletter (No.13) in an article on the water quality of the major springs in the Republic I concluded that groundwater is generally of good quality. The experience of other hydrogeologists working in Ireland would generally support this view. There would appear to be a conflict in the conclusions drawn from these two surveys. The explanation however is quite simple. A borehole or spring producing 1,000-2,000m^3/d at a location in Ireland, with average hydrogeological conditions, will normally receive the bulk of its supply from the recharge within an area of 1-5km^2 (100-500 hectares) around and mainly upflow of the source. Similarly a well providing a domestic and/or farm supply of up to 5m^3/d will be recharged mainly from an area of about 1.0 hectares (within 100m of the well). In general the waste produced by a farm and/or domestic house will have a disproportionally higher impact on the zone of influence of the latter. Hence the reason we find so many contaminated low yielding wells and uncontaminated large springs and high yielding boreholes. Springs and high yielding boreholes give a much better reflection of overall groundwater quality in Irish aquifers. If the local contamination is allowed to continue indefinitely however, then in time it will begin to have an impact on larger areas.

The principal reasons for the current state of affairs are that;
(a) regulations for location, design, construction and maintenance of private water supply wells and waste disposal systems in Ireland are minimal,
(b) the regulations that do exist generally ignore the very variable hydrogeological conditions in Ireland, and
(c) enforcement is normally minimal and only takes place at the construction phase and not over time.

This position is unlikely to change in the foreseeable future. Hence in the next couple of issues of the Newsletter I intend to discuss some of the problems and make some suggestions to well owners, drillers, engineers, planners, etc. on how to improve the quality of private groundwater supplies and groundwater in general.

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Eugene Daly, Geological Survey of Ireland.

DETERMINING HYDRAULIC CONDUCTIVITY OF IRISH SOILS

I read with interest Ray Flynn's contribution "Permeability values that don't cost the earth" in GSI Groundwater Newsletter No. 19 August 1991. There is considerable experience in Teagasc and University College Galway on the measurement of both saturated and unsaturated hydraulic conductivity of soils. The following procedures are employed:

1. The Auger-Hole and Piezometer methods below a watertable are used only in gravel and stone free soils such as peats and some alluvial and coastal soils. It is not practical to drill out a uniform cylindrical hole in Irish glacially-derived soils because of gravel and stones, so excluding the auger-hole method. Likewise, gravel and stones interfere with driving a piezometer tube. Both methods are widely used for peats and alluvial soils. In the case of the auger-hole (van Beers, 1979) measurements of the rate of rise have to be made within 5-30 seconds after bailing depending on the rate of inflow to minimise the funnel-shaped drawdown. A discussion and procedure for carrying out the piezometer method can also be found in Boersma (1965) as well as in B.S. 5930.

2. The Drain Discharge method is used where parallel drains of known spacing and length are installed. It is only required to know the depth to the impervious layer, to the drain centre and to the crest of the watertable midway between the drains and the drain discharge. The hydraulic conductivity can be computed from a nomogram by Toksoz and Kirkham (1961).

3. The Infiltrometer and Inversed Test Hole methods are used for soils above a watertable. In the Infiltrometer method it is assumed that unit hydraulic gradient develops as the moisture content and depth of the

moisture transmission zone increases. The horizontal asymptote of the infiltration-time curve is then taken as the saturated hydraulic conductivity. The Infiltrometer method can be employed at successive depths in a test hole. In the inversed test hole a square shallow hole is cut into the soil layer under test. A hole can be cut by a spade with least disturbance compared with an auger. As in the infiltration method, unit gradient is assumed. Both methods can be used in all except very gravelly and stony soils. Discussion and procedures can be found in Kessler and Oosterbaan (1974). In a comparison of these methods with the auger-hole test below a watertable and the drain discharge method on 4 soils of widely differing texture, van Hoorn (1979) found that all 4 methods agree quite well.

4. The Pit Bailing method described by Bouwer and Rice (1983) is the only satisfactory method for stony and gravelly soils with a high watertable. In this method, a pit is excavated by hydraulic digger to the desired depth below the watertable. A pit of 3 metres diameter with battered sidewalls is suitable. After equilibrium, the watertable is dropped instantaneously and the rate of recovery measured. Piezometer theory is then applied to the measurements. This method is not cheap but gives good results.

