Minnesota Ground Water Association

Volume 10, Number 2: June, 1991

President's Page

Registration - Necessary Evil?, Bureaucratic Nightmare?, Assurance of Quality?, or All/None of the Above?

Once again, the professional registration/certification of geoscientists in Minnesota is becoming an issue for discussion, planning, and action (?). Geoscientists as a group have been somewhat indifferent to registration/certification/definition perhaps because geoscientists are a group with widely varying interests, education, areas of specialization, careers, and motivations.

Registration/certification appears to be necessary as the earth sciences become more visible to the public and geoscience becomes a larger part of policy and decision making. For example, there have been recent proposals that individuals preparing Remedial Investigation/Feasability Study (RI/FS) reports be registered *engineers*. The manufacturing and business sectors have requested help in defining, identifying, and regulating individuals, consultants, companies, etc. who are qualified to undertake various aspects of environmental/geologic/hydrogeolo gic investigations.

There have been past discussions about the need to do something about this issue, and it now appears to be time for members of the geoscience community to either take action and participate, or allow their fate to be decided by "others". Those others may be legislators, regulators, attorneys, engineers, geoscientists, or any "spokesperson" deciding they want to play a role. To make sure you are represented in this process you must represent yourself and make sure your voice is heard and opinions represented.

Currently 13 states have registration of geoscientists with a formal test as part of the registration process. One state specifically registers hydrogeologists/ground water professionals, two have certification requirements (no exam), four have language presenting a definition of a geologist, and two have defining language for a hydrogeology/ground water professional. Additionally, eight states have pending bills or regulations regarding registration, changes to existing rules, or further defining requirements and terminology. Some states define environmental consultants and contractors, others address strictly geologist/hydrogeologist issues. Minnesota will be addressing these issues in the very near future.

I urge you to watch for notification on meetings, planning sessions, etc., on this issue.

As a practicing geoscientist I have my own views on these issues and intend to make my opinions/ideas heard and I intend to participate in the development of registration/certification in whatever ways are appropriate and possible. If your views differ from mine, and I'm sure they do, that's all the more reason to make sure your viewpoint is presented. I present the following ideas as food for thought, motivation, and discussion.

Generally, I am not in favor of registration as I feel it does not, simply by its existence, provide a valid indicator and certainly not a guarantee that the individual is competent or ethical. Also there is the issue of initiating the procedure and creating a regulatory framework to manage and run the system.

However, I am somewhat resigned to the fact that registration/certification is going to happen and I do have some views on what criteria and procedures should be. Some of the basic factors that I feel should be included are;

- The process should be one of registration with a formal exam as part of the registration process. This should include review of education, experience, and letters of recommendation;
- Registration should be of geologists with sub-specialties addressed and accommodated in part of the exam;
- Grandfathering would be permitted only for individuals currently registered in another state that has similar requirements including testing;
- Experience requirements could be met by straight years of employment or a combination of education and employment up to some maximum allowance for education.

Finally, an issue not part of the registration process *per se*, but an issue related to regulatory review and approval. If rules dictate that a report, analysis, or other action be

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Near-Surface Geophysics: A Tool for the Hydrogeologist

Introduction

Near-surface geophysics can be used to determine many things from the location of buried trash to the subsurface geologic conditions. Surveys are conducted to find buried metal and tanks, ground water contamination and plumes, the bedrock subcrop (elevation and lithology), and sink holes and voids and to investigate stratigraphy (both glacial and bedrock).

Both environmental investigations and engineering projects begin with an assessment of the conditions at the work site. Near surface geophysics can be very valuable during this initial assessment phase. The first priority on an environmental site is to find out what is on the site and where it is located. Without this information, a cleanup plan can't be made.

Site assessment is also the first phase of an engineering survey. The geotechnical parameters, such as the soil conditions, depth to bedrock, and depth to ground water need to be determined prior to the design phase.

Near surface geophysics is one of the quickest and least expensive options for site assessment. Its noninvasive character helps prevent the spread of contamination and keeps the cost low. It produces accurate results without digging or drilling.

There are many types of near surface geophysical surveys. Some of the most common surveys include seismic refraction and reflection, electromagnetic (EM), resistivity, and ground penetrating radar (GPR). This report will discuss the seismic refraction and reflection techniques. Other techniques will be discussed in a future article.

Seismic Refraction Primer

The seismic refraction technique measures changes in the velocity of geologic materials with depth. This method assumes that

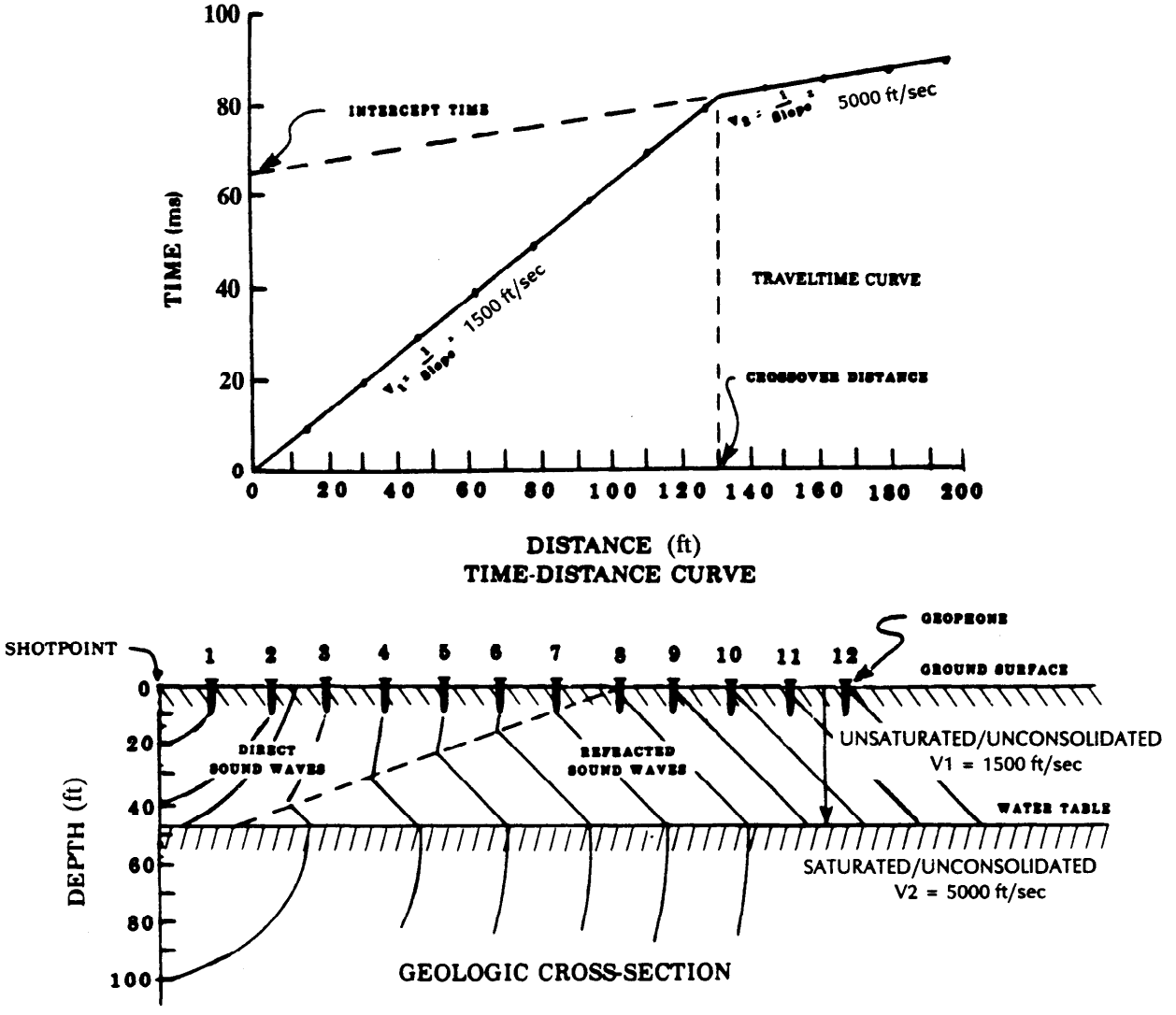

Figure 1: Diagrammatic geologic cross-section and resulting time distance curve using the seismic refraction method. (Modified from Haeni, 1986.)

the earth consists of a series of layers, and that deeper layers have a higher velocity than shallower layers. Resolution is limited to three or four velocity layers. Small velocity changes either vertically or laterally are not distinguishable.

