

Minnesota Ground Water Association

Volume 12, Number 3: September, 1993

President's Letter

The following story is an excerpt from an editorial written by Jd Belanger, Withee, Wisconsin, who publishes "Countryside and Small Stock Journal" (used with permission).

Flood on the McKenzie

It's been a wet year, here. Most farmers got their crops in late, and many fields weren't planted at all. Much of the first-crop hay was lost. Gardens are fewer and smaller than usual.

The rain was seldom heavy, but it was regular, day-after-day, for weeks. Then a real gully-washer hit. The ground was already saturated, and there was nowhere for the water to go.

There is a small stream on our place — McKenzie Creek — that originates in a small lake about a mile north of us. Ordinarily at this time of the year you can wade across it and the water won't come to the tops of your boots.

Normally you can't hear the gurgling brook from a hundred yards away; now I could hear it from the house, more than a quarter of a mile east.

As I walked the path through the still-dripping woods, the roar grew louder and louder. Then it became deafening. But the sight was even more overwhelming than the sound.

There was no "falls" below the beaver dam: the water was the same level on the pond above as on the stream below. But flowing over the dam it looked like molten lava.

Then it turned into a churning, frothing, tidal wave, tearing at the banks and bulldozing tree roots and sending spray high into the already misty air.

It was awesome.

As the shock wore off and I stood entranced by the gushing water, I thought of how it would course through the marsh, meet Diamond Creek, join the Black River, then combine with the Mississippi, and eventually become part of the Gulf of Mexico. Thinking of that, I tossed a stick into the churning waters, wondering if it would reach the Gulf and how long it would take.

A day or so later the Black River overflowed its banks. As people spoke of the Black, I couldn't help but think of the McKenzie... and all the other small streams that in some curious way *became* the Black. More wondrous yet, it all started with a single raindrop. And another, and another. I could envision my stick — working its way south, day by day. La Crosse, Dubuque, Davenport, Des Moines, St. Louis.

People marveled at, railed against, and feared the Mississippi. But what is the Mississippi but a thousand McKenzies? And what is the McKenzie but a few trillion drops of rain?

The Wisconsin, the Missouri, and the Ohio become part of the Mississippi, and the Gulf of Mexico, and the Atlantic Ocean...

A spoonful of pesticide, a puff of auto exhaust, and a discarded hearing aid battery are swept along to become pollution.

Here's another angle. The day the McKenzie was raging, how many people downstream knew what lay in store for them? How many people can see ahead, to what will happen when those other "raindrops" — individual people and seemingly insignificant actions and events — arrive downstream at the chronological equivalents of Des Moines and St. Louis?

No one could stop the rain or change nature. But as rampaging

as the McKenzie was and as many small streams as were involved, technically it would have been much easier to control them than to confine the Mississippi. While it might seem more overwhelming to stem a few hundred smaller problems at their source, that's still more reasonable than hoping to gain control of one massive, hopeless problem further downstream.

The story is about surface water, but we can draw a parallel with ground water. Adverse impacts to ground water start small and multiply. Downgradient users probably have no idea about what is coming their way. As ground water experts, we act for ourselves and on behalf of our clients and constituents to address ground water issues. We can each take small, significant actions now to mitigate or prevent future water quality impacts.

A good opportunity to learn about this issue is to attend the MGWA Fall Conference on November 30. "Perspectives on the Future of Ground Water Protection", an all-day conference, will include local, national, and international speakers (see page 15). I hope to see you there.

—Larry Johnson, MGWA President

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MPCA Voluntary Investigation and Cleanup Program

By Lynne Grigor and Gerald Stahnke, Minnesota Pollution Control Agency

Beginning in 1988 with two staff assigned to oversee and assist voluntary investigation and cleanup actions, the Property Transfer Technical Assistance Program of the Minnesota Pollution Control Agency (MPCA) has undergone a great deal of change during the five years of its existence. This year, now with sixteen staff, the program has a new name, the Voluntary Investigation and Cleanup (VIC) Program. The name change reflects the availability of the program to most properties which have a voluntary party wishing to investigate and/or cleanup the soil and ground water at the property, not just those properties that are changing owners.

MINNESOTA'S VOLUNTARY APPROACH

Minnesota was one of the first states to recognize the many economic and environmental benefits which could be attained by offering persons motivated by an impending financial or real estate transaction an alternative to the Superfund administrative process.

Several states currently have laws which mandate that industrial and commercial properties be investigated and cleaned up before they are sold. In contrast, Minnesota's program is completely voluntary.

Individuals who wish to conduct voluntary investigations and cleanups under the VIC Program are expected to formally request this assistance by completing a Request for Assistance Form. Persons requesting such assistance are also expected to adhere to certain standards in the in-

vestigation of the extent and nature of contamination, and any necessary cleanup actions. In addition, the parties requesting VIC staff review and oversight are required by statute to reimburse the MPCA's costs of providing assistance.

KEY FUNCTIONS

The key functions of the VIC Program are to: 1) set standards for an adequate voluntary site investigation, 2) provide MPCA review of the adequacy and completeness of such investigations and 3) approve cleanup plans (response action plans) for significant contamination. By obtaining MPCA approval of investigation and response action plans, an interested person can be reasonably confident that they know the extent of any environmental problems on the property, can determine the most appropriate cleanup action, and can calculate the costs of cleanup measures needed to satisfy statutory requirements.

STATUS OF VIC SITES

Since the start of the VIC Program 301 sites have entered the program (Figure 1). By the end of the first year, 15 cleanup plans had been approved by the VIC Program. During the first half of 1993 eleven cleanup plans have been approved by the program. Thirty-

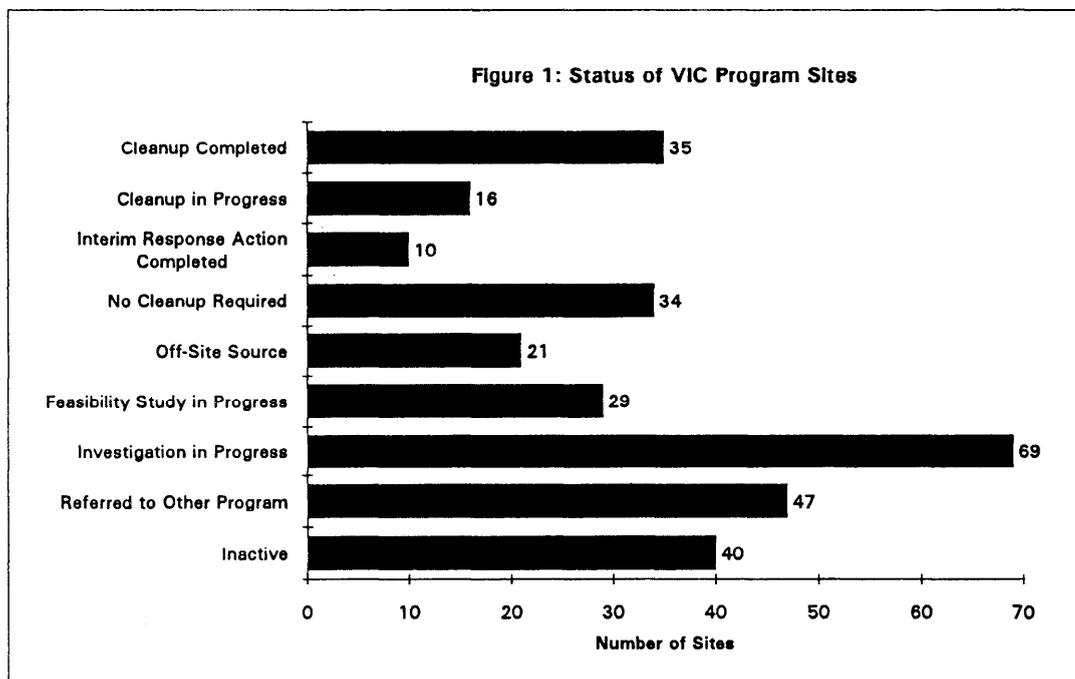
five cleanups have been completed and sixteen are in progress. In addition, ten sites have completed interim response actions; that is, a partial cleanup was completed concurrent with the investigation of the entire site. At thirty-four sites no cleanup was required. An additional twenty-one sites were determined to have off-site sources of contamination, therefore cleanups were not required of the property owners.

