ISSN 0790 - 7753

THE GSI GROUNDWATER NEWSLETTER

- Exploration
- Management
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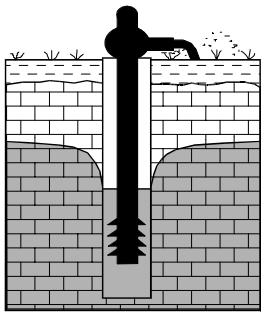

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Published by the Geological Survey of Ireland
Beggars Bush, Haddington Road,
Dublin 4.
Tel: (01) 6782811. Email: donal.daly@gsi.ie

Foilsithe ag an Suirbhéireacht Gheolaíochta Éireann
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No. 43 October 2004

In This Issue

The **groundwater maps** (aquifer, vulnerability and groundwater protection zone) for nine groundwater protection schemes (Clare, Kildare, Kilkenny, Roscommon, Monaghan, South Cork, Tipperary North, Laois and Wicklow) **can now be viewed, free of charge, on the GSI website** (www.gsi.ie) (see details in article by Una Leader on page 3). The maps for Kildare, Donegal and Meath should be available by the end of 2004. Querying the website enables not only the aquifer category, vulnerability and groundwater protection zone for any site/area to be ascertained, but also the groundwater protection responses. In addition, country-wide bedrock unit and aquifer maps can be viewed by public servants, consultants, academics, students and members of the public.

Articles on **septic tank systems** have been a regular feature in the Newsletter, and in this Newsletter we have two thought provoking articles by Nick Gray (pages 9 and 13) on **septic tank design and installation**.

Tracing is an effective means of checking groundwater vulnerability; an experiment in Switzerland by Ray Flynn and Michael Sinreich is described on page 16. They show how fast water and pathogens can travel in unsaturated soil and limestone, and their results raise questions about the role of topsoil in attenuating pathogens.

'Do we need contaminated land legislation after all?' should be a question to grab your attention! See Jonathan Derham's view on page 18. The following article (page 19) by Jonathan and Malcolm Doak summarises the **Environmental Liability Directive 2004**.

With sadness we include an appreciation by Bruce Misstear and Geoff Wright (page 2) of **Lewis Clarke,** who died recently. Those of us who knew him gained personally; those who read his book on wells and his paper on step tests gained professionally.

Donal Daly, Geological Survey of Ireland

Lewis Clark – An Appreciation

The well-known British hydrogeologist Lewis Clark died on 9th July. He had been in poor health for a couple of years. Lewis had many friends in Ireland and he contributed to two of the early IAH seminars in Portlaoise (in 1981 and 1983), experiences he greatly enjoyed.

The early part of Lewis Clark's career in hydrogeology included consultancy assignments in several developing countries, notably Sudan, Thailand and Saudi Arabia. He was part of the talented Hunting Technical Services and Sir M Macdonald and Partners team – which included Wiktor Bakiewicz, Roy Stoner and the late Don Milne – that worked on a major water supply project for the Saudi Arabian capital Riyadh in the 1970s, one which involved the design and construction of a wellfield with more than 60 large capacity wells tapping a deep sandstone aquifer. This and subsequent experience in the design, drilling and testing of wells led Lewis to publish his excellent Field Guide to Water Wells and Boreholes in the 1980s. He also published a significant and much-quoted paper on step drawdown tests in QJEG in 1977.

In the late 1970s Lewis Clark joined the Water Research Centre (now WRc plc) and he soon became involved in applied research in groundwater quality and pollution. His research publications were always insightful and useful. One paper that has stuck in my mind described the finding of synthetic organic chemicals in ancient British groundwaters, the implication being that despite stringent sampling procedures the samples had somehow become contaminated – a lesson we should always bear in mind when interpreting the results of groundwater sampling investigations. In 1993 he was appointed Visiting Professor in Hydrogeology at University College London. He retired from WRc in the late 1990s and set up his own consultancy, Clark Consult, in 1997. He continued working as a consultant until shortly before his death in July.

For the last two years I have been working with Lewis on a new book on water wells and boreholes, based partly on an update of his Field Guide. He was a very likeable and knowledgeable man, as all those who knew him will be aware. He is a great loss to the hydrogeological community.

Bruce Misstear, Department of Civil Engineering, TCD

Geoff Wright, Geological Survey, adds:

Following a PhD at Leeds University, Lewis spent some time with the Uganda Geological Survey, where he worked under Dr Cyril Williams, later Director of GSI (1967-87). It was Cyril who assigned Lewis, an expert photogeologist, to a UNDP project in Karamoja, where he first became involved in hydrogeology.

Later Lewis joined Hunting Geology & Geophysics and employed both his photogeological and hydrogeological expertise in Northern Darfur, Sudan (now much in the news). Later the HG&G hydrogeologists transferred to Hunting Technical Services, where I shared an office with Lewis in 1971. He was an ideal colleague – always ready to help, encourage and appreciate, always slow to interfere.

When I arrived in Darfur late in 1971 to undertake another project I found Lewis had left behind a legacy not only of a report which is still much-used in Sudan, but also of his considerable artistic expertise – his children's furniture was abundantly decorated with cartoon characters.

He will be sorely missed.

Groundwater Maps – Now Online

Introduction

The Geological Survey of Ireland (GSI) is pleased to announce that a large percentage of currently available Groundwater Protection Scheme Maps can now be viewed online. This is the latest move in an ongoing GSI Web Mapping Project which is putting GSI datasets and maps on the web.

The maps that are currently available online can be divided into two basic groups:

(a) National Maps
Bedrock Aquifer Map, Gravel Aquifer Map and Generalised Bedrock Map.

(b) County Based Groundwater Protection Scheme Maps
Groundwater Protection Zone Map, Aquifer Map, Vulnerability Map, and
Landfill Responses Map, Landspreading Responses Map & On Site System Responses Map
Available for Counties Clare, Kildare, Kilkenny, Laois, Monaghan, Tipperary North, Roscommon, South Cork and Wicklow.

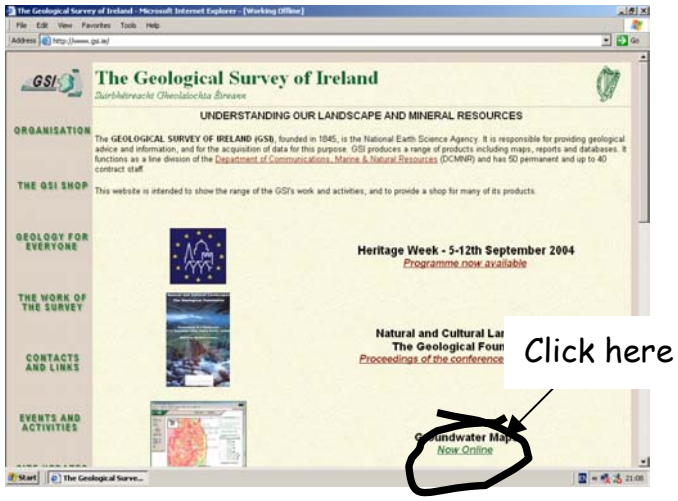
The system that is being used to display the maps is a customized tool for viewing GIS enabled maps online (GIS/Geographical Information System). GIS enabled means that rather than a map just being a picture to be viewed, each point on a map has information attached to it *(e.g. Aquifer Classification, Bedrock Type, Vulnerability Category etc.)*. The user can query maps for this information, either by location (e.g. within a selected rectangle), or by requesting that areas, which have a particular type of information attached to them, be highlighted on the map. Maps are divided into themes or groups of particular types of maps and the user can choose which maps or layers they wish to be displayed and queried. The maps can be displayed if so wished over a base of either an Ordnance Survey (OS) 1:500,000 map or the 1:50,000 OS Web Map.

Note: The 1:50,000 OS Web Map was created by the OS, as a simplified countrywide version of its 1:50,000 Discovery Series Maps, for use on the web. It contains a limited number of features such as roads, towns and rivers, but does not contain elevation information. County boundaries can also be shown if desired.

The GSI Web Mapping Tool is not as powerful as a full GIS program such as ArcMap; however it provides a very useful way, for those without such GIS software, to access the Geological Survey's geographically referenced information remotely.