Applied to common engineering and environmental problems, seismic refraction surveys will typically resolve three layers: the unsaturated/unconsolidated zone above the water table, the saturated/unconsolidated zone below the water table, and the top of bedrock. The thickness of the first two zones and the seismic velocity of all three zones can be determined.

Seismic surveys require an acoustic (sound) wave source, a line of geophone sensors, and a seismograph to record the data. A sound wave is input at the shot point: usually with a sledge hammer, or larger weight drop, pipe gun, or explosive. This sound wave propagates from the shot point to the line of geophones.

The seismic refraction method is based on Snell's Law, which describes the bending of a ray path across an interface where the wave propagation velocity changes. If a seismic wave travels into a layer of higher sound velocity, the ray path will be bent away from the normal (an imaginary line at 90° to the interface). At some critical angle, the ray path will be bent 90° from the normal and will travel along the interface as a head wave or refraction wave (see Figure 1). These refraction waves will be produced at all geologic boundaries where the seismic velocity of the lower layer is significantly larger than the layer immediately above it. The head wave continually leaks energy back to the surface, these refracted sound waves are then observed by the geophones.

The seismic refraction method uses only the first arrivals (the first seismic energy to reach the geophones). First arrivals are formed by the direct wave and by refracted head waves (see Figure 1). The direct wave is the first arrival for the geophones nearest the source. Refracted arrivals form the first arrival for geophones farther out. On Figure 1, the direct arrival is the first arrival for geophones 1 through 7 and the refracted arrival from the water table is the first arrival for geophones 8 through 12.

When the first arrival data are plotted as arrival time versus geophone-source distance, the first arrivals lie along a line for each geologic layer; the slope of the line will decrease with each deeper layer.

The inverse slope of these lines is equal to the velocity of the geologic medium where the wave is propagating. For example, for geophones 1-7, the inverse slope of the first arrival times is equal to the velocity in the unsaturated zone, and the inverse slope of the first arrival times for geophones 8-12 is equal to the velocity of the saturated zone. If the geophone spread is long enough, any deeper layers, that have a higher velocity, will show up. For example, an arrival from the bedrock would be the first arrival for geophones at some larger distance beyond geophone 12. While there is no theoretical limit to the number of layers visible with seismic refraction, the practical limit is three or four layers.

Seismic velocity values provide good information on lithology and water saturation. Typical seismic velocities are given in Table 1. Unconsolidated sediments have velocities ranging from 1000 to 8000 ft/sec. If they are saturated with water, their velocity will be at least 5000 ft/sec. Bedrock typically has higher velocities than unconsolidated sediments. Sandstone velocities range from 4600 to 14200 ft/sec, limestone velocities range from 5600 to 20000 ft/sec and igneous/metamorphic rocks have velocities which typically range from 15000 to 28000 ft/sec. Velocities also vary considerably with porosity, fracturing and percent saturation, but these are good general guidelines.

Many parts of Minnesota are ideal for investigations using seismic refraction. Most of the state has a blanket of glacial material overlying igneous/metamorphic bedrock. This produces a very high velocity contrast and makes the determination of depth to bedrock relatively easy.

Table 1: Ranges for seismic velocities in various geologic materials.

Geologic Material	Range of Seismic Velocities (ft/sec)
Unconsolidated Sediments	1000 - 8000
Sandstones	4600 - 14200
Limestones	5600 - 20000
Igneous/metamorphic	15000 to 28000

Table 2: Comparison of seismic reflection and refraction.

Seismic Reflection	Seismic Refraction
Deeper penetration	Shallow penetration
Better resolution	Maximum resolution 3 or 4 layers
Allows horizontal changes	Assume layers horizontally consistent (only vertical changes)

Although much of Minnesota has a relatively flat topographic surface, there is often a very irregular bedrock surface underlying glacial deposits. The irregular thickness of the glacial blanket is not always easy to determine from surface observations alone. Thus geophysical information can be very useful. Some of the common geologic problems which can be solved with seismic refraction are the location of buried valleys (common in southeast Minnesota), the delineation of granite knobs (in central Minnesota) and the depth to the water table in unconsolidated sediments.

By defining aquifer boundaries, such as the depth to the water table and to bedrock, this method is very useful to the hydrogeologist.

Seismic Reflection Primer

The seismic reflection technique also measures changes in the velocity of geologic materials with depth. Data are collected in a similar manner to seismic refraction, in fact they can be collected at the same time. Seismic reflection surveys for typical engineering or environmental site investigations usually use 12 to 24 geophones, the larger the number the better.

The major difference between reflection and refraction is that reflection uses the entire seismic waveform. This waveform (which is a plot of ground motion as a function of time) is plotted as a trace for each geophone, and each geophone trace is plotted relative to its absolute surface location. This gives a distance versus time plot (similar to the refraction plot) which can be interpreted for depth. The seismic refraction technique uses only the first arrivals from this plot. Another major difference is that the geophones are spaced more closely (10'-15') for reflection than for refraction (10' to 30'). Because of these differences, seismic reflection has a deeper penetration and better resolution than seismic refraction. Table 2 summarizes these differences.

The data is processed to focus on the reflected wave paths (Figure 2). Sound waves will reflect off any interface with an impedance contrast, that is, a change in velocity or density. Because of this, the seismic reflection method is not limited to areas where the velocity increases with depth, as is refraction.

Seismic reflection is a very good tool for stratigraphic studies. Intraglacial stratigraphy, which is not definable through refraction, because velocity does not increase with depth, is possible with seismic reflection. The bedrock stratigraphy of southeast Minnesota is also much easier to resolve with reflection.

Defining the intraglacial stratigraphy of Minnesota is very useful from a number of perspectives. It is very helpful in defining the water resources in confined drift aquifers in western Minnesota. It is very useful in mineral exploration. It is also potentially very useful in Quaternary mapping.

Seismic reflection will help better define the bedrock stratigraphy of southeast Minnesota, by extrapolating information on bedrock strata beyond wells and outcrops. It will be possible to map the edges of confining beds and aquifers. This will improve the boundary conditions for ground water models and studies. It is a good technique to better image the hidden subsurface geology.