5. The Falling Head Laboratory method is used for soils of low permeability such as clays. A discussion and procedure for this test is given in Klute (1965).

6. The Piezocone is frequently used by the Department of Soil Mechanics at University College Galway to estimate the hydraulic conductivity of slow draining soft soils and peats with very satisfactory results. It is also used to classify the soils and to give undrained shear strength. It is a cheap and rapid method and is extremely useful for landfill sites on soft soils (Rodgers, 1989).

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THE USE OF CONE PENETRATION TESTING AS PART OF A GROUNDWATER CONTAMINATION INVESTIGATION

When investigating a groundwater contamination problem it is important to gain as much information as is possible on the geology and soil conditions without exceeding the allocated budget. Where the soil conditions are complex, conventional methods of investigation, such as shell and auger boring, may not be sensitive enough to identify thin layers of higher permeability that could act as a pollutant pathways within an otherwise low permeability material. In addition the groundwater sampling methodology employed may not be sensitive enough to obtain samples with sufficient confidence from these horizons. These samples are important in the assessment of the existing nature of, and in the prediction of the future state of the problem.

In situations like this, cone penetration testing has proved a versatile and cost effective method of soil profiling and groundwater sampling. On a recent project in Ireland approximately 180m of profiling and 12 discrete groundwater samples were achieved in 30 hours of working.

The piezocone is well known in the civil engineering industry as an accurate soil profiling tool. The recording of cone resistance and sleeve friction during the steady 2cm/sec penetration rate of a standard Dutch cone test enables the soil type to be identified. The additional measurement of pore pressure with the piezocone assists in identifying the soil type. Variations in pore pressure reflect changes in stratification that cannot always be detected by standard cone testing. For instance in the project mentioned above, changes in the pore pressure response in a clay layer indicated thin permeable seams or lenses that may greatly influence the mass permeability characteristics of the deposit. Penetration may be stopped at any time to measure the dissipation of excess pore pressure. Studies show that the rate of dissipation of excess pore pressure depends mainly on the horizontal permeabilities. Estimates of the horizontal permeabilities (k_h) can be derived from the relationship:

$$k_h = c_h . m_h . 8_w$$

where c_h - is the coefficient of horizontal consolidation which] which can be estimated from dissipation tests (m²/s)

m_h - is the horizontal coefficient of volume change (m^2/MN)

8_w - is the unit weight of water (kN/m^3)

Groundwater sampling at discrete depths can be time consuming and difficult to perform accurately in conventional boreholes without causing cross-contamination. The deployment of proprietary sampling devices such as the "BAT" sampler and the "HYDROPUNCH" by the cone penetration unit enable groundwater samples to be obtained to within 2cm of the desired depth. Because the samplers are pushed into the soil in a closed position with a protective sheath, cross contamination is minimised. The depth limitations of these devices are similar to those of the standard cone where cobbles, boulders and sands with "N" values greater than about 40 are generally impassible. However, most other soils can be investigated using the available 20 tonnes thrust capacity of the 6 wheel drive purpose built trucks units available in Ireland today.

The use of conductivity measurements in groundwater contamination studies is well known. The development of a cone capable of measuring conductivity is however a more recent development. The conductivity cone gives a continuous recording of the electrical conductivity of the soil-water media as well as a measurement of the cone resistance and sleeve friction. The two measuring electrodes are placed 50mm apart some 325mm behind the cone tip. The tool is useful where the contamination has altered the soil water conductivity. Once background values can be established, tests (approximately 10 No. to 10m in a working day) can reasonably delineate a pollution plume.

If a monitoring network needs to be established the cone truck can be used to push in simple monitoring points in suitable soil to supplement other more conventional monitoring points. Where the soil conditions are complex and deemed suitable for cone penetration testing, the versatility and cost effectiveness of the method (about £1,000 per day) makes it a worthwhile addition to an investigation of groundwater contamination.

Jer Keohane, Fugro-McClelland Limited.

GROUNDWATER RESOURCES DEVELOPMENT, QUALITY AND POLLUTION : FUTURE NEEDS

What are the future needs for groundwater resources in Ireland? My views are given below. They are the conclusions of a paper given at the recent UCD conference "Environment and Development in Ireland". The proceedings of this conference will be published in the near future. Any comments and views would be welcome.

General Needs

1. A greater awareness of the presence and importance of groundwater is required by the general public and decision-makers, as it is "out of sight, out of mind" for many people.

