Let's Keep It Clean

Exploring A Collaborative Approach to Groundwater Protection

2011 Groundwater Foundation National Conference and Groundwater Guardian and Green Site Designation Celebration

October 4-5-6, 2011 ~ Omaha, Nebraska

Conference Proceedings
CONFERENCE AGENDA

Click on bold blue titles to view presentations.

Tuesday, October 4

12:00 p.m.  Conference registration

12:45 p.m.  FIELD TOUR

Nitrates and Other Potential Contaminants: Issues and Solutions
Groundwater Foundation Welcome
Concerns and Issues Round Robin
Conference participants share and discuss what groundwater issues they face in their own communities.

Contamination Risks: Nitrates and Other Threats
Dick Ehrman, Lower Platte South Natural Resources District, Lincoln, NE

2:30 p.m.  Arrive Seward, NE Water Treatment Plant
Host: David Lathrop, City of Seward Water Department, Seward, NE
Learn about the community’s nitrate issues and solutions, including a tour of the reverse osmosis treatment plant, use of weather stations, soil probes, and evapotranspiration gauges, and how they’ve addressed the location of an oil pipeline. (View Presentation Slides)

4:00 p.m.  Load bus to return to Omaha
Phytoremediation in Murdock, Nebraska
Lorraine Lafreniere, Argonne National Laboratory, Argonne, IL; Robert Sedivy, Argonne National Laboratory, Lincoln, NE

Wellhead Protection Network: Connections and Collaborations
Facilitator: Jamie Oltman, The Groundwater Foundation, Lincoln, NE

Nebraska’s Wellhead Protection Program Updates
Ryan Chapman, Wellhead Protection Coordinator, Nebraska Department of Environmental Quality, Lincoln, NE

Successes and Challenges from Michigan
Guest Presenter: Christine Spitzley, TriCounty Regional Planning Commission, Lansing, MI

Using Groundwater Models to Perform a Nitrate Alternatives Analysis for the City of Edgar, Nebraska
Karen Griffin O’Connor, Olsson Associates, Lincoln, NE

5:30 p.m.  Tour participants arrive at conference hotel

6:30 p.m.  Networking Dinner, Sponsored by Rain Bird Corporation
Speaker: Dave Johnson, Rain Bird Corporation
Presentation of Intelligent Use of Water Award to Grand Island Groundwater Guardians
CONFEREECE AGENDA

Wednesday, October 5

7:15 a.m.  Conference registration
Exhibits open

7:45 a.m.  GENERAL SESSION
Let’s Keep It Clean – The Collaborative Approach
Jane Griffin, President, The Groundwater Foundation, Lincoln, NE

Panel Discussion — Components of Collaborative Groundwater Protection (View Presentation Slides)
Moderator: Mike Jess
Panelists: Eugene Glock, Farmer/Ag Producer, Rising City, NE
Rachael Herpel, City of Lincoln, NE Groundwater Guardian Team
Megan Kolaczyn, Elkhart Environmental Center, Elkhart, IN
Dick Ehrman, Lower Platte South Natural Resources District, Lincoln, NE

8:40 a.m.  Networking break, exhibits open

BREAKOUT SESSIONS

Urban/Rural Partnerships
Moderator: Jay Beaumont

9:00 a.m.  Sustaining Groundwater Systems through Ecosystem Functions in the Built Environment
Ted Hartsig, Olsson Associates, Omaha, NE

9:30 a.m.  Refinement of an Existing Regional Groundwater Model to Implement a Wellhead Protection Plan for Nitrates: A Hastings, Nebraska Case Study
Luca DeAngelis, HDR Engineering, Kansas City, MO

Community Engagement
Moderator: Don Kraus

Connecting Community through Groundwater Guardian and Green Sites
Theresa McGeady, Miami Conservancy District, Dayton, OH; Jennifer Wemhoff, The Groundwater Foundation, Lincoln, NE

Water Replenishment District Engaging and Educating Latinos on Water Conservation
Elsa Lopez, Water Replenishment District, Lakewood, CA

10:00 a.m.  Unique Aquifer Storage and Recovery will Restore Depleted Aquifer
Denice Bruce, Professional Engineering Consultants, Wichita, KS

10:25 a.m.  Networking break, exhibits open
10:45 a.m.  
**Urban/Rural Partnerships**  
*Moderator: Rick Karlin*  
**Using Zoning Regulations to Promote Low Impact Development and Water Quality**  
Steve Miller, Olsson Associates, Lincoln, NE  
**Sustaining Water Conservation for the Long-Term**  
Rachael Herpel, University of Nebraska–Lincoln, Lincoln, NE

11:15 a.m.  
**Wellhead/Groundwater Protection Audit Tool**  
Christine Spitzley, Tri-County Regional Planning Commission, East Lansing, MI  
**Inspiring Action through Community-wide Awareness Program: The Results**  
Brian Reetz, The Groundwater Foundation, Lincoln, NE and Lois Shelton, former Mayor, Wayne, NE

11:45 a.m.  
**Business Leadership in Sustainability**  
Tom Henning, Assurity Life Insurance Company, Lincoln, NE  
**Linking Systems: Insights for Sustainability from an Integrated Coupled Hydrological, Social and Ecological Model of Groundwater and Surface Water**  
Stephen Gasteyer, Michigan State University, Lansing, MI

12:15 p.m.  
Networking Lunch, Sponsored by Central Nebraska Public Power and Irrigation District and T-L Irrigation  
*Presentation of the Kremer Award to Lee Orton*  
Speaker: Cliff Treyens, National Ground Water Association, Westerville, OH  
(View Presentation Slides)

1:30 p.m.  
**Land-Use Planning**  
*Moderator: Cathy Lotzer*  
**Taking the E out of ET**  
Robert Klein, University of Nebraska-Lincoln, Lincoln, NE  
**Identification of Potential Nitrate Sources to a Shallow Aquifer in Southeastern Nebraska**  
Dana Divine, Lower Platte South Natural Resources District, Lincoln, NE

2:00 p.m.  
**Groundwater Protection in an Urban Landscape**  
Chris Barnett, Marion County Wellfield Education Corp. and John Mundell, Mundell Associates, Indianapolis, IN  
**Hydraulic Fracturing: Facts and Questions**  
John Albert, Water Research Foundation, Denver, CO

2:30 p.m.  
**Environmental Impacts of Increased Ag Production**  
Marc Andreini, Water for Food Institute, University of Nebraska, Lincoln, NE  
**Nebraska Grout Task Force: Unexpected Results – New Solutions**  
Tom Christopherson, NE Department of Health and Human Services, Lincoln, NE
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>3:00 p.m.</td>
<td>Networking break, exhibits open</td>
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<tr>
<td>4:00 p.m.</td>
<td>Groundwater Guardian and Green Site Designation Ceremony <em>(View Presentation Slides)</em>&lt;br&gt;All conference participants are invited to attend!</td>
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<td>5:30 p.m.</td>
<td>Celebratory Reception, sponsored by Gothenburg Water Utilization Research Center and Rembolt Ludtke</td>
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<td>6:30 p.m.</td>
<td>Celebratory and Networking Dinner&lt;br&gt;<em>Speaker: Dean Jacobs, Author/Photographer, Fremont, NE</em></td>
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<td>Thursday, October 6</td>
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<tr>
<td>7:30 a.m.</td>
<td>Load bus for tour</td>
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| 7:45 a.m. | **FIELD TOUR**<br>*View Presentation Handout*
|           | Low Impact Development<br>Tour of low impact development areas at the Douglas County Health Center Campus, Omaha, NE<br>Kent Holm, Douglas County Environmental Services, Omaha, NE |
| 9:00 a.m. | Travel to Valmont Irrigation<br>Smart Utilization of Irrigation to Feed the World<br>*James Burks, Senninger Irrigation, Clermont, FL and Tom Spears, Omaha, NE* |
| 9:45 a.m. | Arrive at Valmont Irrigation<br>Tour Valmont’s facility and learn about trends that will shape the future of agriculture and how they will affect the demand for irrigation water. |
| 11:00 a.m.| Lunch at Valmont                                                       |
| 12:00 p.m.| Wrap up/Summary of the 2011 Groundwater Foundation National Conference<br>*Ann Bleed, Ann Bleed and Associates, Lincoln, NE* |
| 12:30 p.m.| Load bus to return to Omaha<br>*Closing remarks by Groundwater Foundation Staff* |
| 1:00 p.m. | Arrive at hotel, conference adjourns                                    |
James Burks has enjoyed over 28 years of working in the field of agricultural irrigation and having the opportunity to serve this industry while living in Nebraska, Kansas, California, Idaho, and Florida. James currently serves as President of Senninger Irrigation Inc. in Clermont, Florida. He is a proud graduate of the University of Nebraska College of Agriculture and is a member of The Groundwater Foundation’s Board of Directors.

Tom Christopherson has been the program manager for the Water Well Standards and Contractors’ Licensing Program for the Nebraska Department of Health and Human Services since 2004. Since 1999 he has served as public information contact and co-coordinator for the Nebraska Grout Task Force project. He holds a Nebraska Water Well Drilling and Pump Installation Contractors’ license and is the 2011 William A. McEllhiney Distinguished Lecturer in Water Well Technology for the National Ground Water Association.

Luca DeAngelis is a registered professional engineer and professional geologist with HDR Engineering. He has 15 years experience in the environmental and water supply industries and has helped numerous communities in the Midwest locate, develop, and protect water supplies and his experience includes designing over 100 water supply wells in most major Midwestern aquifers.

Dana Divine has a BS in Geology from the University of Nebraska-Lincoln and a MS in Geology from Washington State University. After finishing her master’s degree, she became a licensed hydrogeologist and worked as a consultant for five years in the Seattle area. In 2007, Dana returned to Nebraska and is the Project Coordinator for the Eastern Nebraska Water Resources Assessment.

Todd Drefcinski is a Sanitarian with the Kendall County Health Department in Yorkville, Illinois, and a Licensed Environmental Health Practitioner. He is responsible for inspecting food facilities, conducting well and septic permit reviews and installation inspections, managing the county’s non-community water supply program, and integrating GIS into the department’s Environmental Health programs. He is a member of the Northeastern Illinois Regional Groundwater Protection Planning Committee.

Dick Ehrman is a Water Resources Specialist for the Lower Platte South Natural Resources District in Lincoln, Nebraska, where his duties include managing the ground and surface water monitoring programs for the District and assisting in implementation of
the District's Ground Water Management Plan. He is a licensed Professional Geologist in Nebraska, and is also an adjunct instructor of geology and astronomy at Doane College.

Dr. Stephen Gasteyer is an Assistant Professor of Sociology at Michigan State University. Dr. Gasteyer's research focuses on rural community leadership, decision-making and management capacity around key natural resources and development sectors, specifically the dynamic social networks and systems involved in water and wastewater infrastructure systems and the processes and systems around economic and agricultural development. Note: This paper will be co-presented with Nicholas Brozovic, Associate Professor, Department of Agriculture and Consumer Economics, University of Illinois and Ximing Cai, Associate Professor, Department of Civil and Environmental Engineering, University of Illinois.

Eugene Glock was born and raised in Butler County, Nebraska where he farms 720 acres with his son. He has served a wide variety of organizations over the years, including the Butler County Soil and Water Conservation District Board (until the formation of Natural Resources Districts), Ag Builders of Nebraska Board, University of Nebraska’s Chancellor’s Advisory Council and President’s Advisory Council, State Agriculture Representative for Senator Bob Kerrey, and Nebraska’s Water Policy Task Force.

Jane Griffin serves as president of The Groundwater Foundation; she has been with the Foundation since 2008. Jane’s education and professional career have been both in the United States and Italy. She received a BA from Smith College in Northampton, Massachusetts and a diploma from the Universita’ Internazionale dell’Arte in Florence, Italy. Jane has always believed in the power of education and strives to fulfill the mission of The Groundwater Foundation through effective and creative educational programs.

Ted Hartsig is a soil scientist and senior project manager with more than 27 years of experience in natural resources management and restoration, including restoration of streams and riparian resources, stormwater management, land planning, and restoration of disturbed and contaminated land. In addition to his project-related experience, Ted has been prominent in addressing soil science issues of national scope, including chairing the committee that established soil science practice standards. He is a founding member of the National Council of Soil Science Examiners.

Tom Henning is Chairman, President, and CEO of Assurity Life Insurance Company. Tom has served as President of Assurity Life or successor companies for over 22 years. He is active in many industry groups including the American Council of Life Insurers. Tom serves many civic organizations including the University of Nebraska Foundation and Innovation Campus, the Lincoln Chamber of Commerce, Lincoln Chamber Economic Development Corporation. Tom and his wife Candy also operate Henning Farms.

Rachael Herpel is an education and outreach specialist housed in the University of Nebraska-Lincoln Water Center. She serves as a liaison between the University’s water faculty and the Nebraska Legislature, Natural Resources Districts, and other water resources decision-makers from across the State. Rachael returned to UNL in 2008, after 10 years working on community education and action programs for The Groundwater Foundation.

Kent Holm is the director of Environmental Services for Douglas County. Kent is responsible for county planning and zoning, building permits and inspections, landfill operations, weed control, landscape maintenance, snow removal, and County stormwater permit program. He is a certified Stormwater Manager and a Certified Arborist in Nebraska. Kent coordinated the County’s update of its Comprehensive Plan and zoning regulations that require conservation design and progressive stormwater management.

Dean Jacobs, a native of Nebraska, left a secure job with corporate America to pursue a dream to travel around the world and understand the world we share. Sharing his experiences during four years of exploring in over 50 countries that exposed him to the goodness of humanity and the magnificent natural beauty in the world, he offers audiences the opportunity to see these qualities in others and themselves, and leaves them with many choices and decisions on how to make their world a better place to live.

Dave Johnson is Rain Bird Corp’s Director of Corporate Marketing. He is a certified landscape irrigation auditor and was a member of a national committee that worked with U.S. EPA to develop its WaterSense program. Dave is also an active member in the Home Improvement Research Institute and Hardware Marketing Council. He has over 20 years of marketing, sales and product development experience, and has developed, launched and marketed hundreds of products and holds patents on product merchandising systems.
Robert Klein is the Western Nebraska Crops Specialist at the University of Nebraska West Central Research and Extension Center in North Platte, Nebraska. His work includes both rain fed and irrigated crop production using herbicides and limited tillage to conserve soil, water, energy and labor. To improve ground herbicide application, he has used computer analysis of spray patterns, which employs a laser analyzer to study the effects pesticides and additives have on spray particle size and distribution.

Megan Kolaczyk works for the City of Elkhart, Indiana based at the Elkhart Environmental Center, and helps provide environmental education and outreach to youth and adults. She is charged to help local businesses and industries protect drinking water and meet wastewater discharge standards, as well as educate them about stormwater runoff. In addition, she has been working to increase local recycling efforts and market the City’s composting operations. Megan is also coordinator for the Groundwater Guardian team.

Lorraine Lafreniere received a PhD in Geology from the University of Wisconsin-Madison. She worked in the petroleum industry for 18 years, and is currently Manager of the Applied Geosciences and Environmental Management Section of the Environmental Science Division for Argonne National Laboratory in Argonne, Illinois where she is the project manager and principal investigator for a program dealing with carbon tetrachloride contamination at former grain storage facilities in Kansas, Nebraska and Missouri.

David Lathrop is the superintendent for water and wastewater for the City of Seward, Nebraska. David is a registered professional chemical engineer in the state of Nebraska, and a Nebraska Grade VI Wastewater and Grade I water operator. He serves on the executive board of the Nebraska Section of AWWA and is the current coordinator for the Seward Groundwater Guardian team. He also coordinated the Groundwater Guardian Green Site designation for three department areas.

Elsa Lopez is the External Affairs Manager for the Water Replenishment District of Southern California. The District manages groundwater supplies for nearly four million residents in 43 cities of southern Los Angeles County.

Theresa McGeady is the Program Coordinator at The Miami Conservancy District in Dayton, Ohio. She coordinates and interacts with community members, businesses, and federal, state, and local agencies in the Great Miami River Watershed, a 15 county region in Southwest Ohio. She manages Miami Conservancy District’s Phase II Stormwater Program and leads a team that helps communities in the watershed meet the requirements of the stormwater program. She has also helped several organizations earn Groundwater Guardian Green Site status.

Steve Miller has over 20 years experience as a planning consultant and city planner with expertise in land use planning, urban design, and community engagement. As a planning consultant with Olsson Associates in Lincoln, Nebraska Steve assists in the development of comprehensive and master plans, transportation models, and design guidelines for large and small communities. He believes the best plans and processes empower community members to use their time and talents and to become investors in their community.

John Mundell is president and senior environmental consultant for Mundell & Associates in Indianapolis, Indiana. He earned BS and MS degrees from Purdue in Civil Engineering. He has broad experience in hydrogeology, groundwater modeling, geochemistry, plume stability evaluation, remediation design, and brownfield redevelopment. He has served as a contract zoning officer to conduct technical reviews of new construction and addition projects in the city’s Wellfield Protection zoning districts.

Jamie Oltman began her career at The Groundwater Foundation as an intern in 2001. She received a BA in Environmental Studies from the University of Nebraska-Lincoln with an emphasis in sociology in 2004. She was the co-recipient of the 2007 Environmental Protection Agency Region 7 Educators Environmental Excellence Award, and is currently a Program Manager working on the development and implementation of community and youth education programs and activities.

Karen Griffin O’Connor has more than 20 years of experience managing multidisciplinary projects focused in the fields of geology and hydrogeology. She received a bachelor’s degree in geology from Smith College in Northampton, Massachusetts and master’s degree from the University of California in Santa Barbara. She began her career in environmental geology in Santa Barbara working for Metcalf & Eddy, Inc. and worked on the restoration and cleanup of the Rocky Mountain Arsenal National Wildlife Refuge in Denver for over 10 years. She is currently part of the Hydrogeology Team at Olsson Associates in Lincoln, Nebraska.
**SPEAKER BIOGRAPHIES**

**Brian Reetz** has been a program coordinator with The Groundwater Foundation for two years. A News-Editorial major at the University of Nebraska at Kearney, Brian began his career in print communication at a number of newspapers and magazines. At The Groundwater Foundation, he is involved in community engagement with the Let’s Keep it Clean program. He also teaches a communications class at the University of Nebraska-Lincoln and does freelance writing for publications in Lincoln.

**Bob Sedivy** is a hydrogeologist in the Environmental Science Division with Argonne National Laboratory, where he develops models of groundwater flow and contaminant transport for remediation and water supply alternatives. He also works to develop innovative remedial technologies. He has a BS in geology and an MS in Geophysical Science/Geochemistry.

**Lois Shelton** is the former mayor of Wayne, Nebraska. Her commitment to the environment started when she became involved with the recycling movement. When she moved to Wayne from New York state, she began composting and her environmental interests expanded from there. She has been a City Council member and President, as well as Mayor. She feels that the highlight of her time as Mayor is the new Wastewater Treatment Plant which uses technology new to the U.S., resulting in a sludge-free effluent.

**Tom Spears** was the President of Valmont Irrigation from 1998 to 2004. He helped Valmont improve the mechanical performance of their Center Pivot irrigation products to give farmers better and more precise control over water application to crops. He then was group President for Valmont’s North American Lighting, Specialty Structures, Coatings and Wind Energy Structures divisions. Tom left Valmont in 2008, and after a brief time as President of Lindsay Manufacturing’s Infrastructure Business, he retired to pursue his interest in writing fiction.

**Christine Spitzley** has served as the Environmental Programs Planner at Tri-County Regional Planning Commission in East Lansing, Michigan since 1990. She works with municipalities, counties, authorities and boards to create effective, economical programs to protect the environment, including solid waste plans, land-use planning, air quality, watershed planning, a children’s water festival, groundwater protection, abandoned wells and wellhead protection programs. She is also responsible for grant writing, administration and reporting for these programs.

**Cliff Treyens** is public awareness director for the National Ground Water Association, a professional and trade association representing the groundwater industry. Cliff began his career in newspapers and was part of a team that won the 1983 Pulitzer Prize for Distinguished Public Service for coverage of public education issues. He also spent seven years in politics, serving as communications director for former Mississippi Governor Ray Mabus and the longest serving Speaker of the Ohio House of Representatives, Vern Riffe.

**Jennifer Wemhoff** is a Program Manager at The Groundwater Foundation. She joined the Foundation staff in 2000 as a part-time project assistant, and began full time in 2001 after receiving a BA in Communication. She works with the Foundation’s community-based education programs, organizing and delivering workshops and trainings, managing the Groundwater Guardian and Green Sites programs, and developing community education materials. She is also the editor of *The Aquifer* quarterly newsletter.
Support for the 2011 Groundwater Foundation National Conference provided by:

**National Conference Co-Sponsor**
Nebraska Department of Environmental Quality

**Conference Partner**
Valmont Industries

**Supporting Sponsors**
Lower Platte South Natural Resources District
Olsson Associates
Senninger Irrigation
Water Research Foundation

**Additional Conference Support**
Central Nebraska Public Power and Irrigation District
Gothenburg Water Utilization Learning Center
Marshfield Utilities
Prairie Fire
Rain Bird
Rembolt-Ludtke LLP
T-L Irrigation

Support for the Groundwater Guardian program provided by the U.S. Geological Survey.
Support for the Groundwater Guardian Green Site program provided by Rain Bird.
Lower Platte South Natural Resources District Approaches to Nitrate Concerns

Dick Ehrman
Lower Platte South NRD
Lincoln, Nebraska
Nebraska’s Natural Resources Districts

- Formed in 1972
- Delineated along major watershed boundaries
- Governed by locally-elected Boards of Directors
- Managed by professional staff
- Property taxing authority
- Responsibilities in ground water quality and quantity management as well as other resource management
- Required to develop and implement Ground Water Management Plans
Lower Platte South NRD: GWRs & CWSPAs*

*GWR: Ground Water Reservoir

*CWSPA: Community Water System Protection Area (similar to Wellhead Protection Area)
Phased Management

- **Phase I: Entire NRD**
  - Emphasize education
  - Develop cost-share programs for BMPs
  - Require permits for all wells >50 gpm

- **Phase II: Any area w/ >50% of network wells >50% of MCL (after 2-year verification study)**
  - Continue above requirements
  - Require nitrogen training certification
  - Develop additional cost-share programs for BMPs

- **Phase III: Any area w/ >80% of network wells >80% of MCL (after 2-year verification study)**
  - Continue above requirements
  - Discontinue (or modify) cost-share
  - Implement additional BMP requirements
EXAMPLE:
Otoe Co. RWD #3/Weeping Water CWSPA Phase II Area

- Total Area ≈ 4 mi.²
- Designated as Phase II area 1/2010
- Boundaries modified slightly after additional modeling by NDEQ
- Advisory group met twice in 2010
- Rules & regulations developed & effective 10/1/2011
Ground Water Nitrate Levels
Shallow Soil Nitrate
Nitrate in Unsaturated Zone

Assumed nitrogen leaching minimal < 8 #/A/ft.
OPPORTUNITIES & CHALLENGES

- Continue ground water monitoring
- Develop unsaturated zone monitoring
- Implement BMPs

BUT....

- Nitrate levels significant in soil & unsaturated zone
- Fine-grained soil/sediment means slow recharge
- Effects magnified by limited aquifers?
- PWSs face short-term pressure due to state & federal requirements
Dick Ehrman
Lower Platte South NRD
(402) 476-2729
dehrman@lpsnrd.org
Database facts

- Project began in 1996.
- Mainly agricultural chemicals (non-point).
- Sample results utilized from 1974.
- 28 entities have submitted samples.
- Over 400,000 results in database.
- Results ranked (flagged) based on QA/QC.
- Results available to public.

Who does the work?

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<tr>
<td>Nebraska Dept. of Agriculture</td>
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<tr>
<td>Nebraska Dept. of Environmental Quality</td>
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<tr>
<td>Nebraska Health &amp; Human Services CDC</td>
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<tr>
<td>University of Nebraska - Lincoln</td>
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<tr>
<td>U.S. Geological Survey</td>
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Where do they come from?

<table>
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<tr>
<th>Well Type</th>
<th>Number of Analyses</th>
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<td>Irrigation</td>
<td>87,456</td>
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<td>Domestic</td>
<td>58,116</td>
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<tr>
<td>Commercial/Industrial</td>
<td>1,192</td>
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<td>Monitoring</td>
<td>232,318</td>
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<tr>
<td>Livestock</td>
<td>1,709</td>
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<tr>
<td>Other</td>
<td>2</td>
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<tr>
<td>Total</td>
<td>404,162</td>
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What are the parameters?

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<th>Compound</th>
<th>Percent of Samples Determined for Reporting Limit (RL)</th>
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<tr>
<td>Zn</td>
<td>5%</td>
</tr>
<tr>
<td>nitrate-N</td>
<td>94%</td>
</tr>
</tbody>
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Long list in Appendix A of report

How is it used?

[Map or chart]

How is it used?

