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THE GSI GROUNDWATER NEWSLETTER

NUACHTÁN SCREAMHUISCE SGÉ

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IN THIS ISSUE

Never in the history of humanity has environmental concern and awareness been so great. This is reflected not only in the media coverage of environmental issues, but also in legislative changes. It is also reflected in the growing need for scientists and engineers who have expertise in the environmental area. Terms such as **"environmental geology"** are not just buzz words, they are a response to the needs of modern society. On page 2, Ger Kiely explains what is meant by **environmental engineering** and **environmental geology** is described on page 3. This year the I.A.H. (Irish Branch) responded to the legislative changes, in particular **S.I. No. 349 of 1989,** by organising the Portlaoise Seminar on **"Groundwater Aspects of Environmental Impact Assessments".** Summaries of two of the papers are given on pages 6-10 with Richard Thorn dealing with **agriculture and EIA's** and Shane O'Neill with **landfills and EIA's. Iron and manganese** are a common complaint in many wells in Ireland. David Harrington provides a chemists viewpoint on page 11. On page 15 Dave O'Brien questions our dependence in Ireland on the **conventional septic tank design.** Well **pumping tests** are the most commonly used method of calculating **permeability** by hydrogeologists. On page 17 Ray Flynn advocates the use of small-scale methods such as the **variable head piezometer method.**

If you have any views, comments, articles or news on any groundwater issue, please send them to me before **1st November,** 1991.

Editor

ENVIRONMENTAL ENGINEERING

Civil Engineers, by virtue of their technical and administrative positions within the Irish Local Authority system, are key personnel in Environmental Management. Although civil engineers are technically competent in many areas including water and wastewater treatment, there are many areas of the environment where their academic and practical training is inadequate. Such inadequacies are apparent in air and waste environments.

Environmental Engineering is that branch of engineering concerned with problems and solutions in the water, air, waste and noise environments.

Environmental Engineering is concerned with protecting the environment from the potentially harmful effects of human activities, protecting humans and other life forms from adverse environmental scenarios and improving environmental quality.

Anthropogenic pollutants have increased over the past century to levels disturbing the natural equilibrium of the environment. Many of these environmental disturbances have resulted from the rush towards development. In the past, engineers have had design and construct briefs, which did not include protection of the natural environment. From an environmental perspective, this resulted in some adverse developments. Environmental Engineering takes on board the added brief of environmental protection, and improvement of the natural environment.

Engineers have been involved in Sanitary Engineering for well over a hundred years, and coupled with breakthroughs in microbiology, the successes of the early part of the 20th century led to great improvements in public health. These breakthroughs were in treatment and disposal of wastewater and in the treatment of potable water. Both of these areas are currently experiencing exciting research developments.

The area of solid waste treatment and disposal (both municipal and hazardous) has until recently been given scant treatment in Ireland by engineers. However, applied work in Denmark and the United States has shown how waste treatment and disposal can be designed with minimal environmental impact. Landfill design and management, along with considerations of incineration for urban areas, are areas where engineers must work together with hydrogeologists, ecologists and chemical engineers.

The area of the air environment, ignored for so long, is now receiving the attention of scientists and engineers. Physical modelling, using wind tunnels and numerical modelling of pollutants in the air environment is fundamental to engineering courses. Wind tunnel modelling allied to computer simulation, advances the capability of understanding and subsequent solution of air pollution problems.

Hydrogeology is also an area where engineers have had little training in the past. As engineers, not only in local authorities but also in consulting firms, are continuously evaluating groundwater supplies and landfill sites etc., there is an immediate need for increased hydrogeological courses within the civil engineering curriculum. If these can be implemented the decision - making engineers may not make the same mistakes that their continental counterparts have made, with consequent deteriorating groundwater quality.

The need for improved environmental engineering education in Ireland is now obvious. Ireland has been at the forefront of waste water treatment and water treatment. However, the areas of solid waste management and protection of the air environment have been a low priority. Opportunities to address these deficiencies are now available through a wide range of EC research programmes and the Civil Engineering Schools need to collaborate with the Biological, Physical and Human Sciences to produce engineers who are more sensitive to the environment and capable of leading multi-disciplinary environmental teams.

Ger Kiely, Civil Engineering Department,

PUBLICATIONS

Environmental Impact Assessment - A Technical Approach
Eds. K. Bradley, C. Skehan, G. Walsh. DPTS Ltd. Environmental Publications. Dublin. 1991. 160pp. (Price £18.50).