LOCATION

Given the location of industry and higher property values in the state, it's not surprising that over 80% of the sites in the VIC Program are in the metro area (Figure 2). With the exception of sites where rubbish, demolition debris, ash or industrial wastes were disposed on rural or vacant properties, the sites are (or were formerly) entirely industrial, manufacturing and commercial properties or are adjacent to such properties.

MEDIA AFFECTED

Approximately 80% of the sites in the VIC Program have been found to have soil contamination and 70% have ground water contamination. Cleanups are not required of the voluntary party or owner at sites where the source of the contamination is off-site.



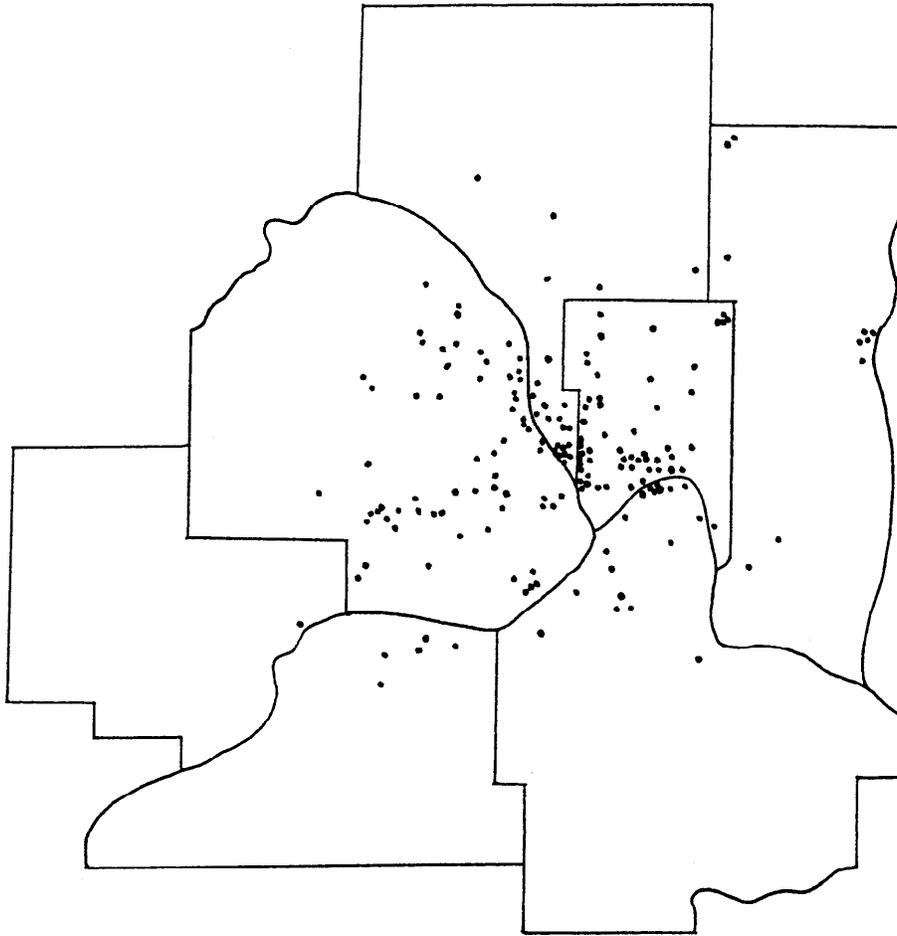


Figure 2: Location of VIC Sites in Seven County Metro Area

SITES WHICH QUALIFY

In order to be accepted into the VIC Program a site must not have impacted or threatened to impact a drinking water well. Those sites are usually referred to the Superfund enforcement program where the project may continue on a voluntary basis or as an enforcement action.

Sites where release of contamination from Resource Conservation and Recovery Act (RCRA) regulated generators exists are transferred to the MPCA RCRA Program.

Petroleum Sites are generally transferred to the MPCA Underground Storage Tanks (UST) Program unless non-petroleum contaminants are also present. Sites with both petroleum and non-petroleum releases are usually handled concurrently by both UST and VIC Programs.

Voluntary investigations and cleanups at agricultural chemical

sites, including wood treating sites, are handled by the Department of Agriculture.

A site becomes inactive in the VIC Program if little information was gathered about the site and the voluntary party decides not to continue the investigation and/or cleanup. In other cases, where a documented release is identified, the site is transferred to the MPCA's Site Assessment Unit for placement on the CERCLIS list. CERCLIS is the first step in the Superfund process. It is the list from which sites are chosen for scoring for placement on the state and/or federal Superfund lists. Since the start of the program thirty-three sites have been transferred to the Site Assessment Unit and nine have been placed on the state Superfund list.

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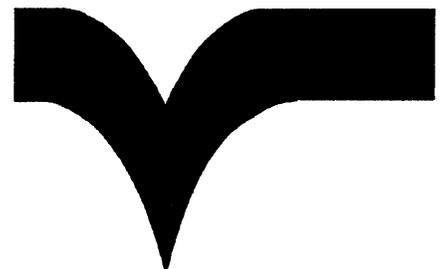
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TYPES OF ASSURANCES

There are five broad categories of written assurances that can be issued by the MPCA Commissioner or designated MPCA staff following the approval of investigative reports and cleanup plans.

- **TECHNICAL ASSISTANCE APPROVAL LETTER**

Technical Assistance Approval Letters to the voluntary party provide the MPCA staff comments and approvals of technical reports and other submittals for determining the adequacy of investigation activities and cleanups. A Technical Assistance Approval Letter does not normally contain assurances from the commissioner regarding administrative and future liability protection. However, a Technical Assistance Approval Letter may be the only type of written assurance available to certain parties depending on Land Recycling Act eligibility requirements.

- **NO ACTION LETTER**

In addition to providing technical comments and approvals a No Action Letter provides a degree of assurance to the voluntary party regarding future Superfund enforcement actions by the MPCA. No Action Letters, which are issued by the MPCA Commissioner, can be issued to a voluntary party regardless of whether they are a responsible person or not as defined by the Minnesota Superfund law. No Action Letter assurances do not extend to other parties associated with the property not specifically identified in the Request for Assistance Form. In situations where only a discrete area of the property is investigated or remediated, a Limited No Action Letter will be issued on a case by case basis.

- **NO ACTION AGREEMENT**

The voluntary party can also enter into a No Action (Covenant Not to Sue) Agreement with the MPCA Commissioner in lieu of being issued a No Action Letter. A No Action Agreement, also referred to as a Consent Order, is a signed agreement between the Commissioner and the voluntary party and is normally not negotiated until after the Commissioner approves the voluntary response action plan.