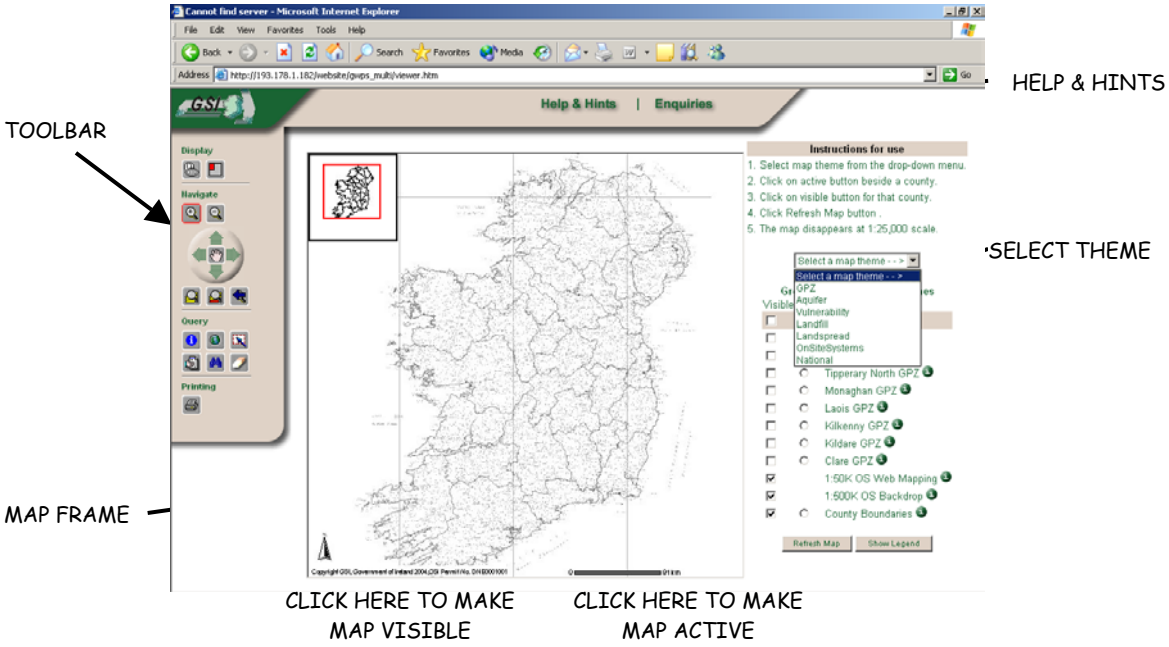
Getting Started

To access the maps, viewers must first enter the GSI website at www.gsi.ie and then scroll down the front page to the icon "Groundwater Maps Now Online".



Clicking on this icon will bring you into the map viewer for the Groundwater Maps.

The page below is what you will see each time you enter the site. It consists of a map frame in the centre and a tool bar on the left, which allows you to do many of the basic operations you would carry out in GIS. The right hand menu allows you to select the theme, or type of maps you wish to view.



Selecting a Theme

There are seven themes (types of maps to view) currently available:

1. Groundwater Protection Zones (GPZ)
2. Aquifer Classification
3. Groundwater Vulnerability
4. Groundwater Protection Responses for Landfills
5. Groundwater Protection Responses for Landspreading
6. Groundwater Protection Responses for OnSite Domestic Wastewater Treatment Systems
7. National

These can be divided into two basic groups:

(a) National Maps
(*Bedrock Aquifer, Gravel Aquifer and Generalised Bedrock Maps)*;

(b) County Based Groundwater Protection Scheme Maps
(GPZ, Aquifer, Vulnerability, and Landfill, Landspreading & On Site System Responses).

The default theme, which appears each time you enter the site, is Groundwater Protection Zones (GPZ). To select another theme you can use the drop-down button where it says "*Select a map theme*".

The right hand menu also allows you, once you have selected one of the themes above, to select which maps you wish to make 'Visible', and which to make 'Active'. When a map is active it means it can be queried. While several maps can be made 'visible' at the same time, only one map can be active at any particular time.

When you make a change to which maps are visible or active you need to click on the *'Refresh Map'* button at the base of the right hand menu. This loads your new map selection. To view map legends click on the *'Show Legend'* button.

Tools & Functions

The *'Help & Hints'* button at the top of the screen opens a second window with a very useful and clear explanation of what each button in the left hand toolbar does and how to query maps. It is to be recommended that users read this section so as to make sure they are using the site to its full potential.

The function of any button in the left toolbar will be displayed by holding the cursor over it and a full description of the function obtained in the Help & Hints section.

A number of tools are provided to help you navigate to your area of interest:
You can pan (), zoom in () or out (), zoom to full the full extent of the maps () and zoom to the active layer (). The 'zoom to previous

extent' button ( ) should be used to retrace your steps to previous views. The back button of your internet explorer should not be used once you have entered the map viewer!

A number of tools are provided to query the information behind the maps:
The results of queries are shown in a separate window. You can only query information from one layer (map) at a time. To query a map you must click on the right menu to make it *'Active'*. You can display all the associated information for a particular point on a map by clicking on the identify tool ( ) and then clicking on your point of interest. You can use the select by rectangle button ( ) to return all the associated information for a selected area. The Hyperlink tool ( ) will open any web pages associated with a map at a particular point. Associated web pages include the Groundwater Protection Response Matrix and the full text version of what is meant by a particular Groundwater Protection Response. The Find tool ( ) can be used to highlight areas on the map that have information associated with them that matches an entered value (e.g. Areas with an R1 response for Landspreading or with an Ll Aquifer Classification). The search is case sensitive so you need to know the correct way of writing the various classifications.

The report generator ( ) allows you to select a particular area, either by drawing an on-screen polygon or by specifying a set of grid references, and generates a report with all the available data for that area. This is quite a useful tool as the report will also include a Figure of the relevant section of the map showing your selected area. The Print tool ( ) enables selected areas of maps to be printed with a Title and Legend.

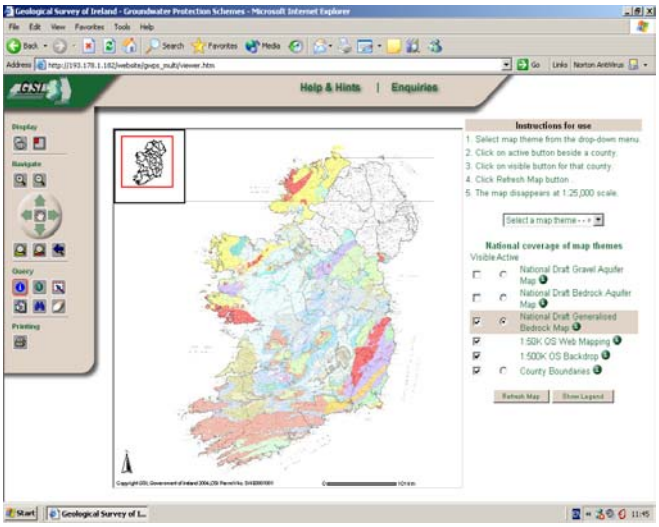
Viewing the Groundwater Maps

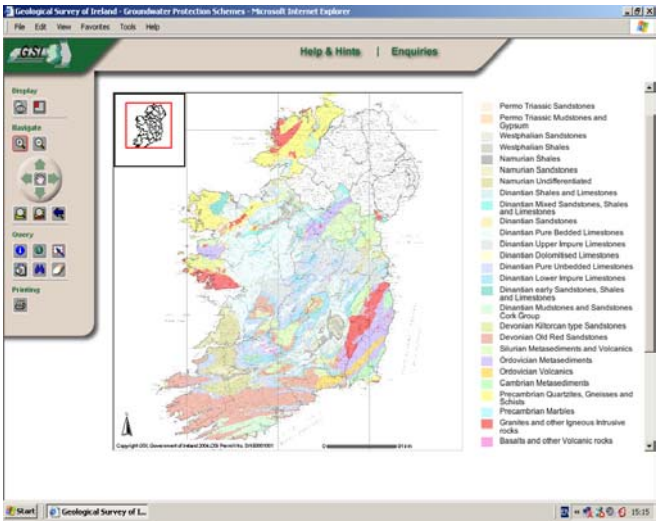
National Maps

When you select the 'National' theme from the drop down menu a list of the National Coverage of Map Themes appears in the right hand menu. To view any of the three national coverage's – Generalised Bedrock Map, Bedrock Aquifers or Gravel Aquifers you must make them visible by clicking in the box in the visible column. If you wish to query a map you must make that map layer active.

Generalised Bedrock Map

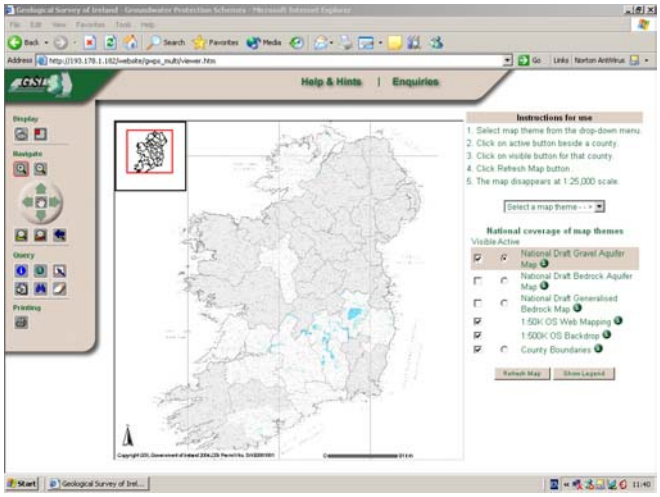
The Generalised Bedrock Map is shown below (with legend shown in second figure).