[Graph or chart]
Where to find it.
- Let us go to the web.............
- dnr.ne.gov
- DATA BANK MAPS AND DATA
- Relational/Tabular Databases
- Groundwater Data
- Quality-Assessed Agrichemical Contaminant Database

Clearinghouse to Spreadsheet
- During query, select "Import to Spreadsheet"
- Develop entire query, select "Submit"
- "Save as" in Excel as a Text File (txt)
- Open document in Excel
- Select "Delimited" then "Next"
- Uncheck "Tab" and check "Other"
- Place a "1" in the box next to "Other"
- Select "Finish"
- Remove all unwanted headings and have fun!
Seward

by David Lathrop
Superintendent Water/Wastewater
Groundwater Guardian Team

Nitrates
- Cause methemoglobinemia in babies & fetuses
- Deprivation of oxygen causes infants to turn blue
- Federal Limit is 10 ppm
- Average of Seward’s wells 14.4 mg/l NO₃-
- Nitrates considered acute health risk

City of Seward, Early Efforts
- A committee formed in early 1990s to address issue
- The committee became a charter member of Groundwater Guardians 1995
- Early efforts focused on agricultural best management practices – BMP

City of Seward, Early Efforts
- BMP – Early Best Management Practices
  - Reduced irrigation
  - Reduced fertilizer inputs
  - Crop rotation
  - No or minimal till
- BMP unable to reduce nitrate contamination
  - Because water age 25 to 30 years old
  - Dealing with agricultural practices of many years ago

Three Well Fields – Nine Wells

Graph 3: Average Nitrate Levels

10/4/2011
West Well Field

West 10 Well Pump

City of Seward's Well Field
- 6 of 9 City wells in County
- Ample water except during drought & irrigation season
- Water restrictions during summer in mid 2003 to 2007
- Seward uses 300,000,000 gallons per year
- Or slightly less than 1000 acre foot per year
- About 7% of aquifer withdrawals in region

City of Seward, Mid Years
- Second Effort after BMP Did not Reduce Nitrate Levels
- Blending Well Water
  - $1.2 million spent on new water mains in 2001
  - Brought water to a central point for blending
  - Blending worked for a while, nitrate levels kept rising
- In 2003, Partner with USGS age water dating $44k
- In 2003, DHHS issue City an AO for corrosive water
- In 2003, DHHS issue City an AO for nitrates in water

City of Seward, Mid Years
- Decision was made to build RO plant at central blending point
- In June of 2004, RO plant went online
  - $5 million
  - RO Energy intensive treatment plant
  - $80,000 per year in electricity
  - Raw well water blended with RO permeate water

2
City of Seward, Later Years
- In 2009, Seward County Groundwater Guardians reformed
- 2009 ROA – Three Result Oriented actions
  - One: Keystone pipeline
  - Two: Interlocal agreement with County for City wells in county
  - Three: Modify County zoning to protect against oil pipelines

City of Seward, Later Years
- 2010 ROA
  - One: Operation of weather stations to minimize irrigation.
  - Two: Creation of a City ordinance for the WHP plan inside corporate limits.
  - Three: Department of Transportation (DOT) as a High Consequence Area.
  - Four: Obtained grant to monitor Keystone Pipeline for leaks

Mid Years
- 2005 to 2008: Seward’s Groundwater Guardian Lapsed
- 2005 & 2006: Ethanol Plant

Reverse Osmosis Water Plant
Corrosion Control & Remove Nitrates
City of Seward, Later Years

- 2011 ROA
  - One: Operation of weather stations to minimize irrigation.
  - Two: Creation of a City ordinance for the WHP plan inside corporate limits.
  - Three: Oil Leak Detection Network
  - Four: Groundwater Guardian Activities on City’s web site

City of Seward, Later Years

- 2012 New Alternative Wellfield transmission Main

In Summary

- $.2 million blending, $.5 million for treatment plant, $.6 alternative transmission main
- A total of $7.8 million in capital expenditures due to nitrates
- Ongoing O&M Expense to operate plant $120,000 per year

Keystone Pipeline

Weather Stations

Oil Monitoring Network

- $9,000 from City of Seward
- $48,000 from Dept of Transportation
- $42,860 from USGS Water Quality Program
City of Seward, Later Years

- $800,000 Study on Nitrate movement in Soil Vapor
- City Match of $20,000 over 3 years
- Partners to include NDEQ, Environmental trust, USGS, Big Blue NRD
- City Elected not to participate

Greens Site for 3 Areas

- First Area: Wastewater Plant
  - Water Pollution Control Facility
  - Collection System - leaks & inflow/infiltration
  - Recycling - paper, cardboard, batteries, aluminum, metal
  - Storm water run off flows through green areas
  - Minimal irrigation & chemical use
  - $375,000 Energy Grant & City Match about 50/50
  - Lights, roof, insulation, GHG emissions, alternative energy, heat pump
  - Written Spill Plan

- Second Area: Bio-solids Sludge Field
  - Sprays surface apply bio-solids from wastewater plant
  - Sludge & soil analysis
  - Growing crops - recycling wastes
  - No irrigation, herbicides, pesticides, fertilizer
  - Native grasses no irrigation crops
  - Thicken sludge for fewer trips
  - 30’ set backs from water ways

- Third Area: City’s Well Field
  - City encourages water conservation thru high rates
  - City use is 3% of aquifer use - minimal impact of aquifer
  - Weather Stations & ET Values
  - Irrigation have large impact on aquifer
  - Minimal mowing
  - No irrigation - native grasses
  - Habitat for animals
  - Less gas to drive out or mow
  - WHPA - Written WHIPP

Seward County Groundwater Guardian Team Members

- David Lathrop, Office Manager, City of Seward, david.lathrop@cityofsewardne.com, government
- Jon & Bonnie Krueck, (402) 643-4744, jonbonniekrueck@hotmail.com, private citizen
- Dennis Kahl, (402) 643-2581, dkahlunitednet.com, educator
- Dan Briggs, (402) 643-8078, briggstransportation3.com, commercial interest
Cooperative Water Program—
A Partnership in the Nation’s Water-Resources Program

By Bruce E. Taggart

Increasingly, the Nation’s water resources are vital to the long-term health of our citizens and the stability of our economy. These resources—our rivers, lakes, and aquifers—supply our drinking water, support our industries, transport our products, and provide us with recreational opportunities. Management of these resources is a complex task involving all levels of government and a multitude of laws, regulations, and competing interests. The U.S. Geological Survey (USGS) Cooperative Water Program has been providing basic scientific information needed by water-resources managers across the Nation since 1895.

The USGS Cooperative Water Program is an ongoing partnership between the USGS and non-Federal agencies. The program jointly funds water-resources projects in every State, Puerto Rico, and several other U.S. Trust territories. USGS employees use nationally consistent procedures and quality-assurance protocols in conducting cooperative projects. These standards ensure that all data from the Cooperative Water Program are directly comparable from one region to another and available from USGS databases for use by citizens, public officials, industry, and scientists nationwide. Agencies, or “Cooperators,” that participate in the Cooperative Water Program are primarily State, Tribal, county, and municipal agencies with water-resources management and policy responsibilities. In 2003, more than 1,400 Cooperators participated in the program.

In terms of funding, the USGS contribution to the Cooperative Water Program in federal fiscal year 2003 was $78.4 million; $64.4 million is from

"The USGS surpassed our expectations. Other state and federal agencies instantly received the credibility that USGS brought to the project, enabling us to more quickly utilize the results of the modeling work. We look forward to partnering with USGS on future projects."

— Tim Harbaugh, Director, Kane County, Illinois Department of Environmental Management

Valued Cooperation

The USGS and Cooperators jointly plan the scientific work performed in the Cooperative Water Program. This ensures that this work simultaneously meets the mission objectives of the USGS and the data and information needs of the Cooperators. The result is a national program with broad relevance and widespread use of its products. This significant tie to local and State water-resources needs also creates a program that responds quickly to emerging issues. Cooperators choose to work with the USGS because of the agency’s broad technical expertise, its long-standing record of performing high-quality measurements and assessments, and its commitment to providing public access to data collected by the Cooperative Water Program. The scientific, non-regulatory mission of the USGS means that parties in many types of regulatory and jurisdictional disputes accept its data and analyses as valid. To ensure that these activities do not infringe on work more appropriately done by the private sector,
During 2003, the U.S. Geological Survey was actively engaged in over 1,400 Cooperative Water Program funded water-resources monitoring efforts and investigative studies in every State, Puerto Rico, and several other U.S. Trust Territories.

the USGS distributes a list of activities that should be excluded from the Program, and works through the Federal Advisory Committee Act to obtain advice from both government and non-government entities.

**Data and Information for Many**

The Cooperative Water Program supports the collection of basic hydrologic data, studies of specific water-resources problems, and hydrologic research. In 2003, for example, Cooperative Water Program funds supported about 4,200 stream gaging stations. The program also funds approximately 750 interpretative projects annually targeted at specific issues, such as the effects of urbanization, dam removal, agricultural practices, and energy development on the quality and quantity of the Nation's water resources.

Because data collected in the Cooperative Water Program are directly comparable at the local, regional, and national levels, large-scale syntheses and application of these data to pressing societal and environmental issues are possible. Examples of these syntheses include using historical streamflow information to evaluate regional drought and climate variability, and developing a technique for estimating time of travel for rivers, which provides information for estimating the arrival time for accidental chemical spills.

More recently, data from Cooperative Water Program interpretive projects continue to contribute significantly to emerging water-resources issues across the Nation. Examples include an improved understanding of the links between land-use changes and the physical habitat of streams (USGS Circular 1175), the behavior of freshwater-saltwater interactions in ground-water environments along the Atlantic coast (USGS Circular 1262), and the role of science in managing ground-water resources (USGS Circular 1247). Hydrologic data and results of interpretive projects are published as USGS reports, which are publicly available. In addition, more and more projects result in Internet products ranging from descriptive home pages and online reports, to interactive interfaces that allow users to run predictive models and conduct sophisticated statistical analyses by using data available online. Results from many of these interpretive projects, which are local or regional in scope, have broad transferability to other parts of the Nation where similar water-resources issues exist.

Data collected by the Cooperative Water Program are incorporated into the National Water Information System (NWIS). The NWIS contains hydrologic information collected by the USGS during the past 120 years. It includes streamflow data from 21,000 sites, water levels from over 1,000,000 wells, and chemical data from rivers, streams, lakes, springs, and ground water at 338,000 sites. All of these data are publicly available, and can be readily accessed on the Internet at [http://waterdata.usgs.gov/nwis/](http://waterdata.usgs.gov/nwis/). During 1999, the Cooperative Water Program underwent an extensive review by stakeholders external to the USGS—the first such review in the program's history. The Review Committee provided many insightful observations and recommendations, found at [http://water.usgs.gov/coop/review.html](http://water.usgs.gov/coop/review.html), about the Cooperative Water Program that will help the USGS to maintain the Program's core strengths while leading to significant improvements. More detailed information describing the mission, goals, activities, and accomplishments of the Cooperative Water Program can be found at [http://water.usgs.gov/coop/](http://water.usgs.gov/coop/).

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Ground Water Contamination by
Crude Oil near Bemidji, Minnesota

Ground-water contamination by crude oil, and other petroleum-based liquids, is a widespread problem. An average of 83 crude-oil spills occurred per year during 1994-96 in the United States, each spilling about 50,000 barrels of crude oil (U.S. Office of Pipeline Safety, electronic commun., 1997). An understanding of the fate of organic contaminants (such as oil and gasoline) in the subsurface is needed to design innovative and cost-effective remedial solutions at contaminated sites.

A long-term, interdisciplinary research project sponsored by the U.S. Geological Survey (USGS) Toxic Substances Hydrology Program began in 1983 at a crude-oil spill site near Bemidji, Minnesota (fig. 1). The project involves research by scientists from the USGS and several academic institutions. This research is directed toward understanding the physical, chemical, and biological processes controlling the migration and fate of hydrocarbon contaminants in the subsurface. The goal is to provide information and methods to help evaluate the potential for, and long-term performance of, natural and enhanced bioremediation of hydrocarbon contamination across the nation.

The crude-oil spill site near Bemidji is one of the better characterized sites of its kind in the world. Results of research conducted on processes affecting the migration and fate of crude oil in the environment have provided fundamental knowledge that has been used to remediate similar sites worldwide. The Bemidji research project was the first to document that the extent of crude-oil contamination at a site can be largely limited by natural attenuation. Scientists studying and documenting natural attenuation at other contaminated sites have used many of the methods and approaches developed at the Bemidji site.

Description and History of Site

On August 20, 1979 approximately 16 kilometers northwest of Bemidji, Minnesota, the land surface and shallow subsurface were contaminated when a crude-oil pipeline burst, spilling about 1,700,000 L (liters) (about 10,700 barrels) of crude oil onto a glacial outwash deposit (fig. 1). Crude oil also seeped to the southwest covering an approximately 7,500 m² (square meter) area of land (spray zone). After cleanup efforts were completed about 400,000 L (about 2,500 barrels) of crude oil remained. Some crude oil percolated through the unsaturated zone to the water table near the rupture site (North oil pool, fig. 1). Some of this sprayed oil flowed over the surface toward a small wetland forming a second area of significant oil infiltration (South oil pool).

The land surface is a glacial outwash plain underlain by stratified glacial outwash deposits. The water table ranges from near land surface to about 11 m below the land surface. About 370 wells and test holes had been installed as of 1998.

Research Results

The fate, transport, and multiphase flow of hydrocarbons depends on geochemical processes and on the processes of volatilization, dissolution, biodegradation, transport, and sorption (fig. 2). An interdisciplinary investigation of these processes is critical to successfully evaluate the migration of hydrocarbons in the subsurface. The investigation at the Bemidji site involved the collection and analysis of crude oil, water, soil, vapor, and sediment samples. The oil phase that occurs as floating product on the water table and as residuum on sediment grains provided a continued source of hydrocarbon to the ground-water and vapor plumes. Knowledge of the geochemistry of a contaminated aquifer is important to understanding the chemical and biological processes controlling the migration of hydrocarbon contaminants in the subsurface. Studies were also conducted to document the concentrations of gases in the unsaturated zone.

Multiphase-flow modeling was used to study the oil movement after the spill. Transport and biodegradation modeling was used to simulate the evolution of the plume, evaluate factors limiting biodegradation, and to develop a mass balance for
contaminants at the site and thus evaluate the amount and rate of removal of hydrocarbons by biodegradation.

Oil Phase

Oil movement is affected by sediment properties and, to a lesser extent, by variations in bulk density and permeability, which result in a complex distribution of oil in the subsurface at the North oil pool (fig. 3). A statistical analysis of the flow patterns and temporal variables has been used to explain how spatial variability affects the oil distribution (Dillard and others, 1997). As of 1996, the leading edge of the oil moving to the water table in the North oil pool had moved about 40 m downgradient since the spill.

Degradation of the oil product has resulted in selective loss of soluble and volatile compounds through dissolution and volatilization. Mass loss rates of crude oil at different locations range from 0.08 to 1.25 percent per year. The total mass of oil was estimated at 1.1 percent from 1979-89 (Landrum and Hult, 1991).

Aqueous Phase

Five geochemical zones have been identified at the North oil pool within the saturated zone (Baekecker and others, 1993; Bennet and others, 1993) (fig. 4). Zone 1 consists of contaminated native ground water. Zone 2, which is below the spray zone, is characterized by low oxygen concentrations and high concentrations of total dissolved inorganic and organic carbon. Zone 3, beneath and immediately downgradient of the floating oil, consists of an anoxic plume of ground water containing high concentrations of hydrocarbons, dissolved manganese (Mn$^{2+}$), iron (Fe$^{2+}$), and methane (CH$_4$). Zone 4, a transition zone from anoxic to oxic conditions, contains low concentrations of hydrocarbons as a result of aerobic degradation processes. Zone 5 consists of oxygenated water downgradient from the contamination plume that contains slightly higher concentrations of dissolved constituents, such as benzene, toluene, ethylbenzene, and xylene (BTEX). Zone 6, a transition zone from anoxic to oxic conditions, contains low concentrations of hydrocarbons as a result of aerobic degradation processes. Zone 7, a transition zone from anoxic to oxic conditions, contains low concentrations of hydrocarbons as a result of aerobic degradation processes. Zone 8, immediately above the oil body, is relatively anoxic and contains maximum concentrations of CO$_2$ (>10 percent), CH$_4$ (>10 percent), and hydrocarbon (>1 ppm).

Long-term monitoring of the plume since 1984 has shown that, near the water table, the concentration of total dissolved organic carbon (TDOC) and dissolved oxygen (DO) downgradient from the oil body has remained relatively stable suggesting that degradation of the plume has reached equilibrium. In the anoxic zone (Zone 3), concentrations of reduced chemical species Mn$^{2+}$, Fe$^{2+}$, and CH$_4$ have increased with time, indicating a sequence of Mn reduction, Fe reduction, and methanogenesis. With depletion of dissolved Mn near the oil body, Mn reduction has become a less important reaction. The data show that both Fe(III) reduction and methanogenesis are major reactions in the anoxic plume (Baekecker and others, 1993).

Although these geochemical processes have changed over time, the plume has not migrated as far as predicted considering the ground-water flow velocities and sorption constants for these compounds (Baekecker and others, 1993). As of 1996, the leading edge of the plume of ground water containing a total BTEX concentration greater than 10 parts per billion (ppb) had moved only about 200 m downgradient, whereas advective flow of ground water since the spill has been about 500 m. The primary reason is that hydrocarbons have biodegraded under anoxic conditions.

The rate of removal of organic contaminants by natural attenuation and the factors that affect rates of biodegradation are important considerations in making decisions concerning cleanup of contaminated ground water. Biodegradation of petroleum-derived hydrocarbons in oxic and suboxic environments is generally considered a more efficient attenuation mechanism than is biodegradation in anoxic environments. However, research at this site has demonstrated that biodegradation in anoxic environments can remove substantial amounts of hydrocarbons from ground water (Lowley and others, 1989; Baekecker and others, 1993; Eganhouse and others, 1993; Cozzarelli and others, 1994).

Vapor Phase

Volatile oil components have left the subsurface through volatilization and biodegradation in and diffusion through the unsaturated zone. The distribution of gases (hydrocarbon, oxygen (O$_2$), carbon dioxide (CO$_2$), and CH$_4$) in the unsaturated zone were quantified at the North oil pool during 1997 and used to identify three geochemical zones (fig. 4). Zone 6 exhibits near atmospheric concentrations of O$_2$. Zone 7, a transition zone, is defined by lower concentrations of O$_2$ (0-20 percent), hydrocarbon concentrations less than 1 part per million (ppm), and higher concentrations of CO$_2$ (0-10 percent) and CH$_4$ (0-10 percent). Zone 8, immediately above the oil body, is relatively anoxic and contains maximum concentrations of CO$_2$ (>10 percent), CH$_4$ (>10 percent), and hydrocarbon (>1 ppm).
Figure 4. Geochemical zones in the unsaturated and saturated zones at the North oil pool, 1997 (Modified from Baedecker and others, 1993).

The distribution of gases at the North oil pool has changed considerably since the spill. For example, as of 1985 the leading edge of the plume of hydrocarbon vapors (concentrations > 1 ppm, zone 7) in the unsaturated zone was about 150 m downgradient (Hult and Grabbe, 1988). As of 1997 the plume of vapors had receded to about 75 m downgradient (Fig. 4) and the receding likely was due to aerobic biodegradation.

Microbial Distributions

In 1994, water and sediment samples were collected from a background location and six locations downgradient from the oil body for microbial biomass determinations (Essaid and others, 1995). The Most Probable Number method was used to enumerate microorganisms capable of degradation under differing redox conditions. In the background location, acetobacters and fermenters were the only significant microbes detected. Within the plume the microorganism counts are consistent with the conceptual model of sequential aerobic, Mn/Fe reduction, and methanogenesis degradation sequence. There are 104-105 iron-reducers per gram in the contaminated aquifer compared to none detected in the uncontaminated background area. Similarly there are 102 methanogens per gram in the plume and none detected in the background area. This result is similar to that of Godsy and others (1992) who reported a 100-fold increase in methanogens within a creosote plume. In general, greater numbers of microorganisms were found closer to the oil body and in the upper half of the plume. Denitrifiers and sulfate reducers are present in lower numbers than all other types of microbes, in accordance with the low availability of nitrate and sulfate in the groundwater. The data were used to formulate a model of biodegradation of the contaminants coupled to growth of the microbial population.

Modeling of Solute Transport and Biodegradation

Numerical models that simulate transport and biodegradation processes are useful for integrating information collected in the field and for studying the relative importance of simultaneously occurring processes. It is difficult to develop an accurate mass balance for a contaminant, and thus to distinguish the amount and rate of removal by biodegradation, dilution, and sorption. If sufficient data are available, a numerical model can be used to help explore these questions, simulate the evolution of the plume, and evaluate factors limiting biodegradation.

A two-dimensional, multispecies solute-transport model including multiple substrate uptake, sequential terminal electron acceptor use, and cellular nutrient limitation of biomass growth (BIOMOC, Essaid and Bekins, 1997) was developed to analyze the evolution of the ground-water contaminant plume at the Benidji site (Essaid and others, 1995). Simulations included the biodegradation of volatile (VDOC) and nonvolatile (NVDOC) fractions of DOC by aerobic processes, Mn/Fe reduction, and methanogenesis. Geochemical evidence indicates that these processes are important in degrading the oil. Model parameter estimates were constrained by published Monod kinetic parameters, theoretical yield estimates, and field biomass measurements. Despite considerable uncertainty in the model parameter estimates, results of simulations reproduced the general features of the measured ground-water plume (Fig. 4) and the measured constituent concentrations (Fig. 5). For the simulation shown in figure 5, 46 percent of the TDOC introduced into the aquifer was degraded after 13 years. Aerobic degradation accounted for 40 percent of the TDOC degraded and anaerobic processes accounted for 60 percent: 5 percent by Mn reduction, 10 percent by Fe reduction, and 36 percent by methanogenesis. The model results indicate that anaerobic processes account for more than one-half of the removal of DOC at this site, consistent with the geochemical evidence.

Contributions of Research

- Research at this site has provided a comprehensive documentation of natural attenuation of hydrocarbons in a contaminated aquifer under both aerobic and anaerobic conditions. Project results are an often-cited example of natural attenuation, promoting its widespread adoption for use to remediate oil and gasoline contaminated sites.
Selected References


For more information contact:

District Chief, U.S. Geological Survey
2280 Woodlawn Drive
Mounds View, Minnesota 55112
Phone: (612) 783-3100


Additional information on the U.S. Geological Survey Toxic Substances Hydrology Program is available at http://toxics.usgs.gov/toxics/

Agenda

2:30 p.m. Welcome and Introduction to the Nebraska Wellhead Protection Network

2:45 p.m. Nebraska Wellhead Protection Program
- Overview of program
- Approved Wellhead Protection Plans
- Updates

3:00 p.m. Wellhead Protection Network Field Updates
All meeting participants are encouraged to provide information about the work they are doing during this round robin.

4:00 p.m. Networking Break

4:15 p.m. Successes and Challenges from Michigan
Christine Spitzley, Environmental Programs Planner, Tri-County Regional Planning Commission, Lansing, Michigan

5:00 p.m. Q & A
Guests are encouraged to share, ask questions, and give feedback in a facilitated discussion regarding Wellhead Protection successes and challenges.

5:30 p.m. Adjourn
The Nebraska Wellhead Protection Network

- Initial Meetings February and May 2001

- Questions asked:
  - Who is providing WHP-related services?
  - What can this group do as a whole to improve the delivery and use of those services?

- Original Participants:
  - NDEQ, UNL, various NRDs, EPA Region VII, NeRWA, MUD, NRCS, RC&D, HHS
The Nebraska Wellhead Protection Network

- **Goals: Now and Then**
  - Foster communication and collaboration among individuals, agencies, and organizations interested in or working on behalf of wellhead protection in the state of Nebraska.
    - Networking and collaboration between WHPN members
    - Focus on WHPN members information needs
    - Develop topical themes in consultation with WHP objectives
    - Identify consistent WHP messages and delivery systems
  - Meeting agendas and notes available at:
    - [http://www.groundwater.org/pe/newhp.html](http://www.groundwater.org/pe/newhp.html)
The Nebraska Wellhead Protection Network

- **Quarterly meetings**
  - Various venues throughout Nebraska
  - Presentations and/or tours
  - Member updates
  - Time for networking

- **Sub-group/committees** – work on projects outside of quarterly meetings
  - Wellhead Protection Area Signs
Nebraska Wellhead Protection Program

- Nebraska Department of Environmental Quality
  - Ryan Chapman, Wellhead Protection Coordinator
    - Program Overview
    - Approved WHP Plans
    - Updates
Wellhead Protection Program Field Updates

- All meeting participants are encouraged to provide information about the work they are doing during this round robin.
  - Please provide your name and affiliation as well as:
    - Network members – include communities/agencies you are working with, resources being used or needed, project updates or outcomes, etc.
    - Guests – include any of the above information you see fit and please let us know about any work you do related to wellhead protection
Networking Break

[Logo: NEBRASKA Wellhead Protection Network]
Wellhead Protection Successes and Challenges:

- Identify projects that have been a success (large or small) in WHP programs or related work
  - What aspects of the project lead to it’s success?

- Identify projects/issues that have been a challenge or barrier in WHP programs or related work
  - What was done or can be done to mitigate the challenge.
The Nebraska Wellhead Protection Network

THANK YOU!