- **OFF-SITE SOURCE DETERMINATION LETTER**

The Off-Site Source Determination Letter may be issued when the voluntary party has demonstrated to the satisfaction of the MPCA staff that the contamination on the subject property is the result of an off-site source. A letter issued in this instance is also known as a "Good Neighbor" letter. An Off-Site Source Determination letter will state that the voluntary party is protected from future cleanup liability. However, as required by the Land Recycling Act, the owner of the property must agree to cooperate with the investigation and cleanup of the release. In addition, the voluntary party will be required to avoid actions, possibly including development activities, that would interfere with future cleanup actions or contribute to the release of contaminants.

- **CERTIFICATES OF COMPLETION**

Certificates of Completion are issued upon certification by the MPCA Commissioner of voluntary response action plans and provides protection to persons who are not otherwise legally responsible for the contamination from liability for cleanup. The act also extends this liability protection to other parties associated with the property or with development occurring on the property, if those parties are not otherwise responsible for the contamination. These parties may include property owners, lenders, and their successors and assigns.

The Land Recycling Act of 1992 allows the MPCA Commissioner to approve partial response action plans that address some, but not all, contamination at a particular property, if the cleanup includes all actions needed to carry out any reuse or development of the property in a manner that protects public health, welfare and the environment. Partial response action plans are approvable only when the response actions are being conducted by persons not otherwise responsible for the release or threatened release. Similar to Off-Site Source Determinations, partial response action plans re-

quire the owner of the property to agree to cooperate with any additional cleanup actions needed to complete a full cleanup of all remaining contamination.

Certificates of Completion can also be issued in situations where response actions are undertaken and completed by persons who are responsible for the release or threatened release as defined by the Minnesota Superfund law. In these situations, the responsible person(s) must remedy or remove all releases or threatened releases at the subject property. Upon issuance of the Certificate of Completion, a person who acquires the property and a person providing financing and their successors and assigns who are not otherwise responsible for the cleanup are protected from liability for the cleanup.

- **NO ASSOCIATION DETERMINATION**

With the enactment of the 1993 Amendments to the Land Recycling Act the MPCA Commissioner can issue, upon request from a voluntary party, a No Association Determination Letter. The MPCA Commissioner may also enter into a No Association Determination Agreement with a voluntary party. To qualify for this type of determination the proposed actions under consideration must result in either a benefit to the environment or economic improvement to the property. An economically beneficial action could include sale, refinancing or similar action that would create new economic activity or help assure continuation of existing activity.

CLEANUP GOALS SAME AS ENFORCEMENT PROGRAM

Cleanup policies and standards are the same for the voluntary and enforcement (e.g., RCRA or Superfund) programs. The ultimate goal is a permanent remedy where contaminants are treated rather than contained on-site, transferred to another media, or shipped to landfills. Permanent remedies benefit both the environment and land owners in that contaminants are destroyed and the liabilities for the contaminants are eliminated.

Cleanup goals and standards are determined on a site by site basis. Background levels for metals and polynuclear aromatic hydrocarbons and non-detectable levels for non-naturally occurring compounds are the ideal goals. Several sites in the VIC Program have used these ideal cleanup levels, because the potential lenders or buyers wanted a site "free from contamination" and at these sites ideal cleanup levels were technically feasible (usually due to disposal in a wetland with a thick layer of clay). However, ideal levels are usually not feasible and a leaching model and ingestion guidelines are often used for soils.

Ground water cleanup standards are the Minnesota Department of Health Recommended Allowable Limits (RALs) for aquifers capable of supplying one or more households with drinking water. Ten times the RALs are used for very small perched water zones and ground water in flood plains that can be demonstrated to be entering surface water. State Final Acute Values and Chronic Criteria are also used for ground water entering surface water. Health and environmental risk assessments are an option, but have not been used in the VIC Program, primarily due to the time and costs involved.

Remediation methods are proposed by the voluntary parties. A Focused Feasibility Study (FFS), which is often included in the Response Action Work Plan, is required. Unlike the Superfund enforcement program (which requires extensive documentation and analysis of options), if there is one proven technology obviously suited to the site, an FFS may be only a few paragraphs explaining why the method was proposed.

CLEANUP TECHNOLOGIES

The VIC Program has approved a variety of cleanup methods. Dumps are the most numerous type of site in the program. Excavated waste materials, especially concrete, asphalt, tar and scrap metal are reused in on-site construction projects or recycled when feasible. Other methods that have been approved for waste materials

are excavation and disposal at sanitary, industrial, and hazardous waste landfills and covering the wastes with soil, together with long term ground water monitoring. Often even old dumps and dumps where burning was common need methane venting and a set back from the dump where land use is restricted to green areas. Wetlands may need to be rebuilt or replaced.

One of the greatest challenges is remediation of sites containing ashes and cinders. Much of the Twin Cities metro area was once wetland or low lying areas which have been filled with burned household, commercial and industrial wastes. Unlike wastes from current city garbage incinerators, these older wastes were generally not completely burned and were burned at lower temperatures.

The result is waste that is often part rubbish, part ash and cinders with high concentrations of polynuclear aromatic hydrocarbons and occasionally moderately high concentrations of metals. The metals of concern are often those associated with bottom ash from city garbage incinerators such as lead, zinc, iron, copper, chromium and nickel. To date, only one ash dump site (one with low concentrations of metals) has an approved Response Action Plan. Under that plan, the rubbish will be separated and the ash will be used on-site in sub-base for an asphalt parking lot.

Most proposed remedies have been the more traditional, proven methods of soil and ground water remediation due to the limited availability of innovative remediation technologies and the risk that the technology may not accomplish the cleanup goals. The most common remedies for petroleum compounds have been land-spreading, incorporation into asphalt, venting and/or ground water pump-out. Soil with chlorinated solvents is most often sent to landfills or vented and ground water plumes contained using pump-outs. Cleanups of soil containing metals have included removal to hazardous waste landfills or sanitary landfills with leachate collection systems and capping with long term monitoring and land use restrictions.

Currently both the VIC Program and Superfund enforcement programs encourage the use of newer, more innovative technologies. There has been a strong trend in the past year toward the use of innovative technologies, mainly because the technologies have proven effective at numerous sites and they can be less costly, take less time and/or they result in a permanent remedy without any long term ground water or methane monitoring. Response action plans using bioremediation, bioventing, vapor extraction, air sparging, stabilization and solidification have been approved or are in the process of review.

GUIDANCE DOCUMENTS

Table 1 lists the VIC Program guidance documents which have been developed to provide a phased approach by which voluntary parties conduct their activities. These guidance documents are currently being revised to reflect the provisions of the 1992 state Land Recycling Act and 1993 amendments. The revised documents will be available for distribution in the fall of 1993.

—continued on next page.

Table 1. VIC Program Guidance Documents

- 1 Introduction to the VIC Program
- 2 File Evaluation Program
- 3 Summary of Applicable Laws
- 4 Types of Written Assurances
- 5 Interaction Between RCRA and the VIC Program
- 6 Selecting a Consultant
- 7 Schedule for Conducting Investigation and Response Actions
- 8 Phase I Investigation
- 9 Reporting Requirements
- 10 Site Safety and Contingency Plan
- 11 Phase II Investigation Work Plan
- 12 Phase II Investigation Report
- 13 Procedures for Establishing Soil Cleanup Levels
- 14 Approach to Ground Water Cleanup
- 15 Remedy Selection Treatment Technology
- 16 Focused Feasibility Study
- 17 Design Criteria for Vapor Extraction and Ground Water Modeling
- 18 Response Action Plan

Each document is actually a phase of work to be conducted by the volunteering party. The data generated during each phase will assist the voluntary party in determining the types of information needed during the next phase. Following the guidance documents should expedite MPCA staff review time and provide the necessary information to determine whether cleanup at the property is required.