2. Greater usage of groundwater in order to reduce the costs of infrastructural development.

3. Greater availability of geological maps, particularly subsoils maps, and data as the basis for groundwater resources assessment, development and protection.

4. The commencement of research on groundwater by Civil Engineering Departments in third level colleges.

5. Further research on the hydrogeology of wetlands.

Groundwater Development

1. Drilling regulations to improve drilling standards.

2. Greater use of surface geophysical techniques in locating the optimum sites for boreholes.

3. Improved testing and assessment of public supply wells, including calculations of the aquifer parameters transmissivity and storage coefficient.

4. Improved sanitary protection of wells by grouting borehole liners.

5. A full assessment of the groundwater potential of an area when planning public water supply schemes.

6. Commencement of the examination of groundwater as a source of emergency supplies.

7. Commencement of the examination of the groundwater resources in the gravel aquifers of Kildare and Wicklow as a strategic future resource.

8. Research on numerical modelling of groundwater flow in the major Irish aquifers.

Groundwater Quality

1. A nationwide groundwater quality network of representative sampling points, chosen with adequate knowledge of the hydrogeological, hydrochemical and pollution risk situation.

(The sampling and analyses required by the E.C. (Quality of Water Intended for Human Consumption) Regulations, 1988, are not adequate for monitoring groundwater as the samples are usually treated, and a broader range of analyses are needed).

2. Acceptance that the natural vulnerability of groundwater must be taken into account when locating potentially polluting developments.

3. Increased monitoring of underground storage tanks containing petroleum and other hazardous products.

4. Research on rates of pollutant movement through subsoils.

5. Monitoring and research on trace organics in Irish groundwater.

6. Research on the generation and movement of acid within mine tailings and waste rock and the potential effects on groundwater.

7. Research on nitrates in groundwater.

8. Assessment of the need to treat private water supplies.

Land Spreading of Organic Wastes

1. A Code of Good Practice which would include recommendations on the site investigations required and on the hydrogeologically suitable and unsuitable areas.

Septic Tank Systems

1. An explanatory leaflet on the potential environmental problems which would be given to all applicants for planning permission for houses with septic tanks.

2. Enforcement of the N.S.A.I. (1991) recommendations on septic tank systems.

Landfill Sites

1. The location of landfill sites in suitable areas hydrogeologically in order to reduce the risk to the environment and to humans.

2. Research on the use of peat and peatland to treat leachate.

Groundwater Protection Schemes

1. Continued expansion in their preparation and usage by local authorities.

2. Further research on vulnerability assessments.

Donal Daly, Geological Survey of Ireland.

SHEEP DIPS AND POLLUTION

Sheep dip is highly toxic to fish and other aquatic life, birds, animals and wildlife. Therefore, it MUST be handled and disposed of with great care.

Only licensed dip concentrations should be used, instructions must be followed to the letter. Ensure only as much dip as is needed is prepared so there is no surplus to be disposed of. However, if there is any left over it should be returned to the supplier or taken away by a specialist contractor.

Remember!

The condition of the bath should be examined, a check made to make sure the drain back system is working properly and the drain hole found in older baths sealed.

Never allow the bath to overflow and position it well away from any river or stream. Freshly dipped sheep must also be kept away from any nearby watercourse.

Correct disposal of the used dip is vital. It should never be dumped into rivers or streams or groundwaters, and soakaways are unlikely to be suitable.

Dip can be put onto land but the site must be capable of absorbing it. As a general rule not more than 250 gallons (1,200 litres) should be spread per 0.25 ha. Don't allow livestock to graze after disposal. The land must take the liquid without run-off or the creation of puddles. It must not be on a steep gradient and gravel, coarse sand and peaty soils are unlikely to be suitable.

If there is no suitable land then the spent dip must be retained in tanks for disposal by expert contractors.

Empty containers should never be re-used for any purpose. Containers should be cleaned when the dip is being prepared so that the rinsing liquid can be added to and form part of the diluted dip wash. After cleaning, containers should be punctured or crushed to make them unusable. Clean, perforated or crushed containers will be accepted at licensed disposal sites where they will be regarded as non-hazardous industrial waste.

NRA, National Rivers Authority, Severn-Trent Region

(Comment: This item is copied from a NRA leaflet. Farmers in Ireland are still being advised to dispose of spent sheep dip in soak pits. In my view, this is not recommended. **Editor**).