Join the Network
Email or call Jamie
Joltman@groundwater.org

www.groundwater.org
Nebraska’s Wellhead Protection Network

The Groundwater Foundation’s 2011 National Conference
October 4th, 2011
Omaha Marriott

Ryan Chapman – WHP Program Coordinator
Mary Schroer – Sourcewater Program Coordinator
Nebraska Department of Environmental Quality (NDEQ)
Groundwater In Nebraska

- 1319 Public Water Systems (PWS)
- 592 Community PWS
- 5000+ PWS wells
- 85% of Nebraskan’s Drink GW
- Subtract Omaha and 99% Drink GW
Wellhead Protection (WHP)

- **Program**
  - Protect drinking water
    - Quality
    - Quantity

- **Plan = 91**
  - A framework for protection
  - Voluntary
Five Steps of the Wellhead Protection Program
Online Availability

- Database
- WHP Area Maps
- WHP County Maps
- Statewide Shapefile
Five Steps of the Wellhead Protection Program

1. Contaminant Source Inventory
2. Contingency Planning
3. Delineation
4. Public Education
Five Steps of the Wellhead Protection Program
Management Planning

- Deciding on the best strategies
- Ordinances/Zoning
- Inspections
- Interlocal Agreements
- Closing abandoned wells
- Education
- BMPs on WHPA land
Voluntary Activities

• Agricultural
  – Alternative crops
  – Conservation Reserve Program
  – No-Till Cultivation
  – Nutrient Management Programs
  – Strip Cropping
  – Terracing
  – Water Management Program
Voluntary Activities

• Urban
  – Alternative Lawn Options
  – Improving Soil Structure
  – Installing Water Meters
  – Low Flow Nozzles
  – Mulching Lawn Clippings
  – Permeable Pavement
  – Rain Barrels/Rain Gardens
  – Rain Sensors for Lawn Irrigation
Management Planning for Nitrates

• Is it really a problem?
• Administrative Order
• Typical Options
• WHP Option (Nebraska Only?)
• Experimental/Innovative Options
Nitrates – Affected PWS

![Graph showing the increase in affected PWSs from 2000 to 2011. The x-axis represents the years 2000 to 2011, and the y-axis represents the number of Public Water Systems (PWSs) affected. The graph shows a steady increase in affected PWSs over the years.]
Nitrates – Sampling Costs

![Bar chart showing increasing lab costs from 2000 to 2011. Costs rise from $0 to $30,000.00.](image)
Nitrates

Generalized Concentrations in NE
Typical Options

- Drill a new well
- Hook up to another system
- Treatment – Reverse Osmosis (RO) / Ion Exchange (IE)
- Dissolve your Public Water System
- Get a State Approved WHP Plan (Nitrates Only) and more...
Administrative Order

- Project Costs (Nitrate AOs)
  - McCook – Ion Exchange, 2 wells, pump station
    - $10,424,000 / pop 7,996 = $1,303 per person
  - Seward – Reverse Osmosis
    - $4,272,000 / pop 6,425 = $664 per person
  - Ragan – Connection to Wilcox, tank
    - $1,848,626 / pop 46 = $40,187 per person
  - Hastings (projected) = $72M (RO) or $57M (IE)
WHP Option for Nitrate AO

- Nitrate Administrative Order - Using the Wellhead Protection Option to Address the Problem
Five Steps of the Wellhead Protection Program

1. Delineation
2. Contaminant Source Inventory
3. Contaminant Source Management
4. Contingency Planning
5. Public Education
Contingency Planning

Emergencies

• Planning for:
  – Well failure
  – Natural disasters
  – Mechanical problems
  – Etc.

• Long & short term
Contingency Planning

New Well(s)

• Why
  – Growth of community
  – Replace old wells
  – Contamination

• Land (purchase, easements)

• Potential contaminants
Five Steps of the Wellhead Protection Program
Education

• **Required (§46-1505)**
  – 30 days of public review
  – Opportunity for public comment at a regularly scheduled meeting
  – Publish official notice (newspaper, posting notices, and/or letters, etc.)
Education

• Suggested
  – Handouts, brochures, posters
  – Public involvement and buy in throughout the process
  – Signs
Sign Changes
Funding

• **319 (non-point source) funding**
  – **60/40 federal/non-federal match**

• **Source Water grant**
  – Mary Schroer 402-471-6988
    maryschroer@nebraska.gov

• **Nebraska Environmental Trust**

• **Natural Resources Districts**

• **Local sources**
Success Stories

- 91 state approved WHP Plans
- 6 using WHP to address Nitrate AO
- Increased awareness
- Focused BMPs (Edgar, Hastings, Sidney, etc.)
- “Fixing” Nitrate Takes Time!
Phyto remediation in Murdock, Nebraska

Lorraine M. LaFreniere and Robert A. Sedivy
Argonne National Laboratory
2011 Groundwater Foundation National Conference
Omaha, Nebraska
Grain Fumigation Practices in the Midwest Have Resulted in Carbon Tetrachloride Contamination of Aquifers

Vadose Soil Zone (unsaturated)

Groundwater Zone of Saturation (Aquifer)

Groundwater Flow

1950s
1960s
1970s
1980s
1990s
2000s
The Problem: CCl₄ Identified at Murdock During Routine Sampling of Public Water Supply Wells - 1985

- 1985: Routine testing of public water system identifies CCl₄ at concentrations above MCL of 5 µg/L.
- 1986: Immediate removal action by EPA; village connected to a municipal water distribution system.
- April 2005-present: Implementation of non-time-critical removal action approved by EPA Region VII.
1985: Routine Testing of Public Water System Identifies CCl₄ at Concentrations above MCL of 5 μg/L

- Early 1950s to 1972: 5 acres used for grain storage.
- At peak: 9 Quonset huts and 112 circular bins.
- Max storage: 651,000-898,000 bu.
- “80/20” grain fumigant: 80% CCl₄ and 20% CS₂.
- Application rate: 10 gal/3500 bu.
- Usage: ≥ 2566 gal/yr.
CCL₄ was Identified at Murdock During Site Characterization Studies

- CCL₄ identified:
  - In near-surface and deeper unsaturated (vadose zone) soil associated with former CCC/USDA grain storage facility.
  - Soil-to-groundwater pathway demonstrated.
  - In deep groundwater plume extending from former CCC/USDA facility and under western margin of town.
  - In downgradient groundwater seepage and surface water in creek headwaters, northwest of town.
Interpretive Geologic Cross Section Along Plume

2004 Values

- Water level (ft AMSL), measured April 12, 2004
- 26 Carbon tetrachloride (µg/L)
- ND Not detected
- Sample interval
- Erosional unconformity

Soil CT conc. at SB85
- 232 µg/kg @ 27 ft BGL
- 361 µg/kg @ 29 ft BGL
- 303 µg/kg @ 31 ft BGL
- 223 µg/kg @ 33 ft BGL
Distribution of Drain Tiles

- 4-5 in diameter
- 4-5 ft BGL
- Drainage of tiles (1000 gal) (May to Nov. 12, 2004)
  - TD1: 2790
  - TD2: 785
  - TD3: 220
  - TD4: 30
  - TD5: 530
  - TD6: 1953
  - TD7: unknown
- CT concentration (µg/L)
  - TD1: 8.2
  - TD2: 88
  - TD3-TD6: ND
Integrated Systems Approach to Remediation

- **Element 1**: Hot-spot hydraulic control involving extraction of groundwater and treatment with a modified spray system that irrigates recreational lands.
- **Element 2**: Interception of the CCl₄ plume before the contaminated groundwater enters surface water through use of phytotechnologies, including deep-rooted trees with focused root development.
- **Element 3**: Supplemental treatment by engineered wetlands immediately downgradient of the discharge zone for contaminated groundwater.
Phytoremediation Configuration

- Trees planted in April & May 2005 over a 4.5 acre plantation.
- ~2000 trees representing six species:
  - Niobie Willow
  - Black Willow
  - Eastern Cottonwood
  - Hybrid Poplar
  - Green Ash
  - Northern Catalpa
- TreeWell® Technology utilized in areas where static groundwater is below 4.5 ft BGL.
- Conventional planting techniques used in areas with contaminated groundwater less than 4 ft BGL.
- Groundcover mixture of native prairie grasses, wildflowers, and multiple additional species were planted among trees and adjacent buffer zones.
Deep-Rooted Trees with Focused Root Development as an Integrated Element of Phytoremediation System

Tree extracts carbon tetrachloride from the aquifer, incorporates it into tissues, and transpires some fraction into the air.

Native grasses take up rainwater, so that tree roots must draw primarily from the aquifer.

Perforated aeration tube brings air to the base of the well.

In situ bacterial community in rhizosphere promotes further breakdown of contaminants.

Contaminated aquifer supplies water for tree's growth.

Downstream wetlands extract any remaining CT.
Murdock, NE: Largest and most professionally designed phytoremediation project in EPA Region VII history; “beneficial reuse” create park and wetlands for habitat enhancement
Welcome to the

MURDOCK

GROUNDWATER

CLEANUP PROJECT

A Cooperative Conservation Effort of
U.S. DEPARTMENT OF AGRICULTURE
FARM SERVICE AGENCY
COMMODITY CREDIT CORPORATION
with
U.S. ENVIRONMENTAL PROTECTION AGENCY
ARGONNE NATIONAL LABORATORY
Phytoremediation Wetlands Trail

Please enjoy this self-guided trail through the phytoremediation and wetlands areas of the Murdock Groundwater Cleanup Project.

- Trail guides are in the box next to this sign.
- Thank you for taking the trail guide home with you or returning it to the box for the next visitor.

This trail and the parking area are designed to be accessible to people with disabilities.

Please use this public access area with care. The landowner and the USDA cannot accept responsibility for personal injuries to visitors.

This area is open to the public between dawn and dusk. The trail is designed for walking or jogging. Swimming and motorized vehicles are not permitted.

"That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics. A land ethic, then, reflects the existence of an ecological conscience, and that in turn reflects a conviction of individual responsibility for the health of land."

Aldo Leopold
Pioneer in American Conservation
Surface Water Effects: Dual-Weir System at Wetlands Outfall

- Automatic measurement of surface water flow exiting wetlands.
- EPA point of compliance for VOCs in surface water.
Initial study results indicate a decrease of approximately 28% in total nitrogen levels associated with the passage of the contaminated water through the Murdock wetlands.
Extensively Instrumented and Monitored Remediation System to Assess System Performance

- Baseline study performed in July 2005
Groundwater Monitoring

- A network of 19 permanent groundwater monitoring wells established with twice yearly sampling and analysis for selected VOCs and geochemical parameters.
- Wells established individually or in clusters screened in multiple zones.
- Installation of groundwater data loggers in 2005 in 16 monitoring wells with quarterly downloads.
- Installation of small diameter shallow monitoring wells in selected tree wells.
CT Levels in Groundwater from Monitoring Wells at the Headwaters
Trees and Vegetation

- Twice yearly sampling of natural and planted vegetation in phytoremediation and wetlands area for VOC analysis.
- Tree tissue and leaf analyses.
- Measurement of tree height and girth.
- Sap-Flow meter array installed temporarily in 2008 and 2009. ~20,163 gals/day
- Dissection of selected trees for estimation of total biomass and CT distribution for associated studies.
Monitoring tree growth by DBH

Average DBH by Species

- Nobe Willow
- Hybrid Poplar
- All Species
- Eastern Cottonwood
- Black Willow
- Northern Catalpa
- Green Ash

Year

DBH (mm)

2005 2006 Apr 07 Nov 07 Oct 08 Nov 09 Oct 10
## Monitoring tree growth by DBH

### Eastern Cottonwood

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>Δ</th>
<th>2006</th>
<th>Δ</th>
<th>Apr 07</th>
<th>Δ</th>
<th>Nov 07</th>
<th>Δ</th>
<th>Oct 08</th>
<th>Δ</th>
<th>Nov 09</th>
<th>Δ</th>
<th>Oct 10</th>
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</thead>
<tbody>
<tr>
<td>DBH</td>
<td>26</td>
<td>73</td>
<td>45</td>
<td>-7</td>
<td>42</td>
<td>65</td>
<td>69</td>
<td>24</td>
<td>86</td>
<td>24</td>
<td>107</td>
<td>32</td>
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### Niobe Willow

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>Δ</th>
<th>2006</th>
<th>Δ</th>
<th>Apr 07</th>
<th>Δ</th>
<th>Nov 07</th>
<th>Δ</th>
<th>Oct 08</th>
<th>Δ</th>
<th>Nov 09</th>
<th>Δ</th>
<th>Oct 10</th>
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<tbody>
<tr>
<td>DBH</td>
<td>37</td>
<td>78</td>
<td>66</td>
<td>7</td>
<td>70</td>
<td>59</td>
<td>112</td>
<td>32</td>
<td>147</td>
<td>18</td>
<td>173</td>
<td>26</td>
<td>219</td>
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### All Species

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>Δ</th>
<th>2006</th>
<th>Δ</th>
<th>Apr 07</th>
<th>Δ</th>
<th>Nov 07</th>
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<th>Oct 08</th>
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<th>Nov 09</th>
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<tr>
<td>DBH</td>
<td>24</td>
<td>74</td>
<td>41</td>
<td>27</td>
<td>53</td>
<td>60</td>
<td>84</td>
<td>29</td>
<td>109</td>
<td>20</td>
<td>131</td>
<td>23</td>
<td>160</td>
</tr>
</tbody>
</table>

Mean DBH in mm.
Δ is % change in growth (DBH) between neighboring years
Note: 2005 & 2006 stats are from random caliper of trees planted, then used for mean caliper for each species.
Note: Oct 10 stats are from subsampling of site
Measuring Sap Velocity for Water Use Estimations
Sap velocity × sapwood area = sap flow

- Trees cored to determine sapwood area.
- Different length TDP needles used.
- Sap Flux (Density): Sap velocity/sapwood area.
- Sap flow calculated per tree, extrapolated up to stand.
- Estimate yearly water use by stand.
Thermal Dissipation Probes - Granier Method

Measuring heat dissipation via differences in voltage between thermocouples
Sap Flow Rates: Determining Groundwater Usage by Plantings in July-August 2008

- Thermal dissipation probes in trees generated sap flow data (mm/cm-hr).
- Total usage by tree stand = 14,200 gal/day (8,200-20,000 gal/day = 2 SD range).
- Species uptake: 84% by Niobe willows, 15% by cottonwoods, 1% by others.
- For 180-day growing season, water usage by tree stand = 2.2 million gal/yr.
- Average daily "pumping rate" per tree = 9.9 gpm; accounts for 50-67% of the average daily reduction in wetlands outfall (15-20 gpm) in July-August. (Buffer area and wetlands grasses and evaporation account for the remainder.)
## Average Water Use Over 3 Years: July 24-Aug 31

<table>
<thead>
<tr>
<th></th>
<th>Eastern Cottonwood</th>
<th>Niobe Willow</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2010</strong></td>
<td></td>
<td></td>
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<tr>
<td>Daily Use/Tree</td>
<td>42</td>
<td>111</td>
<td>L/d</td>
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<tr>
<td>Daily Stand Use</td>
<td>30280</td>
<td>102511</td>
<td>L/d</td>
</tr>
<tr>
<td>Annual Stand Use</td>
<td>993</td>
<td>3360</td>
<td>mm/y</td>
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<tr>
<td><strong>2009</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily Use/Tree</td>
<td>19</td>
<td>63</td>
<td>L/d</td>
</tr>
<tr>
<td>Daily Stand Use</td>
<td>17923</td>
<td>15504</td>
<td>L/d</td>
</tr>
<tr>
<td>Annual Stand Use</td>
<td>588</td>
<td>1924</td>
<td>mm/y</td>
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<tr>
<td><strong>2008</strong></td>
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<td></td>
</tr>
<tr>
<td>Daily Use/Tree</td>
<td>16</td>
<td>23</td>
<td>L/d</td>
</tr>
<tr>
<td>Daily Stand Use</td>
<td>11682</td>
<td>21126</td>
<td>L/d</td>
</tr>
<tr>
<td>Annual Stand Use</td>
<td>383</td>
<td>693</td>
<td>mm/y</td>
</tr>
</tbody>
</table>

180 day growing season  
1.821 ha site for tree plantation  
1 mm = 10,000 L/ha

**Average Sap Flux:**  
Cottonwood: 11 g/cm²-hr  
Willow: 18 g/cm²-hr
Diurnal Sap Flow in July-August of 2008 and 2009 in Two Trees

One Cottonwood

One Niobe Willow
Groundwater Effects: Results of Groundwater Level Monitoring

- Water levels show small-scale oscillations in all MWs.
- Oscillations are consistent with diurnal water uptake by the plantings.
- Maximum diurnal oscillations occur in July-August, during peak plant growth and groundwater use.
Groundwater Effects: Small-Scale Fluctuations Reflect Diurnal Groundwater Uptake by Plantings and Crops: Maximum Amplitude 0.6 ft at PMW8
Surface Water Effects: Water Usage

- Measured flow variations — at tile drains, sonic meters, and transducers at wetlands outfall — correspond to observed diurnal cycle in groundwater levels in the phytoremediation area:
  - Maximum rates: 110-150 gpm, at 9:00-12:00 daily.
  - Minimum rates: 70-120 gpm, at 18:00-21:00 daily.
- Correlation suggests causes for decreased water flow in remediation area:
  - Evapotranspiration "pumping" action of plants & nearby crops.
  - Direct evaporation process in wetlands.
- Effects on water flow rate and volume:
  - Rate reduced by 30-40 gpm during peak daily use
- Volume discharged decreased by ~ 27% (ave. 15-20 gpm over 24 hr)
Water Use for Niobe Willows in 2009

- Mean DBH = 19.7 cm
- Sap flow:
  - Measured by 30-mm thermal dissipation probes.
  - 63 L/day per tree (range 18-131 L/day per tree).
  - 63 L/day per tree x 926 trees = 10.7 mm/day.
- Annual average sap flow for willow stand = 1.9 m/yr
  - Assumes 180-day growing season.
  - Indicates increase for willow stand:
    - From 3.8 mm/day in 2008 to 10.7 mm/day in 2009.
    - From 23 L/day per tree in 2008 to 63 L/day per tree in 2009.
Carbon Tetrachloride Removal: Preliminary Estimates of Mass Removal Rates

- Removal by phytoremediation system in 2008: 170-310 grams
  - Calculation based on diurnal effects and CCl₄ concentrations at SWM2.
- Removal by wetlands in 2008: 200-400 grams
  - Calculation based on flow rates and CCl₄ concentrations at SWM2 and SWM3.
- Total system mass removal in 2008:
  - 370-710 grams
  - Equivalent to removal of 2.2 million gallons of contaminated water with average CCl₄ concentrations of 19-38 µg/L.
Summary of Observations to Date

- High apparent degree of sensitivity in the system is directly reflected in groundwater and surface water concentrations and flow rates, contaminant uptake by vegetation, and sap flow rates. All systems are totally interdependent.
- Observed patterns in hydrologic response and flow rates indicate fluctuations associated with diurnal cycles of groundwater uptake in the phytoremediation plantings.
- Transient reductions in water flow suggest a decrease of $\sim 27\%$ ($15-20$ gpm) in surface water discharge at the compliance point.
Murdock Spray-Phytoremediation-Wetlands Treatment Benefits

- Eliminated treatment processes by utilizing a natural cleanup system.
- Reduced GHG emissions by 89%.
- Saved 88% of total energy.
- Eliminated wastewater generation; beneficially reused 57 million gallons of contaminated groundwater.
- Saved 37% of the cost.
- Calculations based on 30 year time frame.
Distribution of Energy Consumption and Emission

Integrated Phytoremediation

Pump and Treat
“That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics. A land ethic, then, reflects the existence of an ecological conscience, and that in turn reflects a conviction of individual responsibility for the health of the land.”

Aldo Leopold
Pioneer in American Conservation
Murdock Surface Water Sampling 2005-2011

- Seepage at Creek Headwaters
- Discharge from Phytoremediation Area
- Discharge from Wetlands

Carbon Tetrachloride (µg/L)

Sampling Event
City of Edgar, NE

Nitrate Investigation and Feasibility Study

Groundwater Foundation National Conference
October 4, 2011
Nitrate in the Water Supply Wells

Options Presented in KM Report

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Approximate Capital Cost</th>
<th>Estimated Annual O&amp;M Cost</th>
<th>Total Present Worth Costs (in 2006)</th>
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<tr>
<td>New Treatment Plant 400 gpm with blending</td>
<td>$993,000</td>
<td>$36,500</td>
<td>$1,471,000</td>
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<tr>
<td>New Well Field 800 gpm capacity</td>
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<td>$1,120,000</td>
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<tr>
<td>Clay County Regional Water System 800 gpm capacity</td>
<td>$1,100,000</td>
<td>NA</td>
<td>$1,100,000</td>
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</table>

Source: Kirkham Michael, 2006
Vadose Zone Sampling
UNL Research Projects 2005 and 2010

Nitrate in Vadose Zone - 2005 vs 2010
Sites with Nitrate <1000 lbs/acre

From Spalding and Jensen, 2010
Presentation Outline

- Options presented in 2006 KM Report
  1. Treatment Plant
  2. New Well field
  3. Regional Water System
- Alternative Option --- Extraction Well/Wetland
- Feasibility Study of the Extraction Well/Wetland
  - Aquifer Assessment
  - Groundwater Model
  - Cost/Feasibility Analysis
- Conclusions and Recommendations

Wetland Alternative

- Install pumping wells near areas of high nitrates
- Pump groundwater from wells to a new wetland on north end of town
  > Advantages – potentially lower cost with wetland and habitat benefits
  > Disadvantages – untested and feasibility study required
McReynolds Irrigation Well Test

Groundwater Model Analysis

- Model Input parameters
  - Geology
  - Well pumping records
  - Streams and Recharge
  - Aquifer parameters
- Model Calibration
  - Water level measurements from NRD
Calibration of Model

Model Results Illustrate Capture Zone

Modeled 20 year Capture Zone
Nitrate Hot Spots, Spalding 2010

Nitrate in Vadose Zone - 2005 vs 2010
Sites with Nitrate >1000 lbs/acre

From Spalding and Jensen, 2010
Concentration Reduction with only the Hotspots in the Groundwater Model

Groundwater Model Results

Estimated Percent Reduction of Nitrate in Groundwater

- Concentration Reduction with Hot Spots Only
- Concentration Reduction with All Nitrate Sources
Olsson Proposed Offline Wetland

Wetland Advantages

- Plants thrive in nitrate-rich water
- Allows nitrates to filter out of water
- Design focuses on avoiding impacts to existing wetlands; therefore eliminating permitting
- If wetland mitigation bank is created the sale of credits will help pay for the project long-term
- Design focuses on limiting the impact to the river corridor
Cost Estimates

<table>
<thead>
<tr>
<th>Project Description</th>
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<th>Estimated Total Cost (in 2011)</th>
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<tbody>
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<td>Clay County Regional Water System</td>
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<td>Engineered Wetland and Extraction Well Option</td>
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Recommendations

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<tr>
<th>Alternative</th>
<th>Project Description</th>
<th>Cost</th>
<th>Power Technology</th>
<th>Wetland Permitting</th>
<th>Financial Comparison</th>
<th>Future Risks &amp; Risk</th>
<th>Annual O&amp;M Costs</th>
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<tr>
<td>1</td>
<td>New Treatment Plant 400 gpm with blending</td>
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<td>New Well Field 800 gpm capacity</td>
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<td>3</td>
<td>Clay County Regional Water System 800 gpm capacity</td>
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<td>Engineered Wetland and Extraction Well Option</td>
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</table>
Next Steps

- Grant funding
  - Well abandonment
  - Water meters
  - Treatment plant
- City of Hastings Submersible Pump option

Questions??