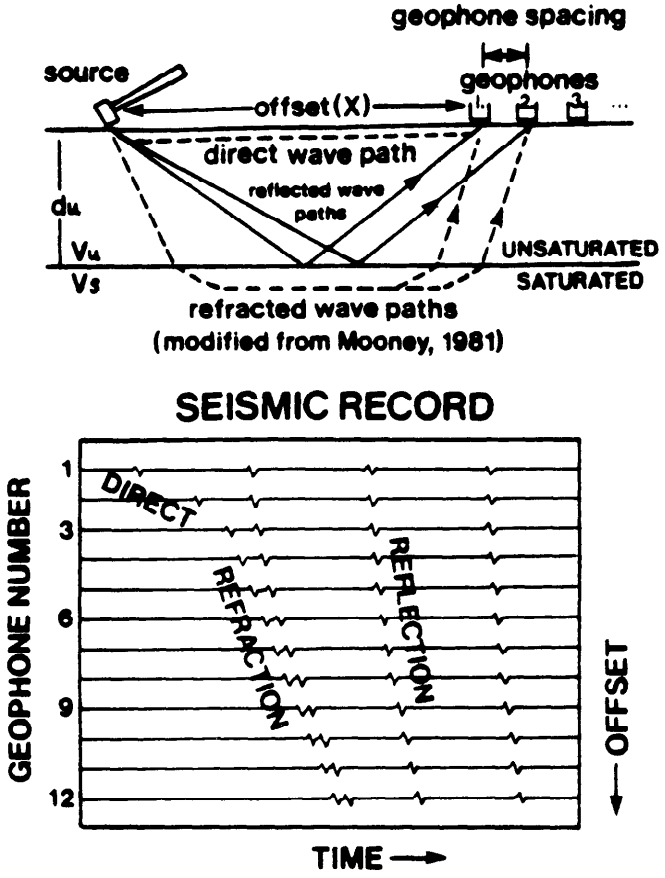

Figure 2: Idealized cross section of direct, refracted and reflected wave paths from seismic source to geophones and idealized seismic record. (Modified from Mooney, 1981.)

Equipment needed

Seismic studies require an engineering seismograph, marine batteries for power, a set of 12 or 24

geophones, and cables to connect them, a seismic source (such as a sledge hammer or dynamite), and a computer (to download data from the seismograph and to process the data). This equipment is relatively expensive, especially for seismic reflection work, which requires more complex switching equipment and a seismograph capable of finer resolution.

Data reduction

Data reduction for seismic refraction is typically done by computer program. The programs available vary in their assumptions from those that assume all layers are planer, to more complex ones, that allow for the natural rugosity or "bumpiness" of geologic interfaces. Seismic reflection processing requires an even more complex computer program, which includes the capability of time signal analysis.

As with any specialized field, it is imperative to hire staff people who are well acquainted with the seismic technique to do the field work and to process the data. If staff and equipment are not available it would be prudent to subcontract this work to a specialist, who can get good results for a reasonable cost in both time and money.

—Todd Petersen, Minnesota Department of Natural Resources, Division of Waters

Minnesota DNR Geophysical Capabilities

The Minnesota DNR has three geophysicists on staff in the geophysics group. The primary responsibility for the group is to conduct various geophysical surveys to support water resource investigations by State and Federal Governmental Agencies. The group also does research in the application of the seismic reflection technique in glacial terrain for aquifer definition, mineral potential, and Quaternary mapping. A secondary responsibility is to review geophysical reports submitted to the State of Minnesota.

Further reading on the topic of geophysical methods.

Dobrin, M. B., and others, 1988, Introduction to Geophysical Prospecting, Fourth edition, McGraw-Hill, Inc., 867 p.

Haeni, F. P., 1986, Application of Seismic Refraction Methods in Groundwater Modeling Studies in New England, Geophysics, Vol. 51, No. 2, 236-249.

Mooney, H. M., 1981, Handbook of Engineering Geophysics: Bison Instruments Inc., 191 p.

MGWA Meeting and Field Trip in October

MGWA will sponsor a joint meeting and field trip with the Minnesota and Wisconsin AIPG Sections, Wisconsin Ground Water Association and the Iowa Ground Water Association on **September 20 and 21** in La Crosse/Winona. Talks and presentations will be Friday, followed by an evening banquet Field trip stops on Saturday will be in Minnesota and Wisconsin.

Do You Give Talks to Kids?

There is an excellent booklet prepared by SEPM, "A Sedimentary Geologists' Guide to Helping K-12 Earth Science Teachers: Hints, Ideas, Activities, and Resources," that is available for $6.75 (including shipping and handling) from SEPM, P.O. Box 4756, Tulsa, OK 74159-0756.

(reprinted from *GSA Today*, April 1991)

Jay Lehr Resigns as Executive Director of NWWA

In 1983, the National Water Well Association ("NWWA") entered an agreement with the U.S. Environmental Protection Agency ("EPA") to develop a national mapping system of ground water resources to be used by EPA in the control of ground water contamination.

The EPA has questioned the amount paid to NWWA under the terms of the project which was completed in 1987. After a detailed review of this matter with legal counsel, the NWWA board of Directors has unanimously agreed to settle the dispute between NWWA and EPA. The settlement agreement between the parties provides for the following:

- NWWA will pay $203,273.50 to the EPA.
- NWWA in no way admits liability with respect to the project.
- The government releases NWWA from any civil claims related to the project.
- No past nor present members of the NWWA board of Directors had knowledge of the circumstances surrounding the dispute.

The NWWA Board of Directors was advised that the EPA's inquiry into the project is continuing with respect to the involvement of the Executive Director Jay Lehr and Finance Director Keith Lelux. On April 21, 1991, at a Special Meeting of the NWWA Board of Directors, Dr. Lehr and Mr. Lelux resigned from their positions. Dr. Lehr continues his work at NWWA as a ground water scientist and Mr. Lelux continues his duties in the areas of data processing and order services. An Executive Search Committee, comprised of six Board Members and one past President, has been established to recommend candidates to the Board for the position of Executive Director.

(reprinted with minor editing from an NWWA letter to members, April 23, 1991)

radius of influence. Blower size and the grain size of the soils particles are both factors which influence this last measurement These results are necessary in determining the spacing and number of extraction wells needed.

4) monitor the air quality on discharge.

Typically, pilot study vacuum extractors are explosion-proof, operate on 115v, do not need costly electrical connections, are portable and inexpensive to ship.

Upon completion of a Field Pilot Study that indicates the feasibility of soil venting as a viable treatment, the selection of the equipment for the permanent installation becomes the next consideration. The air flow rate, how much air is moved for each foot of soil, determines the type of blower needed for the site. Several blower choices are available, depending on site/soil needs. Centrifugal blowers such as those offered by New York Blower typically move a lot of air (150-800 cfm) but have a low vacuum capability (max 55" W.C.). These blowers work well in medium to coarse sand. If a medium air flow (100-200 cfm) with a mid-range vacuum capability such as in fine sand (max 100" W.C.) is required, a regenerative blower (Rotron) is the best choice. If the site is clay or silt, low