The book contains four sections that deal with legislative and procedural aspects of EIA in Ireland, the assessment of impacts on human beings, the landscape and cultural heritage and the physical and biological environments, case studies and future developments in EIA. The book, in general, is a useful source of information and references. However, the chapter dealing with the impact of developments on water bodies deals with surface water only while that on soils is very brief (5 pages) in contrast to the two chapters on noise and vibration which are 21 pages in total.

Richard Thorn, Sligo RTC.

Proceedings of Environmental Engineering Conference 1991.

Eds. G.K. Kiely, E.J. McKeogh and J.P.J. O'Kane. UCC 377pp. (Price £45.00 - can be obtained from the Department of Civil Engineering, UCC)

This conference, the first to be held on Environmental Engineering in Ireland, covered a broad range of topics - E.C. Policy and Legislation, EIA's, Inland and Coastal Waters, Solid Waste Management, Sewage Treatment and Anaerobic Digestion, Water and Wastewater Treatment and the Air Environment. Almost 50 papers were presented containing both theory and practice. I can recommend these proceedings to all Irish scientists and engineers working in the environmental area.

Editor.

COURSE

Organic Pollution of Groundwater. A four day course offered jointly by the Universities of Birmingham and Waterloo (Ontario). The course will be held at The Grand Hotel, Birmingham, 21-24 October 1991. Fee is £550 excluding accommodation. For further details contact Vanessa Chesterton, Hydrogeology Research Group, School of Earth Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK, telephone 021 414 6751.

ENVIRONMENTAL GEOLOGY

Geological Materials and Society

Geological materials provide, literally, the foundation of our society. They are the rocks (subsoils and bedrock) that form the surface of the earth and are the base for all human activity. In addition to the bearing function, geological materials are a major part of the natural and physical environment. The human interaction with the geosphere is broadranging:

Human Interaction with the Geosphere

Engineering/Geotechnical	Waste disposal Urban and rural housing Infrastructural development Industrial development
Agriculture	Farming practices including farmyard development Soils Land drainage and reclamation
Extraction of Raw Materials	Groundwater Sands and gravels Metallic and industrial minerals Fuels
Education/Leisure/Tourism	Landscape/Topography National Parks Areas of Scientific Interest/ Conservation General recreation Evolution/philosophy of life

In spite of this broad range of human activities that interact with and are dependent on geological materials, the main focus when considering geological materials, even among geologists, is on extraction of metallic and industrial minerals and fuels. However we believe that it is beneficial for this country that geosciences information be available and be used when making planning and development decisions: decisions on waste disposal such as the location of septic tank systems, farmyards, piggeries or landfill sites; decisions on major construction projects such as pipelines and roadways; and decisions on the use of our natural resources such as gravels, minerals and groundwater.

Environmental/Applied Geology

The Geological Survey of Ireland (GSI) defines environmental geology (it may also be called applied geology) as **"The collection and provision of earth science information in a form that is useful to decision-makers such as planners, engineers, environmental health specialists and politicians, and anyone else concerned with land development or human interaction with the natural environment: this in order to enable the use,**

improvement, design and development of the earth surface in the knowledge of all relevant earth science information".

The products of environmental geology are thematic maps and accompanying reports. They are produced as part of a suite and consists of maps at three interpretative levels.

Level 1 - Primary data maps - for example: Bedrock lithology, subsoil (Quaternary) lithology, depth to bedrock, geochemistry, geophysical, mineral occurrence, water table, permeability/specific capacity, soils, geomorphology, fracture analysis and seabed sediment maps.

Level 2 - Derived maps - for example: Aquifer, groundwater vulnerability, geochemical anomaly, geophysical anomaly, soil suitability, geological hazard, earth science areas of scientific interest, geotechnical properties and metallogenic maps.

Level 3 - Land-use and marine priority maps - for example: Groundwater protection, land and marine resource priority, coastal area land-use suitability and recreation potential maps.

As the main aim of environmental/applied geology is to provide earth science information for resource priority assessment, environmental assessment and planning, the maps and reports must by definition be useful to and easily understood by non-geologists.

A large amount of geological information currently available from and produced by the GSI is suitable for inclusion (mostly at level 1), so it is not a new area of geology. However the emphasis and approach is new - the language used is user-friendly and the users or clients are planners, engineers and other decision-makers. We believe that this area of geology should become a priority among earth scientists. However this will depend on the needs, wishes and demands of the user. If planners and engineers, etc., accept the need for this information, then they must make their views known to the geological profession.