Karen O'Connor, PG
Olsson Associates, Lincoln, NE
402-458-5033
koconnor@consulting.com
Successful Components of Collaborative Groundwater Protection

MODERATOR: MIKE JESS
Panelists

~~~

EUGENE GLOCK
Farmer/Ag Producer, Rising City, NE

RACHAEL HERPEL
City of Lincoln, NE Groundwater Guardian Team

MEGAN KOLACZYK
Elkhart Environmental Center, Elkhart, IN

DICK EHRMAN
Lower Platte South Natural Resources District, Lincoln, NE

2011 Groundwater Foundation National Conference
What do you see as the vital components of a successful collaborative approach?
What have you, your business, or your community accomplished that would not have been successful without a collaborative approach?
What challenges have you faced in implementing a collaborative approach?
What issues are you, your business, or your community facing now, or may face in the future, and how will a collaborative approach help?
Panelist wrap-up
Closing remarks
The Groundwater Connection

- Groundwater systems are a primary component of many ecosystems
- An essential, highly valuable natural resource
- Groundwater in urban areas threatened
- Protection through sustainable ecosystem restoration in urban areas
- Protection through stream and riparian corridor restoration
Urban Groundwater

- Throughout the world, reliance on urban groundwater is growing
- Trends show per capita use decreasing in American urban areas, but increased overall urban consumption (greater populations)
- Emphasis on sustainable management of groundwater resources
Revisiting the Groundwater Model
Urban Development and the Environmental Disconnect

Somewhere in the modern philosophy of urban development, our conventional wisdom dictated that....
Urban Development and the Environmental Disconnect

Stormwater is bad.
Urban Development and the Environmental Disconnect

Streams are lined, straight, and efficient in moving water.

Photo courtesy of seagrant.psu.edu/nemo/photos/photos.html
Urban Development and the Environmental Disconnect

Streets must be wide
Urban Development and the Environmental Disconnect

And that nature can be reproduced in parks – or what we think is nature
Kansas City

1974

264,230 Acres of urban land use

Source: Missouri Resource Assessment Partnership (MoRAP), 2003
Kansas City

1999

683,259 Acres of urban land use

419,029 acre (258%) increase in urban area in 25 years

Source: Missouri Resource Assessment Partnership (MoRAP), 2003
Omaha

- Percent of Papillion Creek Watershed
Urban Development and the Environmental Disconnect

Unfortunately, the cost is high

- Maintenance and repair
- Property damage
- Property value
- Energy consumption
- Water consumption
- Pollution

The costs are too high to be sustainable
Uniqueness of the Prairie

Ecosystem was a function of climate, water, vegetation, and soil in balance

Input = output
Uniqueness of the Prairie

Mid-Continental Climate

Cold winters

Wet springs

Hot, dry summers

Nebraska – varies from 13 in to 30 in average precip

Most comes during Intense storms
Uniqueness of the Prairie

Deep rooted vegetation

Access to moisture, nutrients
Uniqueness of the Prairie

Soils and Geology
Understanding Ecosystem Function

- Balance in the Interconnection of Water, Vegetation, and Soil
- Affects how people live
- Affects energy and water consumption
- Affects economic vitality
Understanding Ecosystem Function

- At the heart of every ecosystem is water – even the human ecosystem
Urban Ecosystem Function?

- How does this affect groundwater?
  - Restoration of groundwater recharge
  - Conservation of groundwater resources through reduced use
    - Public supply
    - Industry

Input = Output
Sustainable Communities

- **Ecosystem Function and Energy Conservation**
  - Temperature
    - Evaporative cooling
    - Shade of trees
    - Wind blocks
- **Fuels**
  - Reduced electricity for cooling
  - Reduced landscape maintenance
- **Ecosystem Function and Air**
  - Filters pollutants from air
  - Slows wind velocities
  - Maintains oxygen and nitrogen balances of air
Sustainable Communities

- **Ecosystem Function and Water**
  - Filters pollutants from water
  - Reduces water needs for landscapes
  - Reduces and slows stormwater runoff
    - Protects against floods, erosion
    - Reduces stormwater infrastructure need
  - Captures and stores water for future use

- **Ecosystem Function and Hazards**
  - Reduced damages from flooding and erosion
  - Less subsidence in soils
How To Restore Urban Ecosystems

- Restore Landscapes
  - Native Landscapes
  - Conserve water
  - Improve water and air quality
  - Restore hydrologic cycle
- Reduce Consumption
  - Reduce energy needs
  - Less water use
What is native landscaping?

Native Landscaping: use of plants that flourished in America prior to its occupation by settlers from Europe and Asia.
Conventional Landscaping
Common Effects of Conventional Landscaping

- Air Pollution
- Water Pollution
- Erosion
- Noise Pollution
- Costly
- Introduction of aggressive exotic plant species
- Loss of biodiversity
- Habitat loss
Natives Help You Solve Problems

- Adapted to local areas
  - Resist drought and flood
  - Break up clay soil & absorb run-off
- Clean the air / store carbon
- Control Erosion
- Save Energy
- Reduce pollution
- Manage stormwater
- Make our cities more livable
Natives Improve Air Quality

- Reduce the need for mowing
- Reduce energy use in general
- Sequester carbon
The Connection

- Urban Watershed Management and Groundwater Interaction
- Example: Papillion Creek Watershed, Omaha, NE
Watershed Planning

- Addresses the degree and location of future development expected in a watershed
- If compared with known groundwater resources, can paint a picture for how to manage future urbanization
Land Conservation

- Part of planning
- Identify and Conserve:
  - Aquatic resources
  - Water quality
  - Wetlands
  - Forested areas
  - Stream and riparian corridors
  - Groundwater resources
  and connections
Aquatic Buffers

An aquatic buffer is a transition zone between a developed area and a waterbody

- Benefits of Buffers:
  - Flood control
  - Habitat for wildlife
  - Wetland protection
  - Pollutant reduction
  - Natural Floodplains
Stream Evolution

- Groundwater connections affect stream evolution, and vice versa
- Incised streams may be a big outlet for local groundwater

http://water.epa.gov/scitech/datait/tools/warsss/successn.cfm
Impacts to Urban Streams

- Once streams are degraded, both too much or too little groundwater can accelerate further degradation
- Loss of base flow
- Saturated vs. unsaturated stream banks

http://water.epa.gov/scitech/datait/tools/warsss/successn.cfm
Stormwater Management

- Stormwater Management BMPs
  - Sources for groundwater recharge
  - Filter groundwater contaminants
  - Reduce groundwater reduction
Conservation Site Design

- Reduces impervious cover
- Conserves natural areas
- Improve surface and groundwater quality
Erosion and Sediment Control

• Help restore sediment balance in streams and lakes
• Keep surface and groundwater connections open
Other Pollution Sources

- In addition to stormwater runoff there are other contributors to pollution:
  - Septic Systems
  - Groundwater Contamination
  - Confined Animal Feeding Operations
  - Wells
  - Leaky sewers
  - Open excavation and tanks
Watershed Stewardship

- Provides open public feedback
- Makes a plan regionally specific
- Eyes and ears in community
- Long-term understanding
- Education and leadership

Make a difference like the Groundwater Foundation!
What are we trying to mimic?

- Infiltration
- Groundwater movement and recharge
- Evapotranspiration through plants
- Biologic processing in soil
  - Some of this biologic organism cannot survive without the vegetation
- Chemical processing in the soil
  - Organic matter plays a big role in chemical processing
- Surface and Groundwater quality
- Stream, lake and wetland function
Restoring What We Lost
Conserving What We Have

Ecosystem Function CAN be restored into urban environments

- requires planning and patience
- acceptance of the community
- gradual change of operations
- education
Connecting Community through Groundwater Guardian and Green Sites

Jennifer Wemhoff, The Groundwater Foundation
Theresa McGeady, Miami Conservancy District
It is because of people that groundwater must be protected, but it is only through the efforts of people that it can be accomplished.
Groundwater Guardian Program

- Began in 1994
- Provides a framework for local action
- Supports, recognizes, and connects communities
- "Community" is broadly defined
- Annual earned designation
Groundwater Guardian Program

• Requirements:
  – Community team
  – Local action
  – Paperwork

• Long-term involvement
  – 92% designated for 5 years or more
  – 68% designated for 10 years or more
  – 21% designated for 15 years or more
Groundwater Guardian Program

• Annual Entry (Feb. 15)
  – Community and team information
  – Result-oriented activity (ROA) plans

• Annual Progress Report (Aug. 31)
  – Progress toward activity implementation

• Administrative fee
  – First-time Communities: $100
  – Renewal Communities (those designated the previous year): $75
Groundwater Guardian Program

• Benefits
  – An official Groundwater Guardian plaque upon designation
  – Use of exclusive Groundwater Guardian logo
  – Information, resources, and materials
  – Support and motivation
  – A monthly newsletter with program information and updates, funding opportunities, activity ideas, success stories, and more
  – Access to case studies showcasing successful activities
  – Opportunities to connect with other Groundwater Guardians, through Facebook, blogs, and The Groundwater Foundation’s National Conference
  – Personalized news releases for Communities, with information about specific activities implemented by each team
  – Discounted or free access to Groundwater Foundation webinars
  – A 10% discount on Groundwater Catalog products

• 2006 grant from W.K. Kellogg Foundation to revitalize and grow the program led to the development of…
Green Site Program - WHAT

- Developed to recognize groundwater stewardship
- Calculates, documents, and recognizes benefit of groundwater-friendly practices
- Designation based on earning at least 70% on program application
- Recognizes positive contributions to environmental protection
- Provides education to new and diverse audiences
Green Site Program - WHO

- Green spaces/sites implementing groundwater-friendly practices
  - Golf courses
  - Ball fields
  - School and college campuses
  - Parks (city, regional, community, state, athletic, office)
  - Wellhead protection/utility areas
  - Natural areas
  - Zoos
  - Churches
Green Site Program - WHY

- Publicly recognizes green spaces for their groundwater stewardship.
- Provides an opportunity for green space managers to educate themselves, site staff, and site visitors about groundwater.
- Documents the environmental benefit and encourages the sustained use of sites’ groundwater-friendly practices.
- Positive Public Relations for site, industry, community
- Exclusive use of Green Site logo and name, plaque, road sign
- Small time investment
Green Site Program - WHY

• Participating site managers see how their practices impact water resources
• Demonstrates a commitment to environmental stewardship.
• Prompts site managers to examine their operation and groundwater-friendly practices.
Green Site Program - WHEN

- Site managers applying for first-time Green Site designation may submit their application at any time
  - Applications must by submitted by December 31 to be designated in that program year
- In subsequent years, site managers simply review and update site information, as needed
- Sites are nationally recognized by The Groundwater Foundation.
Green Site Program - HOW

- **Program Application**
  - Hard copy, electronic, online
  - Documents internal and external education efforts, impact of groundwater-friendly practices
  - Uniformly evaluates site practices
  - Educates site managers
  - All information submitted is confidential

- **Administrative fee**
  - **For profit sites**
    - First-time sites: $100
    - Renewing sites: $50
  - **Non-profit sites**
    - First-time sites: $50
    - Renewing sites: $25
Green Site
Sample Best Practices

• Conversion to drought tolerant grass
• Irrigation system updates
• Use of native grasses
• Increase wildlife habitat
• Use of recycled water
• Maintaining no-application zones around surface water and wellheads
• Installation of rain gardens
• Managing runoff
• Timing of fertilizer, pesticide, and irrigation water applications
Lessons Learned

- Best practices benefit source water protection efforts.
- Application serves as an educational tool.
- Sites are already doing good things; Green Site program can help encourage their sustainability.
How do I become a Green Site?

• Complete and submit the Green Site Program Application (available in hard copy or online) and submit administrative fee

• Questions or concerns?
  – Visit www.groundwater.org/greensites.html to learn more.
  – Communicate with Groundwater Foundation staff by calling 402-434-2740 or e-mailing guardian@groundwater.org.
Questions?

The Groundwater Foundation
P.O. Box 22558
Lincoln, NE 68542-2558
Toll free: 1-800-858-4844
Web: www.groundwater.org
Email: guardian@groundwater.org

Support for the Groundwater Guardian Green Site program provided by the U.S. Geological Survey.
Support for the Groundwater Guardian Green Site program provided by Rain Bird.
Groundwater Guardian Green Sites in Southwest Ohio

Theresa McGeady
Miami Conservancy District
October 5, 2011
Overview

- Miami Conservancy District
- GGGs for MCD
- GGGs in the area
- Benefits
- Promoting GGGS in Southwest Ohio
The Miami Conservancy District

- Great flood of 1913
- Ohio Conservancy Act
  - Signed into law in 1914
  - Innovative, watershed-based political subdivision
  - Broad authority primarily for water-related purposes
- MCD established 1915
MCD’s Mission

- **Protecting** people and property from flooding
  - ◦ Dry dams and levees
  - ◦ Floodplain preservation

- **Preserving** the quantity and quality of water
  - ◦ Aquifer protection
  - ◦ Stormwater management
  - ◦ Water quality credit trading
  - ◦ Low impact development

- **Promoting** waterways & community vitality
  - ◦ Land and water trails
  - ◦ Parks and preserves
Protecting via Arthur Morgan’s eco-friendly design

- Flow-through dam
- Floodplain preservation
- Levees and channel modifications minimized
Preserving

• **Groundwater**
  – Expansive monitoring network
  – Volumes and sustainable yields
  – Source water protection
  – Low impact development
Promoting

- Land and water trails
- Provide maps
- Parks and preserves
Great Miami River Watershed

- 4,000 mi² (OH)
- Major tributaries:
  - Stillwater River
  - Mad River
- 1.5 million residents
- Dayton is largest city
- Agriculture is dominant land use
What’s GREAT about it?

• Cities protected from flooding
• Water abundance
• Excellent drinking water
• Protected greenspace
• World class fishing
• Water & recreation trails
• Economic opportunities
• Our aquifer!
Buried Valley Aquifer

- Underlies rivers & many urban centers
- Drinking water for 1.6 million people
- Significant exchange of surface and ground waters
- 1.5 trillion gals. of water storage
- Yields > 2,000 gallons of water/ min
Aquifer Preservation Subdistrict

- Created in 1997
- Funded by assessment
- Guided by a Liaison Committee
- Monitor & report on aquifer conditions
- Support local efforts
- Provide education programs
Groundwater Guardian
Green Site

- MCD received award 2009-2011
- Over 1500 acres
- Land along the Great Miami River
- Primary purpose = flood control
- Secondary purpose = recreation
GGGS Application

• Simple
• One application for all sites
• Scoring makes sense
• Does a great job of evaluating all practices
• Environmental Impact
• Renewal, very simple
GGGS around the area

- City of Tipp City - Prairies/ Wellfields
- City of Vandalia - Sports Complex
- Concord Township, Miami County - Historical Covered Bridge Park
- Miami Conservancy District
- Miller Coors Trenton Brewery
- Wright State University
THE MIAMI CONSERVANCY DISTRICT

Benefits

- Public recognition!
- Free signage
- Monthly newsletter from Groundwater Guardian
- 10% discount on Groundwater Catalog products
- Discounted or free access to Groundwater Foundation webinars
- Networking opportunities
Promoting GGGS

- Workshops
  - Overview of program
  - Walk through application
- Web-site
- Meetings
- E-mail blasts
- Press Releases
- Individual one-on-one meetings
MCD can help

- Assistance in completing the GG Green Site application
- Administrative fees paid for two years
- Up to $2000 (reimbursable) to implement groundwater-friendly practices
MCD’s vision

*Thriving communities, a healthy watershed, and a higher quality of life, sustained by well-managed water resources throughout the watershed.*

*Photo by Kendall Draeger*

Luca DeAngelis, P.E., R.G.
Water Resources Engineer/Hydrogeologist
luca.deangelis@hdrinc.com
Presentation Outline

- Introduction to Hastings and Hastings Utilities
- Addressing nitrates in WHPA
  - 20-year water facility plan study
  - Groundwater model
- Groundwater model details
- Model results and conclusions
Introduction – City of Hastings

- Hastings, Nebraska
  - 24,000 people
  - Primarily agricultural land use

- Hastings Utilities
  - Provides electrical, natural gas, water and sewer

- Hastings Utilities – Water
  - 25,000 people
  - 77 MW coal fired power plant

Study Area
Hastings Water Supply

- 100% groundwater source
  - High Plains Aquifer
  - 200 ft of sand and gravel that overlies the Ogallala Formation

- Dealing with water quality issues
  - Nitrate is number one drinking water issue

- Other water quality issues
  - Area-wide Hastings Superfund site
  - USACE Superfund site

- Water quantity is not a problem
Hastings Water Utility - Background

- Well field includes 32 water supply wells
  - No system storage
  - No treatment or disinfection
  - Pumped directly into distribution

- Avg daily system demand is 8 MGD
  - Max day = 25 MGD (City power plant)

- Pumping not evenly distributed
  - Well 33 (23% total flow for 2004 to 2008)

- Nitrate concentrations increasing in most wells
Immediate Concerns

- Three newest wells impacted by nitrates
  - Well 33
    - Near nitrate MCL (10 mg/L) in 2008
  - Wells 34 and 35
    - On-line 2009
    - Nitrate presently 8 mg/L

Area of Emphasis
Long Term Concerns

- Projected nitrate concentrations at treatment plant
  - Trend lines using historical data
Hastings Utilities 20-Year Water Facility Plan

- Define water supply needs for Hastings
- Evaluate impacts of nitrate on Hastings’ water supply system
- Develop concepts for addressing nitrate issues
  - Evaluate treatment options
  - Evaluate alternative pumping options
    • Groundwater Model is part of the study
- Develop a phased plan for system improvements to provide a sustainable drinking water supply for Hastings
Groundwater Modeling Objectives

- Develop a well field management tool
- Construct a groundwater/solute transport model
- Use to predict future concentrations in wells
- Evaluate management options for Wells 33, 34 and 35
- Include source water quality results in a 20-year planning study
- Evaluate alternative pumping scenarios to reduce treatment
- Pump, treat, recharge
First Step Conceptual Model

- **Primary Aquifer – Pleistocene Alluvium**
  - Paleo-channel containing Quaternary-age valley-fill deposits
  - Filled with sand and gravel
  - No continuous units of silt or clay

- **Aquifer base – Cretaceous Pierre Shale or Tertiary Ogallala Formation**

- **Aquifer thickness**
  - Depth to Water = 115 feet
  - Depth to Rock = 235 feet

- **High well yields**
  - Well 33 design = 2,500 gpm
Groundwater Model Building Block - COHYST Study

- **COHYST Study**
  - COoperative HYdrologic STudy
  - Represent NE interests in Cooperative Agreement on Plate River

- **COHYST Models** -
  - Regional scale models
  - Three groundwater models developed from state border to Columbus
  - Focused on Platte River

![COHYST Groundwater Model Study Areas](image)
Convert COHYST MODEL to Adams Co. Sub-Regional Model

- Telescopic Mesh Refinement (TMR)
  - Construct sub-regional model from one layer COHYST EMU
  - Sub-regional model boundaries and aquifer properties from EMU

- Change cell size
  - 100 ft x 100 ft near Wells 33, 34, 35
  - Compared to ½ mile x ½ mile
  - Model area equal to Adams Co plus Platte River to north

- Import HU pumping wells (Groundwater Vistas)

- Size comparison
  - EMU – 41,743 active cells in one layer
  - Hastings sub-regional 164,742 active cells in one layer
Delineate WHPA – 20 Year Time of Travel

- Perform particle tracking to delineate HU well field Well Head Protection Area
  - Use USGS MODPATH code
- HU well pumping – Average annual conditions
  - Avg. annual rate for each well (2004 to 2008 data)
    - 7.4 mgd
- Check capture zones for Wells 33, 34, and 35
  - Well 33 – 1,200 gpm
  - Well 34 and 35 – 1,000 gpm
Solute Transport Model
Nitrate Sources

- Naturally occurring inorganic chemical
  - Ammonia to nitrate in oxic environments

- Anthropogenic sources
  - Synthetic fertilizers
  - Animal waste
  - Septic systems
  - Waste water effluent

- Groundwater contamination often widely distributed
  - Regional problems (non-point source)
  - Local problems (point source)
Nitrate Fate and Transport

- Transport highly dependent on oxidation state of aquifer
- **In anoxic (reducing) groundwater**
  - Oxygen is depleted - little to no DO
  - Denitrification - Nitrate to nitrogen gas
    - $\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} + \text{N}_2\text{O} \rightarrow \text{N}_2 (g)$
    - Bacteria in the soil remove nitrogen from compounds and convert to nitrogen gas
- **In oxic (oxidizing) groundwater**
  - DO present in groundwater
  - Nitrification - Ammonia (fertilizer) to nitrate
    - $\text{NH}_4^+ \rightarrow \text{NO}_2 \rightarrow \text{NO}_3$
    - Oxidation of ammonia into nitrite by bacteria in soil
Impact of Oxidation State on Nitrate Concentrations

- **USGS National Water Quality Assessment Program**
  - National study including surface water and groundwater
  - 1992 to 2004 data (Published Sep 2010)

- **Results**
  - Concentrations significantly higher in oxic groundwater regardless of land use

Median nitrate concentration oxic = 5.5 mg/L
Median nitrate concentration anoxic < 1 mg/L

Source: USGS Fact Sheet 2010–3078
Nitrate Data

- Need to understand distribution of nitrates
  - Most important component of project
- HU and local NRD’s implemented a Well Head Protection Plan sampling program
- Combination of domestic, irrigation, and municipal wells
- Over 500 well samples collected within WHPA
  - Collected in Summer 2010
- GIS database
Nitrate in Well Head Protection Area

- 500 plus data points
- Mix of wells
  - Irrigation
  - Municipal
  - Domestic
- Used contouring program to help
  - QC’d by hand
Hastings - Nitrate Setting

- Nitrate transport tied to oxidation state of aquifer
  - High DO measured
  - Isotope samples show no denitrification

Conclusion:
- Oxic groundwater conditions
- No degradation of nitrate in aquifer

Hastings NAD Data Show High Dissolved Oxygen

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<td>Dissolved Oxygen (mg/L)</td>
<td>-7.5</td>
<td>9.75</td>
<td>8.17</td>
<td>7.78</td>
<td>10.4</td>
<td>8.76</td>
<td>6.4</td>
<td>6.9</td>
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<td>Ph</td>
<td>-86.7</td>
<td>71.7</td>
<td>71.7</td>
<td>43.2</td>
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<td>-53.1</td>
<td>-48.2</td>
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<td>Specific Conductance (μS/cm)</td>
<td>0.690</td>
<td>0.603</td>
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<td>1.991</td>
<td>0.769</td>
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<tr>
<td>Temperature (°C)</td>
<td>14</td>
<td>13.6</td>
<td>14.2</td>
<td>13.6</td>
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<td>13.5</td>
<td>13.5</td>
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<td>13.5</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>-4.1</td>
<td>2.7</td>
<td>0.8</td>
<td>1.9</td>
<td>2.4</td>
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<td>Groundwater Elevation (ft NGVD)</td>
<td>1772.36</td>
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<td>1771.79</td>
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DO range 6 to 10 mg/L (near saturation)

Source: USEPA 5 Year Review
MT3DMS code is state of the practice
- Coupled to MODFLOW to obtain flow field

Initial nitrate conditions
- Set equal to interpreted nitrate concentrations – 20 Year TOT

Model simulates conservative transport
- No retardation
- No “natural attenuation” of nitrate – no denitrification

Simulations performed over 20 year period
- Time 0 = present day

**ASSUMES NO ADDITIONAL NITRATE SOURCES:**
- Sources are unknown and source modeling is complex
Example Model Results
Increase Use of Well 33

- **Flow Field**
  - System continues to operate as is, but:
    - Well 33 increased from 1,200 gpm to 2,000 gpm
    - Total Well field flow = 9.5 mgd

- **Results**
  - Well 33 – Similar
  - Well 34 and 35 concentrations decreased some
Capture Well Scenario – Location Map

- **Capture Scenario**
- System continues to operate as is, but:
  - Site a well designed to pump as much nitrate as possible
  - Capture Well = 2,000 gpm
  - Total Well field flow = 8.3 mgd
  - Capture Well to treatment
Capture Well Scenario - Results

- Capture Well – 18 mg/L in 2014
- Nitrate concentrations stay below MCL for other wells
Pump/Treat/Recharge - Concept

- Pump from Well 33 and new Capture Well
  - Well 33 = 1,500 gpm
  - Capture Well = 2,000 gpm
  - Variable Treatment - 2 mg/L or 5 mg/L
  - Recharge
    - 7 wells at 500 gpm
  - Well spacing
    - 1,500 feet, perpendicular to flow
Recharge Particles

Recharge Wells
Study Results
“Background” nitrate in WHPA is between 5 and 10 ppm
- Consistent with USGS study for similar aquifers

Nitrate in the aquifer isn’t going anywhere (but down gradient!)
- Aquifer is oxic, no evidence of denitrification
- No “natural attenuation” of nitrate

For Well 33, the worst is yet to come
- Wells 33, 34, and 35 in direct flowpath of highest nitrate concentrations
  - Well 33 – 2013
  - Wells 34 and 35 - 2024

HU has management alternatives to deal with nitrate issues
- Pump and Recharge option could be used to reduce treatment needs
  - Blend treated upgradient with untreated downgradient
20 Year Planning Study Results—No Modifications to Pumping

- **Phase 1** – Well 33, 34, 35 Capture & Treatment
  - Reduce/eliminate nitrate plume
  - Westbrook WTP
    - $4 to 5 M cost
- **Phase 2** – Storage, Pumping and Conveyance
  - Delay treatment by blending wells to achieve 8 mg/L nitrate goal
  - $14 M estimated cost
- **Phases 3 and 4** – North Baltimore Treatment Plant
  - $23 to $32 M estimated cost
- **Phase 5** – Southern Storage Tank
  - $2.5 M estimated cost
Pump and Treat with Aquifer Recharge
Treatment Impacts

- Increase reliance of wells in “recharge bubble”
  - 9 wells pump out recharged (and treated) water
- Decrease treatment volume required
- Increases blending options with untreated wells
- North Baltimore WTP construction would likely be delayed and footprint reduced
  - $23 to 32 M estimated cost = large potential savings
Final Conclusions

- Study and groundwater model improved understanding of current nitrate conditions in the aquifer
  - Allows Hastings to plan for future conditions
  - Provided better estimates of future nitrate conditions
- Groundwater sampling within the WHPA identified sources of nitrate
  - Fertilizer application is primary
  - High concentrations attributable to animal waste
- Groundwater modeling identified a potential modification to pumping that could reduce future project costs
- Pump, treat, recharge option could reduce the size or eliminate one treatment plant
THANK YOU
ARE THERE ANY QUESTIONS?
Spring 2010 Water Levels

- Objective: Check that sub-regional model represents today’s conditions
- Spring 2010 water level measurements
  - LBNRD and UBBNRD
  - Interpret groundwater elevations
- Check model ability to reproduce Spring 2010 water levels
  - NRMS Error = 2.8%
Pump and Treat with Aquifer Recharge – Pilot Program

- Groundwater modeling
  - Evaluate recharge well configurations
  - Estimate impact to nitrate concentrations in aquifer

- Will require small scale demonstration phase
  - Construct pilot program
    - Recharge wells
    - Monitoring wells
    - Chemical monitoring
  - Pilot program will be used to determine effectiveness
    - Provide final recommendation on constructability

- Will require discussions with permitting agencies
Engaging & Educating Latinos on Water Conservation

Groundwater Foundation’s 2011 National Conference
Presented by
Elsa Lopez, Manager of External Affairs
The Water Replenishment District of Southern California (WRD) was created by the vote of the people in 1959 to manage the West Coast and Central Groundwater Basins in the southern part of Los Angeles County.

WRD serves 10% of the State’s population by protecting and managing groundwater resources for nearly four million residents in 43 cities.
The pilot program included a Free 4 class series that included:
- Basic irrigation
- Native plants
- Maintenance
- Landscape Design

The classes were marketed and offered in Spanish

These classes became an interest to city and school maintenance crews
Southern California resident’s outdoor water use is about 70% of their daily water use.

In 2006 WRD developed pilot program for residential gardeners and named it Jardineros Ecologicos.
During the pilot program the participants evaluations came back stating that they would like to be Known as “ECO Gardeners”

The 70+ trainees received decals for their trucks stating that they had completed the ECO Gardener training program.
Some of these landscapers became a new breed in the industry

- They had a new and upcoming skill, changing out and maintaining Native Landscapes