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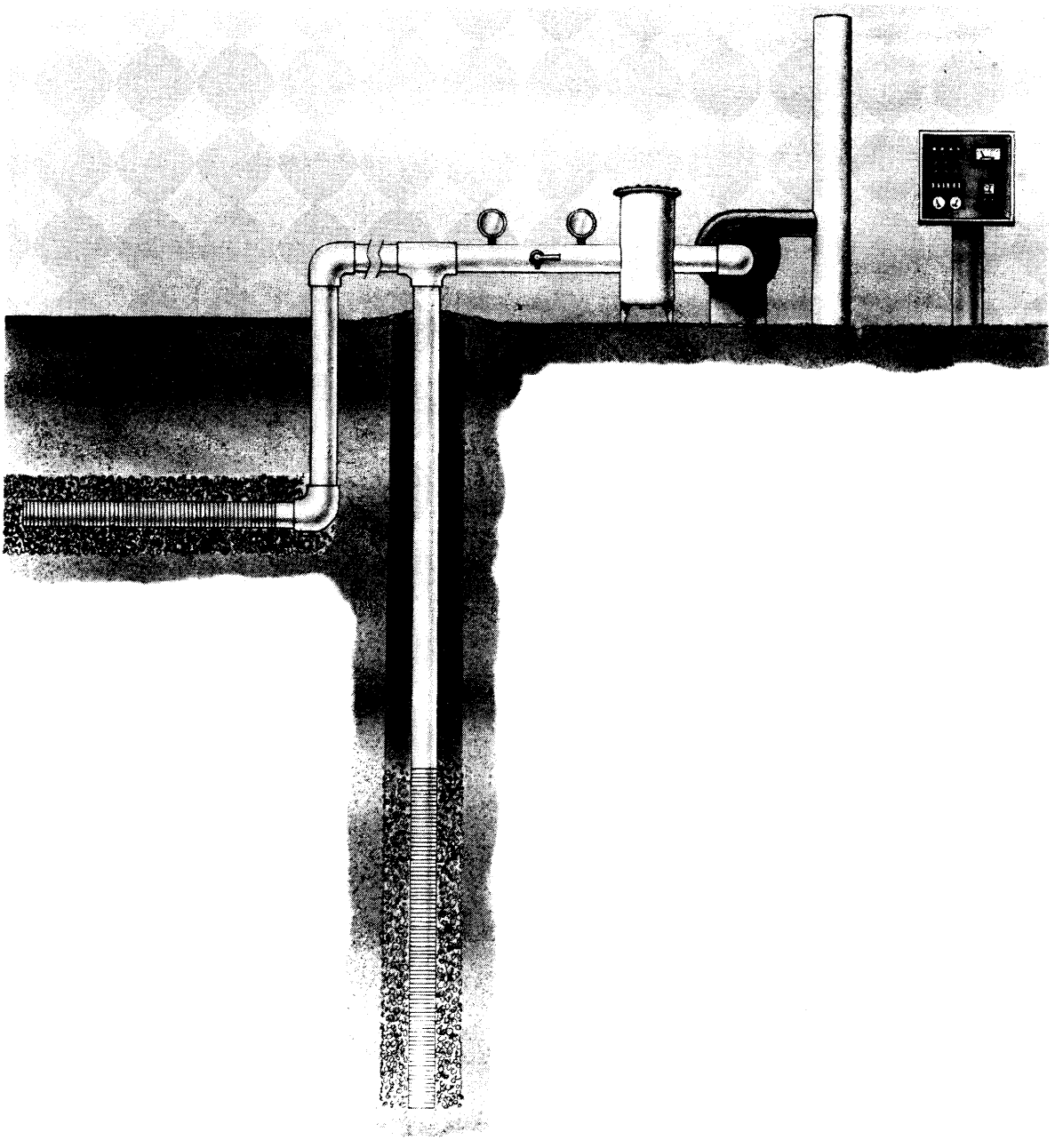

Investigations Assess Risks

Expanding environmental laws have increased the risks associated with real estate and other business transactions.For example, a business that buys or leases property contaminated with hazardous substances or a building containing asbestos may also acquire staggering liabilities if environmental risks are not examined before entering the transaction. Similarly, a lender that forecloses on or becomes actively involved in managing contaminated property may be held liable for remediating environmental problems at the site greatly exceeding the original loan value. Even corporate officers, directors and shareholders may be liable for environmental problems. Thus, environmental site assessments have become a crucial part of real property transactions to inform the parties about the real estate's true condition and their potential liability.

The purpose of an environmental site assessment is to identify all known or suspected environmental hazards to enable parties relying on the report to evaluate their exposure and take steps to manage or allocate risk. To assemble necessary information in a logical order at a minimum cost, environmental assessments are generally conducted in phases. With a site known or strongly suspected to be contaminated, however, a single, comprehensive investigation may save time and money.

Phase I. A so-called "Phase I" assessment provides a general overview of the site. It includes a visual inspection of the property, and any improvements located on it, and an investigation into past and present ownership and uses. It also includes a review of regulatory agencies files and databases related to the site and adjacent properties. Phase I costs vary enormously, but are typically in the range of $2,000 to $15,000.

Phase II. A "Phase II" assessment typically involves a field investigation consisting of soil borings and installation of monitoring wells to ascertain the condition of the soil and ground water beneath the site. Phase II includes the testing of soil and ground water samples by a qualified laboratory and evaluation of the analytical reports. Phase II costs generally range from five to ten times higher than those of Phase I.

Phase III. Hopefully, the field investigation and evaluation will identify the nature and extent of any contamination discovered; if not, additional investigation or Phase III may be necessary. Phase III work typically involves more soil samples and monitoring wells, and the cost depends on the extent of further study. Phase III work usually is done when the parties to the transaction need to quantify the environmental risks. Thus, the Phase III work may include an estimate of the costs of cleaning up contamination.

"Innocent" purchasers. Environmental assessments are driven in part by the federal "superfund" law, which establishes a defense to its strict liability scheme for certain "innocent" purchasers of contaminated property. To qualify for innocent purchaser status under the superfund law, a party must establish that, when it acquired the property, "All appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice in an effort to minimize liability" was undertaken. "Good commercial or customary practice" means that in commercial transactions, a competent professional is retained to conduct the site investigation. Environmental legal counsel and an environmental consultant should be retained at an early stage.

To protect data developed by the environmental consultant as attorney work product, the environmental attorney, rather than one or both of the parties, should retain the environmental consultant. Preferably, a retainer letter contract would clearly spell out the purpose and scope of the investigation and provide for delivery of all reports in draft form to the attorney for review. Factual misstatements, inadequate or irrelevant technical investigations, and erroneous legal advice from non-lawyers can appear in assessments reports. Unfortunately, once released, these reports have come back to haunt parties in a real estate transfer.

On-site inspection. A number of factors and sources of information should be considered by any party acquiring property or financing an acquisition. First, an on-site inspection should be made by a qualified consultant, preferably in the company of environmental legal counsel, as part of Phase I, to look for obvious environmental problems. This inspection also creates an opportunity to interview knowledgeable employees or officers about past ownership and uses.

The on-site inspector should always look for hazardous materials such as barrelled waste, asbestos, PCB electrical equipment, urea formaldehyde, storage tanks, and other signs that the property is or may be contaminated by hazardous substances. Wells should be identified, because both functioning and abandoned wells may provide a pathway for contamination. To the extent feasible, the Phase I inspector should examine adjoining properties to determine whether off-site contamination may be migrating onto the property.

Ownership and operational history. The Phase I environmental auditor should conduct a thorough review of the site's history. In particular, the auditor should inspect relevant company records, including all operating permits, reports filed with government agencies, hazardous-waste disposal records, storage tank records, environmental-lien records and communications from regulatory authorities. Old aerial photographs should be obtained and reviewed. Interviews with key present and former officers and operational employees are critical. As part of determining present and former uses, the environmental auditor should identify the raw materials used at the site, methods of delivery and storage of hazardous materials, history of former and existing storage tanks, location of storage areas, on-site and off-site waste disposal methods, waste-oil management practices, and other environmental uses of the property.

A review of Minnesota Pollution Control Agency (PCA) and United States Environmental Protection Agency (EPA) files relating to the property and adjoining properties is a mandatory part of any Minnesota site assessment. Local health and fire departments may also have files on complaints regarding the facility or spill reports.

PCA assistance. The PCA will assist the public in determining whether hazardous substances, pollutants, or contaminants have been released at a site. On request, PCA staff will evaluate agency records for evidence of contamination at or near a site. In addition, PCA staff will review and approve investigation plans and reports, as well as cleanup plans, to insure that contaminated sites are properly investigated and cleaned up. Parties requesting PCA assistance must reimburse the agency for the cost of its services. PCA approval is not required to transfer property in Minnesota, nor does Minnesota require that an owner certify a property to be cleaned up before a transfer.

If contamination, asbestos, or other environmental risks are encountered during a Phase I investigation, a Phase II assessment is important to quantify the risk to the extent possible. When these risks are quantified, the parties will know whether to reject, restructure or accept the deal. Appropriate terms in the transaction agreements can then be negotiated to satisfy buyers, sellers and lenders.

In summary, environmental risks can be enormous for parties involved in property and related commercial transactions. A Phase I environmental site assessment and, if necessary, Phase II and Phase III assessments are vital steps to avoid environmental liability surprises and to prevent environmental risks from needlessly killing property transactions.