The Future

The application of geological information to the human use and exploration of the environment is by no means new, but the systematic collection, synthesis and application of geological, hydrogeological and mineral-resource data to land-use planning and environmental protection are tasks of increasing urgency in today's society. Technological ("engineering") solutions alone are frequently expensive and risky. Sound engineering involves the proper assessment of the natural environment - the geological materials - combined with good engineering design and practice based on this assessment. In conclusion, geoscientists, engineers, planners and other decision makers must work together to conserve Ireland's environment in a planned, cost-effective manner.

Donal Daly, Willie Warren and John Morris, Geological Survey of Ireland.

Agriculture, Groundwater And Environmental Impact Assessments

(This article is a summary of a paper presented at the 11th Annual IAH Groundwater Seminar on "Groundwater Aspects of Environmental Impact Assessments". Portlaoise, April, 1991.)

This article aims to identify those developments of an agricultural and related nature that require the submission of an Environmental Impact Statement (EIS) with the planning application and to "scope" the likely contents of the associated environmental impact assessment (EIA).

Agricultural and related developments that require an EIS to be submitted with the planning application are as follows (they are categorised as in Schedule 1 of SI No.349 of 1989).

Class of Development		Development
Agriculture	(a)	The use of uncultivated land or semi-natural areas for intensive agricultural purposes.
	(b)	Water management projects for agriculture.
	(c)	Afforestation and land reclamation where the area involved would be greater than 200 hectares.
	(d)	Poultry rearing installations.
	(e)	Pig rearing installations.
Food industry		All food industry projects noted in Schedule One of SI No.349 of 1989 in which it is proposed to landspread waste materials, e.g. whey, blood, fish waste etc.
Other Projects		Sludge deposition sites where the expected annual deposition is 5,000 tonnes of sludge.

Two broad groups of projects have a potential to cause groundwater problems:

(i) Afforestation, land reclamation and cultivation of virgin or near virgin land.

Afforestation with coniferous trees has the capacity to cause an increase in the acidity of soil and groundwater with consequent problems of enhanced levels of metals, in particular iron and aluminium, in both surface and groundwaters. The acidification will be greatest where the underlying rocks are acidic, e.g. granites, gneisses and some sandstones. To assess the likely impact of afforestation on groundwater the information required will include the following:

Size of development.
Rock and overburden type and characteristics.
Extent and characteristics of groundwater resources.

Land reclamation and the bringing into cultivation of virgin or near virgin land is likely to have implications for groundwater quality. These changes may occur through the application of fertilisers in excessive quantities or at inopportune times of the year and may also relate to reductions in the organic matter content of the reclaimed soils. Reductions in the organic matter content, which are brought about by microbial processes, result in the release of nutrients, in particular nitrogen, which can move to groundwater. Applications of pesticides may also result in a deterioration in groundwater quality. To assess the likely impact of land reclamation projects on groundwater the information required will include the following:

Size of project;
Timetable for project;
Soil and overburden type and characteristics;
Cropping and fertilising regime;
Extent and quality of groundwater.

(ii) The spreading of organic wastes from pig and poultry units and from food processing and the spreading of sewage sludge.

Wastes from pig and poultry production contain large quantities of nutrients, organic matter and, in the case of pig wastes, copper. Both chemical and hydraulic overloading of soils can result from the landspreading of these materials. Hydraulic overloading is more likely to effect surface waters than groundwaters and is not dealt with further here. Application of quantities of wastes in excess of plant requirements can lead to a build-up of harmful salts and copper and will lead to leaching of excess nitrates to groundwater.

The spreading of animal wastes may also have a role in disease dispersal if animals are contributing to the waste volume. The control of pathogens is best undertaken by a combination of waste storage, grazing restrictions and placement of the waste on tillage rather than pasture crops.

A range of wastes from the food processing industry are and have been spread on land and include paunch material, blood and whey. Because the wastes frequently contain large quantities of nutrients and organic matter problems of chemical overloading similar to those described above may arise. In particular, blood contains very large quantities of nitrogen and this must be taken into account when considering the design of a land spreading operation. A further problem arises with some food processing wastes, notably waste dairy products; they may, because they are highly reducing, cause iron and manganese to be mobilised in the soil and move to groundwater.