- They were listed on the WRD & MWD websites as trained California Friendly Landscapers
- Others enrolled (with WRD’s assistance) into extended horticulture classes at local community colleges
- Some went as far as getting jobs with cities and school districts and some went even further by going in water fields by taking water technology courses and getting certified for waste water treatment operators
By 2008 over 300 landscapers had been trained

By 2009 residents wanted to take part in this new trend of California Friendly and Native Plant landscape training

A new curriculum was developed to be given in either English or Spanish.

Classes went from 15 to 25 attendees to more than 70 participants per class
In 2010 WRD contracted with WaterWise Consulting to develop a training program that could assist municipalities, school districts and water agencies. And ECO PRO 20X2020 was born...
The Eco Pro 20X2020 is a customized training program for city, school district and water agency personal.

In 2011 we launched ECO PRO 20x2020 and had three cities participate.

Presently we have two trainings going on simultaneity for 8 cities.
Workshop 1 – Understating the CA Water Efficient Model Landscape Ordinance (AB 1881)

- This workshop educates landscape professionals on AB 1881. It has relative information about water efficient landscape design, irrigation efficiency needs, along with other practical but obligatory water use conscious landscape construction & maintenance goals.

Workshop 2 – Irrigation Systems

- Participants evaluate the components and the layout of an irrigation system for efficiency. They also cover new water efficient irrigation technologies available and that are recommended for new installations or during retrofitting/upgrading. A section of the workshop is dedicated to the maintenance of the most common irrigation problems that occur in the landscape as well as possible solutions.

Workshop 3 – Sustainable Landscape Design

- The workshop focuses on design concepts, ideas and application techniques which will factor in the use of plant material and their relationship with the surrounding environment for a CA compliant water efficient landscape. These design techniques can then be used in real world applications in the public, CII or residential sectors.
**Workshop 4 – Water Efficient Plants**
- This workshop is designed to show landscape professionals the importance of using water-efficient and California native plant material in the landscape. Participants become familiar with various trees, palms, shrubs, succulents, and groundcovers that are readily available and well suited for this region.

**Workshop 5 – Landscape Management**
- This workshop covers some of the fundamentals of horticulture for sustainable landscape management practices. The instructor discusses the classification, anatomy, nomenclature, & physiology of plants. They also discuss soils, amendments, and nutrient management. There is a section that includes general principles for pruning plants and trees and the best time of the year to prune. Last, the cover some cultural practices that will help minimize the occurrence of certain weeds, diseases and insects while being environmentally conscious.
IF YOU RAN YOUR GARDEN HOSE NONSTOP FOR ABOUT 6 YEARS...
. . . you’d have the amount of water the city of Wichita, Kansas’ Aquifer Storage and Recovery (ASR) program will be able to return to the Equus Beds aquifer each day.
WHERE DOES WICHITA’S WATER COME FROM?

- Surface water: Pre 1995: 20%, Post 1995: 40%
- Groundwater: Pre 1995: 80%, Post 1995: 60%
MAP OF THE EQUUS BEDS AQUIFER
Sources:
U.S.G.S.

AQUIFER DEPLETION
1940-1992
92 BILLION GALLONS, OR 288,000 ACRE-FEET REMOVED

Source: U.S.G.S.
Who relies on the Equus Beds? Who pays for ASR?

One in Five Kansans Rely on the Equus Beds Aquifer

- Crop Irrigation: 50%
- Municipal: 24%
- Industrial: 13%
- Recreation/Other: 3%
- Distribution to Streams: 10%

Who is Paying for it, and What Does it Cost?

- Federal Funding
  - 12% $27,000,000
- State of Kansas
  - 1% $1,900,000
- Federal Funds
  - 87% $191,100,000

Phase II - $220 Million

The City of Wichita pays approximately $1 million annually to the State Water Fund.
HOW MUCH IS AN ACRE FOOT?
River intake site
Surface water treatment plant
Private Well Education & Mapping Project

Kendall County Health Department

&

Northeastern Illinois Regional Groundwater Protection Planning Committee

Todd Drefcinski
Licensed Environmental Health Practitioner
A little background...

- Groundwater systems in DuPage Co.
  - Water level declines of 800 ft.

- Lake Michigan water available to municipalities

- Municipalities sealed deep wells and thousands of public water connections occurred

- Abandoned private wells!
Kendall County, IL
by the numbers

- 322 sq miles
- 45 miles sw of Chicago, IL
- One municipality with Lake Michigan water
- Other municipalities served by groundwater
- Groundwater withdrawals nearly tripled from 1995-2005 (ISWS)
Kendall County, IL
by the numbers

2000 pop. = 54,563

2010 pop. = 114,736

110.4%

Fastest growing county in the United States based on 10 year percentage of growth (2010 Census)

2010 foreclosures = 2,612
Kendall County - Well & Septic Permit #'s

Total # of W+S Projects permitted '00 to present

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<td>209</td>
<td>122</td>
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<tr>
<td>2010</td>
<td>76</td>
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To Do...

...When It's Slow
Private Well Education & Mapping Project (PWE&MP)

1. Provide educational materials to residents
   - people moved from sewer & water to well & septic
   - door-to-door site visits, face time!

2. Global Positioning System (G.P.S.) location of private water wells
   - records date back to 1972 – bar napkins
   - target the older unincorporated subdivisions

3. Require and/or recommend corrective action for well code violations
   - form letters and follow-ups
Education
In the beginning...

TOP TEN WAYS TO
PROTECT & CONSERVE
GROUNDWATER

1. Dispose of chemicals properly
2. Take used motor oil to a recycling center
3. Limit the use of fertilizers
4. Take shorter showers
5. Shut water off while brushing your teeth
6. Run full loads of dishes and laundry
7. Check for leaks and repair them
8. Water outside only when necessary
9. Keep a pitcher of water in the fridge
10. Teach others about groundwater

Kendall County Health Department
Environmental Health Unit
811 W. John St.
Yorkville, IL 60560
www.kendallhealth.org
(630) 551-9100

- Water sampling recommendations
- The basics of groundwater
- How to protect your wellhead
- Common water quality problems
- Septic system maintenance
- Water conservation
- Water efficiency
- Upcoming educational classes
Wait a minute...

We aren’t getting any feedback!
We are using a lot of color ink & paper!

Let’s try something different...

Can we build a web page for the well project?
Create a survey(feedback), incorporate fact sheets, brochures, pictures, links to other organizations!
PWE&MP - 2010/2011

- We designed a web page with information on well maintenance, water sampling and water conservation.

- A postcard was then created that outlines the project and includes a link to the web page. The postcard is mailed to pre-selected areas in the county.

- We conduct site visits two to three weeks after the mailing of the postcard.

- During the site visits we collect well locations using a handheld G.P.S. receiver.

- The visible portions of the private water well are inspected. If code violations exist the property owner is notified.
Private Well Education & Mapping Project
Kendall County Health Department Environmental Health Unit
630.553.8026 Phone 630.553.9603 Fax

In the next few weeks the Kendall County Health Department will conduct a brief site visit at your property (5 minutes or less) to collect a G.P.S. location of your private water well. You need not be home for this brief site visit.

Private water well locations are being added to a G.I.S. (geographic information system) database at the Health Department. The information collected (G.P.S. coordinates) will only be used by the Health Department.

Want to learn more about this groundwater protection project? Please visit the following website:
www.kendallhealth.org/wellproject

No internet? Please call, or visit, the Kendall County Health Department.

www.kendallhealth.org/wellproject
Private Well Education & Mapping Project

The Private Well Education & Mapping Project was created in the summer of 2008 by the Kendall County Health Department. The first objective of this project is to provide residents in the county with detailed information about private well water sampling, groundwater conservation and groundwater protection.

The second objective of this project is to collect precise water well locations using a handheld G.P.S. device (shown at right). The information collected is strictly confidential and will only be used by the Health Department. After each well location is recorded, it is added to the G.I.S. (geographic information system) database. We are able to use this database to track trends in water well construction and in the future it will serve as a tool to notify residents quickly in the event of a groundwater related emergency.

It's important to sample your private water well!

In the last two years 14 out of 75 private water well samples sent through our department have shown some detect for bacteria or nitrates! That's 19% of the total samples collected by Kendall County Health Department.

FREE WELL & SEPTIC 101 CLASS

Want to learn more about private wells and septic systems?
G.P.S. location of private water wells
G.P.S. location of private water wells

- 52 properties during initial pilot project in the summer 2008
- 200+ in 2009
- 300+ collected in 2010
- 350+ collected in 2011 – Goal of 425
- Over 1,200 well points collected since 2006
  - Final inspections on new wells since 2006
Technology Component

- Excel – construct database(s)
- Microsoft Publisher – postcard, etc.
- Microsoft Word – letter writing
- Google Earth
  - Historical images (1993)
- Mercury d-base – scanned permit records
- G.I.S. Coordinator
  - ArcMap/ArcView
  - Kendall County - G.I.S. maps
  - G.P.S. receivers on loan
Require and/or recommend corrective action for well code violations
Here’s what we’re finding during our site visits...
Damaged well casings
Damaged well caps
Loose well caps
Loose or damaged wiring conduit
Cisterns & unapproved well pits
Approximately 8-20% of the wells are out of compliance with the state water well construction code.

No increase in the number of water samples being collected after our site visits.

Google Analytics provided with numbers we never had before.

Running the Numbers are we making a difference?
Corrections!
Corrections!
Corrections!
Corrections!
Challenges

- **The 4th Amendment**
  - Must get consent to be on the property
  - Slows us down slightly
  - Ready for the challenge!

- Costs – This is not a mandated project

- Public perception is reality!
Cost of the project...

- ArcView license
- Postcards
- Mailing fees
- Magnets & Pens
- G.P.S. units on loan

N.I.R.G.P.P.C.
The future of the project

- We really want to promote water sampling
- Visit areas that are prone to flooding
  - Fox River & local creeks
- Search for grants - equipment & materials
- Interns from Geography programs
Contact Info...

Todd Drefcinski, L.E.H.P.
Kendall County Health Department
Environmental Health Unit
811 W. John St.
Yorkville, IL 60560

630.553.8096  - phone
630.553-9603  - fax
tdrefcinski@co.kendall.il.us
www.kendallhealth.org/wellproject
AGENDA

• Background
• Intent of Overlay District
• Goals of Overlay District
• McHargian Analysis
• Overlay Criteria
• Outcomes
• Has it worked?
BACKGROUND

Project Partners:
- City of Omaha
- Papio Missouri River NRD
- Nebraska Game and Parks
- U.S. Army Corps of Engineers
- Cunningham Watershed Council
11,000 acre watershed

Located in north-central Omaha

Straddles the county line
Community Based Watershed Master Plan completed in 2005

Directives from the plan:

• Protective zoning overlay district for the entire watershed
• In-lake measures to improve fisheries and aquatic habitat
• Information and education programs
• Major sediment control structures
• Protective zoning overlay districts for the entire watershed

BACKGROUND
BACKGROUND

Lake rehabilitation completed -- 2006-2009

Cunningham Lake Park facilities renovation completed -- 2009-2010

Overlay district ordinance approved -- 2009
The intent of the water quality overlay district is to:

- Protect quality of groundwater
- Protect and preserve stream corridors
- Protect and preserve habitat corridors
- Protect and preserve views sheds
- Restrict development on steep slopes to minimize erosion
GOALS

Easy to understand for landowners.

Easy to implement for city staff.

Based on proven and objective data (i.e. not arbitrary).

Avoid additional impact fees.
Ian McHarg is credited as being a founder of ecological planning. He is best known for pioneering the planning method of **suitability analysis** which involves using layers which identify various environmental constraints.

Layers are then superimposed on top of each other. Environmentally sensitive areas, as well as areas suitable for particular human activities, are revealed.
Cunningham Lake Water Quality Overlay District
Omaha, Nebraska
Map Appendix

Layers Contained:
- Glen Cunningham Park Boundary (Pink Line)
- CORP of Engineers Land
- Soil Restricted Land
- Slope/Soil Restricted Land
- Future Stream Lines
- Basin Buffer
- 3rd Order Stream Buffer
- 2nd Order Stream Buffer
- 1st Order Stream Buffer
- Lonesong Lake Buffer

Justification:
A water quality overlay district has been designed and developed to ensure the continued preservation and protection of Cunningham Lake and the entire Cunningham Lake watershed.

The effects of the water quality overlay district should mitigate the negative environmental impacts of development that will occur within the watershed (i.e., increased storm water runoff, decreased water quality).

Layer Properties:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Acres</th>
<th>% Open Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>合计面积 (Total Acres)</td>
<td>1,162</td>
<td><strong>27.4%</strong></td>
</tr>
<tr>
<td><strong>合计</strong> (TOTAL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"Total watershed acreage contained within Douglas County is 6,482 acres"
Cunningham Lake Water Quality Overlay District
Omaha, Nebraska
Map Appendix

LAYERS CONTAINED
- Glen Cunningham Park Boundary (Pink Line)
- CCRP of Engineer Land
- Soil Restricted Land (Orange)
- Slope / Soil Restricted Land (Red)

JUSTIFICATION
Considered by USGS (United States Geological Survey) and the NRCS (Natural Resources Conservation Service) as "soils that have severe limitations that make them unsuitable for cultivation, development, or commercial plant production and restrict their use to recreational purposes, wildlife habitat, or aesthetic purposes."

Slope gradients are typically broken into five classes, each a range of slopes: in the interest of eliminating sedimentary run-off, all "Moderately Steep" and "Steep" slopes were deemed non-buildable. Steep slopes begin at 17.5%.

LAYER PROPERTIES

<table>
<thead>
<tr>
<th>Layer</th>
<th>Total Acres</th>
<th>% Open Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCRP of Engineer Land</td>
<td>1,011</td>
<td>15.7%</td>
</tr>
<tr>
<td>Slope / Soil Restricted Land</td>
<td>281</td>
<td>4.22%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,292</td>
<td>(20.92%)</td>
</tr>
</tbody>
</table>

"Total watershed acreage contained within Douglas County is 6,182 acres."
SEDIMENT STRUCTURES/BUFFERS

Cunningham Lake Water Quality Overlay District
Omaha, Nebraska
Map Appendix

LAYERS CONTAINED
- Glen Cunningham Park Boundary (Pink Line)
- CORP of Engineers Land
- Soil Restricted Land (Orange)
- Slope/Soil Restricted Land (Red)
- Future Frain Sites (Dark Green)
- Rain Buffer (Light Green)

JUSTIFICATION
Basins are structures which are built upstream from a populated area so that precipitation flows do not flood and cause the loss of life or property. They are normally dry, but are designed to detain surface water temporarily during and immediately after a rainfall event. Their primary function is to attenuate the storm flows by releasing flows at a lower flow rate. Fifty (50) foot buffers around each basin were inspired by values recommended by the NRD (Natural Resource District).

LAYER PROPERTIES

<table>
<thead>
<tr>
<th>Layer</th>
<th>Total Acres</th>
<th>% Open Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORP of Engineers Land</td>
<td>1,274</td>
<td>16.11%</td>
</tr>
<tr>
<td>Slope/Soil Restricted Land</td>
<td>184</td>
<td>4.33%</td>
</tr>
<tr>
<td>Basins Land Buffers (30 feet)</td>
<td>81</td>
<td>0.76%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,411</strong></td>
<td><strong>21.15%</strong></td>
</tr>
</tbody>
</table>

*Total watershed acreage contained within Douglas County is 6,182 acres*.
Cunningham Lake Water Quality Overlay District
Omaha, Nebraska
Map Appendix

Cunningham Lake

LAYERS CONTAINED
- Glen Cunningham Park Boundary (Pink Line)
- Comp of Engineering Land
- Soil Restricted Land (Orange)
- Slope / Soil Restricted Land (Red)
- Future Water Sites (Dark Green)
- Basin Buffer (Light Pink)
- 3rd Order Stream Buffer (Dark Purple)

JUSTIFICATION
Stream buffers are ecological right-of-way which help to the elimination of development-associated run off and sedimentary deposits. The intent of the stream buffers is to provide a conservation area to protect high quality streams and to help in the capture of pollutants within stormwater runoff. A stream inventory was conducted to assess and classify all streams.

2nd Order Streams = 3:1 = 80 + 300
* 3:1 = 50 is a city / county buffer standard width for a 3rd order stream. The additional 250 ft on each side accounts for water quality protection and wildlife habitat. Total buffer width was implied by values recommended by the USDA Natural Resources Conservation Service.*

LAYER PROPERTIES

<table>
<thead>
<tr>
<th>Layer</th>
<th>Total Acres</th>
<th>% Open Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp of Engineering Land</td>
<td>1,076</td>
<td>16.1%</td>
</tr>
<tr>
<td>Basin Buffer</td>
<td>384</td>
<td>4.93%</td>
</tr>
<tr>
<td>Slope / Soil Restricted Land</td>
<td>51</td>
<td>0.71%</td>
</tr>
<tr>
<td>3rd Order Stream Buffer</td>
<td>No Additional</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

TOTAL: 1,411

*Total watershed acreage contained within Douglas County = 6,482 acres *
2nd Order Streams/Buffer

Cunningham Lake Water Quality Overlay District
Omaha, Nebraska
Map Appendix

Layers Contained:
- Glen Cunningham Park Boundary (Pink Line)
- CORP of Engineers Land
- Soil Restricted Land (Orange)
- Slope / Soil Restricted Land (Red)
- Siltation basin sites (Dark Green)
- Basin Buffer (Light Pink)
- 3rd Order Stream Buffer (Dark Purple)
- 2nd Order Stream Buffer (Light Purple)
- 1st Order Stream Buffer (Light Blue)

Justification:
1st Order Streams = 1:1 + 20 + 150
2nd Order Streams = 3:1 + 20 + 150
3rd Order Streams = 4:1 + 20 + 150

The additional 20 feet on each side accounts for water quality protection and wildlife habitat. Total buffer width was inspired by values recommended by the USDA Natural Resources Conservation Service.

Layer Properties:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Total Acres</th>
<th>% Open Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORP of Engineers Land</td>
<td>1,016</td>
<td>14.1%</td>
</tr>
<tr>
<td>Slope / Soil Restricted Land</td>
<td>254</td>
<td>4.26%</td>
</tr>
<tr>
<td>Basins and Buffers (100 feet)</td>
<td>51</td>
<td>0.73%</td>
</tr>
<tr>
<td>3rd Order Stream Buffer</td>
<td>No Additional</td>
<td>0.00%</td>
</tr>
<tr>
<td>2nd Order Stream Buffer</td>
<td>130</td>
<td>2.11%</td>
</tr>
<tr>
<td>1st Order Stream Buffer</td>
<td>337</td>
<td>4.84%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,320</strong></td>
<td><strong>20.16%</strong></td>
</tr>
</tbody>
</table>

*Total watershed acreage contained within Douglas County is 6,182 acres*
1st Order Streams/Buffer

Cunningham Lake Water Quality Overlay District
Omaha, Nebraska
Map Appendix

Layers Contained
- Glen Cunningham Park Boundary (Pink Line)
- CORP of Engineers land
- Soil Restricted Land (Orange)
- Slope / Soil Restricted Land (Red)
- Future Farm Sites (Dark Green)
- Basin Buffer (Light Pink)
- 2nd Order Stream Buffer (Dark Purple)
- 3rd Order Stream Buffer (Light Purple)
- 1st Order Stream Buffer (Light Blue)
- Lonergan Lake Buffer (Beige)

Justification
The additional 50 ft buffer around the lakes accounts for water quality protection and wildlife habitat. Total buffer width was inspired by values recommended by the USDA Natural Resources Conservation Service.

Layer Properties

<table>
<thead>
<tr>
<th>Layer</th>
<th>Total Area</th>
<th>% Open Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORP of Engineer Land</td>
<td>1,076</td>
<td>16.7%</td>
</tr>
<tr>
<td>Slope / Soil Restricted Land</td>
<td>254</td>
<td>4.20%</td>
</tr>
<tr>
<td>Basins and Buffers (30 feet)</td>
<td>61</td>
<td>0.76%</td>
</tr>
<tr>
<td>3rd Order Stream Buffer</td>
<td>100</td>
<td>2.01%</td>
</tr>
<tr>
<td>2nd Order Stream Buffer</td>
<td>105</td>
<td>2.01%</td>
</tr>
<tr>
<td>1st Order Stream Buffer</td>
<td>51</td>
<td>0.76%</td>
</tr>
<tr>
<td>Lonergan Lake Buffer</td>
<td>22</td>
<td>0.47%</td>
</tr>
<tr>
<td>Total</td>
<td>1,782</td>
<td>27.4%</td>
</tr>
</tbody>
</table>

*Total watershed acreage contained within Douglas County is 6,182 acres*
Approval of the Cunningham Lake Water Quality Environmental Overlay District Ordinance in August 2009.

Key features:

- Prohibited use regulations
- Impact study
- Mitigation of impacts
Sustaining Water Conservation for the Long Term

Rachael Herpel

Mayor's Water Conservation Task Force
aka - City of Lincoln’s Groundwater Guardian Team

October 5, 2011
Water Conservation Task Force

- Created in 1988
- Develop positive, voluntary approaches to water conservation
- Since 1995, has earned Groundwater Guardian designation for Lincoln
Water Conservation Task Force

- Public Education
  - Poster Competition
  - Printed Information
  - Indoor
  - Outdoor

- LWS-led Efforts
  - Rate Structure
  - System Management
  - Infrastructure
  - Irrigation Audits
  - Rain Sensors
WCTF Public Education

- 5th Grade Coloring Contest – Poster Competition
WCTF
Public Education
Poster Competition
Winners
WCTF Public Education

- Printed Information
  - Bill Boards
  - Bus Boards
  - Posters
WCTF Public Education

- Printed Information
  - Brochure and Pamphlets
  - Bill Stuffers
WCTF Public Education

- Waterwise Landscape Garden
WCTF Public Education

Landscape Garden
Rain Garden Addition
Lincoln Water System - Major Water Conservation Efforts

- Water Conserving Fixtures
- Lincoln’s Increasing Block Rate Structure
- Lincoln Water System Management - Water Management Plan
- Infrastructure
- Automatic Irrigation Systems –
  - Irrigation Audits
  - Rain Sensors
Increasing Block Rates

- Water sold by the unit.
- One unit equals 100 cubic feet or 748 gallons.
- Fact remains – Lincoln’s water is cheap.

<table>
<thead>
<tr>
<th>Residential Price Blocks</th>
<th>$1.28/unit</th>
<th>$1.82/unit</th>
<th>$2.82/unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
<td>1-8 units</td>
<td>Next 15 units</td>
<td>All additional units</td>
</tr>
<tr>
<td>Bi-monthly</td>
<td>1-16 units</td>
<td>Next 30 units</td>
<td>All additional units</td>
</tr>
</tbody>
</table>
Water Management Plan
Relative Discharge of Major Rivers in Nebraska
Well Field Drawdown
Platte River @ Ashland
2007 River Flow

- **2002**
- **Median***
- **2006**
- **2007**

*Median daily flow since construction of the Loup River Power Canal (not calculated for October).
Lincoln’s Aging Infrastructure

Red: 100 Year Old Mains - 45 miles
Orange: 80 - 100 Year Old Mains – 115 miles
Yellow - 50 - 80 Year Old Mains
25 Years of Broken Mains
LWS Observations

- Looking Further Ahead than Ever Before
- Average Per Person Use is Down More than 10%
  - Conservation Efforts are Paying Off
  - Peak Customer Use Shifting from PM to AM
- Reliable, Sustainable Delivery of Water Depends on -
  - Climate Conditions
  - Condition of Infrastructure
  - Capacity and Reliability of the System
  - Well Equipped & Trained Staff
- LWS Needs to Further Develop Information & Technology to Better Manage Infrastructure Assets
- Number of Broken Mains on Pipes less than 50 years
- Security of Information Essential
Irrigation Audits

Site Visit & Inspection
Irrigation Audits
Report to Customer

- Describe Project Background

- Summarize Findings

- Provide Recommendations

Table 2. Summary of extra cost.

<table>
<thead>
<tr>
<th>Billing Period</th>
<th>Excess Water over Season (in)</th>
<th>Excess Water over Season (gallons)</th>
<th>Excess Water Used (units)</th>
<th>Cost of Excess Water ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April to October</td>
<td>17</td>
<td>1,673,665</td>
<td>2,237</td>
<td>$3,088</td>
</tr>
</tbody>
</table>
Rain Sensors
Observed Trends in Water Use

- Residential Per Capita Consumption Down
- Shift in Peak Hour Usage from PM to AM
- Reduction in Peak Hour
- Conservation of Water
1988 Max Day Demands

Normalized Max Day Diurnal Curves - System Total

Hourly Demand:Daily Demand (ratio)

Time

0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00

0.000 0.200 0.400 0.600 0.800 1.000 1.200 1.400 1.600 1.800

1988

Normalized Max Day Diurnal Curves - System Total

Hourly Demand:Daily Demand (ratio)

Time

0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00

1988

1998
Future

- Public Works and Utilities must plan for adequate supply, transmission and distribution of water

- Water Conservation has payback

- Conservation, Climate, and Customer Attitudes will affect future water needs
CHRISTINE V. SPITZLEY, AICP
Environmental Programs Planner
Tri-County Regional Planning Commission
Lansing, MI
UP494: PLANNING PRACTICUM

Wellhead Protection Evaluation Group

Spring 2011

Group members:
Jon Benaderet
Kellie Green
Tyler Klifman
John Pickering
Ryan Soucy
Yue Zhang
OVERVIEW

Introduction
• The Client
• Area of Study

Elements
• Trends

Wellhead and
Groundwater
Protection Audit Tool
• Findings
• Recommendations

Wellhead Protection
• Goals
• Methods
The Client

Tri-County Regional Planning Commission

Environmental Collaborations:

- Clean air and energy security initiatives
- Groundwater management efforts
- Stormwater management
- Regional wellhead protection
- Clean air and energy security initiatives

www.mitcrpc.org
The MSU Urban and Regional Planning Practicum Wellhead Evaluation Group has compiled an analysis of wellhead protection planning including local ordinance evaluation for six communities:

• Delhi Charter Township
• Delta Charter Township
• The City of East Lansing
• The City of Lansing
• Lansing Charter Township
• Meridian Charter Township
GROUNDWATER IN MICHIGAN

- Large dependence on groundwater resources
  - Private households
  - Businesses
  - Agriculture
- More private household wells than any other state
- 700 million gallons of groundwater consumed each day

Source: Michigan Department of Environmental Quality (MDEQ) and USGS
benefits of wellhead protection planning

monetary:
- vital to economic & residential development

non-monetary:
- sale reliable water supply
- land & habitat protection
- public health & welfare
- supports compliance with state & federal regulations
- cost savings due to pollution prevention
- expanded opportunities for grants & low interest loans
GOALS

• Review community documents to assess the effectiveness and implementation of wellhead protection programs and planning

• Assess existing strategies in order to identify opportunities for improving local wellhead protection efforts

• Develop recommendations for future strategies
METHODS

- Qualitative research
  - Face-to-face interviews
  - Document reviews
- Case study research
- Development and application of Wellhead and Groundwater Protection Audit Tool
WELLHEAD AND GROUNDWATER PROTECTION AUDIT TOOL

Purpose:

To identify strengths, weaknesses, opportunities and threats related to groundwater resources in the community, and to provide a framework for individual community recommendations.
Organization & Content

The communities were evaluated based on three categories:

- Master Plan
- Zoning Ordinance/Site Plan Review
- Expert Interviews
MASTER PLAN EVALUATION

Evaluation completed using:

– Communities’ master plans
– Supplementary adopted plans

Includes specific questions for:

– Groundwater protection
– Wellhead protection
## Wellhead Protection

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Are the wellhead protection areas (WHPA) included in the plan?</td>
<td>No; however, WHPAs are present in the Meridian Township Greenspace Plan: Appendix, Final Report (pg. 9)</td>
</tr>
<tr>
<td>2) Are WHPAs defined?</td>
<td>Yes. The wellhead protection area is defined by the State of Michigan as “the surface and subsurface areas surrounding a water well, or well field, which supplies a public water system, and through which contaminants are reasonably likely to move toward and reach the water well, or well field within a 10-year time of travel.”</td>
</tr>
<tr>
<td>3) Does the community utilize overlay zones for WHPAs?</td>
<td>No overlay zones are present for WHPAs; however, at one time Meridian attempted to use overlay zoning for groundwater recharge areas. chapter 2, pg. 14</td>
</tr>
<tr>
<td>4) Is there reference to designated Brownfield sites located within WHPAs?</td>
<td>No</td>
</tr>
<tr>
<td>5) Does the plan account for future land use changes on groundwater?</td>