—Steven M. Christenson, attorney in the Environmental and Regulatory Affairs Department of Dorsey & Whitney

(reprinted with permission from *Minnesota Real Estate Journal*, Vol 7 No 3)

Working as a Ground Water Specialist in the Middle East

Working in an oil-rich and water-poor country such as the United Arab Emirates as a ground water specialist is very gratifying. It would seem that ground water specialists, especially from North America, have much to offer any country in the field of ground water. For example, many North American ground water specialists have extensive experience in arid-zone hydrology, which is so important in the Middle East. The ground water industry of North America, and the application of science and engineering within the industry, is in general, second to none. However, it certainly is not dominant. North America, in general, also leads in the development and manufacture of ground water equipment, such as drilling rigs and water supply equipment.

Another big plus for most North American ground water specialists is that English is becoming the international technical language as well as the international business language.

Persons in the Middle East use the following criteria in evaluating equipment including ground water equipment: quality, quality, quality. This is the apparent reason that Japanese and German cars, which are perceived as being of better quality than North American cars, are so common in the Middle East. Heavy construction equipment produced by a certain American company is another example of perceived quality. That firm has a very good reputation for quality, and thus its equipment is widely sought. For equipment produced by firms whose reputation for quality is not known or established, the dominant criterion for selection will be "high" technology or the perception of high technology. The last and sometimes least important criterion is the price of the equipment.

In selecting service, such as consulting, in the Middle East, the criterion are different: technology and science are most important. Those persons using the highest technology equipment seem to be preferred. Experience, education, and price are also important criteria. There are many persons who claim experience and education in ground water. However, in reference to education, not all degrees are equal, although they use the same alphabetic abbreviations. Some third-world colleges, although performing a remarkable job for their society, do not have available the technologically advanced equipment and facilities, or the "world class" products found in their western counterparts. Thus, the quality of their ground water "educational experience" may not be equal to that of a western university graduate.

In reference to price for service, third-world scientists, and even many European scientists, are typically willing to work for considerably less than their North American colleagues. Accordingly, based on price, they may be selected. This, of course, is appropriate if the experience and education are equivalent or better. Accordingly, the North American must ensure that the selecting party is aware that not all "hydrogeologists" are equal, and additionally, that the type and quality of the experience are very important.

Middle East countries are developing at an incredible rate because of the wealth of many of these countries. Of course, development without careful planning can result in environmental problems. To date in the Middle East, environmental concerns generally have not received widespread attention. However, environmental problems are being created and shortly will be recognized. Thus, the age of environmental regulation and cleanup will soon emerge in the Middle East as it has in North America and Europe. It would seem prudent for North Americans and others seeking to sell their services in the Middle East to emphasize the potential environmental problems and call attention to their experience in dealing with such problems.

Many cultural matters need to be considered by Westerners. North Americans, in particular, are

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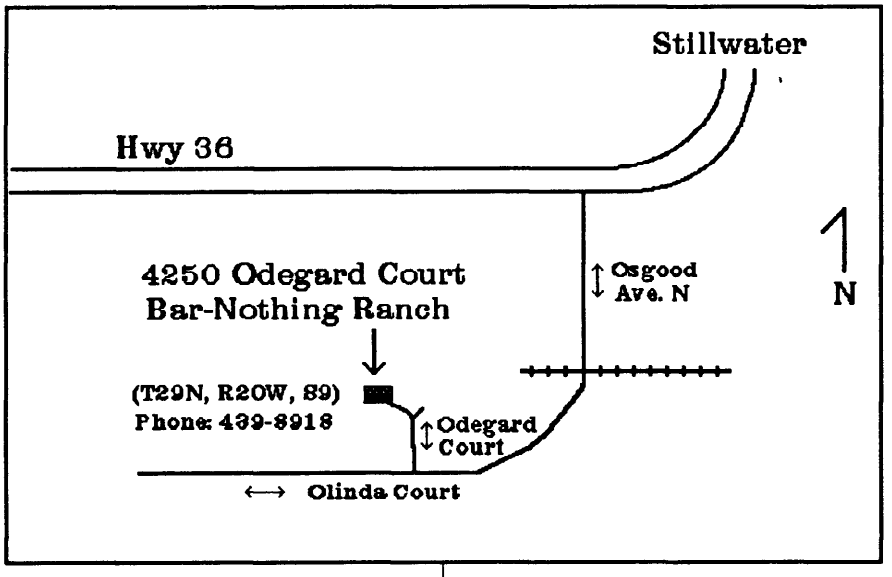
Minnesota Ground Water Association and TCG Hog Roast— June 15, 1991

Twin Cities Geologists, the **Minnesota Ground Water Association**, and the **Minnesota Chapter of AIPG** would like to invite all of our members and friends (and their families) to a hog roast picnic commemorating the 34th anniversary of Twin Cities Geologists (TCG). This event will be our last meeting until fall, and will be held on Saturday, June 15, 1991 (rain or shine). Festivities will commence at 1:00pm, with dinner served at approximately 3:30pm. The menu will consist of roast hog, buns, green salad, beans, cookies, and/or bars, and beverages (beer and pop). Hot dogs, buns, and chips will be provided for the kids.This function will be held at the Bar-Nothing Ranch (Bruce Bloomgren's homestead), at the map location below. No speaker has been scheduled, however, a soap box will be provided for any who become so inclined. The cost is $5.00 per adult (children under 16 are free) and this amount should be mailed to TCG at the address below before June 10, so that the quantities of consumables can be appropriately planned. We hope you will be able to attend.

Twin Cities Geologists
c/o Bruce Bloomgren
Minnesota Geological Survey
2642 University Ave. W.
St. Paul, MN 55114-1057



USGS Publishes First in Series of Atlases

The first atlas in a new full-color series of regional atlases describing the ground water resources of the nation has been published by the U.S. Geological Survey, Department of the Interior.

Printed in 18 by 24 inch format, the series of atlases will provide a source of comprehensive information, written in non-technical language, on the ground water resources, region by region, of the nation.

The 28-page initial atlas in the series contains more than 100 maps and figures. It covers Alabama, Florida, Georgia, and South Carolina.

Eventually, 12 more atlases will be published in the series to describe the location, geology, geography, water quality, water use, productivity, and hydrologic characteristics of the major aquifers across the nation. Information that might be particularly useful includes data on the effects of human activity on ground water, which can result in such problems as poor quality, salt water encroachment, and land subsidence.

The first atlas in the series, titled "Ground Water Atlas of the United States, Segment 6 - Alabama, Florida, Georgia, and South Carolina," written by James A. Miller, a USGS hydrologist in Atlanta, was published as USGS Hydrologic Investigations Atlas 730-G.

Copies can be purchased for $12 each from the Branch of Distribution, U.S. Geological Survey, Denver Federal Center, Box 25286, Denver, CO 80225; (303) 236-7477.

Association of Minnesota Water Resources Professionals Formed

The 13 counties of the South Central Minnesota Counties Comprehensive Water Planning Project have initiated AMWRAP, the Association of Minnesota Water Resources Administrators and Planners.

AMWARP's goals are three-fold. First, to provide a forum for sharing ideas and to promote the association of people with water related interest. Second, to provide a program of continuing education and professional development for its membership on a variety of water related subjects, activities and technical requirements. Third, with the help of a large membership base, to develop an active grass roots voice on legislative and rule making issues that effect water resources management.

Membership to AMWRAP is open to persons interested in enhancing the quality and quantity of surface and ground water resources of Minnesota. Membership dues are $10 per year.

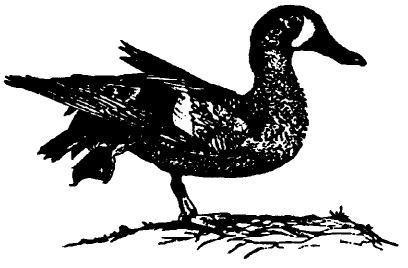
Contact:
Rick Hanna
Blue Earth County
Water Resources Administrator
P.O. Box 8608
Mankato, MN 56001
(507) 387-8381

Hey, What's Up?