The spreading of sewage sludge on agricultural land is controlled by a European Community directive of 1986. Sewage sludge is defined by the directive as "residual sludge from sewage plants treating domestic or urban waste waters and from other sewage plants treating waste waters of a composition similar to domestic and urban waters". The directive lays down rules as to what type of soils and on to what crops the sludge can be spread.

The main groundwater problems associated with the spreading of sewage sludge are, elevated metal levels, particularly if the soil is acidic (less than pH 6), and disease spread.

The following information will be necessary to assess the impact of land spreading of organic wastes from pig and poultry production and from food processing and the spreading of sewage sludge on groundwater:

Amount and type of waste/sludge.
Soil and subsoil characteristics.
Design of proposed spreading operation.
Extent and quality of groundwater.

Useful references

Department of Agriculture (1985). *Guidelines and Recommendations on Control of Pollution from Farmyard Wastes.* Department of Agriculture. 63pp.

European Community (1986) Council Directive of 12 June, 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. *(86/278/ECC). Official Journal of the European Communities,* No. L. 181/6-12.

Grundey, K. (1980) *Tackling Farm Waste.* Farming Press Ltd. Ipswich. 249pp.

United States Environmental Protection Agency (1983) *Process Design Manual for Land Application of Municipal Sludge.* United States Environmental Protection Agency, Centre for Environmental Research Information. Cincinnati, OH 45268. EPA-625/1-83-016.

Various Authors in *Environmental Impact of Landspreading of Wastes.* Proceedings of Seminar in Johnstown Castle Centre for Soils and Environmental Research and Development. Wexford. 30-31 May. 1990.

Richard Thorn, Sligo RTC.

The EIA of A Landfill with Respect to Groundwater

This article is a summary of a paper presented at the IAH Groundwater Seminar on "Groundwater Aspects of Environmental Impact Assessments".

EIA Legislation

An EIS is compulsory if installations for the disposal of industrial and domestic waste have an annual intake greater than 25,000 tonnes. However there are two other instances where an EIA could be compulsory. These are:

Local Government (Planning and Development) Regulations, 1990, (S.I. No.25 of 1990): Article 6 (1)

Local Government (Planning and Development) Regulations, 1990, (S.I. No.25 of 1990): Article 35

These state that if the planning authority or the Minister consider that the development of a landfill will have an effect on the local environment then they or the Minister can insist that an EIS is prepared as part of the planning application regardless of the size of the development.

Data Necessary To Identify And Assess The Main Effects

The following data and sources of data should have been examined:

Topographic maps and stream flow data for the hydrology; Geology maps to assess Quaternary cover, bedrock geology, and geological structures; Aerial photograph interpretation; Site investigation records; Meteorological data.

The following should be carried out by field work:

A boundary and topographic survey; Additional geomorphology/geology mapping; Land and land-use survey; Visual assessment of ground conditions; Detailed ground survey and mapping of significant ecological and cultural detail; Trial pit excavations and drilling investigations to evaluate the geological, hydrogeological and geotechnical properties of the site.

The groundwater data should be compiled as a series of geological and hydrogeological maps and cross sections for the site and surrounding area, including:

A local well inventory; Preferential flow paths of overland drainage; Location and characteristics of superficial and "bedrock" formations; Occurrence of aquifers; Piezometry; Permeability; Groundwater contoured maps; Groundwater flow paths; Groundwater quality; Surface water quality; Details of any ground water abstractions in the area.

Description Of Effects On The Environment Of The Development

The importance of water with respect to the flora, fauna and cultural heritage would depend on their use of the water. The effect on flora and fauna would be of relevance if the surface or groundwater was feeding into marsh or fen areas. The effect on humans would be of relevance if the local inhabitants were using either groundwater from a local aquifer that could be affected or if they used a local surface water body that could deteriorate in quality as a result of leachate.

The effect on soil or by soil would have a bearing on water if it was acting as an impermeable barrier between the landfill and the groundwater or nearby surface water. The visual impact of a landfill could be direct as it is usually located in a former quarry or sand pit. Waste disposal sites can alternatively be raised sites. In this instance a large embankment of material could be built up on the side of a hill for example. This would have an obvious effect on the local hydrology and hydrogeology.

The Inter-action Between Any Of The Foregoing

A qualitative model of the entire system should be developed. It should try to describe what is happening at present, before the landfill has been developed and then predict what could happen during and after the development of the landfill.