For More Information

To be placed on a mailing list for the new guidance documents or to receive a copy of the application for admission to the program contact Kristin Nelson at 296-7291; from greater MN dial toll-free (800)657-3864. For more information about the VIC Program contact Jerry Stahnke at 297-1459 or Joe Zachmann at 296-7744.

DC Monitoring Requirements

District of Columbia staff are in the process of developing regulations for ground water monitoring wells. Currently, these wells are not regulated under the Districts' existing well program. For further information, contact the Washington, D.C., Department of Consumer and Regulatory Affairs, Environmental Regulation and Administration, 2100 Martin Luther King Jr. Ave SE, Washington, D.C., 20020, (202)404-1120.

ASBOG Geologist Exam Development Workshops Continue

The Association of State Boards of Geology (ASBOG) has been conducting test development and validation workshops to develop a national examination for geologists. Participants included representatives from the states of Arizona, Arkansas, California, Delaware, Georgia, Idaho, Indiana, South Carolina, New York, North Carolina, Tennessee, Texas, Virginia, Wyoming, and professional geological societies.

During the final workshop 20 geologists developed a list describing "What do geologists do?" that became the guiding blueprint for exam content.

The examination consists of two parts: Fundamentals of Geology and Principles and Practice of Geology. Until an appropriate statistical database has been established, the exam results will be evaluated by a national cross section of experienced geologists working under psychometricians' guidance. Arizona and Wyoming currently use the examination to test registration candidates.

For further information and schedule of future workshops, contact Sam Swinehart, Executive Director, ASBOG, P.O. Box 11591, Columbia, SC 29211-1591, fax (803) 252-2432.

NGWA Briefings - Fall 1993

New Books, etc.

University of Minnesota Press

Global Climates Since the Last Glacial Maximum, H.E. Wright, Jr., John E. Kutzback, Thompson Webb III, William F. Ruddiman, F. Alayne Street-Perrott, and Patrick J. Bartles, editors.

The result of a fifteen-year inter-institutional interdisciplinary research program, this book summarizes the geological, paleoecologic, and oceanographic evidence for environmental and climatic changes during the past 18,000 years over most of the world's continents and oceans, and compares the data with paleoclimatic simulations based on models of atmospheric general circulation at 300-year intervals from 18,000 years ago to the present. Cost \$59.95.

Available from University of Minnesota Press, (800)388-3863.

Other geology-related titles previously published:

Minnesota's Geology, Richard W. Ojakangas and Charles L. Matsch, 1982, \$26.95.

The Patterned Peatlands of Minnesota, H.E. Wright, Jr., Barbara Coffin, and Norman E. Aaseng, editors, 1992, \$44.95.

Late Quaternary Environments of the Soviet Union, A.A. Velichko, editor, H.E. Wright, Jr. and C.W. Barnosky editors of the English-language edition, 1984, \$49.95.

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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 1993. Annual dues are \$15 for professional members and \$10 for students. Additional donations toward the use of 100% recycled paper will be gratefully accepted.

Just complete the form below and mail to: MGWA, c/o WRI, 4779 126th St. N, White Bear Lake, MN 55110.

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Affiliation _____
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Work Telephone Number _____
Home Address (optional) _____
City, State, Zip Code _____
Home Telephone Number _____
Which Address should we use for Directory Listing? _____
Which Telephone Number should we use for Directory Listing? _____

Lake Sediments and Environmental History, Elizabeth Y. Harworth and John W.G. Lund, 1984, \$29.95.

Quaternary Landscapes, Linda C.K. Shane and Edward J. Cushing, editors, 1991, \$29.95.

Climate - Our Future?, Ulrich Schotterer, tr. by Kerry Kelts, 1992, \$39.95.

Handbook of Hydrology

A reference on both theory and practice, the *Handbook of Hydrology* is a survey of the field and a synthesis of the established facts of hydrology. Cost of the book is \$110.50. To order, call (800)2-McGraw.

American Water Resources Association

AWRA Symposium Proceedings on Geographic Information Systems and Water Resources, John M. Harlin and Kenneth J. Lanfear, editors.

A collection of the most recent applications of Geographic Information Systems technology to the field of water resources. It demonstrates how practicing professionals are using this exciting tool in innovative ways to solve challenging problems. Hard cover, 640 pages, cost \$76.00. Contact: AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192; (301)493-8600, fax (301)493-5844.

Environmental Software Directory

The *1992/1993 Environmental Software Directory* has 446 pages and is organized into the following chapters: hazardous substance information, legislative/regulatory information, hazardous substance management, waste management/remediation, risk and hazard assessment, general environmental/ecology, site information, geographic/geologic information systems and mapping, ground water/solid, surface water, water/waste water, air pollution, laboratory information systems, and related systems. It costs \$75. For further information, contact Donley Technology, Box 335, Garrisonville, VA 22463; (703)659-1954.

September, 1993

Environmental Leadership Journal

PRI Publishing and Rensselaer Polytechnic Institute have introduced *Corporate Environmental Strategy: The Journal of Environmental Leadership*. *Corporate Environmental Strategy* is the first journal to document the experiences of environmental strategists. The journal will appear quarterly and costs \$195 for an annual subscription. Contact: PRI Publishing 32B Wernik Place, Metuchen, NJ 08840; (908)548-4609; fax (908)548-2268.

Proceedings of Groundwater Sampling Symposium

The purpose of the National Groundwater Sampling Symposium was to compare the results of various ground water sampling methods. Nine experts from major universities, the U.S. Geological Survey, and the environmental industry presented technical papers. Copies are available through the sponsor, Grundfos Pumps, for \$17.50. Contact: Grundfos, 2555 Clovis Ave., Clovis, CA 93612; (209)292-1865, fax (209)291-1357.

In Situ Bioremediation in Ground Water

The Waterloo Centre for Groundwater Research at the University of Waterloo in Canada has evaluated six approaches to in situ bioremediation of benzene, toluene, ethylbenzene, and xylene (BTEX) in ground water. They are passive bioremediation, oxygen addition, acclimated microorganisms, the vacuum-vaporizer-well, land surface application, and subsurface volatilization and ventilation (SVVS). The findings are reported in *Reviews of Six Technologies for In Situ Bioremediation of Dissolved BTEX in Groundwater*.

A copy of the Waterloo report can be obtained by contacting Canada's Groundwater and Soil Remediation Program Manager at (416)336-6438.

Biofouling in Wells

The most common approach to addressing iron biofouling problems in wells is crisis management, even though preventive main-

tenance would be more cost effective. An American Water Works Association Research Foundation project sought to evaluate biofouling monitoring programs, field test biofilm sampling and well-performance monitoring methods and conduct a laboratory research program. The project report *Methods for Monitoring Iron and Manganese Biofouling in Water Wells* is available from AWWA Member Services (800)926-7337 (order number 90617, cost \$46).

Ground Water Database Summary

The EPA has released summaries of a massive database of information concerning pesticides in ground water. *Pesticide in Ground Water Database: A Compilation of Monitoring Studies: 1971-1991* is on EPA's interactive Pesticide Information Network (PIN). PIN user support is (703)305-7499. Hard copy of the nearly 200-page national summary report EPA-055-000-00413-7 may be purchased from the Government Printing Office for \$13. The 10 regional volumes cost between \$27 and \$112 each and are available from NTIS.

1994 Henry Darcy Distinguished Lecturer

The eighth Henry Darcy Lecturer will be **Dr. Edward Sudicky**. A professor at University of Waterloo and member of the Waterloo Centre for Groundwater Research, Dr. Sudicky has prepared a lecture on *Contaminant Migration in Complex-Structure Porous and Fractured-Porous Geologic Media: A Simulation Perspective*.