The main purpose of this newsletter is to share information among MGWA members. Remember, we don't always see items of interest that might come across, or originate from, your desk. Thanks to all who have contributed. (That wasn't so hard was it?)

Share your news and ideas by sending them to:

Jan Falteisek
Editor, MGWA Newsletter
DNR - Division of Water
500 Lafayette Road
St. Paul, MN 55155-4032



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quarter page	*3.5x5*	*$90*
half page	*7x5*	*$170*
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Changes

Patricia Bloomgren was appointed Assistant Commissioner of the Minnesota Pollution Control Agency. The appointment was effective May 15, 1991. Pat was Assistant Division Director for the MPCA's Water Quality Division.

Hydrogeologist in the Mid-East continued:

generally perceived much as we depict ourselves in TV programs and movies, which are popular here. This can contribute to inaccurate perceptions about the actions and morality of North Americans. Westerners must be careful not to "validate" these misconceptions by their actions. Specifically, public drinking and wearing clothes that do not cover the body (such as shorts and tank tops) are not advised. Boisterous or loud talking is considered inappropriate. Respect and courtesy toward religion and customs of the Middle East are essential. Although there is some anti-Western or anti-North American sentiment in most countries in the Middle East as elsewhere, North Americans generally can work easily in the Middle East. For the most part, the people in the Middle East are friendly and courteous toward North Americans.

Working in the Middle East can be financially rewarding. However, most importantly, the satisfaction of professionally assisting in the development and management of ground water in countries where it is important is gratifying. Finally, the opportunity to experience the rich, warm culture of the people of the Middle East should not be overlooked.

—by Don Jorgensen, CGWP

(reprinted from *The Newsletter of the Association of Ground Water Scientists and Engineers*, February 1991)

The Expert Hydrogeologist — Role and Responsibility

In response to the increasing trend for issues of ground water contamination to be resolved by litigation, there is a corresponding increase in requirements for hydrogeologists to provide expert testimony or technical analysis to support litigation. In a legal environment, the requirements of an expert hydrogeologist are somewhat different from the requirements of the more traditional or routine investigations and analyses.

The expert as an educator

One of the principal roles of the expert hydrogeologist in settlement or litigation of a hazardous waste case is that of educator. The expert often educates the client as much as, if not more than, the court. The expert's opinion is one of many important considerations that counsel will use to formulate a settlement negotiation or trial strategy.

The expert hydrogeologist provides an assessment of the technical issues related to ground water flow and contaminant migration. The expert should provide an unbiased opinion regarding these matters to the client. He, or she, is equally responsible to provide to the client a realistic appraisal of the uncertainties in the analysis. This analysis would include identification of, and education about, the basic hydrogeologic/geochemical principles that affect the movement of ground water contaminants, as well as site-specific hydrogeologic conditions which prevail.

After the expert has conducted an independent appraisal of site hydrogeologic conditions, it is important for the expert to identify those hydrogeologic issues that support the client's position as well as those issues which are least supportive. The client needs to know and understand the hydrogeologic issues to help make decisions regarding settlement and litigation options.

The expert's ability to educate the court and the client can have a significant effect on the outcome of a trial. During direct testimony, the expert witness must be able to present opinions to the court in a form which is both logical and easy to understand. During cross examination, the expert witness must be able to respond to the opposing counsel in a manner which continues to convey to the court the logic and reasonableness of the opinion. Continual reference to basic principles and simple analogies, and use of visual aids, will be of significant help in this regard.

An equally important contribution the expert can make during trial is in preparation for the cross examination of the opposing expert witnesses. The success of cross examination depends on the ability of counsel to recognize and understand the weak points in the witnesses' opinions and to pursue them effectively. In many circumstances, successful interrogation will be a direct result of the mutual education process between counsel and their own expert prior to trial.

The use of hydrogeologic models

The expert will need to be particularly knowledgeable and skilled in presenting discussion about the use of hydrogeologic models in a simplified manner. During the last two decades, there has been a significant increase in the use of modeling techniques to analyze hydrogeologic problems— some techniques are good and some bad. There also is a trend toward reliance on modeling in federal regulatory programs. Therefore, it is likely that the expert's opinions will have been based on some form of modeling analysis. It is equally likely that the opposing expert(s) used modeling analyses and, in all likelihood, a different modeling approach. The expert, therefore, should be familiar with a wide range of modeling techniques.

Some general modeling topics about which the expert will most likely be asked to testify or render an opinion are:

- The usefulness and reliability of hydrogeologic models;
- Considerations in selection of an appropriate model;
- Model use and misuse; and
- Comparisons between modeled conditions and site conditions.

Expert Dilemmas

During settlement negotiations or litigation, there are several apparent difficulties which the expert is likely to encounter. These conflicts arise because the working of science and the law are different. The scientist is trained to accept uncertainty and be neutral in problem analysis. In a legal setting, however, the expert realizes that, although the testimony is objective, it is not neutral.

One topic which is likely to create difficulty for the scientist who is not experienced in the legal environment is explaining the validity of their opinion despite the uncertainties which are likely to exist, including:

- Uncertainties resulting from the need to understand and describe a spatially and temporally varying system on the basis of discrete data points.
- Uncertainties which result from scientific limitations.

The expert must explain complex phenomena in simple terms. The physiochemical processes and site-specific conditions which affect the migration of contaminants are complex, and the expert's message to the court may not be understood. This is a particular concern in the courtroom setting when the judge and jury are generally not knowledgeable about the key scientific issues and the witness has only one chance to present the basis for the opinion. The use of visual aids to illustrate various aspects of the testimony are likely to be necessary and useful.

Regardless of the forum of presentation, the expert has an obligation to provide objective analysis and interpretation of the technical issues. The client and the expert are best-served when the expert is objective and the lawyers are the advocates.

reprinted from the GeoTrans, Inc. newsletter, Spring, 1991.

Directory Update

New Members are listed here, as are "old" members whose addresses were not included in our last directory.

Save this page and add it to your copy of the directory.

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Calendar

June 10 - 19, 1991. *Fundamentals of Stochastic Modeling of Flow and Transport in Porous Formations.* To be held in Indianapolis, Indiana by IGWMC.

June 18 - 20, 1991. *Microbial Processes in the Degradation of Ground Water Contaminants.* To be held at the Sheraton Resort in Clearwater Beach, Florida by NWWA.

June 21, 1991. *Environmental Property Assessments.* To be held at the Sheraton Sand Key Resort in Clearwater Beach, Florida by NWWA.

June 22-23, 1991. *Proving the Technical Case: Soil and Ground Water Contamination Litigation.* To be held at the Congress Hotel in Chicago, Illinois by the University of Wisconsin-Madison College of Engineering. Contact Department of Engineering Professional Development, 432 North Lake St., Madison, Wisconsin 53706. (608) 262-2061.

June 24-28, 1991. *Safety at Hazardous Materials Sites.* To be held in Valhalla, New York by NWWA.

June 26-28, 1991. *Bioremediation Engineering.* To be held in Boston, MA by General Physics Corporation, 6700 Alexander Bell Drive, Colombia, MD 21046-2100.

June 28 - 29, 1991. *Methods for Delineating Wellhead Protection Areas in Fractured Aquifer Settings.* To be held at the Holiday Inn in Boston, Massachusetts by the American Institute of Hydrology and the U.S. Environmental Protection Agency. Contact American Institute of Hydrology, 3416 University Avenue S.E., Minneapolis, MN 55414-3328.