Measures To Avoid, Reduce Or Remedy Adverse Conditions

This section deals with the engineering of the site. The first step is to determine the likely waste quantities and characteristics. This will effect the quantities and quality of leachate generated. Controlling the leachate generated can be achieved by:

Preparative earthworks; Leachate management and landfill gas control and monitoring measures; Site preparation for lining and site lining; Under-drainage if the site is to be lined; Optimum landfilling method evaluated should be based on the overall hydrogeological setting of the landfill. This will indicate the optimum cell size that will be economically viable and open for the shortest time; Surface drainage will be required within the landfill during development; Many landfill developments do make for the provision of intermediate and final capping material. The volumes of material required may not be available at the site. Therefore the volumes of material required should have been calculated and sourced outside the landfill site.

The final restoration contours and landscaping will control the amount of precipitation that will infiltrate into the landfill, flow off the capped landfill and the direction of that flow.

Monitoring wells for leachate and landfill gas are critical. The position of the wells should be such as to interpret ground water flow moving down gradient from the landfill. There should be boreholes up gradient of the landfill to act as control wells. Designing and implementing a regular water quality monitoring programme of both surface water and groundwater is essential. It is recommended that the groundwater and surface water should be sampled at monthly intervals from the start of the development until leachate generation from the site has ceased, and chemical analysis of the samples carried out.

Non Technical Summary Of Data Collected

A semi-quantitative model should be put forward of the likely impact of the landfill on the local environment. It should integrate the topography, geology, hydrology and site investigation data into a single system.

Finally attention should be drawn to the probable scenario that would occur if leachate did escape from the landfill whether by overland or through the base of the landfill. The risk of this occurring should be quantified and provisions included for the remediation of the site in the event of a deterioration of the environment as a result of the landfill development.

Shane O'Neill, Ballygowan Spring Water Company Ltd.

Iron and Manganese in Groundwater

I read with interest in the November, 1990 issue of the **GSI Groundwater Newsletter** the contribution by Frank Clinton, (Sligo County Council), on iron and manganese problems in wells in County Sligo.

We need to know the reasons why more and more groundwater is becoming problematical with the presence of iron and manganese, not just in Sligo but right around the country. It is a known and accepted fact that organic matter (such as silage or slurry effluent) carelessly or irresponsibly disposed can cause the dissolution of iron and manganese compounds in the ground (anaerobic/reducing conditions yielding Fe^{++} and Mn^{++} (lower oxidation states, soluble)). These solubilised metal ions can then migrate through an aquifer (in some cases a considerable distance) and reappear in a borehole. The soluble iron and manganese (colourless) are precipitated when the water is re-aerated at the surface.

Water from such a borehole/well is invariably free of organic pollutant or faecal bacteria. Below are a few chemical reactions (oxidation/reduction) demonstrating the point.

SOILS AND MINERALS		DE-AERATED WATERS (NO D.O.)		RE-AERATED WATERS (WITH D.O.)
Fe_2O_3 (S) Ferric Oxide $FeCO_3$ (S) Siderite	->	Fe^{2+} Ferrous ion (Colourless in true solution)	->	Fe $(OH)_3$ (S) Ferric Hydroxide (Red-Brown Precipitate)
MnO_2 (S) Manganese Dioxide	->	$Mn2^+$ Manganese ion (Colourless in true solution)	->	Mn* $(OH)_3$ (S) Manganic Hydroxide (Precipitate) *"MnO (OH)" in textbooks = Mn $(OH)_3$ minus H_2O

The above Table sets out the chemical circumstances in groundwater leading to Fe and Mn problems for the consumer. It is seen that the reduced forms of iron (ferrous, Fe^{2+}) and manganese (manganous, $Mn2^+$) give rise to colourless solutions but on oxidation (exposure to air) iron and manganese are converted to higher oxidation states of ferric, Fe^{3+} and manganic Mn^{3+} which both form insoluble red-brown precipitates.

A borehole polluted in this way can be difficult to identify because a chemical/microbiological analysis will invariably show no exceptional or unusual concentrations of any constituent with of course, the exception of iron and manganese.

Oxygen depletion is not always a result of pollution by organic matter as shown by the following chemical reaction:

$$2\ FeS_2 + 7O_2 + 2H_2O = 2\ Fe^{2+} + 4SO_4 + 4H^+$$

iron pyrites	Dissolved Oxygen in recharged groundwater

I have seen many bored wells in County Wicklow containing problematical levels of iron and manganese but I have not always been convinced that this problem was due to geological composition alone.