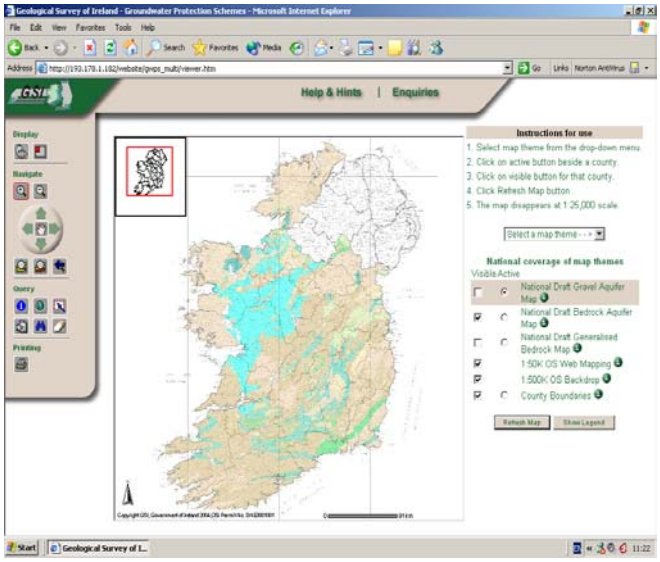
Gravel Aquifer Map.

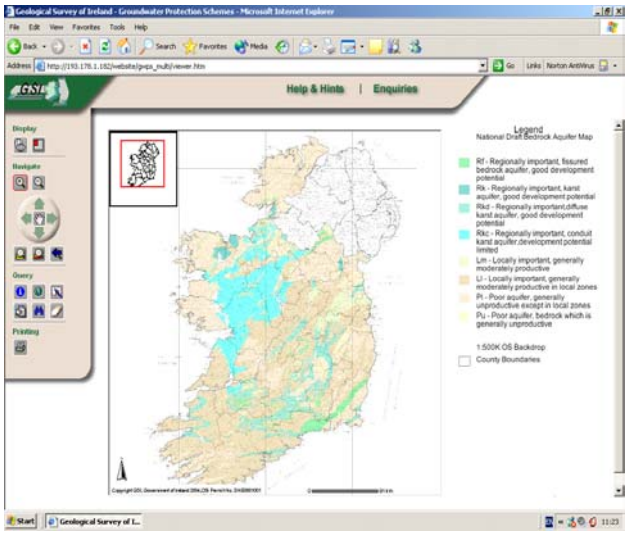
Gravel aquifers have only been mapped in a limited number of counties. Counties where gravels have not been mapped are greyed out. In some mapped counties no gravel aquifers have been designated (aquifers not of sufficient size or the available data did not indicate the presence of any significant gravel aquifers). It is important that when identifying aquifer types in an area of interest you view the gravel aquifer map as well as the bedrock aquifer map to ensure that you are not omitting possible gravel aquifers.



Bedrock Aquifer Map

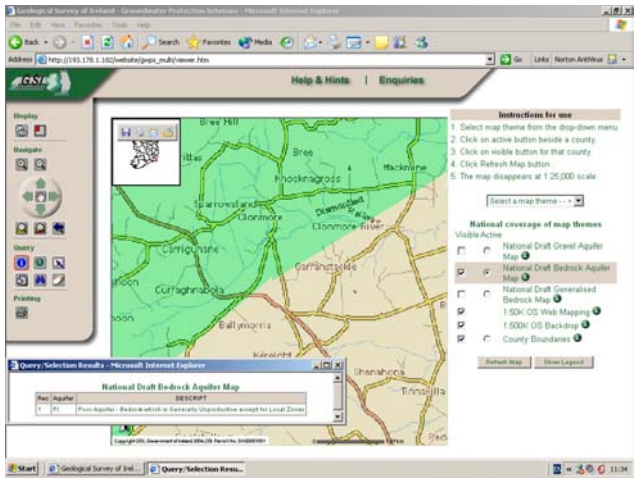
The Bedrock Aquifer Map is shown below with and without the map legend.





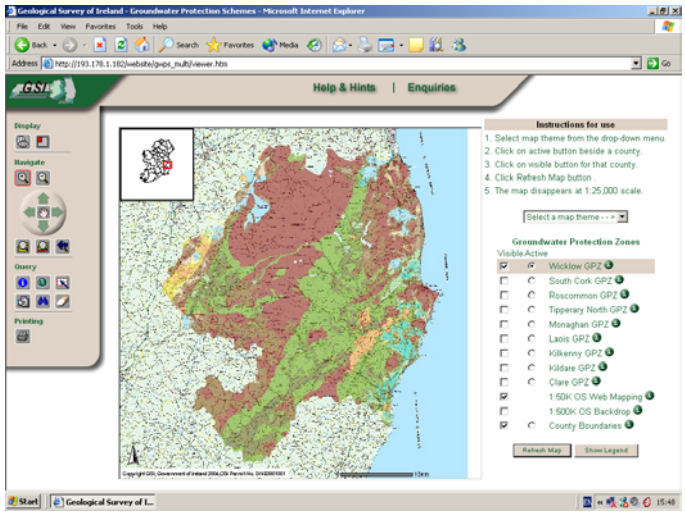
By zooming in on particular areas in the map the features on the OS 1:50,000 map become visible and it is easier to find particular locations. Making the Bedrock Aquifer Map 'Active' allows you to query the map.

The results of a query with the identify tool ( ) are shown in a second window which opens over the map window (below).

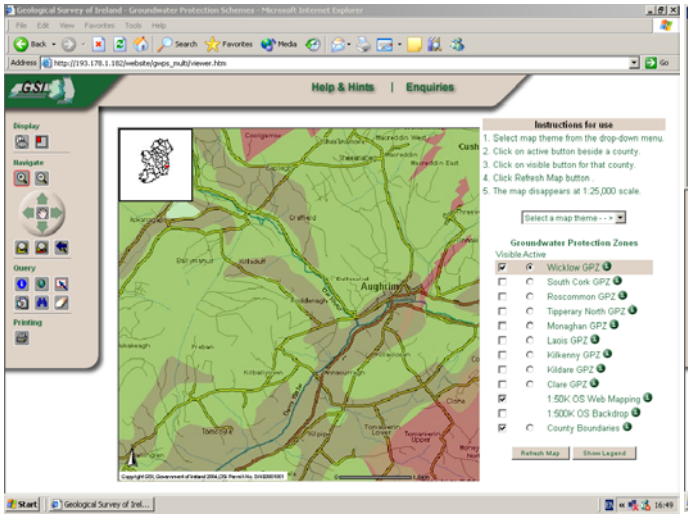


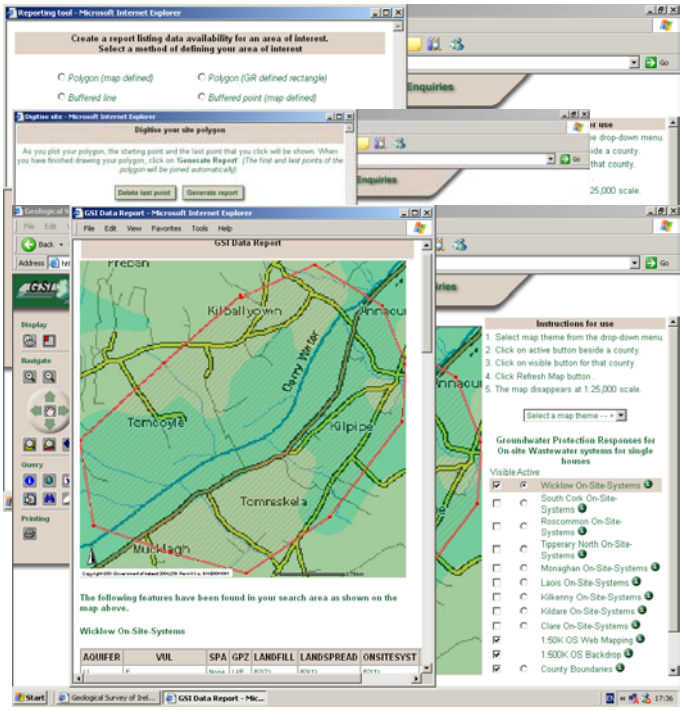
Groundwater Protection Scheme Maps:

When you select any of the 6 themes relating to Groundwater Protection Scheme Maps (GPZ, Aquifer, Vulnerability, Landfill, Landspreading, On-site Systems), you are given a choice of maps from 9 counties (Wicklow, South Cork, Roscommon, Tipperary North, Monaghan, Laois, Kilkenny, Kildare and Clare). By making a layer active and visible you can zoom to the active layer ( ). The map below left shows the Wicklow Groundwater Protection Response Zones.



Using the zoom tool you can zoom in to a particular section of the map.





Changing the map theme allows you to display other maps such as vulnerability and maps showing the groundwater protection responses for Landfill, Landspreading and On-site Systems.

Generating Reports for Specific Areas

By using the report generator tool ( ) you can select an area of interest either by drawing a polygon on screen, defining a set of grid references, or by drawing a line or selecting a point which can be buffered to define an area of interest. You can then produce a report which shows your selected area on the map and all the available information for that area.