Lecture requests for the 1993-1994 academic year must be received by NGWA no later than October 8, 1993. Academic institutions may contact Jackie Mack, National Ground Water Association, fax (614)761-3446.

— AGWSE Newsletter, August-September 1993.

Swimming with the Sharks on the MGWA-AIPG Fall Field Trip

The annual MGWA-AIPG fall field trip on Saturday, September 11th to the Minnesota River Valley and environs was another "gneiss" success. The trip to southwestern Minnesota was introduced by an afternoon program in New Ulm on the 10th.

Bob Bauer, University of Missouri, Columbia, provided an introduction to the long and complicated history of the old rocks, the Morton and Montevideo Gneisses, exposed in the Minnesota River valley. These old rocks, at one time dated as the oldest in the world (3.6 billion years old), are an important window to the understanding of the formation of the North American continent as we know it today. These metamorphosed and repeatedly folded rocks are also important as economic resources of visually spectacular building facing stone.

To top off the oldest bedrock in the area, Dale Setterholm from the Minnesota Geological Survey introduced the youngest bedrock in Minnesota. Cretaceous sandstones, siltstones and shales underlie much of the southwest part of the state and are exposed in Minnesota River valley. These rocks, laid down by repeated transgressive and regressive cycles of marine seas, as demonstrated by the presence of shark's teeth like the one found on the trip, infilled ancient valleys in intensely weathered granite and other basement rocks. These zones of intense weathering are today sources of economic deposits of the clay kaolin.

Carrie Patterson of the MGS next described how she is unraveling the details of the Quaternary history of southwest Minnesota. Utilizing the latest research in glaciology and Laurentide Ice Sheet behavior, Carrie described geomorphic and other evidence of several pulses of the Des Moines lobe which were then followed by regional stagnation. She is using this

1. John Heine at Ochs' Springfield Clay Pit
2. Bob Beltrame at Morton Quarry
3. Morton Gneiss



2.



3.

better understanding of the recent glacial history of the area to identify older ice pulses, and possibly predict their geologic remnants such as buried sand and gravel bodies which may of sufficient volume, recharge and quality to be utilized as aquifers.

A complete change of pace from the usual lithified or unconsolidated geology presentation was the talk on "Rock-Art" by Guy Gibbon of the University of Minnesota Anthropology Department. He described numerous examples of Native American images on rocks throughout the United States, including the nearby Jeffers Petroglyphs.

John Heine of the Natural Resources Research Institute in Duluth provided additional detail on the kaolin resources of the area.

Protection of the area's public health and ground water resources was the focus of the talk by Bonnie Holz of Brown-Nicollet Community Health Services. She described the results of water sampling that

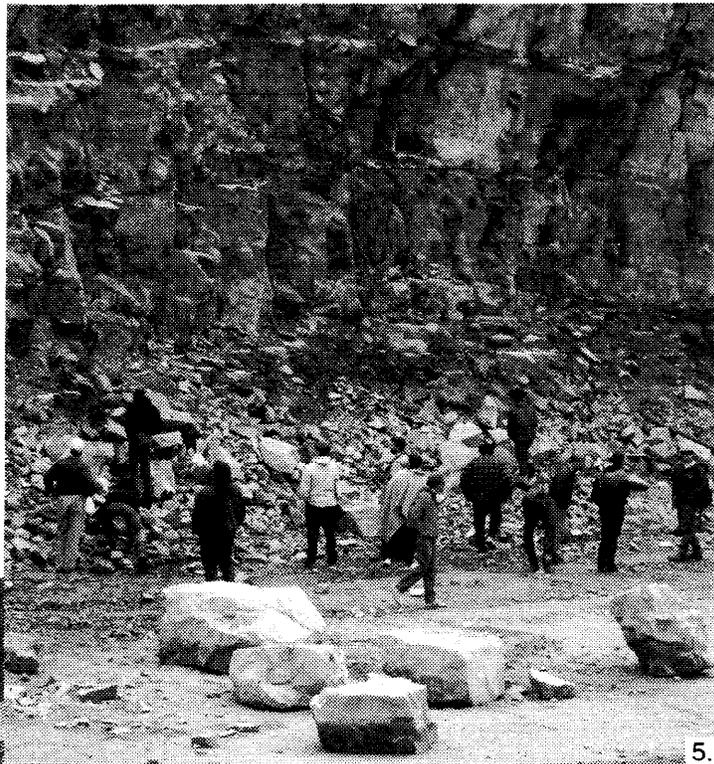
has been conducted for several years. High levels of nitrates in water supplies have been found widely in the area, prompting further work to identify the sources and controls of this contamination. Bonnie is currently working towards the development of Best Management Practices (BMP's) to protect ground water resources in the future.

Wrapping up the program for the afternoon, Tim Larson from the Minnesota Pollution Control Agency reviewed the health of the Minnesota River and the results of the Minnesota River Assessment Project. He pointed out that while contamination from point sources, such as sewage treatment plants, has been reduced, contamination from non-point sources, such as run-off, continues to be a problem. A basin-wide implementation plan to address non-point contamination sources is currently underway.

— Jan Falteisek, editor



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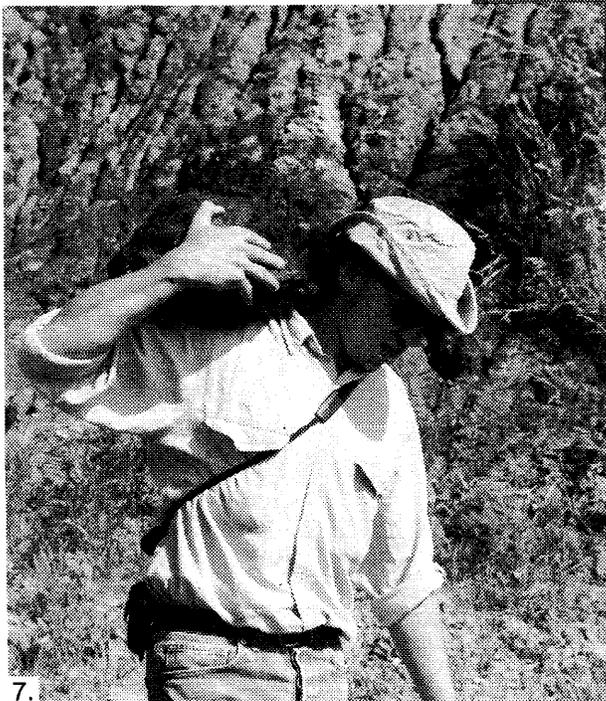
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- 4. Fossil Search at Ochs' Springfield Clay Pit
- 5. New Ulm Quartzite Quarry
- 6. LaBrea Clay Pits (Ochs Morton Clay Pit)
- 7. Nice hat, Jay!
- 8. Redwood Falls lunch stop

photos by Sean Hunt



7.



New Gibson Professor at U of MN

Last spring, Mark Person joined the Department of Geology and Geophysics at the University of Minnesota as the Gibson Chair of Hydrogeology. From the University of New Hampshire, Dr. Person has set up shop in the basement of Pillsbury Hall where he has filled his office space literally wall to wall with the computers and related gear of the new Gibson Computational Hydrogeology Lab. He intends to make good use of this equipment to continue his research in regional-scale hydrogeology of sedimentary basins. Person has developed finite-element-based mathematical models to evaluate the role of regional-scale ground water flow in geologic processes such as the genesis of mineral and energy deposits. His study areas have included the Rhine Graben, the Great Artesian Basin in Australian, and the Rio Grande Rift System. He is also developing interactive educational modeling software for the hydrogeologic community.