CAVES IN IRELAND

Irish Speleology, 14

Irish Speleology number **14** , the Journal of Irish Caving has recently been produced and may be of some interest to those people concerned with groundwater. The Journal covers a range of caving topics from expedition reports (Project Spain 90) to reports of new discoveries (Carrigtwohill, Co. Cork) and extensions and surveys of known systems (e.g. Cullaun 1, Pollnacgeim, Robbers Den Cave and Seven Streams in Co. Clare, Shannon Pot/Pollahune).

However, a major element of the Journal is scientific papers on different aspects of speleology. In this edition there are papers on

1) Caves, geology, hydrology and dye tests in the northern Darrty Hills, Co. Leitrim.
2) Caves and karst of Portrane, Co. Dublin.
3) Locating marine caves using geophysical methods, Doolin.
4) Review of work done on the Ture System, just south of Blacklion in the Cuilcagh Karst.

There are also four discussion papers concerned with the important theme of cave conservation, covering recent developments in Clare, at Poll an lonain, and at other sites nationally. Also there are some suggested guidelines for the designation of caves as sites of scientific importance.

A topical paper "All you never wanted to know about Leptospirosis" covers this fresh water borne disease. This is topical for both cavers and other water "users" e.g. canoeists, but also is wider terms. Of all people, cavers probably have the most direct contact with groundwater, and may well be the first to have contact with point sources of pollution in limestone aquifers, such as sewage or slurry inputs or dead carcasses dumped in a sinkhole. The Journal is available from the editor, Matthew A. Parkes, Department of Geology, Trinity College Dublin, Dublin 2. It costs £3 plus 50p p&p, cheques payable to S.U.I. Details of available copies of previous editions are contained in Irish Speleology 14, or from the above.

Matthew Parkes, T.C.D.

STATEMENT BY THE INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS AT THE INTERNATIONAL CONFERENCE ON WATER AND ENVIRONMENT, DUBLIN 1992.

The International Association of Hydrogeologists (IAH) is a world-wide body of professional scientists and engineers whose objectives are to promote better understanding and management of the earth's groundwater resources for the greater benefit of mankind and the environment.

A large part of the world's exploitable water resources is abstracted as groundwater. In many parts of the world groundwater provides the only reliable water resource for the future. The human and economic value of groundwater comes from its widespread occurrence and ready accessibility without the need for major engineering works. As a direct result of this accessibility, groundwaters are vulnerable to excessive exploitation and to contamination by unwise land-use practices, especially in urban areas. The protection of the quantity and quality of groundwaters therefore presents special challenges which IAH urges the Conference to address.

IAH draws to the attention of the Conference the declaration adopted in November 1991 by the Environment Ministers of the European Commission, which recognised that:

* groundwater is a natural resource with both ecological and economic value, which is of vital importance for sustaining life, health, agriculture and the integrity of ecosystems;

* groundwater resources are limited and should therefore be managed and protected on a sustainable basis;

* it is essential to protect groundwater resources against over-exploitation, adverse changes in hydrological systems resulting from human activities and pollution, many forms of which can produce irreversible damage.

IAH invites the Conference to take account of the following four issues for sustainable management of groundwater resources for the benefit of man and the environment:

1. Sustainable management of groundwater quantity

In the long term groundwater should not be exploited beyond the limits set by the rate of replenishment, except in the special case of non-renewable resources. Short term overdraft on renewable resources may be an acceptable and economic method of water use but only if adequate investigation has been carried out to make certain that there will not be irreparable damage to ecosystems. The environment has to be recognised as a legitimate "demand" upon groundwater resources and, in many cases, it will be necessary to constrain abstracted use below the rate of replenishment, such that an adequate proportion of the available resource can be devoted to sustaining ecosystems.

2. Sustainable management of groundwater quality

The only truly sustainable methods of groundwater quality management are those which are based upon the concept of prevention because they provide the only approach which protects the total groundwater resource. Treatment at point of use should only be regarded as a tactical response to meet immediate needs and not part of a strategy of water management which accepts the inevitability of pollution. Land-use control practices in force in many parts of the world are not providing adequate protection to groundwater resources in current use. The need to provide new water resources to replace those that are becoming contaminated, is placing new and unnecessary stress on the environment.