When you query the Groundwater Protection Scheme Maps within any of the 6 themes all of the available information is shown in the query window (see below). This is because all of the themes are derived from a master data table. The colouring and legend of the maps change between themes, but the information comes from the same master data table.

Query/Selection Results - Microsoft Internet Explorer

Wicklow On-Site-Systems

Rec	Aquifer	Vulnerability	Source Protection Area	Groundwater Protection Zone	Landfill Response	Landspreading Response	On-Site-Systems Response	Link to Disclaimer and Response Matrix
1	LI	E (Karst/Rock_near_surface)	None	LI/E	R2(2)	R3(1)	R2(1)	gsi
2	PI	E	None	PI/E	R2(2)	R3(1)	R2(1)	gsi
3	PI	E	None	PI/E	R2(2)	R3(1)	R2(1)	gsi
4	PI	E (Karst/Rock_near_surface)	None	PI/E	R2(2)	R3(1)	R2(1)	gsi

Tips for best response - particularly for those on a dial up connection

Access to the Groundwater Maps online can be slow at times, particularly if you are on a dial up connection. This is not a GIS system but only a web enabled map viewer. Each time you submit a request the data need to be retrieved from a web enabled server. This takes time, and more time if you are on a dial up connection. There are however a number of tips which can help you get the best results from the system.

- Zoom into areas of interest with the maps switched off (not visible) this will help speed the response.
- Be specific in your area of interest and try to zoom into it in the least number of stages. The less number of times you need to refresh or

redefine the map the better. Refreshing the map takes time as the program must retrieve the map data from the web accessible server.

- Don't hit the back button on your internet explorer when using the Map Viewer. If you want to go back to a previous view, use the previous extent button ( ).
- Resist the temptation to click on a command numerous times. Once is enough. Clicking a second time will only interrupt the progress of the first command and hang up the system. You just have to be patient and wait.
- If you get a message of "Response from previous request not received" this means that the passage of data has been interrupted. If this happens the quickest option is to close the system and start again. Sometimes if retrieving a map is taking too long, you can at times be better off to shut and open the system again and submit a less complicated request if possible (e.g. selecting a smaller area, making sure you switch off the maps (not visible). If you interrupt any command you are best advised to shut and open the system again.
- For those on a dial up connection the system is of most use if you have a specific query about a particular well defined area and can submit that request in the least number of stages.
- For those who wish to bypass the GSI homepage the direct address for the map viewer is:

http://193.178.1.182/website/gwps_multi/viewer.htm

- If you have difficulties accessing the maps or using the system, contact the Groundwater Section at ☎01 6782782.
- If you wish to print a colour copy of this article, go to the GSI website (www.gsi.ie).

The System is maintained on Friday mornings and will be inaccessible from 9am to 1pm on Fridays.

Final comments

The fact that these maps are now available online (and free of charge) is a huge step forward in making Groundwater data more widely available. The system is not perfect and unfortunately due to the large amounts of data involved, those on a dial up connection may find it frustratingly slow. However, it is possible, with a bit of practice and some trial and error, to successfully use the system.

Groundwater Maps are not the only GSI dataset available online. Other GSI data can be accessed through a similar though separate system via the GSI Web Mapping Project icon on the front page of the GSI website.

Una Leader, Geological Survey of Ireland

Seminar Announcement

National Hydrology Seminar, Tullamore, 16th November 2004

The topic of the 2004 Seminar is "Water Framework Directive – Monitoring and Modelling Issues for River Basin Management". For further information, contact John Martin, Office of Public Works, 17-19 Lower Hatch Street, Dublin 2.
E-mail: **john.martin@opw.ie**

Septic Tank Design and Installation: Observations and Recommendations

Tank manufacture, number of chambers, scum formation and percolation areas

The drawback of septic tanks is their apparent simplicity. Although simple in design, the appropriate selection and installation of tanks, as well of percolation areas, is critical if they are going to be effective in preventing surface and groundwater pollution. While there exist Codes of Practice in most countries, there is little information about how to ensure systems perform optimally. In practice there is little control or regulation of systems once planning consent has been given, with installation and maintenance rarely supervised by trained personnel. This leads to enormous potential for pollution.

Over the past two years a number of septic tank systems have been studied both during initial installation and subsequent use. This was a qualitative study with no data collected, just observations on the selection, installation, and subsequent performance of systems. A number of critical areas were identified: the design of tanks (i.e. jointed tanks, cracks and fractures in the concrete, the number of chambers, and tank capacity), operation (i.e. scum formation and use), and the percolation area (i.e. effective flooding and treatment). All these critical areas are discussed with recommendations on how the system may be improved.

No two sites are the same with tank design and installation having to be optimised for each household and location. The minimum legal requirement is frequently insufficient to prevent pollution. This two part discussion paper attempts to raise some of the problems affecting new septic tank systems and recommend some possible solutions.

Tank manufacture

Cast concrete septic tanks are often sold in two halves to facilitate installation. This allows each section to be lifted and safely installed by a JCB rather than a larger unit. The maximum weight lifted by a JCB is further limited due to the problem of having to work closer to the edge of deep excavations than other units. This often limits the size of tanks installed. However, even with careful grouting, or sealing with waterproof mastic, leaks normally occur at the joint between the tank sections. Manufactures acknowledge that some leakage is inevitable initially but insist that joints will eventually self-seal. In practice this can take a considerable time and a proportion of installed tanks never become watertight. Concrete tanks often have small cracks and fractures arising from manufacture, transport or installation. Such damage can also result in leakage. Another common source of leakage is around the hole made for the outlet.

It is recommended that:

(i) Jointed tanks should not be used if possible and that single cast tanks be installed. While this will result in a significant increase in the weight of installed units, a removable cover significantly reduces overall weight. Realistic site location of the septic tank should be an integral part of the initial design and subsequent construction of the building to facilitate adequate access for tank installation and future maintenance.

(ii) While the tank sides are still exposed within the excavated hole, and before connection to the house, the tank should be tested for leaks by filling with clean water up to the outlet and the level checked after twenty-four hours. Loss of water will require the tank walls to be examined for signs of leaks prior to the tank being pumped out into the percolation area via the distribution chamber, regrouted and then retested.

(iii) The T-piece outlet in septic tanks should, whenever possible, be installed at time of manufacture. Where this is not possible then the holes for the 110 mm outlet should be drilled rather then made using a hammer and chisel. This will provide a closer fit ensuring that the pipe can be effectively sealed. Sealing with waterproof mastic should be done from both sides of the concrete wall.

(iv) Once installed it is difficult to calculate either the volume of a tank or in some cases the number of chambers. Also, with the increasing need to regulate and control septic tank systems, tanks need to be accurately identified. Therefore it is recommended that tanks should carry details of size, number of chambers, manufacturer and a unique identification code. These should be embossed into the top of the tank at time of casting.

Minimum size

There has been an enormous per capita increase in grey water production over the past decade with domestic water usage continuing to increase. The nature of wastewater has also changed with greater amounts of detergents being used. Water use patterns vary significantly with no two installations the same. This has profound effects on sedimentation characteristics within tanks. While changing food preparation practices has lead to less kitchen-derived grey water this has been partially counter balanced by more waste being routed away from the solid waste disposal route to the water disposal route through the necessity of cleaning recyclable materials. This will have a significant affect on the overall organic and a solids concentration of grey water, as recycling becomes a more integrated part of household waste management.

It is recommended that:

(i) That the minimum permissible size of septic tanks be increased to 4,000 litres.

(ii) Septic tanks should not be permitted for domestic households of more than eight persons or those premises where catering or sleeping accommodation is supplied, including public houses, without the provision of secondary treatment other than a percolation area.

(iii) That septic tank systems should be available in three sizes only for domestic situations where used with percolation areas: 4000 litres for a up to a maximum of 4 persons, 5,000 litres for a maximum of 6 persons, and 6,000 litres for a maximum of 8 persons.

(iv) Systems serving a population equivalent in excess of 8 require full secondary treatment and more frequent desludging of the primary settlement chamber (e.g. septic tank). The disposal of the treated final effluent should be subject to greater environmental impact analysis.

Number of chambers

Traditionally septic tanks were only used for toilet wastes with all other waters going to a separate soakaway. Now with all used water being routed to the septic tank there is a problem with solids retention. The most important quality control parameter used in the management of septic tanks is suspended solids. Solids lost from tanks result in a rapid loss of percolation efficiency leading to percolation area failure. It is not only the problem of surge flows, but problems related to the frequency of high volume discharges, mixing within the tank, and also the more expanded nature of the sludge blanket which now rarely achieves Type IV settlement (i.e. compaction). This is due to the level of detergent-based products used and the nature of the solids (e.g. modern toilet papers, female sanitary hygiene products etc.). This results in a higher solids concentration in the final effluent as well as a greater chance for significant loss of settleable or floatable solids from the system. All tanks studied showed indications of the loss of large solids from the tank, mainly toilet paper.