Dr. Person received his M.S. in hydrogeology from New Mexico Institute of Mining and Technology (1984) and his Ph.D. in hydrogeology from Johns Hopkins University (1990). He was a postdoctoral fellow at the Ecole des Mines in Paris in 1991. Prior to beginning graduate studies at Johns Hopkins he worked at the USGS in Reston.

According to Dr. Person, "a critical mass now exists within the Geology and Geophysics Department for graduate studies in hydrogeology." Together with Dr. E. Calvin Alexander, Jr., and Dr. H.O. Pfannkuch, a revamped hydrogeology program is being developed that will feature a year-long, three-quarter basic program of physical, quantitative and chemical hydrogeology. Person also plans to add an introductory class in fluid mechanics for undergraduate earth science students. Advanced classes will include "Numerical Methods in Sub-surface Flow" and "The Role of Ground Water Flow in Geologic Processes Within the Earth's Crust."

U of M Starts September 23rd

Geology and Geophysics hydrogeology-related courses fall quarter:

Glacial Geology (5261) - 4-5 cr, 9:05-9:55 MWF, 3 field trips, Herb Wright.

Groundwater Geology (5611) - 4cr, lecture 8:05-8:55 MWF; lab 8:00-8:50Th, Olaf Pfannkuch.

Tracers in Hydrogeology (5613) - 3cr, 3:00-5:00 M, Calvin Alexander.

Transport Phenomena in Natural Porous Media (8617) - 2-3 cr, 3:35-5:30W, Olaf Pfannkuch.

Selected fall quarter Civil Engineering courses:

Fluid Mechanics (3400) - 4cr, lecture 9:05-9:55 MWF, eight lab sections, C. Farell.

Groundwater Mechanics (5425) - 4cr, 2:30-4:25 MW, Otto Strack.

Mass Transport with Environmental Applications (5504) - 4cr, 3:35-5:30 MW, John Gulliver.

Environmental Water Chemistry (5506) - 4cr, 1:25-3:20 MW, Steve Eisenreich.

Check the class schedule for further details, prerequisites and requirements.

AIPG Meeting Schedule

AIPG meets monthly, at 11:45 on a Tuesday, at the Holiday Inn Roseville.

October 19: **Registration, Politics, and the Future of the Geologic Profession.** Phil Davis, AIPG Minnesota Section President.

November 2: **Aggregate Use and Resources in the Twin Cities Area.** J.D. Lehr, Minnesota DNR Division of Minerals.

December 7: **Wellhead Protection in Mining Districts.** Perry Jones, U.S. Bureau of Mines.

January 11: **Recent Geologic Investigations of the Duluth Complex.** Mark Severson, Natural Resources Research Institute.

WRRC Hydrogeology Grant

The Water Resource Research Center has awarded four research grants for 1993/1994. One of the selected projects is *Hydrogeology of the Itasca moraine, northcentral Minnesota: spatial distribution of recharge, ground water residence time, flow system dynamics, and regional influence.*

The principal investigator is Howard Mooers, Department of Geology, UMD. The project will assess the regional hydrology and establish baseline hydrologic and water quality data for the Itasca moraine, a massive glacial end moraine in northwestern Minnesota.

Little is known about how the moraine may control or influence hydrologic conditions over this area, which represents one-fourth of the land surface of Minnesota. The moraine's influence could potentially include control of the regional ground water flow and dynamics of deep confined aquifers. Results of the project will include:

- 1) maps (glacial-geomorphology, cross sections of hydrostratigraphic and physical characteristics, and spatial distribution of ground water recharge);

- 2) models (influence of the Itasca moraine on regional ground water flow and preliminary 3-D models of the interaction of ground water and surface water); and

- 3) geochemical and age-dating descriptions of ground water chemical evolution, quality, and residence time. The study may benefit all ongoing hydrological research in the area, especially that involving management questions of ground water quality and supply, and potential effects of climate change on water resources in the region.

— *Minne-gram*, WRRC, August 1993.

Directory Update

These corrections and additions are current through September 15, 1993. Please let us know when your information changes!

Listing Format:

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(not necessarily at work)
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Fax Number

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Outdoor Action Conference Comes to Minneapolis

The National Ground Water Association is bringing its eighth National Outdoor Action Conference and Exposition to the Minneapolis Convention Center, May 23-25, 1994.

Papers on research projects or field studies in the following tracks will be considered:

- Remediation
- Sampling and Analysis of Monitoring Wells
- Borehole Geophysics
- Surface Geophysics
- Regulations/Compliance
- Drilling Technology
- Drilling Safety
- Consultant Management
- Contractor Management
- Glacial Geology and Hydrology

Only a limited number of papers will be selected for presentation to ensure the information presented represents the best in the field.

Outdoor workshops and demonstrations are an important part of this conference. Demonstrations should last 30 minutes, workshops should last from one to two hours. Presenters should share field techniques, sampling, and remediation technologies which solve problems. "Hands-on" applications should be stressed.

The deadline for receipt of abstracts and proposals for workshops or demonstrations is November 12, 1993; completed manuscripts must be received by February 28, 1994. For format and other requirements, contact:

Sherry Morse, Coordinator
8th National Outdoor Action Conference
NGWA
6375 Riverside Drive
Dublin, OH 43017
(800)551-7379
fax (614)761-3446.

Fall 1993 Geology Seminars

Seminars are presented on Thursdays (unless otherwise noted) in the Department of Geology and Geophysics at 3:30 pm in 110 Pillsbury Hall, followed by refreshments in 121 Pillsbury Hall.

September 23: **Professor W. E. Seyfried, Jr.**, Head, N. H. Winchell School of Earth Sciences; *Welcome and Introduction to the New Academic Year.*

September 30: **Dr. Deborah Kelley**, School of Oceanography, University of Washington, Seattle; *Fluid Evolution in Submarine Magma-Hydrothermal Systems.*

and

October 1: 10:30 am, 121 Pillsbury Hall; *Carbon-Bearing Fluids in the Oceanic Crust.*

October 1: **Dr. Alexander Gorshkov**, International Institute of Earthquake Prediction and Mathematical Geophysics, Russian Academy of Sciences, Moscow; 3:30 pm 121 Pillsbury Hall; *Recent Block Structure of the Crust and its Interrelation with Seismicity and Mineralization.*

October 7: **Dr. Peter McSwiggen**, MN Geological Survey, University of Minnesota, St. Paul; *The Occurrence of Aerigine and Barium Feldspar in the Cuyuna Iron Range, MN: Relevance to the Depositional Environment of Manganiferous Iron Formation.*

October 14: **Dr. Laurel Woodruff**, U.S. Geological Survey, St. Paul; *Keeweenawan Copper Deposits of Northern Michigan.*

October 21: **Dr. Neal Iverson**, Department of Geology and Geophysics, University of Minnesota, Minneapolis; *Entrainment and Deposition of Sediment at Glacier Beds.*

October 28: GSA Meeting — No Seminar

November 4: **Dr. Millard F. Coffin**, Institute for Geophysics, University of Texas at Austin; *Volcanism and Continental Breakup: The Atlantis Story from Large Igneous Provinces.*

November 11: **Dr. Gary Ernst**, Dean of the School of Earth Sciences, Stanford University; *Petrotectonic Evolution of the Klamath Arc.*

and

November 12: 10:30 am, 121 Pillsbury Hall; *Earth Systems Science Curricula — How We Did it at Stanford.*

November 18: **Dr. Stein-Erick Lauritzen**, on Sabbatical Leave from the Department of Geology, University of Bergen, Norway; *Contributions of Karst Research to the Study of Global Change*

November 25: Thanksgiving Holiday — No Seminar

December 2: **Dr. Paul Glaser**, Limnological Research Center, University of Minnesota, Minneapolis; *To be announced.*

Geologists Now Statutorily Defined in Oklahoma

A bill defining geology and geologists in Oklahoma was signed into law July 1, 1993. The bill included a restrictive grandfather clause.