July 8-12, 1991. *Ground Water Pollution and Hydrology.* To be held in Princeton, New Jersey by Omni Environmental Corporation. Contact The Princeton Corporate Center, Three Independence Way, Princeton, New Jersey 08540. (609) 243-9399.

July 16-18, 1991. *Principles of Ground Water Hydrology.* To be held at the Hyatt Regency in Nashville, Tennessee by NWWA.

July 16 - 18, 1991. *Corrective Action for Containing and Controlling Ground Water Contamination.* To be held at the Holiday Inn Crowne Plaza in Nashville, Tennessee by NWWA.

July 16 - 18, 1991. *Introduction to Ground Water Geochemistry.* To be held at Hyatt Regency Nashville in Nashville, Tennessee by NWWA.

July 16 - 18, 1991. *Corrective Action for Containing and Controlling Ground Water Contamination.* To be held in Nashville, Tennessee by NWWA.

July 22-23, 1991. *Proving the Technical Case: Soil and Ground Water Contamination Litigation.* To be held at the Boston Marriott/Cambridge in Cambridge, Massachusetts by University of Wisconsin-Madison, College of Engineering. Contact Department of Engineering Professional Development, 432 North Lake St., Madison, Wisconsin 53706. (608) 262-2061.

July 22-26, 1991. *Ground Water Pollution and Hydrology.* To be held in San Francisco, California by Omni Environmental Corporation. Contact The Princeton Corporate Center, Three Independence Way, Princeton, New Jersey 08540. (609) 243-9399.

July 22-26, 1991. *Environmental Site Assessments.* To be held in Columbus, Ohio by NWWA.

July 29-31, 1991. *Environmental Site Assessments Conference.* To be held at the Fawcett Center For Tomorrow, at The Ohio State University Campus Columbus, Ohio by NWWA.

August 5 - 9, 1991. *Modeling of Ground Water Flow and Pollution.* To be held at University of Cincinnati in Cincinnati, Ohio. Contact Catherine Rafter at (513) 556-2933.

August 11 - 16, 1991. *IBM PC Applications in Ground Water Pollution and Hydrology.* To be held at the Hyatt Regency Princeton in Princeton, New Jersey by NWWA.

August 19 - 22, 1991. *Geochemical Modeling of Ground Water.* To be held in Chicago, Illinois by NWWA.

August 20 - 22, 1991. *Designing in situ Waste Recovery Systems.* To be held at the Fairmont Hotel in Chicago, Illinois by NWWA.

August 20 - 22, 1991. *Treatment Technology for Contaminated Ground Water.* To be held at the Fairmont Hotel in Chicago, Illinois by NWWA.

August 30 - 31, 1991. *Methods for Delineating Wellhead Protection Areas in Fractured Aquifer Settings.* To be held at the Ramada Hotel in San Francisco, California by the American Institute of Hydrology and the U.S. Environmental Protection Agency. Contact American Institute of Hydrology, 3416 University Avenue S.E., Minneapolis, MN 55414-3328.

September 7 - 8, 1991. Introduction to GIS for Water Resources Applications. To be held at Louisiana State University in Baton Rouge, Louisiana by AWRA.

September 8 - 13, 1991. *Water Management of River Systems* and *Resource Development of the Lower Mississippi River, 27th Annual Conference and Symposium.* To be held in New Orleans, Louisiana by AWRA.

September 9 - 13, 1991. *Introduction to Ground Water Modeling.* To be held at the Holcomb Research Institute, Indianapolis, Indiana by IGWMC.

September 11-13, 1991. *Conference on Wellhead Protection Area Delineation in the Western United States.* To be held at the Riviera Hotel, Las Vegas, Nevada by NWWA.

September 15-18, 1991. *Integrating Geographic Information Systems and Environmental Modeling International Conference.* To be held in Boulder, Colorado. Contact GIS/Modeling Conference Secretariat, NCGIA, University of California, Santa Barbara, CA 93106. (805) 893-8224.

continued on next page....

September 16-18, 1991. *Second International Conference on the Abatement of Acidic Drainage.* To be held in Montreal, Quebec. Contact Pamela Friedrich, Centre des Recherches Minerales, 1665 boulevard Hamel, Edifice 2, 1 er etage, Quebec, Quebec G1N 3Y7, Canada.

September 16-18, 1991. *Principles of Ground Water Hydrology.* To be held at Stouffers Dublin Hotel, in Dublin, Ohio by NWWA.

September 18 - 21, 1991. *The Geologic Modeling of Depositional Environments and Its Application to the Ground Water Professional.* To be held at the Holiday Inn, Mt. Pleasant, South Carolina by NWWA.

September 27, 1991. *Environmental Property Assessments.* To be held at the Red Lion Hotel in Seattle, Washington by NWWA.

September 27 - October 2, 1991. *Confronting Environmental Challenges in a Changing World.* To be held in St. Paul, Minnesota. Contact John Baldwin, Proceedings Chair, 147C Hendricks Hall, PPPM Department, University of Oregon, Eugene, OR 97403. (503) 346-3895.

September 30 - October 4, 1991. *Annual Meeting of the Association of Engineering Geologists.* To be held in Chicago, Illinois. Contact Theodore R. Maynard at (312) 744-3530.

October 4 - 5, 1991. *Methods for Delineating Wellhead Protection Areas in Fractured Aquifer Settings.* To be held at the Thunderbird Hotel in Minneapolis, Minnesota by the American Institute of Hydrology and the U.S. Environmental Protection Agency. Contact American Institute of Hydrology, 3416 University Avenue S.E., Minneapolis, MN 55414-3328.

October 8 - 10, 1991. *Introduction to Ground Water Geochemistry & Corrective Action for Containing and Controlling Ground Water Contamination.* Both to be held at Hartford Marriott Farmington in Farmington, Connecticut by NWWA.

October 9-11, 1991. *36th Annual Midwest Ground Water Conference.* To be held at Hilton at the Circle in Indianapolis, Indiana. Contact Indiana Department of Natural Resources, Division of Water, 2475 Directors Row, Indianapolis, IN 46241.

October 10-11, 1991. *Minnesota GIS/LIS Consortium and Annual Conference.* To be held at the Thunderbird Hotel in Bloomington. Contact Minnesota GIS/LIS Conference, c/o the Management Co., Inc., 1700 N. Skyline Drive, Burnsville, MN 55337.

October 16-19, 1991. *American Institute of Professional Geologists Annual Meeting.* To be held in Gatlinberg, Tennessee. Contact Lawrence I. Benson, ERC/EDGE. P.O. Box 22879, Knoxville, TN 37933-0879. (615) 966-9761.

October 21-23, 1991. *NWWA 43rd Annual Convention & National Water Well Expo.* To be held in Washington, D.C. by NWWA.

October 21-24, 1991. *Geological Society of America Annual Meeting.* To be held in San Diego, California. Contact GSA, Meetings Department, P.O. Box 9140, Boulder, CO 80301 (303) 477-2020.

October 28 - 30, 1991. *Principles of Subsurface Contaminant Fate and Transport Modeling.* To be held at the Holiday Inn Financial District in San Francisco, California by NWWA.

November 3-7, 1991. *Hydrology & Hydrogeology in the '90s.* To be held at the Grosvenor Resort at Walt Disney World in Orlando, Florida by the American Institute of Hydrology. Contact Sam B. Upchurch, AIH Program Chairman, Department of Geology, University of South Florida, Tampa, Florida 33620.

November 5-6, 1991. *24th Annual Water Resources Conference.* To be held at the Earle Brown Continuing Education Center, University of Minnesota St. Paul Campus, In St. Paul Minnesota. Contact Bev Ringsak, 335 Nolte Center, University of Minnesota, 315 Pillsbury Drive, Minneapolis, MN 55455. (612) 625-6689.

November 5 - 7, 1991. *Designing in situ Waste Recovery Systems.* To be held at the Fairmont Hotel in Chicago, Illinois by NWWA.