Where jointed tanks are used the internal gap between the chambers, usually a narrow rectangular slit, may result in the primary chamber having a maximum containment volume of between 40-45% of the total capacity of the chamber. The hydraulics of this chamber becomes rather difficult to predict, but a greater loss of solids with poor settling characteristics appears greater than with other designs. In that sense, some tanks of this design may be more appropriately treated as single chambered units.

It is recommended that:

(i) That all septic tanks have a minimum of two chambers and that larger tanks have three in order to prevent loss of solids.

(ii) That separate solids traps or small screens are employed between the final chamber and the distribution box. Such intercepting traps will require regular maintenance.

Scum formation

There appears to be two significant changes in used water production that affects scum formation in domestic situations. One is the significant increase in the use of household detergents that results in increased buoyancy of material within the tank while causing greater dispersion of fats. The other is the reduced use of heavy cooking oils and fats that traditionally formed the scum. Scum formation from modern households is increasingly made up of faecal material and discarded sanitary products with grease and fats of less importance. With the greater use of lighter cooking oils scum formation can in some cases be very patchy and thin with floating plaques regularly collapsing resulting in little or no scum formation in the primary chamber; although a more normal scum layer often develops in subsequent chambers.

It is recommended that:

(i) In two chambered tanks the upper separating baffle must be of sufficient depth to prevent lower scum creep through the separating

orifice. Care must be taken not to reduce the effective sludge retention capacity of the primary tank or it's sedimentation characteristics.

(ii) New septic tanks should be filled with clean water before being used for the reception of wastewater. This protects the land drainage pipes, comprising the percolation area, from becoming blocked due to the loss of floatable material. For the same reason existing tanks should also be filled with water immediately after desludging.

(iii) The nature of the scum can encourage fly development resulting in localized nuisance and potential health risk. Tank vents should be covered with suitable netting to prevent egress of flies. Such vents will require periodic cleaning to ensure adequate venting of the tank. Unfortunately such vent covers are not commercially available in Ireland.

Percolation area

The original design of percolation areas, formally known as dispersion fields, was based solely on effective hydraulic dispersion-infiltration of the wastewater with little concern about groundwater quality. In more recent times an assumption has been made that percolation areas also provide aerobic treatment of the strong wastewater that is discharged from septic tanks. Observations of some percolation areas have shown that there is, not unexpectedly, biofilm development within the percolation trenches and the assumption has been made that biological treatment was occurring. However, in practice the degree of treatment is very variable and unpredictable with most treatment primarily physico-chemical and occurring within the soil below and adjacent to the percolation trenches. Shallow fixed film reactors are widely employed as a secondary treatment system, however, the construction of exiting percolation trenches to existing Codes of Practice do not fulfil the criteria for successful aerobic treatment. The most important factors are: frequent wetting to ensure adequate biofilm development and maintenance, sufficient wastewater-biofilm contact time, sufficient weight of active biofilm to ensure continuous treatment, and sufficient oxygen to maintain aerobic conditions. To this end percolation trenches should in theory be deeper, vented at the base as well as via the main distribution pipe to generate a flow a air through the fill material, and the flow of wastewater to the trench must be controlled to ensure more effective use of trenches and better wetting of the fill material. This increase in airflow will result in greater odour potential at the site.

It was remarkable how many new houses studied were built on land that had unsuitable percolation. Several of these sites became flooded during periods of continuous or heavy rainfall. Some flooded systems were discharging through banks into ditches. Many sites examined were causing surface water pollution, which became increasingly worse as the size of the stream became smaller. Sewage fungus growths, deposition of solids, odour and eutrophication were common in such situations.

It is recommended that:

(i) Percolation trenches should, where possible, be designed to encourage maximum biofilm development on the fill material (i.e. medium). This will require trenches to be deeper and vented near the base (see Fig.1).

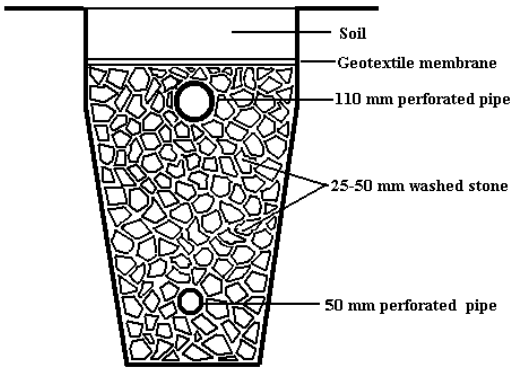


Fig. 1. Cross section through a distribution trench designed to achieve aerobic biological treatment.

(ii) Percolation tenches should be filled with good quality graded aggregate between 20-40 mm nominal grade. Smaller medium or excessively flat medium should not be used. A compromise is required between a larger grade giving good-sized interstices that will not become blocked due to biofilm development and solids discharged from the tank, but still having a reasonable surface area to maximize biofilm growth and hydraulic retention time.

(iii) Medium supplied for percolation areas is often poorly graded and not washed. Fill supplied as clean is not free of fines and can result in a reduction in porosity of the trench base due to blinding due to fine solids. It is very difficult to obtain high quality aggregate suitable for percolation

areas. Therefore a new quality standard for this type of material is required.

(iv) A major problem in trenches that are not affected by high water tables is that percolation is restricted to a very small length of the trench. This results in minimal potential treatment and wastewater being discharge largely as a point source reducing the chances of attenuation with the soil and leading to potential pollution. To be effective, as much of the percolation area should be used as possible. This also prolongs the life of the percolation area and ensures maximum treatment within the medium and maximum attenuation in the soil in which the trenches are laid. To achieve this an extra tank should be used as a dosing chamber so that large volumes of wastewater can be discharged at intervals to flood the entire trench network. Such dosing chambers can be discharged using a pump controlled by a timer or float switch, or more appropriately using a passive siphon discharge. The siphon can be designed to discharge any volume required. In this way the percolation area can be used more effectively Consideration should also be given to discharging surface water to this chamber, not the septic tank, where the system is servicing a holiday home in order to maintain the biota comprising the biofilm.

(v) Percolation pipes should only be used within the percolation trench. The connection between the distribution box and the trench should be via watertight pipes and ensuring that the connections between it and the distribution box and the percolation pipe are also watertight.

(vi) Percolation areas should not be within 100 m of a stream or ditch where water is present.

(vii) Sites of less than 0.75 acre should incorporate a secondary treatment step other than a percolation area.

(viii) Where sites are liable to flood and the surface water is able to reach a stream, then a septic tank system should not be used.

(ix) If land drainage is used to improve unsuitable sites then a septic tank with a percolation area should not be used.

(x) Raised percolation areas should not be employed without a prior secondary treatment step.

It should be emphasized that the points and recommendations raised here are meant to be foci for further discussion and research. Existing Codes of Practice are legally binding and must be adhered to. However, as stated at the outset, no two sites are the same with tank design and installation having to be optimised for each household and location. Strict adherence to Codes of Practice should be seen as the minimum acceptable level of compliance. In many cases minimum compliance is seen to be inadequate to protect surface and groundwaters, and prevent nuisance. Much more can be achieved by careful and thoughtful design and installation. In the second part of this discussion paper operation and maintenance are considered rather than design and installation. In particular desludging frequency is considered in relation to obtaining better sludge stabilization and reduction, maintenance is examined with householders taking more responsibility for their systems, and how use may be a factor in overall performance. (Comments and discussion to nfgray@tcd.ie)

N.F. Gray, Centre for the Environment, Department of Civil, Structural and Environmental Engineering, TCD.

Septic Tank Design and Installation: Observations and Recommendations:

Emptying v sludge reduction, maintenance, use and conclusions

This is the second part of a discussion paper arising from a two year qualitative study of new septic tank systems. In the first part design and installation were considered. In this part desludging frequency is examined in relation to obtaining better sludge stabilization and reduction, maintenance is examined with the proposal that householders should take more responsibility for their systems, and finally how wastewater generation may be a factor in overall performance. The discussion paper attempts to raise some of the problems affecting new septic tank systems and recommends some possible solutions.

Emptying v sludge reduction

It is important that septic tanks are emptied regularly. However, there are advantages to retaining the settled sludge for as long as possible. The rate of sludge accumulation in septic tanks undergoes a cyclic pattern. Accumulation occurs at a constant rate throughout the year although the net amount of sludge in the tank is affected by the short period of degredation that occurs during the summer as the temperature of the tank rises sufficiently for anaerobic activity to be optimized. So while the net amount of sludge increases each year there are periods when the sludge is being actively degraded and stabilized. Ideally tanks should be emptied after this period of stabilization (i.e. mid – late autumn) and if the design volume is large enough then the sludge should be retained for at least two years (i.e. two summers) but no more than four. Tanks designed using minimum volumes specific in Codes of Practice should be desludged annually, again if possible after the summer thus giving maximum settlement volume for the period where no reduction in volume is possible (i.e. winter and spring).

It is recommended that:

(i) Tanks should be designed to allow for a minimum of two years retention of solids.

(ii) Tanks are desludged after the maximum period of degradation (i.e. autumn) to ensure minimum sludge is produced and that it is as stabilized as possible. This also reduces the chance of solids being lost from the tank.