For more information, contact the Oklahoma Geological Survey, phone (405)325-3031.

—AGWSE Newsletter,
August-September, 1993

Pennsylvania Geologist Registration Law

On December 16, 1993, it will become illegal to practice geology in Pennsylvania without a license. The Prof. Engineers and Land Surveyors Law now includes geologists and requires that two geologists be named to the registration board. For information, contact the State Board of Prof. Engineers, Land Surveyors and Geologists, 6th Floor, Trans. and Safety Bldg., Harrisburg, PA, 17120-0029.

—AGWSE Newsletter, June-July, 1993.

Calendar

October 6-8, 1993. Midwest Ground Water Conference, Champaign, IL. FFI: Steve Burch, Illinois Ground Water Survey, ph. (217) 333-5388.

October 7-14, 1993. Second USA/Hungary Joint Conference on Environmental Hydrology and Hydrogeology, Budapest, Hungary, in cooperation with the Hungarian Hydrological Society and the American Institute of Hydrology. An associated workshop, Chemical and Biological Remediation Technologies in the Hydro-Environment: Research, Development and Application, is also planned. Contact AIH, 3416 Univ. Ave. S.E., Minneapolis, MN 55414-3328, ph. (612) 379-1030, fax (612) 379-0169.

October 11-14, 1993. Introduction to Ground Water Geochemistry. Nashville, TN. To be held by NGWA.

October 11-15, 1993. Capture Zone Analysis for Contaminant Remediation and Wellhead Protection. Nashville, TN. To be held by NGWA.

October 17-20, 1993. 45th National Ground Water Association Convention and Exposition. Kansas City, MO. To be held by NGWA.

October 20-22, 1993. December 6-8, 1993 (various locations), Modeling Workshop for Landfill Design and Evaluation (HELP 3.0). Sponsored by University of Wisconsin, Milwaukee. FFI: Stephen J. Scott (414) 227-3115.

October 21-22, 1993. Minnesota Association for Environmental Education Conference, St. Paul Student Center, Univ. of MN, St. Paul. Contact MN Assoc. for Environ. Education, 3815 E. 80th St., Bloomington, MN 55425-1600, ph. (612) 854-5900.

October 25-28, 1993. Annual Meeting, Geological Society of America, Boston, MA. FFI: GSA Meetings Department, ph. (800)472-1988, fax (303)447-0648.

October 25-29, 1993. Safety at Hazardous Materials Sites: A 40-Hour Hands-On Workshop. Valhalla, NY. To be held by NGWA.

October 26-27, 1993. 26th Annual Water Resources Conference,

Earle Brown Center, University of Minnesota, St. Paul Campus. Sponsored by University of Minnesota and American Society of Civil Engineers, Minn. Section. FFI: Bev Ringsak, (612) 625-6689.

October 27-29, 1993. Rocky Mountain Ground Water Conference, Albuquerque, NM. Call for papers, deadline May 28, 1993. Will be held in conjunction with the Sixth Annual Conference of the New Mexico Section of the American Water Resources Association. FFI: Michael Campana, Dept. of Earth and Planetary Sciences, Univ. of New Mexico, Albuquerque, ph. (505) 277-3269, fax (505) 277-8843 or William Stone, NMED-Ground Water, Santa Fe, ph. (505) 827-2434, fax (505) 827-2965.

November 1-3, 1993. 4th National Pesticide Conference: New Directions in Pesticide Research, Development, Management, and Policy. Richmond, VA. FFI: Diana L. Weigmann, Virginia Water Resources Research Center, VPI&SU, ph. (703)231-5624.

November 8-9, 1993. Contemporary Interpretation of Inorganic Water Quality Data: A Practical Geochemical Approach Using Personal Computers and the Program WATEVAL. Houston, TX. To be held by NGWA.

November 8-9, 1993. In Situ and On Site Bioremediation, Houston, TX. Class precedes NGWA National Conference at the conference facility. FFI: Int. Network for Environmental Training, Potomac, MD, ph. (301)299-1150, fax (301)299-8653.

November 8-12, 1993. Soil and Groundwater Remediation, Los Angeles, CA. Short course sponsored by UCLA Extension. FFI UCLA Extension, Short Course Program, 10995 Le Conte Ave., Suite 515, Los Angeles, CA 90024-2883, ph. (310) 825-3344, fax (310) 206-2815.

November 10-12, 1993. Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration — A Conference and Exposition. Houston, TX. To be held by NGWA.

November 15-19, 1993. MODFLOW for Simulation of Ground Water Flow and Advective Trans-

port. San Diego, CA. To be held by NGWA.

December 6-10, 1993. American Geophysical Union Fall Meeting. San Francisco, CA. FFI (202)462-6900.

February 2-4, 1994. Forum on Remediation of Ground Water Contamination. Denver, CO. To be held by NGWA.

February 16-19, 1994. Breakthroughs in Karst Geomicrobiology and Redox Geochemistry, Colorado Springs, CO. Contact, Arthur Palmer, Earth Sciences Dept., SUNY Oneonta, Oneonta, NY 13820-4015, ph. (607)436-3064, fax (607)436-2107.

March 27-30, 1994. Second International Conference on Ground Water Ecology, Atlanta, GA. To be held by AWRA.

April 10-13, 1994. Toxic Substances and the Hydrologic Sciences. Austin, TX. FFI AIH, 3416 University Ave. SE, Minneapolis, MN 55414-3328. (612)379-1030, fax (612)379-0169.

April 11-15, 1994. Transport and Reactive Processes in Aquifers — IAHRS Symposium, ETH-Zurich, Switzerland. Contact Th. Dracos or F. Stauffer, Institute of Hydromechanics and Water Resources Management (IHW), ETH-Honggerberg, CH-8093 Zurich, Switzerland, ph. (01) 377 30 66 or (01) 377 30 79, fax (01) 371 22 83.

April 28-29, 1994. GSA North-Central Section Meeting. Kalamazoo, Michigan. FFI Alan Kehew, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616)387-5495 fax

More details available from:

AWRA, contact Michael C. Fink, AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192, (301)493-8600, Fax: (301)483-5844.

NGWA, 6375 Riverside Drive, Dublin, Ohio 43017 (614) 761-1711.

IGWMC, Institute for Ground Water Research and Education, Colorado School of Mines, Golden, Colorado 80401-1887, (303)273-3103, Fax (303)273-3278.

Changes at Minnesota Geological Survey

Grew now at University of Nebraska-Lincoln

Priscilla Grew, Director of the Minnesota Geological Survey since 1986, has accepted a position of Vice Chancellor for Research at the University of Nebraska-Lincoln beginning September 1993. At the University of Nebraska-Lincoln she will hold joint appointments in the Department of Geology and the Conservation and Survey Division of the Institute of Agriculture and Natural Resources. She will oversee all research activity, the Office of Grants and Contracts, patent and technology transfer, Institutional Animal Care, the Experimental Program to Stimulate Competitive Research, interdisciplinary research centers, the University of Nebraska State Museum, the University of Nebraska Press, the Whittier facility, and other research support programs.