The location of these contaminated wells follows no definite pattern. On the contrary, they appear to occur sporadically and in areas where such problems would not be expected.

Surely there are other chemical labels in groundwater capable of informing us as to how these high levels of Fe and Mn came about and whether a discharge of organic matter (silage, slurry) into the aquifer (even at a remote distance!) was the cause of these elevated levels of metals.

After all, even to a chemist, a concentration of 0.2mg/l (Drinking Water Directive Limit) iron is a very small quantity indeed!

David Harrington, Wicklow County Council.

TOXIC WASTES IN EUROPE - PARLIAMENT, PEOPLE, POLITICS, PROBLEMS AND POTENTIAL.

4-Politics

In the last article in this series it was noted that there is a clear division between the industrialised countries in the north of Europe with their concerns about production based pollution and Ireland and the southern European countries with their concerns about consumer based pollution. How do these concerns translate into action? Do the voting public elect politicians who would be likely to enact legislation beneficial to the environment? If we make the assumption that it has, until recently, been the Green Party that has politicised environmental concerns, then an examination of the share of the vote and the number of seats obtained by Green Party candidates in European Parliament elections in 1979, 1984 and 1989 should help us to answer the questions posed above. Table 1 shows the membership of the European Parliament by the Green Party and the % of the vote they received in each of the elections in 1979, 1984 and 1989.

Table 1

Membership of European Parliament by Green Party and % of Vote in Elections

Country	1989		1984		1979	
	Seats	%	Seats	%	Seats	%
Belgium	3	13.9	2	8.2	0	3.4
Denmark	4	18.9	4	20.8	4	21.4
France	9	10.6	0	3.4	0	4.4
Germany	8	8.4	7	8.2	0	3.2
Ireland	0	3.8	0	0.5	0	0
Italy	5	6.2	0	0	0	0
Netherlands	2	7.0	2	5.6	0	0
Portugal	A Green Party candidate is elected for the first time in 1989 as part of a larger group.					
United Kingdom[2]	0	14.5	0	0.6	0	0

1 The figures include "People Movement against the EC" members.

2 The UK is the only country to use the "first past the post" method of election - which explains why the Green Party achieved 14.5% of the vote in 1989 yet received no seats.

In Greece, Spain and Luxembourg the Green Party did not contest the elections.

Two points can be made about the data in Table 1. First, with the exception of Denmark, which includes "Peoples Movement Against the EC" candidates with Green Party candidates in the returns for the elections, every country in the Table recorded an increase in the percentage of the vote received by the Green Party and/or an increase in the number of seats obtained in the 1989 elections. Second, the increase in the percentage of the vote received and the number of seats obtained by the Green Party between 1984 and 1989 in the UK, Ireland, France and Italy respectively, suggests that these countries are rapidly approaching countries like the Netherlands and Germany in the extent to which environmental issues have encroached upon national politics.

If we look at the environmental awareness survey results, noted in the last article, together with the election results an interesting point emerges. In those countries and in particular, Ireland and Italy, that experienced large seat and/or percentage vote gains by the Green Party in 1989 the forms of environmental damage considered most serious were rubbish and litter. In contrast, in countries in which production pollution was considered most serious, e.g. Denmark, Germany and the Netherlands, the increase in the percentage of the vote received and or the increase in the number of seats obtained by the Green Party was relatively small. What does this mean? It suggests to the author that although many countries in Europe have and are becoming "greener" there are distinct phases in the greening process. In the northern European countries, which have had a much longer tradition of environmental activism and in which environmental concerns are, arguably, at a more sophisticated level, it appears that the Green Party may have gone as far as it can go in terms of its encroachment upon national politics.

Richard Thorn, Sligo RTC.

I.A.H. NEWS

I.A.H. Annual General Meeting

This will be held on 1st October at 5.30pm at the GSI

ON-SITE WASTEWATER TREATMENT - AN ALTERNATIVE VIEWPOINT

Throughout the U.S.A. many states have discovered that conventional septic tanks systems are not appropriate for wastewater treatment in some soil systems and under certain environmental conditions. However, sanitary codes in many of these areas, similar to Ireland, are tied to the conventional septic tank design and allow only minor variations. Several states such as Maine, Connecticut, Idaho, Maryland and Washington, allow, what are termed, innovative and alternative technologies (I and A). Washington State has established three different categories of on-site systems:

1. standard septic systems
2. alternative systems; and
3. experimental systems

Since 1987, Washington state has published guidelines for the following alternative systems:

(a) aerobic systems;
(b) pressure distribution;
(c) incineration toilets;
(d) composting toilets;
(e) sand filters;
(f) alternating and dosing systems; and
(g) fill and mound schemes.