(iii) Tanks designed to minimum Code of Practice volumes should be desludged annually.

(iv) All tanks should be desludged after a maximum of four years regardless of volume or use.

Maintenance

The owner of a septic tank must take full responsibility for its operation and maintenance. This includes monitoring sludge and film development as well as ensuring it is emptied correctly and regularly. When a tank reaches either its maximum sludge or scum capacity then it must be emptied regardless of the time interval. Records of the design and installation, as well as the operation and management of the tank should be kept.

It is recommended that:

(i) That the desludging of septic tanks should be inspected by the owner to ensure that it is carried out correctly.

(ii) Due to the different nature of the scum on the surface of the first chamber, it should always be removed when tanks are desludged.

(iii) That the entire contents of the first chamber are removed and that a small volume from the second chamber floor be removed. Any scum in the second chamber should also be removed.

(iv) Tanks should not be allowed to refill slowly by incoming wastewater. Instead the tank should always be refilled with water before use. It is recommended that the tank be refilled via the second chamber inspection cover until both the inlet and outlet vertical pipes, as well as the chamber separating orifices, are well submerged.

(v) Sludge depth and scum thickness should be tested to ensure that capacity is sufficient for the production of solids from the household. Where this is not tested then tanks must be desludged annually. In some cases it may be necessary to desludge tanks more frequently than once a year.

(vi) Records should be kept including details of original design, scum and sludge levels

and deslugding. It may be necessary to provide proof in the future that your tank has been regularly desludged.

(vii) Tanks should not be covered with soil and the inspection cover should be available at all times. Vents should be kept clean.

(viii) Percolation pipes rising from the ends of percolation trenches should not be sealed, but protected to ensure adequate ventilation.

Use

There are certain products that should not be discharged to septic tanks. This is for three reasons. Firstly some substances can interfere with the process. Secondly, because treatment is incomplete in septic tanks, many potential pollutants will be discharged from the system intact or insufficiently degraded into the ground or surface water. Finally some materials rapidly increase scum or sludge formation effectively reducing the solids holding capacity of the tank.

It is now possible to purchase bacterial seed, usually in a freeze dried form, for septic tanks that optimise the anaerobic breakdown process in the primary chamber. These vary considerably in quality but are generally helpful, especially where sludge is retained for periods in excess of 12 months. They are not a substitute for desludging, proper maintenance or sensible use, and systems will work well without them. However, they can have a role to play when commissioning new systems or when the bacterial composition of the tank is damaged. It is unlikely that other additives are useful. Chemical degreasers should not be used in conjunction with septic tanks as this causes fats to be discharged into the percolation area.

It is recommended that:

(i) If excessive cooking oils or fats are being used then a grease trap must be fitted. The grease trap must be on a separate drainage line from the kitchen that is used for the disposal of fats and cool liquids only, so that other solids are not recovered within the trap. Chemical degreasers should not be used.

(ii) Substances that can interfere with the process and that should not be disposed of in the septic tank under any circumstances include: hydrocarbons and oils, paint, varnishes or solvents, liquid cleaners, waste detergents, strong alkaline or acidic liquids. Small amounts of detergents, bleach, household cleaners cause no problem but leftover material should not be disposed of via the sink. Buckets of floor washing compounds are best disposed of onto grass if at all possible. Intensive house cleaning which necessitates the use of cleaners should be carried out over a number of days to minimize the effect on the process. Bottles containing any of the above materials should be disposed of at a recycling centre during one of the nation-wide hazardous waste collections.

(iii) Detergent containers, especially shampoo bottles or dishwashing liquid bottles, should not be rinsed out down the sink unless all the material has all been used. Excessive use of bath foaming products should be avoided.

(iv) Pharmaceuticals (e.g. antibiotics and other medications) should not be disposed of via the toilet or drain nor should pesticides or other unwanted chemicals. They should be taken to one of the nation-wide hazardous waste collections.

(v) There is a problem with the disposal of certain female sanitary products. These do not always settle and can easily be carried through the tank and end up in the percolation pipe. While it is not possible or desirable to restrict their use, their disposal via the toilet should be minimized as much as possible. A separate solids trap can be placed between the tank and distribution box to capture these products. An alternative is to place a small screen either inside or before the distribution box. Such interception devices will need to be regularly (weekly) checked. Also it is important that neither the outlet or inlet down pipes have rough or jagged edges where these products can become caught. The outlet pipe should also be checked regularly to ensure that they are not causing a partial or full blockage.

(vi) It is undesirable to discharge anything to the tank that can be easily removed and disposed of separately. This includes food, tea leaves and coffee grinds. Such items significantly increase the solids loading to the tank and can be dealt with more sustainably by composting. For that reason garbage grinders should not be used with septic tanks unless desludging is carried out annually and the tank capacity is extended. Non-degradable items discharged to the tank should be minimized (e.g. soil, clay, etc.).

In conclusion

The increase in rural housing has led to a rapid expansion in the installation of septic tanks at a time when wastewater treatment is coming under increasing control and regulation. Existing tanks are largely undersized, poorly installed and inadequately maintained. The size of new houses is rapidly increasing, as is per capita water usage. The majority of septic tank systems that were installed at new houses during this study were found to be inadequate in some way. Many were on sites where there was little or no percolation. A frequent solution was to raise the percolation area and allow the surface water and drainage from the percolation area into a boundary ditch. Several sites that were covered with reeds and waterlogged in the summer and that were actually under water during the winter, still received planning consent. Section 104 interventions were often sought and obtained for such sites. Once obtained, conditions were frequently very relaxed whereas they should have been exceptionally strict to protect the environment.

Surface and groundwater contamination from individual and clusters of new houses was not uncommon. A frequent problem was that sites were often physically too small for proper tank and percolation area location. The minimum distances stated in Codes of Practice are generally unhelpful as they are frequently inadequate for problem sites. For example, in practice it would seem that percolation areas must be at least 100 m from streams if a discernible impact is to be avoided. The smaller the stream the less dilution will be available and so the greater this distance should be. Local authorities often allow subsequent development around one-off housing, but fail to centralize and treat the wastewater. Septic tank treatment with percolation areas should not be allowed in new clustered developments and may in fact be illegal under the Urban Waste Water Treatment Directive. There is an urgent need to adhere to County Development Plans in regard to housing development to ensure safe disposal of wastewater.

When people install a septic tank they take on a responsibility to treat their own wastes in such a way as to protect the environment, protect public health and not cause a public nuisance. Unfortunately this responsibility is not always taken seriously, with the attitude of 'out of sight out of mind' very much the case. None of the families studied were prepared to make any concessions to the way they lived in order to facilitate the septic tank system. All had totally unrealistic expectations as to what the system could and would do. Nearly all the tanks studied were buried within a month of installation. Many were subsequently landscaped making access difficult. In these cases subsequent monitoring or desludging will be a major undertaking resulting in considerable disruption. It would seem that in many cases there was no intention of maintenance of the newly installed septic tank system or realization that any attention was necessary. Therefore, it is inevitable that the installation of suitable septic tank systems will have to be more closely monitored and their operation and maintenance more closely regulated.

While the septic tank system is a low energy process its sustainability has to be questioned on the basis of its poor treatment capability. Another problem relating to sustainability is the need to remove the settled sludge from the site for treatment elsewhere. There are many other disposal and co-disposal options for septic tank sludges that could be considered which would make the system more sustainable. However, with better design, installation and use, they can be made more effective. This coupled with better regulation and inspection will ensure better ground and surface water protection for the future.
(Comments and discussion to nfgray@tcd.ie)

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Groundwater Vulnerability: Does the Unsaturated Zone Have an Influence?

It was interesting to read in recent editions of the groundwater newsletter that despite the on-going emphasis placed on "exotic" synthetic contaminants in recent legislation, water pollution from perhaps one of the oldest forms of pollution, i.e. pathogenic micro organisms, remains a problem in Ireland. Indeed, it is somewhat paradoxical that these pollutants have been causing problems for such a long period and yet they often loose their capacity to cause infection in a matter of weeks. Nonetheless, the realization that aquifers have variable degrees of vulnerability to such contaminants is a recent concept. The factors that influence vulnerability are numerous, but there is a general consensus that geological and hydrogeological factors, including the texture, geochemistry and water content of the various units encountered by a contaminant along a flow path play an important role. Moreover, the spatial variation in these properties can be critical in determining whether contaminant breakthrough to a water supply will occur.

Despite recognising the importance of the hydrogeological properties of aquifers and protective layers, vulnerability studies to date have largely been phenomenological, in that they have described existing contamination and its association with geological conditions and formations. These studies have nonetheless recognized the importance of the texture, geochemistry and water content of deposits for attenuation.

An alternative approach to investigating groundwater vulnerability involves simulating contamination by injecting a contaminant, or more commonly a surrogate, under controlled conditions. The higher degree of control associated with these experimental methods has the advantage of permitting the influence of particular transport and attenuation processes to be more confidently identified. By injecting one or more easily identifiable tracers that mimic the behaviour of particular contaminants and monitoring their concentration in groundwater at selected observation points, we can begin to more confidently quantify attenuative processes.