Prior to being Director of the MGS, Grew was commissioner of the California Public Utilities Commission from 1981 to 1986, director of the Department of Conservation for the State of California from 1977 to 1981, and from 1972 to 1977, a research geologist at the Institute of Geophysics and Planetary Physics at the University of California, Los Angeles.

The interim director, David L. Southwick, will serve for one year, from September 1, 1993, while a nationwide search for a permanent director is held.

MGS Newsletter, Summer, 1993

David L. Southwick Interim Director of MGS

David L. Southwick has accepted an appointment as Interim Director of the Minnesota Geological Survey, a unit of the Institute of Technology at the University of Minnesota. He is filling the vacancy created by the departure of Priscilla Grew for the University of Nebraska-Lincoln.

Southwick is a native Minnesotan who received his B.A. at Carleton College and his Ph.D. at the

Johns Hopkins University in Baltimore. He is currently Assistant Director and Research Associate at the MGS, and has been on the survey staff since 1977. Dr. Southwick, who previously worked for the U.S. Geological Survey and taught at Macalester College, is also an Adjunct Professor at the Department of Geology and Geophysics at the University of Minnesota. His research interests are structural geology and tectonics, especially as they apply to the geology of Minnesota.

In accepting the appointment, Southwick said, "The mission of the Minnesota Geological Survey since 1872 has been to understand the geology of the state and apply that knowledge to the needs of Minnesotans. My job is to ensure that we continue to do that in the next year and well into the future."

MGS News Release

Anoka Sand Plain Hydrogeology and Geology Maps Available

The Minnesota Geological Survey (MGS) and the Minnesota Department of Natural Resources (DNR) recently published the Anoka Sand Plain Regional Hydrogeological Assessment. The set of three color plates describes the surficial geology and hydrogeology of Anoka, Chisago, Isanti and Sherburne Counties in east-central Minnesota. Presented at a scale of 1:200,000, the Assessment summarizes three years of work by the MGS and DNR staff. Published by the DNR, the Assessment is available from MGS Map Sales, (612)627-4782. Electronic coverages in either EPPL7 or Arc/Info are available from the Land Management Information Center, by contacting Chris Cialek at (612)297-2488.

In addition, a GIS-based (ARC/INFO) 1:100,000-scale map of Isanti County showing aggregate resources and Quaternary Geology was completed by J.D. Lehr, DNR-Minerals Division. The map can be obtained by calling (218)262-6767.

Water '94

The WRRC is planning a Minnesota water conference to be held at the Minneapolis Convention Center on April 21 and 22, 1994. The conference will offer a broad spectrum of issues relevant to the management of Minnesota's rivers and watersheds. This is the fourth in a biennial series of Minnesota water conferences sponsored and organized by the WRRC, in cooperation with the Water Resources Committee of the Minnesota Environmental Quality Board and the district office of the USGS. The '94 conference organizing committee will include representatives from state, local, federal, and University water agencies and programs.

GSA Forum Features Hydrogeology

The July and September GSA Forum, a regular feature of GSA Today, included a condensation of a special forum on ground water clean-up and management concerns held at the 1992 GSA Annual Meeting. The forum included representatives of the Natural Resources Defense Fund, ENVIRON Corporation, RCG, Hagler, Bailly, Inc., and the American Ground Water Trust of Dayton, OH. Fletcher Driscoll of Geraghty & Miller and John Cherry, University of Waterloo, also contributed to the forum.

Ogallala Aquifer

In case you didn't catch it, the March 1993 *National Geographic* included an article on the Ogallala Aquifer. Reprints can be ordered from *National Geographic* at (800)638-4077.

In addition, a new publication, *Flat Water: A History of Nebraska and Its Water*, is available from the Conservation and Survey Division, 113 Nebraska Hall, Lincoln, NE 68588-0517, (402)472-7523, for \$20 plus \$1.50 postage.

The Aquifer, June 1993

MGWA Fall Conference

Land Use and Ground Water Protection: Making the Connection

November 30, 1993
Earle Brown Center
1890 Buford Avenue

St. Paul Campus of the University of Minnesota

Sponsoring Organizations:

Minnesota Ground Water Association; Sensible Land Use Coalition
Minnesota Environmental Initiative; Minnesota Chapter of the American Planning Association

Ground water is a hidden resource which provides vital drinking water for both public and private water supplies, yet it is vulnerable to contamination from many common activities. Contamination may harm both human health and ecosystems, and is very costly, if even possible, to clean up. Through effective planning and land use controls, sensitive ground water supplies can be protected from contamination. The goal of this conference is to present what works and doesn't work at the local level to protect ground water, and to describe the regulatory framework in which these tools exist. All participants will receive a copy of the new publication, *Guidebook for Local Ground Water Protection in Minnesota*, included with the registration fee.

Who should attend: Local planners and zoning administrators, ground water professionals, people who propose and implement land development projects.

Program schedule:

Registration starts at 8 AM, presentations begin at 8:30. Adjourn at 3:30.

Morning plenary presentations:

Keynote: *Land Use Planning as a Tool in Groundwater Protection.*

Martin Jaffee, Professor at the University of Illinois School of Urban Planning and Policy.

Integrating Federal Ground Water Protection Efforts.

Jerri Ann Garl, Head of EPA Region 5's Ground Water Branch

State Ground Water Developments and Initiatives. Speaker to be Announced

Strategic Management of Local Water Resources: Olmsted County's Experience.

Terry Lee, Olmsted County Water Planning Coordinator

The Role of Private Foundations in Ground Water Protection.

Wanda Johnson, Nebraska Groundwater Protection Federation

Private Sector Water Planning. To be Named, Anglican Water Services, England

Afternoon concurrent sessions:

Ground Water Issues and Land Development
Development and Ground Water Protection

Zoning and Alternative Land Use Controls
Information Resources /Needs for Ground Water Protection

Fees and Registration Information: \$60 advance, \$65 at the door. Registration is limited to the first 200 paid attendees. All paid attendees receive a copy of "Guidebook for Local Ground Water Protection in Minnesota", and a list of registered conference speakers and participants, along with lunch and refreshments at breaks.

Send the registration form to: Minnesota Ground Water Association, P.O. Box 65362, St. Paul, Minnesota 55165. Make checks payable to the MGWA. Key contact for answering questions: Gretchen Sabel, MPCA (612) 296- 0550

LAND USE AND GROUND WATER PROTECTION: MAKING THE CONNECTION

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Is it OK to include your name in the list of participants? Yes No

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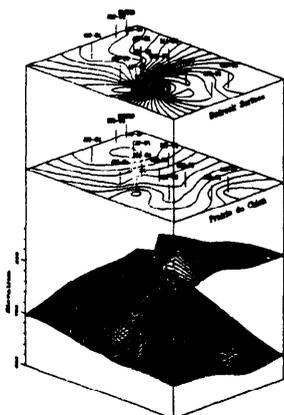
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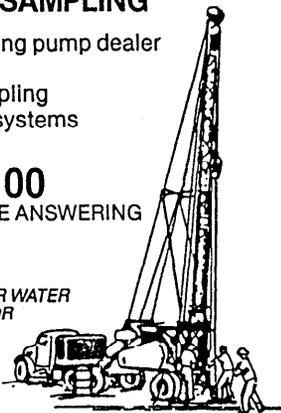
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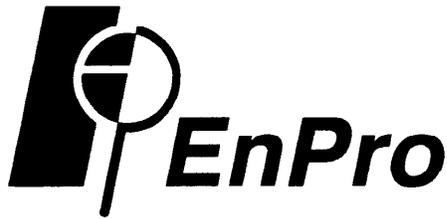
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