<td>Yes, chapter 7, pg. 101: “Meridian Township is a member of the Groundwater Management Board (GMB) which is made up of 12 communities and Michigan State University. The purpose of the GMB is to protect the region’s drinking water resources. Potential sources of groundwater contamination are often identified during site plan review conducted by Township departments including Community Planning, Engineering and Fire. Following approval of the East Lansing/Meridian Wellhead Protection Plan, groundwater protection regulations were incorporated into the site plan review section of the zoning ordinance.”</td>
</tr>
</tbody>
</table>
ZONING ORDINANCE AND SITE PLAN REVIEW EVALUATION

Evaluation completed using:
- Communities’ zoning ordinances
- Site plan review documents

Includes specific questions for:
- Groundwater protection
- Wellhead protection
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>9) Does the WHPA encompass any districts zoned for medium or heavy industrial uses?</td>
<td>Yes, based on a comparison of zoning maps and WHPA maps.</td>
</tr>
<tr>
<td>10) Are abandoned water wells, abandoned monitoring wells and cisterns plugged in accordance with regulations and procedures of the Michigan Department of Environmental Quality as well as the county health department?</td>
<td>Implied but not explicitly stated. (source: Interview)</td>
</tr>
<tr>
<td>(Source: Mark Wyckoff, Recommendations for Tri-County Communities on WHPA Regulations, 2000)</td>
<td></td>
</tr>
<tr>
<td>11) Do any of the community’s ordinances contain regulations on the withdrawal of groundwater (volumes or rates) from industrial/commercial wells?</td>
<td>No</td>
</tr>
<tr>
<td>12) Does the zoning ordinance include the definitions of materials deemed to be ‘hazardous substances’?</td>
<td>Yes, pg. 18-49: “defined as a chemical or other material which is or may become injurious to the public health, safety, or welfare or to the environment.”</td>
</tr>
<tr>
<td>13) Are above ground storage tanks certified, installed, operated, maintained, closed or removed in accordance with regulations of the Michigan Department of Environmental Quality?</td>
<td>Implied but not explicitly stated, pg. 18-49: “Material storage and use areas shall be constructed such that no liquid polluting material can escape via gravity through building sewers, drains, or otherwise directly or indirectly into any sewer system or the surface of ground waters... Secondary containment for aboveground areas where hazardous substances are stored or used shall be provided. Secondary containment shall be sufficient to store the substance for the maximum anticipated period of time necessary, for the recovery of any released substance.”</td>
</tr>
<tr>
<td>(Source: Mark Wyckoff, Recommendations for Tri-County Communities on WHPA Regulations, 2000)</td>
<td></td>
</tr>
</tbody>
</table>
| 14) Are underground storage tanks registered, installed, operated, maintained, closed or removed in accordance with regulations of the Michigan Department of Environmental Quality? | Implied but not explicitly stated, pg. 18-49: “Material storage and use areas shall be constructed such that no liquid polluting material can escape via gravity through building sewers, drains, or otherwise directly or indirectly into any sewer system or the surface of ground waters... The use and storage of a Hazardous Substance, defined as a chemical or other material which is or may become injurious to the public health, safety, or welfare or to the environment, shall be
### Site Plan Review Assessment

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>22)</strong> Please indicate which of the following conditions/requirements are present for approval of site plans:</td>
<td></td>
</tr>
<tr>
<td>Existing topographic elevations at two (2) foot contour intervals. Indicate direction of drainage flow.</td>
<td>Yes, section 50-37 part 2 C; “Existing ground contours at two-foot intervals or less, indicating the direction of surface drainage flow, and the type of surface water present.”</td>
</tr>
<tr>
<td>The location and elevations of existing water sources and water bodies, including county drains and mainline surface drainageways, floodplains, and wetlands.</td>
<td>Yes, section 50-37 part 2 F &amp; G; “Where wetland of any size may be present, as indicated on the city’s wetland inventory map, a report prepared by a qualified wetland consultant which verifies the presence of any wetland.”</td>
</tr>
<tr>
<td>Location for on-site wastewater treatment and disposal systems.</td>
<td>Yes, section 50-37 part 4 J; “Location of any on-site wastewater collection, treatment and disposal system.”</td>
</tr>
<tr>
<td>Location of existing and proposed public and private drinking water wells, monitoring wells, irrigation wells, test wells or wells used for industrial processes.</td>
<td>Yes, section 50-37 part 4 K; “Location of existing and proposed public and private drinking water wells, monitoring wells, irrigation wells, test wells or wells used for industrial processes.”</td>
</tr>
<tr>
<td>Description and location for any existing or proposed above ground and below ground storage facilities.</td>
<td>Yes, section 50-37 part 4 N; “Description and location for any existing or proposed aboveground and belowground storage facilities.”</td>
</tr>
<tr>
<td>If floor drains are permitted: The location and status of any floor drains in existing or proposed structures on the site; the point of discharge for all drains and pipes shall be specified on the site plan.</td>
<td>Yes, section 30-73 part 4 I; “Location and status of any floor drains in existing or proposed structures on the site, indicating the point of discharge for all drains and pipes.”</td>
</tr>
<tr>
<td>If floor drains are permitted: Is it a requirement that they be connected to subsurface wastewater disposal systems?</td>
<td>No</td>
</tr>
<tr>
<td>Inventory of hazardous substances to be stored, used or generated on-site, presented in a format acceptable to the local fire marshal (include Chemical Abstracts Service (CAS) numbers).</td>
<td>Yes, section 50-37 part 4 L; “Inventory of hazardous substances to be stored, used or generated on-site, presented in a format acceptable to the local fire marshal (include CAS numbers).”</td>
</tr>
<tr>
<td>Descriptions of type of operations proposed for the project and drawings showing size, location, and description of any proposed interior or exterior areas of structures for storage, using, loading or unloading of hazardous substances, hazardous wastes, and/or polluting materials.</td>
<td>Yes, section 50-73 part 4 M; “Descriptions of type of operations proposed for the project and drawings showing size, location, and description of any proposed interior or exterior areas of structures for storage, using, loading or unloading of hazardous substances, hazardous wastes, and/or polluting materials.”</td>
</tr>
<tr>
<td>Completion of the Environmental Permit Checklist on the form provided by the Zoning Administrator.</td>
<td>Yes, section 30-73 part 5 O; “Completed environmental permit checklist on the form provided by the planning and zoning office.”</td>
</tr>
<tr>
<td>Does the zoning ordinance contain specific provisions for the on-site handling, storage, use, and manufacture of chemicals?</td>
<td>Yes, section 36-148; “The fire chief shall cause to be delivered a copy of this division and a hazardous material disclosure form for completion to any person who, as a result of an inspection by the city, or based on the nature of the enterprise, may be handling, storing, using, processing, or disposing of hazardous materials.”</td>
</tr>
<tr>
<td>If yes to the previous question, does the zoning ordinance explicitly state that the storage of fluids, chemicals, and other hazardous substances will be stored in a location with an impervious floor that lacks floor drains.</td>
<td>No</td>
</tr>
</tbody>
</table>
These interviews are divided into three sections:

- Procedures and Enforcement
- Education and Outreach
- Information Sharing and Data Management

Each of these sections is then divided into two sub-sections:

- Wellhead Protection
- Groundwater Protection

REPRESENTATIVE INTERVIEWS
## Procedural & Enforcement
### Wellhead Protection

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>22) Does the community require onsite inspections of new land uses in WHPAs?</td>
<td>All new land uses require some form of on-site inspection such as a zoning compliance inspection, building inspection, etc., but the Delhi Township does not require a specific inspection that is aimed only at WHP goals.</td>
</tr>
<tr>
<td>23) How often are plugged wells inspected?</td>
<td>This is done by the Ingham County Health Department.</td>
</tr>
<tr>
<td>24) Is a Phase I Environmental Assessment required before starting development in a WHPA?</td>
<td>No, not by the Township. Phase I’s are typically required by lenders and are usually done when a new entity acquires a property, but again this is not a specific requirement relative to WHP.</td>
</tr>
<tr>
<td>25) How often are new WHPAs assessed and integrated into maps and plans?</td>
<td>The interview subject is not sure about this question and refers to the Tri-County Regional Planning Commission and the Lansing Board of Water and Light (LBWL).</td>
</tr>
</tbody>
</table>

### Groundwater Protection

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>26) Are there any difficulties with the enforceability of any groundwater regulations in the community’s zoning ordinance?</td>
<td>No</td>
</tr>
<tr>
<td>27) Within the past three years, have any variances been given that affect groundwater regulations?</td>
<td>No</td>
</tr>
<tr>
<td>28) Does the community require potentially contaminating land uses to submit contingency plans for emergency response? Do these plans ensure protection from discharges and spills to groundwater?</td>
<td>Yes. A “basic monitoring report” is submitted for each new project. In addition, companies that are potentially contaminating are typically required to file a PIPP (Pollution Incident Prevention Plan) and a FFRTK (Fire Fighter Right-to-Know) report. These detail the potential contaminate sources such as specific chemicals to be stored as well as containment and spill prevention/cleanup procedures.</td>
</tr>
<tr>
<td>29) In what instances does the municipality require groundwater monitoring?</td>
<td>The Delhi Township does not specifically require this. Typically this is a state requirement when a site has been identified through the environmental assessment process as being contaminated. The state works with the property owner to develop a cleanup and mitigation plan that would include specifics about groundwater monitoring (frequency, etc.) if necessary.</td>
</tr>
<tr>
<td>30) Do you have and use an environmental assessment checklist? How often is this updated?</td>
<td>Yes, the interview subject does not think that it’s been updated within the past 5 years. Delhi Township uses the standard Ingham County Environmental Permits Checklist.</td>
</tr>
</tbody>
</table>
Wellhead and Groundwater Protection Audit Assessment

1. Are wellhead protection areas identified?
2. Are WHPAs defined?
3. Does the community utilize a wellhead protection plan?
4. Is there a reference to designation?
5. In the goals and objectives is groundwater an issue of concern?
6. Is groundwater a local issue?
7. Does the plan address and describe groundwater?
8. What is the plan for groundwater protection?
9. Are specific sites with existing wells identified in the plan?

X: Yes, X*: implied, but not explicitly stated. *Question not located in findings - irrelevant beyond identification.

Zoning Ordinance

10. Are WHPAs free of any districts or zones?

11. Are abandoned wells, abandoned wells plugged in accordance with regulations?

12. Do any of the community's ordinates of groundwater volumes or rates from above ground storage tanks or closed or removed in accordance with Environmental Quality?

13. Are underground storage tanks re-designed or removed in accordance with Environmental Quality?

14. Are there any provisions in the zoning ordnances that include the management of site?

15. Are provisions present that require or groundwater, including direct or indirect hazardous waste, and/or polluting materials?

16. Does the zoning ordinance contain specific storage, use, and manufacture of chemicals?

17. Are the previous questions does the no storage of fuels, chemicals, and other hazardous location with an impervious floor that lacks.

Existing topographic elevations at 200 feet with contour intervals. Indicate location of drainage flow

The location and elevation of existing water courses and water bodies, including county drains and manmade surface drainageways, floodplains, and wetlands.

Location for on-site wastewater treatment and disposal systems.

Location for existing and proposed public a monitoring wells. Irrigation wells, and wells.

Description and location for any existing or ground storage facilities.

Completion of the Environmental Permits & Zoning Administrator.

- Does the zoning ordinance contain specific storage, use, and manufacture of chemicals?
- Are there any provisions in the zoning ordnances that include the management of site?

X: Yes, X*: implied, but not explicitly stated. *Question not located in findings - irrelevant beyond identification.
MAJOR STUDENT FINDINGS AND RECOMMENDATIONS

Delta Charter Township provides assistance for plugging wells.

- *Develop assistance programs (financial and/or technical) for locating and plugging abandoned wells*

City of East Lansing & Meridian Charter Township actively promote education and awareness of wellhead protection issues to the public regarding WHPAs through various media campaigns.

- *Engage in media campaigns and events like the Children’s Water Festival to promote awareness about groundwater and wellhead protection*

Lansing Charter Township has strong provisions for the safeguarding of wells as they relate to the demolition of structures, as well as awareness signs about Wellhead Protection Areas (WHPAs)

- *Create ordinance provisions for the demolition of buildings that ensure the safeguarding of wells*
- *Develop an awareness program for WHPAs that includes signage*
Many Master Plans have no reference to groundwater protection, WHPAs or their definitions (with the exception of Delhi, Lansing and Meridian Charter Townships).

- Define WHPAs and reference where to find the most current WHP data and delineations.
- Define WHPAs using local, state, or federal definitions.

There is a lack of data for private and abandoned wells.

- Maintain basic local GIS data on wells and WHPAs.

Contingency plans are not updated.

- Update contingency plans to ensure the wellbeing of groundwater and wellhead protection areas.

Best Management practices are not always followed.

- Encourage best management practices for homeowners and facility managers at the local government level.
STUDENT RECOMMENDATIONS FOR EDUCATION AND OUTREACH

• Wellhead Protection
  – Signage for WHPAs
  – Incentives for abandoned well reporting

• Groundwater Protection
  – Community engagement in media campaigns promoting groundwater awareness
  – Involvement in Children's Water Festival
STUDENT RECOMMENDATIONS FOR INFORMATION AND DATA SHARING

- **Wellhead Protection**
  - Communication among communities regarding newly delineated WHPAs
  - New wells drilled

- **Groundwater Protection**
  - Review by regional authority
  - Representation on the Groundwater Management Board
  - Development and upkeep of GIS data
STUDENT RECOMMENDED BEST MANAGEMENT PRACTICES (for local governments)

- Clear community goals, objectives, and strategies for the protection of groundwater resources
- Ordinances that ensure the safety of wells and prevent discharges
- Abandoned well management (plugging and tracking)
- Local media campaigns to raise general awareness about wellhead protection
- Communication and cooperation between facility managers and local government about potential threats
STUDENT RECOMMENDED BEST MANAGEMENT PRACTICES
(For business and facility managers)

- Pollution Incident Prevention Plans (PIPPs)
- Fuel and hazardous material storage
- Double containment
- Septic system maintenance
- Abandoned well reporting
- Communication and cooperation between facility managers and local government about potential threats
Final product very useful
Fresh perspective
Snapshot of current status
STAFF CRITICISMS OF STUDENT REPORT

- Incorrect analysis based on limitations of the students' full understanding of how each community works.
  Example: What they see as a weakness or missing is actually a responsibility of another agency or is confidential.

- Great tool but needs to be administered by someone who REALLY understands the community being evaluated.
IDEAS/RECOMMENDATIONS FOR IMPLEMENTATION

• Use this as an exercise for your elected board, planning commission/staff or water utility. Could be a great start to:
  – Master/Comprehensive Plan Update
  – Ordinance Review
  – Education/Outreach for new officials
• Engage a student or class to adapt survey for your state/community.
• Share your results with us!
THANK YOU!

• For more information contact:
  – cspitzley@mitcrpc.org
  – www.capitalgroundwater.org
  – (517) 393-0342

• Questions?
INSPIRING ACTION

COMMUNITY-WIDE AWARENESS: THE RESULTS!

Lois Shelton
Former Mayor of Wayne, Neb.

Brian Reetz
The Groundwater Foundation
What is groundwater?
Does groundwater come from an underground ocean?
Does your family change its oil in the alley?
Do you drink groundwater?
How long of a shower do you take?
How informed are you about groundwater in your area?
INTRODUCTION TO
COMMUNITY-WIDE AWARENESS
The Groundwater Foundation

- Identify community
- Meet with key leader
- Meet with city council
- Formulate implementation in the community together
- Present at service organizations
- Present at youth event
- Participate in community event
The Groundwater Foundation -- Wayne

- League of Municipalities Conference
- Green Team
- Council City
- Chicken Show
- Library Event
- Programs
Lois M. Shelton
Former Mayor, Wayne, NE
Wayne, NE –
A Brief Overview

• Population: 5660
• Government: Mayor and Council
• Home of:
  • Wayne State College
  • Wayne Chicken Show
• Taking a proactive approach to environmental issues.
Wayne Green Team

Formed in 2009 to address multiple issues including:

- Solid waste management (recycling)
- Energy use
- Water use and conservation
- Stormwater management
- Other environmental topics
Wayne Green Team Membership

- Ponca State Park employee
- NDOR Environmental Engineer
- Public School Counselor
- City library employee
- Several Wayne State College Professors with backgrounds in: Biology, German, Music, Counseling, Environmental Studies, Sociology
- City of Wayne Planning and Zoning official
- City of Wayne Administrator
- Stay-at-home Dad who is home schooling
- Stay-at-home Mom formerly with Microsoft (attorney)
- Occasionally: Natural Resources District, Center for Rural Affairs, UNL Extension
Wayne Green Team Early Goals

- Reduce energy consumption – both municipal & personal
  
  Quote from the 2009 League of Cities Conference:
  “Tax money spent on wasted energy goes out of the community forever and reduces its wealth.”

- Increase recycling awareness

- Reduce water consumption & “recycle” it

- Engage school children in the sustainability process
Wayne Green Team

Green Team has become the “go to” group for others working on green or sustainable projects.

- Wayne State College
  - Pharmaceutical recycling
- Local refuse haulers
  - Increase recycling awareness
  - Offer “by-the-bag” pick-up
  - Fluorescent bulb recycling
  - Glass recycling
  - Curbside recycling – mixed stream
- Jaycees
  - Electronics recycling
Wayne Green Team

Green team members have been a valuable source for what the public doesn’t know or understand.
Green Expo

- Conceived as the best way to educate the public
- Focus has been on water use and stormwater management
Wayne Green Expo
April 9
Wayne City Auditorium
10-3
FREE TO THE PUBLIC
BRING THE WHOLE FAMILY!

PRESENTATIONS
• 10:00 – 10:30—Building an Ecosystem
• 10:40 – 11:10—Rainwater Harvesting in the Landscape
• 11:20 – 11:50—Water-Friendly Landscaping
• 12:00 – 12:30—Why Buy Organic?
• 12:40 – 1:10—Rainwater Harvesting in the Landscape

DEMONSTRATIONS
• 10:00 – 10:30—Rainwater Harvesting in the Landscape
• 10:40 – 11:10—Water-Friendly Landscaping
• 11:20 – 11:50—Soil Erosion and Runoff
• 12:00 – 12:30—Outdoor Family Trailer
• 12:40 – 1:10—Rainwater Harvesting in the Landscape

DISPLAYS & BOOTHS
• Wayne Community Schools Science Displays
• University of Nebraska & UNL Extension
• Organic Agriculture
• Community Garden and Wayne Farmer’s Market
• Composting and Worms
• WSC A. Jewell Schock Museum of Natural History
• Water Obstacle Course
• Rain Barrels
• Smart Medicine Disposal Information
• Recycling Display
• Wayne Chapter of the FREE TO THE PUBLIC

Cost-Free the Whole FAMILY!
Green Expo

Approximately 200 participants in 2010 & 2011
Green Expo
Green Expo

- Everyone lives in a watershed – but do they know that or what it means?
- Use of interactive watershed map to assist public with understanding where the water that goes down the storm drain ends up and why they should care.
- Map of the city showed the storm drain layout and where it flows into the local creek.
- Tacks used to mark the location of each person’s home and make them a part of the collective process.
Green Expo

- Next year’s focus will change a bit
  - “The Green Path to the Good Life”
Specific Water-related Projects

- Rain gardens
Specific Water-related Projects

- Rain gardens
- Use of large bio-swales & retention basins
Specific Water-related Projects

- Rain gardens
- Use of large bio-swales & retention basins
- 3 Groundwater Guardian Green Sites
Specific Water-related Projects

- Rain gardens
- Use of large bio-swales & retention basins
- 3 Groundwater Guardian Green Sites
- Storm drain labels
  - ~275 inlets labeled
Results

Communities
Wayne, Crete, Minden, Fairbury, Auburn, St. Paul

Dialogue
With different segments of the community

Green Sites
Protection efforts in towns

Actions
Forward pro-active thought

Survey
Interesting results
QUESTIONS?

BRIAN REETZ
THE GROUNDWATER FOUNDATION
5561 S. 48TH ST. SUITE 215, LINCOLN, NE 68516
PHONE: 402-434-2740
WEB: WWW.GROUNDWATER.ORG
REETZ@GROUNDWATER.ORG

LOIS SHELTON
WAYNE, NEBRASKA
DSHELTON@INEBRASKA.COM
Business Leadership In Sustainability
Why would a corporation like Assurity spend our limited time and resources on developing a comprehensive sustainability program?

Current sustainable initiatives at Assurity.

Sustainable features of the new Assurity Center.
Why would Assurity spend our limited time and resources on developing a comprehensive sustainability program?

1. Being an environmental steward is consistent with our number one corporate value of “Ethical Behavior.”

First and foremost, we will conduct ourselves with the utmost integrity, fairness and honesty. We will never compromise our ethics for growth or financial gains. We seek to associate with distributors who share our commitment to high ethical standards. How we achieve results is as important as the results themselves.
Why would Assurity spend our limited time and resources on developing a comprehensive sustainability program? (cont.)

2. It is important to our customers and will help us grow our business.

3. Going green can help the economy.

4. Simply the right thing to do.
Current Green Initiatives at Assurity Life

✓ We use compact fluorescent lamps and the bulbs are recycled.

✓ ServiceMaster, our company’s cleaning service, has a full green cleaning program, and is currently using mostly green products when they clean our buildings.

✓ We focus on buying office supplies which are made from recycled materials.

✓ We are using LEED-certified paper products in our restrooms and our copier paper meets the standard set by the Forest Stewardship Council.
Our company has a comprehensive recycling program in place for office paper, newspapers, magazines and phone books. All paper leaving the building at this time is recycled. The recycling program also includes the following items:

- Used batteries, including cell phone batteries
- Old computers, keyboards and monitors
- Old office equipment and fixtures
- Used copier toner cartridges
- Used printer toner cartridges
- Plastic beverage bottles and aluminum cans
- Intra-office supplies, such as paper clips and rubber bands
- All cardboard boxes
- Last year we recycled over 148,000 lbs. of paper!
Current Green Initiatives at Assurity Life (cont.)

- When possible we use sand rather than de-icer in the parking lot during winter ice storms.
- Our copiers have “power save” settings, which reduces power consumption.
- We are almost paperless – we recently completed imaging all our old policy files.
New Green Initiatives

1. Encouraging walking and bicycling to work.
2. Encouraging use of public transportation.
3. Taking recycling to the next level.
4. Going paperless in more and more ways.
5. Greater use of power saving devices on more machines.
New Green Initiatives (cont.)

7. Investigating a pilot urban farming experiment.
8. New food vendor will source local food.
9. Increased use of webinars and video conferencing rather than traveling.

Stephen Gasteyer
Department of Sociology, Michigan State University
Nicholas Brozovic
Department of Agriculture and Consumer Economics, University of Illinois
Ximing Cai
Department of Civil and Environmental Engineering, University of Illinois

Corresponding Address:
422a Berkey Hall, Department of Sociology, Michigan State University, East Lansing, MI 48824
Tel: 517-355-3505; Email: gasteyer@msu.edu
CHNS Research – Why Couple

• Integrated studies of coupled human and natural systems reveal new and complex patterns and processes not evident when studied by social or natural scientists separately.

• Coupled human and natural systems are integrated systems in which people interact with natural components. Although many studies have examined human-nature interactions, the complexity of coupled systems has not been well understood. (Liu, et al. 2007)
Coupling Hydrologic, Economic, and Social Network Models to improve Understanding of Surface Water-Groundwater Interactions for Protection of Instream Flows

- Ignoring or inadequately characterizing the interactions between individual behavior, social group behavior, and nature in coupled surface water-groundwater (SWGW) systems will lead to poorly calibrated scientific models, to policies that impose unnecessary economic losses on stakeholders, and to unnecessary social conflict.
Assumed interactions

Human systems
Natural systems

INSTITUTIONAL SETTING/POLICIES

Spatial, dynamic behavioral variations (individual and group)

Social constraints on feasible policy choices

SCARCITY AND CONFLICT LEAD TO CHANGE

Technology adoption, crop choice, risk management decisions

DISTRIBUTED WATER RESOURCE SYSTEM

INFLUENCE OF COALITIONS (ADVOCACY, LITIGATION, STAKEHOLDER CONSENSUS)

REGULATORY, INCENTIVE BASED, AND VOLUNTARY ACTIONS
Testing and Implementing Interaction

- Research Site: The Republican River Basin
Integrated Research

- Steps for research:
  - Documenting biophysical interactions
    - And matching water to human use
  - Social statistics and understanding social history
    - What are the institutions and how do they emerge
  - Documenting coalitions and networks
    - How do coalitions and networks implement activities
  - Resource and economic interactions
    - And do those lead to opportunities for solutions
Context: Sustainability, Water and the High Plains Aquifer

• The High Plains region hosts some of the most productive irrigated agricultural land in the United States, made possible by one of the largest contiguous aquifer systems in the world, the Ogallala-High Plains aquifer complex. The Aquifer covers more than 450,000 km² of 8 states including South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, Texas, and New Mexico and is on a fundamentally unsustainable path, having been drawn down by over 300 cubic km since the 1930s (USGS).
Water Use, Ag, and Conjunctive Conflict

- 1880s – First attempt to encourage irrigation
- 5 stages of irrigation development: individual, corporate, district, state and federal (Carlson 2003)
- 1900-1935 – area was largely agricultural
- 1935 – Republican River Flood → “Bluff to Bluff”
- 1940-1960 – development of Irrigation Districts
- 1943 Compact: Colorado 11%, Kansas 40%, Nebraska 49%
- 1955 – development of pivot irrigation
- 1970-1980 – refinement of technology
- 1978 – first USGS report on declining groundwater
- 1980s – Accelerated consolidation of farms
- 1970s-1990s – Increasing corn acres – cattle heads
  - Water levels over time and the coming crisis

“Floods in 1927 spurred interest in Congress for flood control, while drought re-emphasized the need for irrigation, and depression created a need for jobs. The idea of irrigation became more accepted when coupled with the idea of power generation. Hydroelectric plants had a much wider appeal than irrigation alone, and the power revenues were needed to finance and operate projects.” (pg 72)
“The only interruption on the horizon is a long shiny arm with dropped hoses sprinkling gentle rain over the thirsty corn. There will be a crop this year. The harvest is bountiful. [The farmer] remembers the old stories his parents told him as a boy…of constant struggle to keep the crops alive…of sun-scorched farmland and times when entire crops were lost. All they needed was a little rain. What started out as a simple notion to save labor on the farm, ended up changing the world…a technology which allows mankind to grow more crop with precise amounts of energy, chemical, and water” (Groundwater Foundation 2005: 5-8).
A direct impact to public power districts

• At Dawson PPD… “Quick response well” as a worst case scenario
  • $3.9 million in lost irrigation revenue annually
  • Approximately 29% of Dawson PPD irrigation revenue
• Basin
  • NRDs (LB 557 of 1973) – varied pre-suit response
  • Irrigation Districts
  • Farmers (irrigators and well users)
  • Activist residents (waterclaim.org, etc.)
History of the RRB Irrigated Acres
History of RRB -- Cattle