The Technical Review Committee within the state examine alternative technologies as they are developed. This evaluation is based on the following:

1. life expectancy,
2. reliability,
3. performance,
4. testing,
5. installation requirements,
6. operation and maintenance conditions,
7. possible applications,
8. costs and energy requirements
9. aesthetics.

An alternative system can be permitted for use as soon as guidelines have been established. In addition, the environmental health officer requires monitoring of the plant's performance, and each project is reviewed on a three year cycle.

According to Mitchell et al., (1982) the use of aerobic pretreatment of individual household wastewater, before soil disposal, is rapidly increasing. Stockton (1975) reports that up to 10 times more aerobically treated wastewater can be applied to the same amount of soil as septic tank effluent. In general the use of aeration in wastewater treatment will prolong the life of a percolation area. Perry and Harris (1975) show variable clogging behaviour in aerated and non-aerated effluent in sand columns. Non-aerated treatments clogged more slowly than aerated columns, but infiltration rate recovery during resting periods, was more rapid in the aerated columns. Laak (1970), maintains that the clogging rate of soil is dependent upon the BOD and total suspended solids. The area of the seepage bed can be enlarged or reduced depending upon the concentrations of both these parameters at the soil interface. British Standards (1983) recommend a 20% reduction in subsurface drainage trenches where effluents receive secondary treatment such as in aerobic plants.

One unique modification of the soil absorption system, proposed by Niimi (1982), is the "Dojo-Joka Shisutemu" or a soil purification system translated as capillary seepage trench (CST). The CST is similar in many ways to a conventional trench or bed type of percolation system. However, unlike conventional systems, the CST has an impermeable liner along the entire length of the trench and partially up the side walls, which prevents direct percolation downwards. The wastewater collects along the whole length of the trench and then moves upwardly and horizontally by capillary action before percolating downward. The advantages of the system are hypothesised to be:

1. the flowpath of effluent is longer in the CST than in the conventional procedure.

2. the wastewater is more easily distributed along the length of the trench in a CST system because the wastewater first collects in the impermeable trough before it percolates down through the soil matrix.

By 1982, over 25,000 CST units had been installed in Japan, and Reed et al., (1989) in an in-depth study reveal significantly better removal of organic matter in CST systems than in conventional systems examined in parallel.

Reference

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Laak, R. (1970) Influence of domestic wastewater pretreatment on soil clogging. *Journal Water Pollution Control Federation,* 42, 1495-1500.

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Dave O'Brien, Eastern Health Board.

PERMEABILITY VALUES THAT DON'T COST THE EARTH.

How would you determine the permeability of a particular rock? The usual hydrogeological solution is to drill a well and carry out a pumping test. In many cases this is the correct approach. For instance, if we need to know the yield of a particular well pumping tests are the ideal solution.

However, in some cases pumping tests are not necessarily the best technical approach or may simply just not be feasible. Pumping tests tend to be expensive, time consuming and require specialized equipment. Smaller-scale solutions requiring less time, staff and equipment are available but are often overlooked by hydrogeologists and engineers alike. These tests sample a smaller volume of rock or soil than pumping tests. The methodology involved is usually quick, cheap and simple to use. Equipment is usually basic or easily constructed at minimal cost. Small scale field methods are usually applied to situations where permeability is required over a moderate volume of rock or soil immediately around the borehole. This is frequently the case in work focusing on problems relating to pollution, agricultural drainage and engineering. The various approaches are ideally suited to low to moderate permeability media such as sands and silts.

What are these small-scale methods? The most commonly used approaches are variable head piezometer and auger hole tests. Auger hole methods involve exposing the whole wetted surface in a borehole to a variation in hydraulic head. Piezometers on the other hand have part of their saturated thickness cased off so that the test only exposes a limited part of the host rock or soil to head variations.