3. Integrated management

In developing strategies for the better management of groundwaster, issues of quality and quantity cannot be separated. Although this is true of all hydrological systems, it is particularly true of groundwater because of the complexities of hydraulic response to abstraction and drainage and the slow response times in aquifers. An integrated approach must also be adopted in respect of interrelations with surface water systems, recognising, for example, the impact which surface water management can have on the quality and quantity of groundwater and impact which groundwater abstraction can have on ecosystems.

4. Training and education

It has to be recognised that, because groundwater is not confined to pipes or channels, the true managers of groundwater in a global context are not hydrologists and water engineers but water users, municipality officials, industrialists and farmers, and those who take decisions on land use planning and waste management. Unless these people understand the basic concepts of groundwater use and protection then we cannot hope to manage our groundwater resources and the substantial environmental interests which depend upon it adequately. The most urgent need in groundwater management is better training and education for these true water managers and the challenge for the hydrologist is to provide information, in the form of water resource and vulnerability maps, codes of practice and land-use planning guidance, together with accessible expert advisors.

GROUNDWATER LEVELS

The Geological Survey has been monitoring groundwater levels in the southeastern part of the Central Plain (Nore River Basin) for the last 20 years. In view of the recent dry spell, in the eastern part of the country, the water levels monitored in February may be of interest.

There have been long groundwater recessions in this area in each of the last two years. In mid-October 1990 the water levels were probably as low as at any time this century. In October 1991, the water levels came within 10/15 days of the minimum levels of the previous year. Since the end of October last year there have been seven significant recharge events. The recharge events have been unusual in that they were mostly short, intense events with small recessions in between. There does not appear to have been any persistent rainfall events, lasting several days, when maximum recharge can occur.

Water levels were monitored in boreholes which are fitted with autographic recorders. The boreholes penetrate three of the main aquifers in the region i.e. the Dolomitised Waulsortian, the Burren type Karstified Limestones, and Sands and Gravels. The groundwater levels in these aquifers at present (end of February) are similar to those normally present in late April/early May or later, i.e. at least two months ahead of normal. The Water levels are below those of the Winter of 1975/76 which was also very dry and followed a long groundwater recession. These results are only relevant to the southeast and east of the country where rainfall has been below normal for the last three months.

What does this mean? At the moment it is not significant. Heavy rainfall over the next four to five weeks could bring the levels back to normal quite quickly. It is only if the recent pattern continues until April, when evapotranspiration becomes significant, that there will be cause for concern. In that event look at the article in the GSI Groundwater Newsletter No. 12 in June 1989 or watch this space.

Eugene Daly, Geological Survey of Ireland. (26/II/'92)

I.A.H. NEWS

IAH Technical Meetings

These are informal discussion meetings held at the GSI at 5.30 pm. The future topics, dates and speakers are as follows:

5th May The Irish Standard for Bottled Water. Introduced by Shane O'Neill, Ballygowan Spring Water Company.

2nd June EC Directives: their impact on groundwater. Introduced by Kevin Cullen, Consultant.

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

12th Annual Groundwater Seminar

The Irish Group of the IAH have announced the details of the forthcoming 12th Annual Groundwater Seminar. The seminar will be held at the usual venue, the Killeshin Hotel in Portlaoise on Tuesday and Wednesday 7th and 8th April.

The theme of the seminar this year is "Groundwater and Regional Water Supply". Talks at the seminar will cover a wide range of topics under the following headings:

- Groundwater and regional supply
- Groundwater exploration and development
- Treatment and distribution of groundwater
- Problems with Groundwater quality

Speakers from Thames Water Utilities and a U.K. Hydrogeological Consultancy firm will be included in this years line-up.

Registration for the Seminar remains unchanged this year at £70 per person. This fee will cover a four course lunch on each day of the seminar, as well as a bound compilation of the talks presented. Given the normal rate being charged for seminars generally, this represents very good value.

Further details are available from:

Frank Clinton
I.A.H. Seminar Secretary,
Sligo County Council,
Riverside,
Sligo or phone (071) 43221 Exn 298/246

CONTRIBUTIONS FOR THE NEXT ISSUE OF THE NEWSLETTER

The **GSI Groundwater 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, management, water quality,pollution and energy. It is published at three-monthly intervals.

Your contribution to the dialogue would be welcome. These should reach the Geological Survey before 15th May 1992.