November 6-7, 1991. *Applied Drilling Engineering for Rotary and Auger Methods.* To be held at the Tampa Marriott Westshore in Tampa, Florida by NWWA.

November 18-20, 1991. *Theory and Practice of Ground Water Monitoring and Sampling & Theory and Application of Vadose Zone Monitoring, Sampling, and Remediation.* Both to be held at the Sheraton Dallas Hotel in Dallas, Texas by NWWA.

November 19-22, 1991. *Petroleum Hydrocarbons Conference and Expo.* To be held in Houston, Texas by NWWA.

December 3-5, 1991. *Treatment Technology for Contaminated Ground Water.* To be held at the Stouffer Concourse Hotel, in Denver, Colorado by NWWA.

January 5-10, 1992. *IBM PC Applications in Ground Water Pollution and Hydrology.* To be held at the Holiday Inn Golden Gateway in San Francisco, California by NWWA.

For information about meetings and seminars to be held by the AWRA, contact Michael C. Fink, Meetings Manager AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192 (301) 493-8600, Fax (301) 493-5844.

For information about meetings and seminars to be held by the NWWA, contact NWWA at 6375 Riverside Drive, Dublin, Ohio 43017 (614) 761-1711, Telex 241302.

For information about Short Courses held by the International Ground Water Modeling Center (IGWMC), contact the IGWMC, Holcomb Research Institute, Butler University, Indianapolis, IN 46208 (317) 283-9458.

Changed Your Job or Career Lately?

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Please fill out and mail to: Bob Beltrame, Donohue & Associates, 7200 Hemlock Lane, Maple Grove MN 55369.

Professional Registration, Certification and Definition

Interest continues in states across the country in the registration, certification & definition of Professional Geologists and Hydrogeologists. The following is a compilation from the April 1991, Vol 7 No 2 *AGWSE Newsletter.*

- Geologist registration (requires testing): Arizona, Arkansas, California, Delaware, Florida, Georgia, Idaho, Maine, N. Carolina, Oregon, S. Carolina, Tennessee and Virginia.
- Geologist certification: Alaska and Indiana.
- Geologist defined: Colorado, Kansas, Missouri, Wyoming.

Fewer states have certified Hydrogeologists or Ground Water Professionals. To date New Jersey and Wisconsin have definitions and Nevada has registration procedures. Many states have bills pending that would certify professionals. These states are: California, Connecticut, Georgia, New Jersey, Oklahoma, Tennessee and Wyoming.

A federal regulation is pending (56 FR 2108) that defines a qualified geologist or geotechnical engineer.

Minnesota does not fall into any of these categories.

Join the Minnesota Ground Water Association!

If you are reading this newsletter second-hand, we'd like to take this opportunity to invite you to become a member of **MGWA** for 1991. Annual dues are $15 for professional members and $10 for students.

Just complete the form below and mail to: Susan Price, MGWA Treasurer, 2177 James Avenue, St. Paul, MN 55108

Name _____
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President's Page continued:

prepared by or under the direction of a registered geoscientist, then any official review, evaluation, approval or other 'official' action upon that report analysis should also be prepared by or under the direction of a registered geoscientist.

I do not propose that the above stated concerns are by any means exhaustive or all inclusive. This is a difficult and complex issue that will not be readily dealt with or resolved. There are a great many aspects to the process. Work and discussion have just begun and there will be considerable time spent on developing the rules and procedures.

There will undoubtedly be meetings, planning sessions, and opportunities for personal expression. I urge you to watch for notices, announcements, meetings, etc. and to make an effort to participate in the formulation of these registration/certification procedures.

The Minnesota Ground Water Association **will not** adopt an official position on this issue as it would be difficult to formulate a position representing all constituents. However, we would solicit your comments, feeling, and opinions as well as experiences in other states. These can be presented as comments, editorials, and letters in future MGWA newsletters. Of course your comments should also be addressed to the appropriate group, person, planning board, as the registration/certification procedures develop.

—Gordie Hess, MGWA President

Soil Venting continued:

air flow (25-150 cfm) and a very high vacuum is required (max 175" W.C.), then a positive displacement blower similar to M-D Pneumatic's is indicated.

Additional equipment includes: a silencer on the vacuum extractor, a condensate separator, an electrical control panel, and instrumentation for monitoring treatment effectiveness and operation.

The condensate separator removes moisture from the air stream. Changes in the velocity of the air stream, combined with passage of air through a coalescing medium, promotes condensation of moisture. An added feature of the coalescing medium is small-particulate removal. A note of caution: the liquid gathered in the sump of the separator is, in all probability, a hazardous waste and must be treated accordingly.

The electrical control panel is needed to interface the vacuum extractor and the condensate separator. A sensor inside the separator shuts down the blower when liquid level in the sump rises, permitting the separator to drain. The system restarts when the draining of the condensate separator is completed. A 24-hour clock allows the system to be operated specific hours of the day or night, depending on site needs, such as site location near a residential area.

Gages are needed to measure both air velocity and vacuum at various points within the system. The vacuum is measured within the piping itself as well as within the soil adjacent to the vacuum extraction wells or the intervals being screened. Performance level is assessed by monitoring of tension within the soil. Finally, monitoring of the discharge will dictate if the method is achieving remediation and also if the discharge meets and doesn't exceed discharge requirements. In referring to the accompanying diagram, note that no mention has been made of the means to handle discharge from the system. Some treatment may be required, either through vapor phase carbon, or thermal/catalytic incineration.

As a final consideration, subsurface installations can be either horizonal and/or vertical screening. Horizontal screening is laid in a trench, back-filled with materials yielding increased permeability. the surface area is then sealed to insure the effectiveness of the vacuum's area of influence. A vertical bore hole is drilled to accommodate vertical screen casing and filter pack. The annular spacing between the casing and the bore hole needs to be tightly sealed because air leakage will decrease the efficiency of the vacuum.

Soil venting can be integrated with other ground water remediation systems, even in direct conjunction with ground water recovery wells. An emerging technology, soil venting holds promise as a less costly, more effective remediation over soil excavation and offers treatment options for those applications severely restricted by prior site development, and cost of soil removal/disposal.

—David Kill, P.E.,Recovery Equipment Supply, Inc.

Ground Water Ranked Top Environmental Priority by Congressional Staffers

Ground water and clean water are ranked as the nation's major environmental priority for the 102nd Congress, according to a recent poll of senior staff members in the 351 U.S. House and Senate Offices.

The poll was conducted for NWWA by the Washington, D.C., office of Fleishman-Hillard, a public relations firm.

When asked to name the major environmental priorities for the Congress, staffers identified ground water and clean water as the top two issues (26 percent), followed closely by solid waste management, specifically the Resource Conservation and Recovery Act (RCRA), by at least 24 percent.

The 1990 rank for ground water was third, while the 1989 rank was fourth. Ground water takes over from clean air, which received major legislative action in the last Congress.

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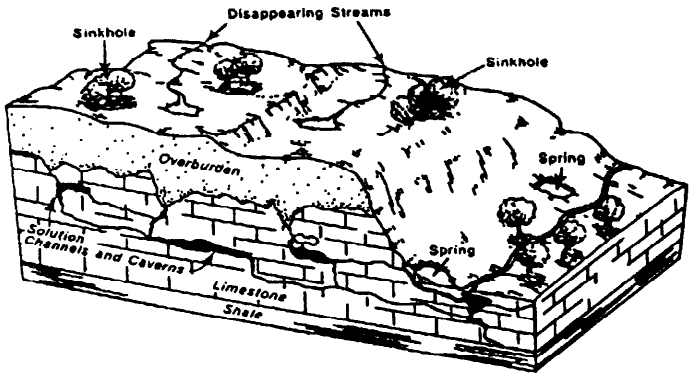

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