Both methods involve either adding or removing water from the hole and monitoring the water-level response. The rate of water entry or exit gives an indication of the permeability of the surrounding material. It is important to note that the data obtained from the piezometric approach yields more accurate results. Depending on the geometry of the piezometer casing and the number of tubes installed an indication of the lithology heterogeneity in vertical and horizontal directions can be obtained. These parameters cannot be determined usually by single well pumping tests.

Before carrying out these tests it is advisable to bail water from the hole a few times and allow it to fully recover. By doing this the chances of smearing affecting the results are minimized.

From a practical point of view the only equipment required to carry out these tests are something to measure water-level fluctuation, preferably a dipmeter, and an apparatus to cause the head variation in the hole. In rising head tests a small bailer, such as a copper pipe sealed at one end or a small suction pump are often used to remove water. If a falling head test is felt to be more practical, water can be added down the hole although this is not advisable since water flowing more slowly down the casing sides may strongly affect results. The difficulty arises since the displacement is meant to be instantaneous. A more satisfactory result is obtained by displacing well water using a heavy object of known volume.

The analytical solutions for both methods can be obtained from B.S. 5930. Analysis has a graphical format. Emphasis should be placed on early data to obtain an accurate result; if later data is used inaccuracies of up to and over an order of magnitude difference form early data can be obtained.

Because these methods can be carried out on very narrow diameter holes smaller boreholes can be drilled. Narrower diameter holes are quicker to drill and require less materials and thereby reduce the cost of manpower, materials and equipment compared to standard well construction techniques. Looking at it another way, for a given budget a greater number of holes can be drilled in a particular project and thereby provide a much better insight into in-situ ground conditions.

A word of warning is needed though; small-scale field techniques are not the solution to all groundwater problems. The approaches have a number of limitations. Both methods mentioned are ideally suited to shallow aquifers of moderate to low permeability such as sandy and silty subsoils. Responses to testing in higher permeability deposits are usually so rapid that little useful data can be obtained before the water returns to its natural level. At the other extreme neither the piezometer or auger-hole methods can be used in very low permeability or expandible media such as clay or peat. Recovery is often over a very long period of time and involves large changes in the materials water content. These factors are not accurately accounted for by any widely available formula and can produce values of permeability that are inaccurate by over an order of magnitude.

Alternative methods employing pressure transducers or constant head piezometer techniques must be used in the latter case if accurate in situ values of hydraulic conductivity are required. Both these methods will be reviewed in a later issue of the **GSI Groundwater Newsletter.**

In conclusion, small-scale, field based methods are useful though frequently ignored methods of obtaining in-situ permeability. The methodology and equipment required make them inexpensive and easy to carry out. For situations where funds are restricted and a permeability value is required small-scale methods offer a cheap and in many ways practical alternative to pumping tests. They are certainly worthwhile from both a economical and technical point of view and will hopefully be employed more frequently in future investigations.

Ray Flynn, E.R.A.

CONFERENCE

Management of Landfill Sites. 7th and 8th November, 1991. Imperial Hotel Cork. Organised by Sherkin Island Marine Research Station. For further information contact Matt Murphy Tele. No. (028) 20187, Fax No. (028) 20407.

IAH Technical Meetings

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

5th November	Mining and groundwater in populated areas. Introduced by Eugene Daly, GSI.
3rd December	Impact of landspreading of organic wastes on groundwater. Introduced by Donal Daly, GSI
7th January	Small scale (limited discharge) permeability tests. Introduced by Ray Flynn, ERA.

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

NEWS FROM ABROAD

MONTANA: Pollution of Private Wells

About 1300 private well samples were tested in Montana for coliform bacteria, nitrate-nitrogen, total dissolved solids, sodium and pH. Nearly 40% of all samples tested positive for coliform bacteria. Distribution was uniform throughout the state. The results indicate the problem is not just related to agricultural practices but also to faulty well construction or contamination at the time of construction - well-casing entry as a result of surface runoff from livestock areas entry into the well cavity because of faulty septic tank siting, and improper sampling procedures.

Coliform bacteria were found to be a more frequent source of contamination than nitrate-nitrogen. About one in every 20 samples had a nitrate - N concentration in groundwater greater than 10ppm federal standard. However, this may not always be due to cropland fertilizer applications. Nearly half the sample containing excessively high nitrate were obtained from only three or four counties where summer fallowing was practised (this relies on mineralisation of organic matter as the primary source of N. for crop needs).

(Source: The Groundwater Newsletter of Water Information Centre Inc., Vol. 20 No.8)

Jennifer Browne, Geological Survey of Ireland.