```
<table>
<thead>
<tr>
<th>Year</th>
<th>Upper</th>
<th>Middle</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1992</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1997</td>
<td></td>
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<td></td>
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<tr>
<td>2002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

Legend:
- Upper
- Middle
- Lower
Crisis – Kansas Wants its Water

- 1990-2000 – increasing recognition of overuse
- 1998 Kansas Files a Lawsuit against Nebraska for Violation of the Republican River Compact
- December 15, 2002, Final Settlement Stipulation
- May, 2003, Approved by the U.S. Supreme Court
  - Important – First official legal recognition between groundwater and surface water.
- Settlement stipulated improved monitoring of water use. Colorado water monitoring excluded them from suit; URNRD had monitoring…
- Jointly developed model to depict water use and relation to stream flow.
- May 3, 2010, Kansas filed suit in the U.S. Supreme Court to enforce the final settlement stipulation.
Trend in Farming in NE and the RRB

NE Farms Over Time

- Nebraska Farms
- RRB County Farms

Year

Farms

<table>
<thead>
<tr>
<th>2005/6 Estimates</th>
<th>Nebraska Counties in RRB</th>
<th>Population</th>
<th>Pop Change 2000-2006</th>
<th>Civilian Labor Force</th>
<th>Unemployment Rate</th>
<th>Employment in Government</th>
<th>Private Non-Farm Employment</th>
<th>Farmland (Acre s)</th>
<th>Land Area (Sq Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nebraska State level</td>
<td>1,768,331</td>
<td>3.30%</td>
<td>974,476</td>
<td>3%</td>
<td>170,891</td>
<td>51,440</td>
<td>45,903,116</td>
<td>76,872.41</td>
<td></td>
</tr>
<tr>
<td>URNRD</td>
<td>Perkins</td>
<td>2,992</td>
<td>-6.50%</td>
<td>1,590</td>
<td>2.30%</td>
<td>371</td>
<td>109</td>
<td>548,264</td>
<td>883.18</td>
</tr>
<tr>
<td>Dundy</td>
<td>2,109</td>
<td>-8.00%</td>
<td>1,069</td>
<td>3.10%</td>
<td>250</td>
<td>380</td>
<td>566,881</td>
<td>919.86</td>
<td></td>
</tr>
<tr>
<td>Chase</td>
<td>3,811</td>
<td>-6.30%</td>
<td>2,096</td>
<td>2.30%</td>
<td>571</td>
<td>1,075</td>
<td>539,607</td>
<td>894.5</td>
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<tr>
<td>MRNRD</td>
<td>Lincoln</td>
<td>35,865</td>
<td>3.60%</td>
<td>21,138</td>
<td>2.80%</td>
<td>2,999</td>
<td>1,019</td>
<td>1,529,011</td>
<td>2,563.98</td>
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<tr>
<td>Hayes</td>
<td>1,029</td>
<td>-3.70%</td>
<td>502</td>
<td>3.00%</td>
<td>107</td>
<td>60</td>
<td>408,290</td>
<td>713.11</td>
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<tr>
<td>Frontier</td>
<td>2,729</td>
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Some empirical or theoretical hydrologic relations are violated by human interferences!?
Irrigation development in the Republic River Basin (RRB) in U.S. Midwest
In RRB, long term average  $P \neq Q + ET$
In dry years, $ET > P$;
in wet years, $ET < P$
$Q$ remains low all years
Impact of irrigation on the inter-year water and energy variability

Chen et al. (2010)
Impact of irrigation on inter-year water and energy variability

Inter-annual variability of human activities (i.e., pumping for irrigation) has been coupled well with the inter-annual variability of climate (ET, PET)?
Economic Contributions

- Analyze alternate water management policies for a large agricultural watershed with ongoing water conflict.
  - Field-level population data capture spatial heterogeneity in both costs and benefits of water use.
  - Damages are derived analytically from spatial, dynamic hydrologic model.
  - Institutional context is amenable to implementation of a tradable permit system.
Conceptual framework

- Implement a field-level optimization model of deficit irrigation for the entire Nebraska portion of the Republican River Basin.
- Generate abatement cost curves for water use reduction at all wells.
- Generate instream damages from groundwater pumping for all wells.
- Compare cost-effectiveness of alternate management policies.
Data Points

- Groundwater Pumping
- Center Pivot Irrigation
  - Quarter section
- Irrigation - Basin Scale
  - 11,000 wells, 1.25 million irrigated acres
- Solve nonlinear optimization:
  - Adapt single field irrigation decision support tool (UNL WaterOptimizer)
  - Choose land allocation, crop choice (irrigated or dryland), and applied water.
  - Constraints on water and land available.
  - Site-specific crop water requirements and yields.
Estimated Total Abatement Costs
Current NRD Allocations

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<th>Total (all wells)</th>
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<td>Republican River Basin</td>
<td>27.73</td>
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</table>
Estimated Marginal Abatement Costs

Current allocations
- Upper (13 inches)
- Middle (12 inches)
- Lower (9 inches)

Republican River Basin
Marginal Abatement Costs
Groundwater Pumping Externality

![Graph showing the effect of distance on stream depletion per unit of pumping over time.](image)
Results

- Farmers choose among three basic strategies:
  - Buying permits to irrigate
  - Selling permits and continuing irrigation
  - Selling entire allocation and moving into dryland production

- In each trading scenario, there are more buyers than sellers.
So, can trading be a tool for RRB

- We find that a Basin-wide market for ground-water will save the average farm approximately $3,000 annually in abatement costs while maintaining current levels of stream protection. In addition, the results show that regulators can capture most of the potential cost savings by establishing a one-to-one tradable permit system that does not account for spatial heterogeneity in the externality. The efficiency of this policy relative to the more complicated, constrained optimal ratio trading solution was discovered thanks to the population nature of our data set. However, we also find that if regulators need to significantly reduce stream depletion from current levels, spatially targeted polices will generate sizable cost savings. (Brozovic, et al.)
Bringing it all together

- Hydrologic systems undergird life itself.
- It is important to remember that key historical events have an impact on human-natural system interactions and create social-economic-biophysical (hydrologic) impacts.
- Understanding the heterogeneity of these systems will be critical to addressing increasingly complex resource distribution challenges.
Problem statement:

• Groundwater is a vital natural resource, yet the public—including many well owners—know little about it.

• How can groundwater advocates effectively raise public awareness on meager resources?
Why is awareness important!
Link between groundwater quality & public health:

Naturally occurring constituents in groundwater, (i.e., bacteria, arsenic, radon)

Manmade contamination, (i.e., industrial sites, nitrate, leaking underground storage tanks, failed septic systems)
Groundwater Use for America
9/2010
©2010 National Ground Water Association

Total
Groundwater (mgd—fresh, not saline) ........................................ 79,600
Percentage of total water supply for nation ................................ 26.4%b
Estimated annual economic value of pumped water1 ........ $20.09 bil.2

Public Supply
Groundwater (mgd) .......................................................... 14,600
Percentage of total groundwater ......................................... 18.3%b
Percentage of total public supply ........................................ 33.03%b
Estimated annual economic value of pumped water ........ $12.91 bil.2
Estimated value of installed well/pump infrastructure ........ $3.73 bil.4

Individual Household
Groundwater (mgd) .......................................................... 3,740
Percentage of total groundwater ......................................... 4.7%b
Percentage of total individual household supply ....................... 97.7%b
Estimated annual economic value of pumped water ........ $3.3 bil.5
Estimated value of installed well/pump infrastructure ........ $64.31 bil.

Irrigation
Groundwater (mgd) .......................................................... 53,500
Percentage of total groundwater ......................................... 67.2%b
Percentage of total irrigation ............................................ 41.8%b
Estimated annual economic value of pumped water ........ $1.07 bil.6
Estimated value of installed well/pump infrastructure ........ $6.0 bil.

Livestock/Aquaculture
Groundwater (mgd) ....................................................... 3,200
Percentage of total groundwater ......................................... 4.02%b
Percentage of total livestock/aquaculture ......................... 29.3%b
Estimated annual economic value of pumped water ........ $64.0 mil.7

Groundwater's Role in America's Economic Vitality
- 43.8%11 of America's population regularly depends upon groundwater for its drinking water supply12
- 41,913,300 American residents served by privately owned individual wells13
- 88,032,021 American residents served by groundwater supplied community water systems14
- 13,249,000 occupied American households served by privately owned individual wells15
- 107,848 community supply16 wells serving 40,02517 American community water systems
- 17,688 nontransient, noncommunity water systems serving 5,415,937 people18
- 81,492 transient, noncommunity water systems serving 10,754,201 people19
- 407,913 irrigation wells used serving 97,690 farms20
- The U.S. bottled water industry used 5.34 billion gallons of groundwater in 200121
Regular water well system maintenance is important. Knowing and practicing the basics of regular well maintenance can reduce risks to your water supply and prevent costly and inconvenient breakdowns.
Water-related Diseases and Contaminants in Private Wells

Over 15 million U.S. households obtain their drinking water from private wells, which are not covered by the United States Environmental Protection Agency (EPA) regulations that protect public drinking water systems. Although the United States has one of the safest drinking water supplies in the world, sources of drinking water can still become contaminated through naturally occurring chemicals and minerals (for example, arsenic, radon), local land use practices (for example, pesticides, chemicals, animal feeding operations), malfunctioning wastewater treatment systems (for example, sewer overflows), and other sources. Contamination of a private well can impact not only the household served by the well, but also nearby households using the same aquifer.

Owners of private wells are responsible for ensuring that their water is safe from contaminants. Private wells should be checked every year for mechanical problems, cleanliness, and the presence of coliform bacteria, nitrates, and any other contaminants of local concern. A local health department or water well systems professional can help ensure delivery of high-quality water from an existing well or, if needed, help locate and construct a new well in a safer area. Additional information about well maintenance and water testing is available at Healthy Water's Well Testing page.

The presence of contaminants in water can lead to health issues, including gastrointestinal illness, reproductive problems, and neurological disorders. Infants, young children, pregnant women, the elderly, and people whose immune systems are compromised because of AIDS...
If you own a household water well system or are considering installing one, some simple steps can minimize risks to your water supply. The National Ground Water Association (NGWA) recommends the following.

Proper well location and construction

Ideally, a well's location should be determined with a contractor or hydrogeologist before the home is built. A qualified water well system contractor will be familiar with state or local well construction codes, including those pertaining to separation distances from potential contamination sources.

Regular well system maintenance

NGWA recommends an annual well system maintenance checkup by a qualified water well system contractor to reduce risks to your water supply and prevent costly and inconvenient breakdowns. A well maintenance inspection should check the well's:
- Equipment to determine if it is sanitary and meets local codes
- Flow rate
- Pump performance
- Pressure tank
- Pressure switch contacts.

A clear, concise, written report should be provided following the checkup, explaining the results and any service recommendations. Water treatment equipment should be serviced according to the manufacturer's recommendations.

Also, every well owner should periodically check the well cover or cap, and the well casing above the ground, to make sure they are in good shape. Check, too, that the ground slopes away from the wellhead to prevent the pooling of water.

Water testing and treatment

Testing the water is one of the well owner's most important responsibilities. Some prudent questions include:
- How often should I test?
- What should I test?
- How do I interpret results?
- What if there is a health concern?

Here are some basic steps you can take. First, determine if your well is clean. A dirty well, for instance one with accumulated sediment or debris at the bottom, can create an environment suitable to bacterial growth and impair effective disinfection. A qualified water well system contractor can determine if your water well system needs cleaning.

Next, NGWA recommends well owners annually test for bacteria, nitrates, and anything of local concern. The water should be tested more frequently if there is:
- Any change in the water's taste, odor, or appearance
- A problem such as a broken well cap or a new contamination source
- A family member or houseguest who has recurrent incidents of gastrointestinal illness
- A pregnant woman or infant living in the home
- A dangerous contaminant that shows up in your neighbors' water.
The challenge is not a lack of information.

The real challenge is effectively communicating information to the public.
You don’t have to reinvent the wheel to launch an effective public awareness program.
Plug into two NGWA recognition events.
Join the team in supporting these events!
Piggybacking on these events is **KEY** to overcoming:

- Time constraints
- Money constraints
- Personnel constraints…

*for NGWA and its many partners.*
Here’s how:

1. Use prepacked messages and logos

2. Link to NGWA content OR customize as necessary

3. Use the communications channels you have in place

4. Partner with someone locally to extend your reach
#1 Pre-packaged messages & logos

- Copy Web version of logos.
- Email ctreyens@ngwa.org for print quality logo.
Excellence in Earth Science Education

September 14, 2010

Protect Your Groundwater Day

We all turn to experts for the right advice. And when it comes to Earth science, who would we rather look to than the leading Earth scientists at the American Geological Institute?

That's why the AGI Education Department has created a comprehensive portfolio of geoscience educational materials and resources for students and teachers — from kindergarten to high school and beyond.

Use the links on the left to navigate the major sections of the site. Join the adventure of exploring Earth science with the American Geological Institute!
It’s Groundwater Awareness Week and We’re Celebrating!

It’s National Ground Water Awareness Week and here at the Water Bureau, we’re celebrating!

Okay, so it’s not one of those balloons and party hats type of celebrations... it’s more like an educational celebration for the state of Oregon’s second largest source of drinking water, our groundwater well field! (You might also know as the Columbia South Shore Well Field.)

What is National Ground Water Awareness Week? Every March, the National Ground Water Association, the Ground Water Foundation and others, sponsor a week-long educational campaign intended to remind well owners to conduct their annual water well check up and to stress the importance of yearly water testing and well maintenance. Since about half the U.S. population receives its drinking water from wells and more than 90 percent of the fresh water in the United States and around the world is groundwater, this week serves a very important purpose!

And while don’t necessarily need the reminder around here (we already conduct regular water quality testing and well maintenance) we’re going to take this week to educate you about our groundwater source right here on the Water Blog.

So stay tuned and check back often. We’ll post one or two new blogs each day this week, each highlighting a different aspect of our groundwater source. Got a question? Just ask! Our staff of expert groundwater aficionados are eager to hear from you!

Jennie Day-Burget
Public Information Officer
Everyone Can Help Protect Water Supply

National Ground Water Awareness Week is a reminder that everyone can help protect the ground water supply.

Everyone can help protect ground water and reduce risks to the water supply during National Ground Water Awareness Week, March 8-14.

“Ground water makes up more than 90 percent of the available fresh water in the U.S. and the world,” North Dakota State University Extension Service water quality associate Roxanne Johnson says. “Nearly 50 percent of the U.S. population relies on ground water for its drinking water supply. Ground water also feeds most surface water bodies, such as rivers and lakes.”

Here are some steps anyone, particularly household water well owners, can take:

- Never dispose of any substance down an abandoned well.
- Maintain your septic system. A failing septic system may pose a risk.

NGWA verbiage
Ground Water Awareness Week March 7-13

March 3rd, 2010 | Posted in New Waves (March 2010)

During National Ground Water Awareness Week, March 7-13, The National Ground Water Association (NGWA) urges household well owners to check their well caps to ensure it is in good condition to protect the water supply from contamination. The NGWA, which sponsors the week, proclaimed March 9 National Inspect-Your-Well-Cap Day to encourage private well owners make this inspection.

The NGWA also urged citizens to be ground water stewards by properly using, storing and disposing of hazardous household substances; having a professional maintain your onsite wastewater treatment system (septic system), and, locating any abandoned wells on your property, then having a qualified water well system contractor make sure it is properly decommissioned.

To learn more about being a steward of ground water and well water, visit the National Ground Water Awareness Week Web site.
Plug into ready resources: Ex. Abandoned wells
Plug into ready resources: Ex. Hazardous household wastes
Plug into ready resources: Septic systems

** Septic Systems - Windows Internet Explorer **


** Septic Systems **

Nearly 25 percent of the population in the United States—more than 25 million homes—disposes of waste water through onsite, or septic, systems. With septic systems, homeowners are responsible for treating and maintaining the disposal of waste water. Most are typically found where centralized waste water treatment would be impractical, such as in rural areas.

The most common method used in a septic system is leaching. Septic systems use soil to treat small waste water flows. When properly maintained, septic systems are safe and reliable.

There are many types of septic systems, but all operate with the same philosophy. Following is more information on how they work and tips to ensure they are always operating efficiently.

** How They Work **

A typical system contains a septic tank, a distribution box, and a rock-and-gravel-lined absorption field, sometimes called a septic field. All are connected by pipes called collection lines.

Tanks are made of concrete, fiberglass, or plastic. They are usually buried and should be watertight. They are usually designed to hold a minimum of 760 to 1,000 gallons of sewage. Their purpose is to temporarily hold the waste water as solids and liquids separate. The solids, known as sludge, collect at the bottom of the tank, while scum floats on top of the liquid. The sludge and scum will remain in the tank and need to be pumped out periodically.

The waste water, or effluent, will pass through the tank to the distribution box. From there, the distribution box separates the flow of the water into a network of underground, perforated pipes in the absorption field. The effluent passes...
#2 Customize AW or PGWD to your purposes.

For immediate release:
September 8, 2010

For more information, contact:
Julie Maas, Public Relations Specialist
(505) 383-4095

"Protect Your Groundwater Day" is September 14

(SANTA FE, New Mexico) - As a means to raise awareness about how everyone can and should do something to protect groundwater, Tuesday, September 14, 2010, has been designated "Protect Your Groundwater Day" here in New Mexico.

The National Groundwater Association, in conjunction with Santa Fe County, the Office of the State Engineer/Interstate Stream Commission, the New Mexico Environment Department Ground Water Quality Bureau, and the New Mexico Water Conservation Alliance, urges the public to ACT – Acknowledge, Consider, and Take Action. It is important to Acknowledge the causes of preventable groundwater contamination. Consider what types of hazardous substances that may be in and around the home, and take Action to properly prevent groundwater contamination.

"The quality and quantity of our water sources are so important,” said Office of the State Engineer Water Use and Conservation Bureau Senior Water Resources and Conservation Coordinator Cheri Vogel. “This public awareness effort to keep groundwater clean is integral to public safety.

Everyone has a stake in maintaining the quality and quantity of groundwater.

For starters, 95 percent of all available freshwater comes from aquifers beneath the ground. Being a good steward of groundwater just makes sense.

Most surface water bodies such as rivers and lakes are connected to groundwater, so how the groundwater is impacted really matters.

(MORE)
Did you know that much of the water you use comes from the ground? National Ground Water Awareness Week highlights the importance of this water source and encourages well owners to properly maintain their wells. Learn more about ground water, the threats to its safety, and how to protect your own ground water sources.

Clean water is one of the world’s most precious resources. People use water every day for a variety of reasons, such as drinking, bathing, recreation, agriculture, cooling, and industry. Although water plays an essential role in every person’s life, many individuals are not aware that much of their water comes from the ground in the form of ground water.

National Ground Water Awareness Week, an annual observance sponsored by the National Ground Water Association (NSWA), is March 7-13, 2010. The focus of this week is to stress the importance of yearly water testing and well maintenance. This year NSWA is asking people to pay particular attention to their well caps by
News Brief

Protect Your Ground Water Day in Louisiana

The state Department of Natural Resources’ Office of Conservation is spreading the word today on water conservation. Joining the National Ground Water Association (NGWA), the American Farm Bureau Federation, and many other national groups that promote the importance of protecting water supplies.

Today is being celebrated as Protect Your Ground Water Day – September 14th. According to NGWA, the two fundamental ways to protect ground water is to keep it safe from contamination and to consume and use it wisely, not waste it.

DNR’s Office of Conservation has an informative website that encourages Louisiana citizens to practice water and energy conservation at home and everywhere. In support of Protect Your Ground Water Day 2010 — additional information and interactive tools for teachers and students are being featured on the website.

DNR officials have pledged through the Ground Water Resources Program to format its online information to serve as a major outlet for a variety of educational materials for school teachers and students all across the state.
Customize to local concerns

Examples:

• Well decommissioning

• Proper storage, use & disposal of hazardous household wastes

• Improperly maintained septic systems

• Proper separation distances from wellhead
Ground Water Awareness Week highlights the need to protect Santa Clara County’s largest reservoir – the aquifer

Contact: Susan Sliava
Office: (408) 265-2607, ext. 2230
Mobile: (408) 398-0754

Date: March 8, 2010

San Jose, CA – Groundwater, stored in the aquifer, is the most critical local asset for ensuring water supplies now and in the future. About half of the water used in Santa Clara County each year is pumped from local groundwater basins. We depend on local rainfall captured in local reservoirs and percolation ponds as well as imported water from the Sierra Snowpack to replenish these aquifers.

As part of National Ground Water Awareness Week, March 7-13, the Santa Clara Valley Water District is encouraging...
#3 Use existing communications vehicles

- Web sites
- Email
- Social media (Facebook, Twitter)
- News releases
- Presentations
- Exhibits
FOR IMMEDIATE RELEASE
March 4, 2010

Contact: Noreen Nickola-Williams
(904) 825-5055 x 1123

GROUND WATER AWARENESS WEEK: MARCH 7-13, 2010

ST. AUGUSTINE, FL – Does your water come from a private drinking well? If yes, St. Johns County Health Department would like to remind its residents that the coming week is observed as Ground Water Awareness Week. This week-long observance celebrates groundwater as a valuable and renewable resource.