These comparative tracer study methods have recently been applied by the Hydrogeology Centre of the University of Neuchâtel to investigate mass transport and microbiological attenuation at a test site in the Canton of Solothurn in Western Switzerland. The site has geological conditions comparable to those that may be encountered in some parts of Ireland, namely former glaciated terrain with a thin layer of peaty soil (10-20 cm) overlying a thick sequence of lightly karstified unsaturated limestone. The Solothurn Test Site has the benefit of having a recently excavated tunnel approximately 10 metres below ground surface which provides a useful means of accessing the subsurface to collect samples of water that have flowed through the overlying deposits.

A series of comparative tracer experiments carried out at the test site involved injecting a cocktail of different solute and particle tracers, including microbiological tracers onto the ground surface followed by irrigation at rates comparable to a moderate to heavy rainfall (10-15mm/hour). By collecting samples in the tunnel at regular intervals, and analysing their content for the various tracers used, tracer responses could be plotted with time to produce breakthrough curves. Comparison of breakthrough curves for selected tracers with those of the conservative solute tracer (chloride in this case) permitted the transport and attenuation processes that occurred in the unsaturated zone during the experiments to be evaluated.

The figure below presents the breakthrough curve for the bacterial tracer Ralstonia (1μm x μm), with those of two much smaller viral tracers, T7 (17nm x 60nm) and H40/1, (39nm x 82nm). The response of the conservative chloride tracer is presented for comparison. Examination of the curves reveals that all tracers arrived at the monitoring point in a very rapid, yet consistent manner. Just over 10 minutes after injection, the tracers could first be seen at the observation point, after which time levels rose to a maximum at between 25 and 50 minutes after injection for the microbiological tracers, and at 65 minutes for the chloride. In fact the response of the chloride differs significantly from the biological tracers in that it has a more prolonged breakthrough curve response with a lower maximum concentration than some of the biological particles. Furthermore, examination of the amounts of each tracer recovered shows that the biological tracers have variable responses demonstrating that they had the opportunity to interact with the soil and/or limestone and undergo attenuation. Perhaps most interesting of all

however, was the fact that over the duration of the test, more bacterial tracer and H40/1 viral tracer were recovered than chloride, even though chloride is frequently considered to behave conservatively in groundwater. Clearly the various tracers are influenced by the diverse attenuative processes to different degrees.

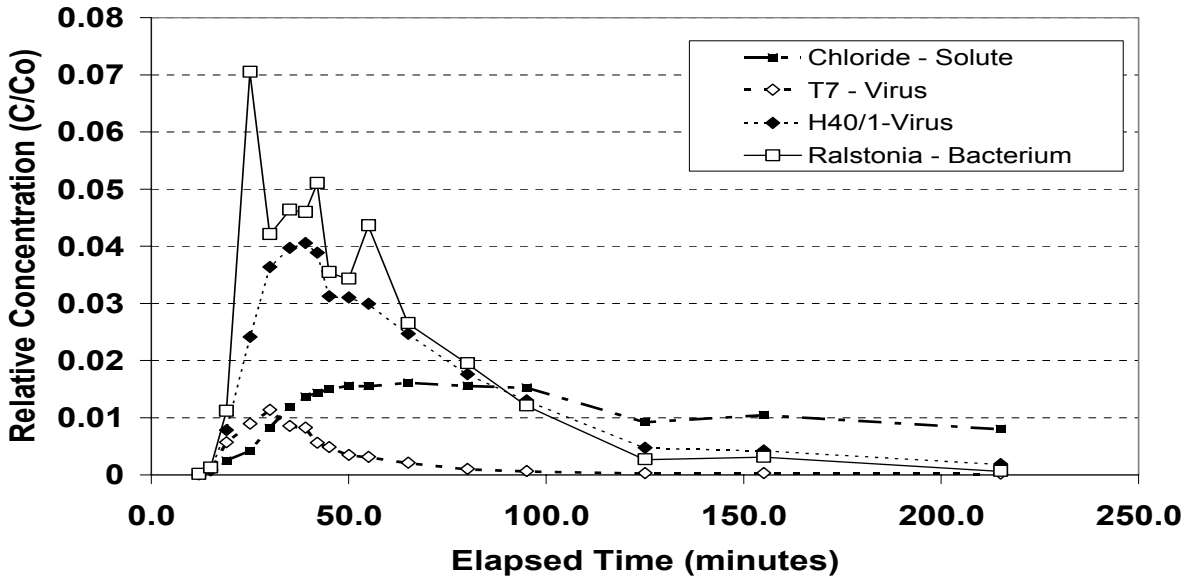

Figure: Solute and micro-organism tracer breakthrough curves generated from data collected at the Solothurn Test Site, Western Switzerland

Overall the results of these experiments demonstrated a number of important points relevant to groundwater vulnerability assessment:

- Water can travel very rapidly through the unsaturated zone, particularly in fractured limestone, even where no signs of karstification are apparent.
- Solutes and particular tracers (including micro-organisms) can behave differently when being transported through the unsaturated zone. Indeed, micro-organisms may arrive at the water table in high concentrations more quickly than solutes. Consequently, solute tracer responses may not necessarily be indicative of those of micro-organisms.
- Although micro organisms may interact with the materials overlying the water table during transport, they will not necessarily be highly attenuated.

The tracer responses observed at the Solothurn Test Site raise a number of important questions concerning our perception of the role of the unsaturated zone in protecting groundwater from contamination. Further studies will be carried out in the forthcoming months to examine the effects of attenuation in unsaturated granular deposits. We'll be sure to let readers of the Groundwater Newsletter know how we get on once the work is completed.

Raymond Flynn & Michael Sinreich, Hydrogeology Centre, University of Neuchâtel, Switzerland.

Do We Need Contaminated Land Legislation After All?!

For many years now professionals in the area of groundwater protection and brownfield sites had thought that specific legislation dealing with contaminated land management would be a good thing. When in fact it was perhaps under our nose all the time!

There are generally five ways that contaminated land gets remediated or managed:

- The land is part of Waste or IPPC regulated facility;
- The land is part of a redevelopment project;
- The land is the subject of a human or animal health issue;
- The land is contributing to a local water quality issue;
- The land is cleaned up as a result of responsible corporate action.

Regulatory authorities are well aware of the facility under the Waste Management Acts 1996 to 2003 to regulate land remediation projects. However this regulatory access to the management of contaminated land has up to now only been possible there was some Recover or Disposal activity on the site in question which was connected to a remediation project.

A recent judgement of the European Court of Justice (Case C-1/03) in relation to a case involving hydrocarbon contamination of ground under a petrol station may result in a profound change to how contaminated land is managed in Ireland.

The Case reached a number of significant conclusions:

1. That hydrocarbons accidentally spilt on or into ground are waste.
2. That the materials which become contaminated by this spilt material are waste.
3. That the holder of the waste is required to Recover or Dispose the spilt or contaminated material in accordance with the Waste Framework Directive.
4. That the suppliers of the hydrocarbons may be liable to costs of clean-up unless they can show negligence on the part of the holder (this was a unique aspect of the case and turns on the formal ties between petrol suppliers and franchise holders).
5. That the contaminate material did not have to be disturbed to become a waste. [This is a significant deviation from the previously operated regulatory position.]

The Court took the view that the fuels spilt (and soil contaminate by it) have been discarded and cannot be further used without some special measures to recover or dispose it.

Although the case considers hydrocarbons the judgement can be easily extended to include all contaminated land. Furthermore, any plume from contaminated land would also be classified as waste.

The classification of contaminated land as Waste within the meaning of the Waste Framework Directive will have a number of significant implications. Some examples are:

1. If I want to sell on my contaminated land, I am, it is suggested, in effect transferring waste. Therefore I cannot transfer it to anyone other than an appropriate person (as defined by the Waste Management Acts 1996 to < 2003 - someone authorised or exempt). A conveyancing nightmare.
2. If I am the owner/occupier of a contaminated site am I then subject to Section 32 of the Waste Management Acts. (viz, A person shall not hold, transport, recover or dispose of waste in a manner that causes or is likely to cause environmental pollution).
3. Section 32(3) requires the holders of waste to immediately notify the Local Authority (LA) where any loss, spillage, accident or other development concerning waste which causes or is likely to cause environmental pollution. All owners/occupiers of

contaminated land might therefore have to 'fess-up' to the LA.

4. Local Authorities may have to issue Section 55 notices on all contaminated sites requiring the management (recovery or disposal) of the waste. Consequential recovery or disposal activities will require authorisation by Permit or Licence as necessary.
5. Local Authority as well as State owned contaminated lands (e.g. Avoca, former landfill sites, .. etc.,) may also be subject to these provisions.

Bob Kalin, in a recent short exchange on this new judgement, also noted a significant point to do with remediated sites. If contaminated land is classified as waste and these lands are subject to successful remediation/reclamation there should be a point where the formally contaminated material can be declassified as waste. This would be an essential point in relieving land owners/occupiers of liability under the waste legislation. No standards currently exist to aid such a decision. The construction materials sector could certainly benefit from such. For certain cases the inert waste criteria in Council Decision 2003/33/EC (on waste acceptance criteria) might be considered in the absence of an alternative. In the case of reuse of wastes in construction the recent CEN Standards for Aggregates open the door for use of secondary materials.
The competent authorities in the first instance would likely be the Local Authorities, unless they are the holder, or if the waste is considered hazardous: in which case the EPA will be the competent authority.

These are just a quick range of thoughts. The judgement is new, and the implications have not yet been digested by national governments or regulatory authorities. I can see considerable difficulties with the retrospective implications of the judgement. See the full judgement at the following address:
http://www.curia.eu.int/jurisp/cgi-bin/form.pl?lang=en&Submit=Submit&docrequ

Jonathan Derham, Environment Protection Agency
(Note: The opinions expressed herein are my own and may not necessarily reflect those of my employer.)

The Environmental Liability Directive 2004/35/CE

The main objective of this Directive is to establish a common framework for the prevention and remedying of 'environmental damage' by applying the Polluter Pays Principle. The concept of 'environmental damage' covers damage to protected species and habitats (i.e. any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats and species) as well as damage to water[1] (significantly adversely affecting the ecological, chemical and/or quantitative status or ecological potential) or land (any contamination that creates a significant risk of human health being adversely affected).

The Directive requires 'operators' of 'occupational activities' to inform the competent authorities in the Member State concerned of the occurrence of 'environmental damage' caused by their operations and to take, at their expense, 'all practical steps' to control, contain, remove or otherwise manage

[1] Water: as defined in the Water Framework Directive 2000/60/EC

the contaminants and damage factors, and to take the necessary remedial measures. The Directive does not apply to emissions, events or incidents that take place before the implementation deadline in 2007, or which are derived from a specific activity predating that date, nor does not apply if more than 30 years have passed since the emission, event or incident occurred that gave rise to the damage. Significantly Article 5 sets obligations to implement preventative action in cases of imminent threat of environmental damage.

The Directive is only concerned with environmental damage. It does not apply to cases of personal injury, damage to private property or to any economic loss. It applies to operators of regulated activities (as defined in Annex III of the Directive, e.g. waste & IPPC facilities, installations discharging dangerous substances to surface/groundwater, GMO contained use) where environmental damage is caused/being caused.

Annex II of the Directive provides a "framework" to be followed in order to identify the most appropriate remedial action. Of note are the different and more conservative requirements for water compared to soil damage:

– In the case of **damage to water**, protected species or natural habitats, the environment must be restored to its "baseline condition", *i.e.,* the condition that would have existed had the environmental damage not occurred, estimated on the basis of the best information available. However, in certain circumstances, the authorities may decide during the remedial process that no further remedial action must be taken if (a) the action already undertaken removed any significant risk of adversely affecting human health, water or protected species and natural habitats and (b) the cost of further action to reach the baseline condition would be disproportionate to the environmental benefits obtained.

– In the case of **land damage**, at a minimum, the contaminants must he removed or contained *"so that the contaminated land, taking account of its current use or approved future use at the time of the damage, no longer poses any significant risk of adversely affecting human health".*

The competent authority must require the operator to take the remedial actions. If the operator fails to comply, cannot be identified or is not required to bear the costs under the Directive, the Member State authority may take these measures itself, as a means of last resort.

The Environmental Liability Directive, when implemented in the EU's 25 Member States by 2007, may be expected to have significant impact on the environmental liability scene in EU. The Directive establishes a positive duty on operators to take preventive and/or remedial action and requires them to bear the costs of cleanup. The Directive (Article 12) grants private citizens and environmental groups standing to bring matters to the attention of the enforcement authorities or the courts.

Commentary from the Department of Environment notes the Directive will be transposed by the date specified in Article 19(1), that being 30 April 2007. There is no decision on the body that will be the competent authority as required by Article 11, but the competent authority will have powers to determine the remedial measures required for remedying of damage to water and/or land.

Malcolm Doak & Jonathan Derham, EPA

International Conference on Groundwater in Fractured Rocks
International Association of Hydrogeologists
Prague, 15-19 September 2003

Joint Convenors:

- IAH Commission on Hardrock Hydrogeology
- IAH Czech National Committee
- Charles University Prague
- Czech Association of Hydrogeologists

The well-organised conference comprised two Plenary sessions, three days of parallel sessions, one poster session, and a choice of three half-day field trips (mine, to visit the Bohemian Karst).

All presentations (oral or poster) were compiled as extended abstracts (mostly 2 pages) in a well-produced A4 volume of proceedings. Authors also had the option of extending their papers to 4 pages for the CD volume of proceedings which all attendees also received.

Sessions were generally well organised and presented and timekeeping (maintained by technicians armed with bleeping timers) generally very good.

I attended the conference as a member of the Scientific Committee and made a presentation on 'Experience of fractured aquifers in Ireland'. Conference attendees amounted to about 220, from over 40 countries.

Besides seven invited keynote lectures, talks & posters were organised in six themes:

- Hydrogeologic environment of fractured rocks (51 abstracts)
- Groundwater flow and resources in fractured rocks (32 abstracts)
- Chemical, physical and isotope properties of groundwater in fractured rocks (22 abstracts)
- Investigation and interpretation methods in fractured environment (38 abstracts)
- Anthropogenic impacts on fractured environment (40 abstracts)
- Numerical modelling of fractured environment (16 abstracts)
- A total of about 200 abstracts were presented, from around 50 countries, over half being European. Some papers stuck strictly to fractured media, others included karst media and/or dual porosity media.

The field trip comprised just two stops: a show cave (Koneprusy Cave) and a large karst spring complex somewhat obscured by a large church built over parts of it. However, the cave itself was interesting in representing an unusual type of karst with virtually no surface features (eg sinkholes, dolines, etc.). This led to a fair amount of (unresolved) discussion about the genesis of the cave. The spring site also displayed a massive (>17m high) tufa mound, now partially removed. We also good views of the landscape and several large quarries in the Silurian-Devonian limestones.

I also attended a meeting of the IAH Commission on Hardrock Hydrogeology (very much an information session on recent regional workshops and further upcoming workshops up to 2005), and another on 'Groundwater Protection Zones in Fractured Aquifers'.

As a summary of the key points of relevance to GSI and Irish hydrogeology, I noted the following:

- A notable gap between academic studies, which tend to be small scale and data-intensive, and the type of regional or national-scale studies, or data-poor local studies, which we (and other national agencies, and many consultants) are engaged in. This gap really needs to be bridged.
- A contrast between resource-oriented work, often with locally important or major aquifers, which is often poorly funded, and pollution-oriented work, generally in poor aquifers/aquitards, which is often well-funded.
- Variations in modelling approaches – e.g. EPM approaches (MODFLOW, etc.) or strictly fractured medium approaches – including stochastic, fractal, etc.
- Contrasting views about the applicability of k and T values, and what they mean.
- Chemical versus Hydrological approaches, e.g. in recharge assessments.
- Isotopes and dating – varying views on how to interpret the results.
- Contrasts between theoretical and field studies. Sometimes there seemed to be little contact between the two!

Prague was a very interesting venue, the weather was glorious for late September, and the city has recovered remarkably from the disastrous floods of August 2002. Altogether, an excellent week!

Note: The fact that the last Groundwater Newsletter was produced in December2003 meant that this article is much delayed in its publication. The next IAH Congress is in Mexico from October 11th-15th 2004.

Geoff Wright, Geological Survey of Ireland

IAH NEWS

Consultants Student Bursary Fund

The IAH (Irish Group) for many years has provided a small financial assistance to students involved in post graduate research, or with a place on a one year MSc course. The idea behind small student bursaries was to help defray some of the costs of fees or living expenses and encourage people to get higher qualifications in groundwater. The amount of assistance has always been dependent on the financial state of the Irish Group, and the number of applicant candidates. This year there were five applications, but the amount of money that could be prudently released by the Irish Group was limited. Roughly €500 would have been available for each candidate.

The IAH Committee is pleased to acknowledge that the following Consultants were contacted and, at short notice, each have agreed to provide a further €500 for an ad hoc Consultants Student Bursary Fund, in order to provide slightly more significant financial assistance to each student this year:
Minerex Environmental, White Young Green, David Ball, RPS Group, URS Ireland, O'Neill Groundwater Engineering, TES Consulting Engineers, Komex Environmental, Fehily Timoney, O'Callaghan Moran and Geotechnical and Environmental Services.

The IAH (Irish Group) Committee will discus the consultants' initiative, and with them, decide whether a Consultants Student Bursary Fund will be set up on a more formal basis for the future.

David Ball, President, IAH (Irish Group)

CONTRIBUTIONS FOR THE NEXT ISSUE OF THE NEWSLETTER

Contributions for the next issue should arrive before 19th November 2004 to:

The Editor, GSI Groundwater Newsletter,
Geological Survey of Ireland, Beggars Bush,
Haddington Road, Dublin 4.

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