Just as you check your furnace or smoke detector batteries seasonally, spring is a good time to have your private drinking well checked and also to have the water analyzed for contaminants since peak water-use season will be here in the coming weeks. According to the National Ground Water Association (NGWA), almost 47 percent of the U.S. population depends on groundwater, the water that fills cracks and other openings in beds of rock and
#4 Find a promotional partner

Examples:

- Health care interests
- Farm bureaus
- Extension services
- News media
- Other governmental entities / public officials
NGWA Public Awareness Snapshot

NGWA's reach through partnerships:

- Farm Burcaus: 50 state and 2,800 local
- Ground Water Protection Council: 50 state agencies
- Automotive Oil Change Association: 2,500 oil change service centers
- National Environmental Health Association: 4,500 environmental health professionals
- National Association of Conservation Districts: 3,000 districts
- Irrigation Association and National Onsite Wastewater Recycling Association: Thousands of members
Partnering helps get the job done!
What have been the results?
Groups embrace Protect Your Groundwater Day

The second annual edition of NGWA’s Protect Your Groundwater Day (PYGD) has been embraced coast-to-coast, as a Google search revealed nearly 200 Web sites and social media sites promoting the event on September 13.

While the number of mentions are to numerous to list, they range from federal agencies such as the U.S. Geological Survey, state governments, and water management districts, to news media, associations and extension services.

“The strategy behind Protect Your Groundwater Day is that there are many potential partners across the country who share our goal of groundwater protection—and this event provides an opportunity for us to come together to really spotlight the issue,” said NGWA Public Awareness Director Cliff Treyens.

“It’s working. This year alone, a combined total of more than 400 Web sites and social media sites have promoted by Protect Your Groundwater Day and National Groundwater Awareness Week,” Treyens said. “Perhaps more importantly, organizations are buying into this event as a recurring way to promote groundwater protection.”
More importantly, partners are making these events annual observances!
What's stopping you from getting on board?
Questions?
Taking the E out of ET

Robert N. Klein
Western Nebraska Crops Specialist
WCREC, North Platte Nebraska
Know how. Know now.

Jack's Place
Imperial, Nebraska
Scottsbluff Inn
Scottsbluff, Nebraska

ECOFAVLOW CONFERENCE

February 26, 1979 and March 1, 1979
Winter Wheat-Ecofallow Rotation

Proceedings...
How It Was – Impact of Research
On Conserving Our Land
Dr. John L. Weiheing, Director Panhandle Station,
Scottsbluff, Nebraska

- I was born on the High Plains of southeastern Colorado.
- On April 14, 1934, a dust storm “blacked out” the sun in mid-afternoon. Almost a month later on May 10, 1934, a second severe storm carried dust particles to the upper atmosphere and eventually released them on Washington, D.C., New York, Charleston, South Carolina and ships in the North Atlantic. On May 12, 1934, visibility at the weather station at Charleston, South Carolina was decreased to four miles because of dust from the Plains.
How It Was – Impact of Research On Conserving Our Land
Dr. John L. Weiherg, Director Panhandle Station, Scottsbluff, Nebraska

• I saw farm houses become empty, weathered and disappear with only a foundation or an old iron hand pump as a marker where once a family lived with great expectations.
In the early 1980s, Kansas and Colorado stopped allowing new groundwater irrigation to be developed in the basin. Nebraska, however, continued to allow wells to be drilled. In the mid-1980s, Kansas began to express its concern that Nebraska was not complying with the Republican River compact in several subbasins. In 1998, after many failed attempts to resolve the dispute, Kansas filed suit against Nebraska in the U.S. Supreme Court to enforce the terms of the compact. The State of Colorado was also a party to the lawsuit. That case was settled December 15, 2002, when the final settlement stipulation was signed by the states.
Harlan County Dam
Know how. Know now.
Know how. Know now.
Know how. Know now.
Know how. Know now.
Know how. Know now.
Know how. Know now.
Know how. Know now.
Figure 16

Average Annual and Average Growing Season Precipitation

Historical Trends in Groundwater Use (continued)

Center-pivot systems numbered 2,757 such systems

Current estimates from industry officials place

Growing Season

Annual Precipitation

10"  12"  14"  16"  18"  20"  22"  24"  26"

Dry Subhumid

Semi-Arid

Moist Subhumid

16"
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Average: 12.8, 23.9
DAVID CITY, NE

Monthly Total Precipitation (inches)

(252205)

File last updated on Jul 29.

*** Note *** Provisional Data *** After Year/Month 2009/03

a = 1 day missing, b = 2 days missing, c = 3 days, ... etc...

z = 26 or more days missing, A = Accumulations present

Long-term means based on columns, thus, the monthly row may not sum (or average) to the long-term annual value.

MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5

Individual Months not used for annual or monthly statistics if more than 5 days are missing.

Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

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<th>JUN</th>
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### David City, Nebraska
#### Monthly Total Precipitation

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<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<td>0.85</td>
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**Total Precipitation:** 28.57
Know how. Know now.
Know how. Know now.
6” Rain on June 12 - 13
Know how. Know now.
Know how. Know now.
Know how. Know now.
The Cornhusker state accounts for about one of every six acres of U.S. irrigated farmland, according to the U.S. 2007 Census of Agriculture.

By the end of 2007, Nebraska had 8.5 million acres under irrigation. Nebraska added 560,000 irrigated acres from 1997 to 2002 and another 930,000 acres between 2002 and 2007.

"About 30,000 irrigated acres may have to be changed to non-irrigated farmland acres as a result, he said. We have a very precious water resource in this state...and we’re developed pretty much to the max," Johnson said."
Registered Irrigation Wells in Nebraska
2007
Groundwater-level Changes in Nebraska - Predevelopment to Spring 2009

Rise
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
> 70

Decline
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
> 70

Surface Water

< +/− 5 feet or no data

CCSOSERVATION AND SURVEY ORION (http://cad.unl.edu)
School of Natural Resources (http://snr.unl.edu)
Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln

Jesse Korus, Groundwater Resources Coordinator, CSD
Mark Burrough, Water Levels Program Supervisor, CSD

U.S. Geological Survey
Nebraska Water Science Center

U.S. Bureau of Reclamation
Kansas-Nebraska Area Office

Nebraska Natural Resources Districts
Central Nebraska Public Power and Irrigation District

September 2009
Know how. Know now.

Taking the E out of ET
Know how. Know now.
Response System

Green light will shine

No need to press “GO”

Press button firmly that best answers question

Expensive, non-functional calculator

Won’t work as a remote
Spray droplets are measured in microns. The human hair is about ___ microns in diameter.

a. 50
b. 100
c. 200
d. 400
e. Small enough that I cannot see one but my spouse saw a blonde one on my jacket the second I walked through the door.
The September 2010 Dakota Country magazine contains the following statement:

a) Cindy Kreufels lands the biggest walleye ever caught in the Dakota’s

b) “To all you hunters who kill animals for food, shame on you; you ought to go to the store and buy the meat that was made there, where no animals were harmed.”

c) Mike Jess gets three pheasants with one shot.

d) Bob Klein bags deer at 160 yards with bow and arrow.
Know how. Know now.

“To all you hunters who kill animals for food, shame on you; you ought to go to the store and buy the meat that was made there, where no animals were harmed.”

Allegedly from an article in a San Francisco newspaper.
1. The number 1 issue in Nebraska is:
   a. The ranking of the football team
   b. The new Haymarket Arena in Lincoln
   c. Nebraska joining the Big 10
   d. Water
2. The E in ET (Crop Water Use) stands for _________.

a) Ethanol
b) Expedient
c) Experimental
d) Evaporation
Evapotranspiration (ET) Consists of Two Processes

Evaporation – soil evaporation is a direct pathway for water to move from soil to the atmosphere as water vapor

- A small amount of evaporation occurs from the plant surfaces after irrigation
- About 0.08 inches

Transpiration – the process of water evaporating near the leaf and stem surfaces
3. With bare soil, evaporation is about _________ of the crop water use in irrigated corn.

a. 6%

b. 11%

c. 22%

d. 33%
Projected Growing Season Evaporation on Corn

Garden City, KS – N.L. Klocke, 2004

Bare Soil

1 – Irrigated Once a Week
2 – Irrigated Twice a Week

Savings over Bare Soil
4. With tillage for seedbed preparation and 1 or 2 cultivations for weed control, crop water use for fully irrigated corn in this area is ___________.

a. 16-19 inches  
b. 20-23 inches  
c. 24-27 inches  
d. 28-31 inches
5. The soil water loss from each tillage operation is ________.

a) 0.1-0.2 inches
b) 0.3-0.8 inches
c) 0.3-0.4 inches
d) 0.2-2.0 inches
6. The rate of water intake in soil in any traffic area that is conventionally tilled without controlled traffic is:

- a. 0.2 inch/hr
- b. 0.4 inch/hr
- c. 0.6 inch/hr
- d. 0.8 inch/hr
7. The rate of water intake in long term no-till with controlled traffic in the non-traffic areas is:

a. 1.0 inch/hr
b. 2.0 inch/hr
c. 3.0 inch/hr
d. Over 4.0 inch/hr
<table>
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<tr>
<th>Wheel Traffic</th>
<th>Conventional</th>
<th>No-till</th>
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</thead>
<tbody>
<tr>
<td>Water Intake inches/hour</td>
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<td>0.6</td>
</tr>
<tr>
<td>Soft Rows</td>
<td>0.4</td>
<td>Over 4</td>
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</tbody>
</table>
Know how. Know now.

2005 Grant, NE
2005 Grant, NE
8. The E in ET is about ______% if the corn is planted in good wheat stubble crop residue.

a. 15%
b. 20%
c. 25%
d. 30%
Projected Growing Season Evaporation on Corn
Garden City, KS – N.L. Klocke, 2004

ET (%)

1 – Irrigated Once a Week
2 – Irrigated Twice a Week

Savings over Bare Soil
Residue study at North Platte

Simon van Donk
2007 corn yield on bare soil (avg. 172 bu/ac) and residue-covered soil (avg. 197 bu/ac) on small plots at North Platte

Yield (bu/ac)

Four replications

Simon van Donk
Know how. Know now.
## Soil Moisture
### Spring 2004 - Red Willow County

<table>
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<th>Stubble Height (in)</th>
<th>Soil Moisture (in)</th>
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<td>18</td>
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*Ecofallow corn yield 122 (109-138)

*Ecofallow sorghum yield 78 (54-100)
10. Corn planted into spread wheat straw produced ______ bu/a more than corn planted into wheat straw that was baled.

a. 5 bu/a  
b. 10 bu/a  
c. 15 bu/a  
d. 20 bu/a
Know how. Know now.

117 bu/A
Straw Spread

97 bu/A
Straw Not Spread and Baled
### 2007 Red Willow County Rainfed Winter Wheat Variety Trial

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<td>Hawken</td>
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<td>Hallam</td>
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<td>Overley</td>
<td>81.5</td>
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<td>Infinity CL</td>
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<td>WESTBRED</td>
<td>Smokey Hill</td>
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**Average of 42 Varieties**: 75.4
Know how. Know now.
Red Willow County
September 3, 2008
Plant 2, Skip 2
Red Willow County
September 3, 2008
Plant 2 Skip 2
Ears in 3 Feet of Row
### Red Willow County No-Till Rainfed Plant 2 Skip 2 Corn Hybrid Test - 2008

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<th>HYBRID</th>
<th>Yield</th>
<th>Moisture</th>
<th>BushelWt</th>
<th>Stand in 2 Rows out of 4</th>
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## Harlan County Rainfed Corn Variety Test - 2009

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<td><strong>Average of 79 Hybrids</strong></td>
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<td></td>
<td>15.0</td>
<td>1.0</td>
<td>1.2</td>
<td>1050</td>
</tr>
</tbody>
</table>
Know how. Know now.
Effect of Wheat Cutting Height on Pheasants

Know how. Know now.
“Even if your on the right track you will soon get run over if you just sit there.”
Identification of Potential Nitrate Sources to a Shallow Aquifer in Southeastern Nebraska

Dana Divine, LPSNRD
Jesse Korus, CSD
Greg Steele, USGS
Dick Ehrman, LPSNRD
Acknowledgements:

NDNR
ENWRA
Bob Lavorne, City of Hickman
Dan Schulz, Al Langdale, LPSNRD
PW3, 175-217'

PW1, 70-95'

PW2, 80-120'

Inactive

PW7, 52-82’

HICKMAN
LANCASTER COUNTY

Drawn by Nebraska Department of Environmental Quality, Wellhead Protection Program, October 2009
Data Sets in Study Area

Soil Samples, 2006
Helicopter Electromagnetic Survey (HEM), 2006
Aquifer Test, 2009
Nitrate (ppm) in Soil Samples

Circle: 12-15 ppm
- 0-4.9 ppm
- 5-9.9 ppm
- >9.9 ppm

Triangle: 0-40 ppm
- 0-20 ppm
- 20-40 ppm
- >40 ppm
Well #3: screened 175-217’

Well #7: 90’

OW1S-55

OW2S-70

OW3S-70

OW4S-70

OW5S-70

Well #7: 90’

OW6-205

Well #3: screened 175-217’
Field Parameters and Concentration of Nutrients During Aquifer Test, Well No. 7

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Flow</th>
<th>pH</th>
<th>Specific conductance @ 25°C</th>
<th>Temperature, degrees C</th>
<th>Ammonia, in mg/L as N</th>
<th>NO$_3$+NO$_2$, in mg/L as N</th>
<th>Nitrite, in mg/L as N</th>
<th>Orthophosphate, in mg/L as P</th>
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<tr>
<td>9/21/2009</td>
<td>1200</td>
<td>800</td>
<td>7.26</td>
<td>1020</td>
<td>13.6</td>
<td>&lt;0.02</td>
<td>19.5</td>
<td>0.02</td>
<td>0.16</td>
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<td>9/22/2009</td>
<td>1730</td>
<td>700</td>
<td>7.09</td>
<td>1060</td>
<td>15</td>
<td>&lt;0.02</td>
<td>25.5</td>
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<td>9/23/2009</td>
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<td>700</td>
<td>7.02</td>
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<td>1200</td>
<td>700</td>
<td>7.04</td>
<td>1070</td>
<td>13.3</td>
<td>&lt;0.02</td>
<td>24.7</td>
<td>0.02</td>
<td>0.08</td>
</tr>
</tbody>
</table>
23 feet bgs

Radius of influence during test (3.7 days @ 700-800 gpm)

Approximate direction of groundwater flow
Conclusions, Part I

• New insight into the groundwater system are made possible through the integration of soil chemistry data, aerial geophysics, and aquifer tests.

• The source of nitrate observed in Well #7 is not definitively identified, but Wells 1, 2, & 3 appear to be at lower risk of contamination.
What about deep aquifer?

Approx. Aquifer Test Location

Figure 3. Geologic cross-section through a paleovalley aquifer near Firth, Nebraska produced on the basis of ENWRA test-hole logs. From Divine et al., 2009
Water Levels Deep vs. Shallow Observation Wells

Date
9/21/2009
9/22/2009
9/23/2009
9/24/2009
9/25/2009
9/26/2009

Drawdown (feet)
Conclusions, Part II

- New insight into the groundwater system are made possible through the integration of soil chemistry data, aerial geophysics, and aquifer tests.
- The source of nitrate observed in Well #7 is not definitively identified, but Wells 1, 2, & 3 appear to be at lower risk of contamination.
- Deep aquifer has very limited connection to shallow unconfined aquifer at Hickman WHPA.
Questions?
Groundwater Protection in an Urban Landscape: A Mixed Voluntary/Non-Voluntary Approach

The Groundwater Foundation’s 2011 National Conference

Chris Barnett, Marion County Wellfield Education Corporation
Methodist Hospital

Peerless Pump
Urban Wellfield Detail (Riverside)

MULTIPLE HOSPITALS (INCLUDES VA, COUNTY GENERAL, RILEY CHILDREN’S, IU, AND IU SIMON CANCER CENTER)

WATER UTILITY FACILITIES AND WELLS

CARGILL MILLING
Cargill milling

VA Hospital
IU Hospital-Simon Cancer Center
Operating dry cleaning plant

Closed dry cleaning plant
Historic laundry and dry cleaning plant

Historic auto and paint plant (demo 2011)
Sand and gravel mining

Print shops
Presentation Outline

- Wellfield Setting – Indianapolis, Indiana
- Wellfield Protection Program History
- Voluntary Program (Education)
- Non-voluntary Program (Plan Review)
- Program Challenges/Lessons Learned
- Future Developments
Wellfield Protection Areas in Indianapolis
Flows, Soils, Urban Wells

Geology and Hydrogeology of Marion County

Glaciers formed landscape

Melting glaciers filled areas with sand and gravel = aquifers

Drinking water is stored in aquifers
Groundwater Locally

• 13.8 billion gallons of drinking water is pumped from Indianapolis wells each year

• Over 19,000 acres of land in the Indianapolis wellfield protection areas
  • 58% Residential
  • 26% Business and Industry
  • 16% Open Space

• Over 1.2 million people live, work, or travel through the wellfield protection areas each day
Groundwater Locally

- **Seven** wellfield protection areas in Marion County

- Each wellfield is divided into two distinct districts:
  - **W1**: One-Year Time of Travel
    Area within which a ‘drop’ of groundwater will reach a pumping well within one year.
  - **W5**: Five-Year Time of Travel
    Area within which a ‘drop’ of groundwater will reach a pumping well within 5 years.
Potential Sources of Contamination

679 total potential sources
458 total known active sources
Riverside Wellfield Assessment Status

An Initial Site Visit/Preliminary Assessment Screening was Completed at Each Location Shown.
Potential Urban Sources of Pollution

- Residential, Commercial, Industrial
- Storage, use, disposal of
  - Gasoline, oil, other engine fluids
  - Cleaners, paints
  - Lawn and garden chemicals
  - Road Salts/De-icers
  - Fertilizers, Pesticides
  - Other Hazardous Wastes
- Gas stations, dry cleaners, vehicle repair facilities, maintenance facilities, institutional facilities
Wellfield Ordinance History

- Wellfield Protection Ordinance was influenced by the fact that it is a Zoning Ordinance.
- Wellfield Protection Zoning Ordinance was developed to protect the city's drinking water thru administrative (non-voluntary) and educational (voluntary) means.
- Wellfields were established from data submitted to the city by the public water utilities in Marion County.
Wellfield Education

• Wellfield Protection Zoning Ordinance established the Marion County Wellfield Education Corporation (MCWEC) to provide public outreach and education of drinking water issues.

• Established a Voluntary Business Registration program for existing facilities within each wellfield.
History of the MCWEC

• Created in 1997 through City Ordinance

The mission of MCWEC is:

To prevent contamination to the groundwater resource of Marion County through public awareness and education.
Existing Business Education

- Marion County Wellfield Education Corporation (MCWEC) offers wellfield businesses:
  - FREE, VOLUNTARY, CONFIDENTIAL education and consultation related to groundwater protection
    - Site assessments, staff training, facility signage, educational literature, etc...
BUSINESS ASSESSMENTS

- Preliminary Screening Questionnaire
  - Chemical Use: yes/no
  - Waste/wastewaters: yes/no
- Business Self-Assessment Questionnaire
  - Chemical/waste type/quantity and storage
  - Facility condition: floors/drains, vehicles
- On-site Assessment
  - Walk-through; tailored to business needs
  - One-on-one educational opportunities
  - Quasi-waste management ‘audit’
Purpose of Observations

• To identify businesses that may appear to need help with handling their wastes to prevent groundwater contamination.
• Properties have ‘visual’ evidence of poor waste handling practices – storage and spillage of wastes and chemicals outside.
• Desire to contact to determine if they want free environmental help.
• No regulatory enforcement or ‘big brother’. 
Facility Assessment

• Facility Assessment – Is there a chemical release concern?
• Free technical advice to fix concerns.
• Free pollution prevention equipment – spill kits, containment pallets, drum holders, oil dry,
• Waste management help – contacts for waste haulers; layout changes.
Typical Site Observations
Site Improvements
Educational Awareness Efforts

- Wellfield signage, billboards
- Site-specific signage
- Site visits, general handouts
- Targeted-business handouts
- Spanish handouts/Spanish language visits
- Schools – Grade school to university
- Events – Earth Day, health fairs
- Professional society presentations
VEHICLE MAINTENANCE SHOP GUIDANCE
Best Management Practice Summary
Marion County Wellhead Protection
April 2007

FACILITY OPERATIONS TOP TEN LIST

1) Store all chemical products and wastes in containers in secondary containment areas inside the site building.
2) All seams, joints and cracks in the floors within active maintenance areas should be sealed to a liquid-tight condition.
3) All vehicle maintenance activities should occur within the interior of the site building on a liquid-tight, uncracked, hard floor surface (asphalt or concrete).
4) Vehicles brought to the facility leaking fluids should not be stored on unpaved areas outside the site building.
5) All drains in active maintenance areas should be permanently closed and/or sealed, if possible.
6) A spill kit should be kept on site at all times.
7) All personnel should know where the spill kit is and how to use it.
8) All existing underground storage tanks, associated piping and dispensing units should comply with applicable regulations.
9) Wet mopping should be used at the facility for normal facility surface cleaning. No wash down of chemical spills or releases into the facility sewer drains should occur.
10) Chemical products and wastes should be handled appropriately to prevent spills. No chemical products, wastes containing chemical products, or oil filters should be disposed of in a dumpster.
Please Use Caution:
You are refueling in a Groundwater Protection Area.

Spilled gasoline pollutes groundwater!

A message from the Marion County Wellfield Education Corporation

Groundwater is Your Drinking Water… Protect it!

- Do not “top-off” tanks.
- Use caution when adding oil or antifreeze.
- Notify attendant if spill occurs.

www.indyh2o.org
Educational Challenges

- Business turnover
- Manager/employee turnover
- Environmental awareness/education
- Cultural differences
- Government/regulatory fears
- Business economics/time constraints
- Environmental ‘numbness’
- Nature of groundwater (out-of-sight)
Administrative Review

- Wellfield Review - Ordinance addresses NEW development within the Wellfields through City’s Improvement Location Permit process.
- Wellfield Plan Review - ILP information is sent by City to the Technically Qualified Person (TQP), Marion County Health Department and appropriate Water Utility for review.
Wellfield TQP Review

- Any existing uses*
- Setbacks*
- Landscaping, screens, walls, fences*
- Sewage disposal facilities*
- Vicinity map (U.S.G.S. quadrangle preferred)
- Brief history of site of new building or addition (usage, historical environmental concerns, abandoned wells, underground storage tanks, septic tanks)
- Site map (drawn to scale) including:
  - All existing and proposed structures*
  - Paved and nonpaved areas*
  - Utility lines (inside and outside structures) including sanitary sewers, storm sewers, storm retention ditches/basins/french drains/dry wells, etc. (both proposed and existing)
  - Floor drain locations and outlets
  - Chemical/product storage locations
  - Waste storage locations
  - Liquid transfer areas
Wellfield TQP Review

• Site surface water bodies (streams, rivers, ponds)*
• Underground storage tanks
• Aboveground storage tanks
• Proposed containment area detail drawings--area, heights, materials, specifications, if applicable
• Description of proposed operations including chemicals/products used or generated, chemical/product storage area descriptions, waste generation quantities, equipment cleaning/maintenance procedures, heating source (oil/gas), liquid transfer/loading areas.
• Methods and locations of receiving, handling, storing, and shipping chemicals/products and wastes.
• Response measures and reporting.
• Description of slopes near containment vessels and waste storage areas*
• Such site and development plan shall be provided to the Health and Hospital Corporation of Marion County and applicable water utilities when sent to the technically qualified person.
Administrative Process

- Response - TQP prepares response which is forwarded to City and the Applicant.
- A list of design and operational conditions are provided for obtaining approval.
Administrative Challenges

• Getting right information in permit submittals
• Business changeover not suited for built facility
• Building what is designed
• Operating as required
The Future

- Wellfield ordinance under review
- Changes to build on strength of program
- Increase protection
- Ease of implementation
Contact Information

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chris@nearnorthconnect.org

JOHN MUNDELL
JMundell@MundellAssociates.com
Our Purpose

Groundwater is YOUR drinking water—Protect it!

Western Wisconsin Drinking Water Protection Area

Entering Wellfield

www.WWWDYH2O.org or 464-2219

Back to Agenda
Hydraulic Fracturing-Water Industry Concerns

Groundwater Foundation National Conference October 5th 2011 Omaha, NE

John Albert
Pressures for Fracking

Future Natural Gas Development Promises:

- Positive Regional Economic Impacts
- Energy Independence
- Billions in taxable revenues
- Hundreds of thousands of jobs
- Less carbon-intensive energy source
Drillers Face Methane Concern

Contamination of Water Supply Near Gas-Drilling Operations Prompts Industry Focus on Design of Wells

By Ryan Tracy

GRANVILLE SUMMIT, Pa.—Sherry Vargson has cooked with water from a five-gallon jug for the past year. It's inconvenient, but preferable to using tap water containing enough methane gas that she can light a match and see an orange flame flare out of the faucet.

Many water supplies in northern Pennsylvania have long contained detectable levels of methane, because of poorly constructed water wells and the unusual geologic features here. But the contamination in Ms. Vargson's existing well is among the first cases that state regulators have attributed to natural-gas drilling, prompting a normally competitive group of drilling companies to work together to fix the problem.

Cases like Ms. Vargson's are gaining more attention amid a boom in U.S. natural-gas production. But methane-leakage problems in water wells are distinct from problems that some environmentalists attribute to hydraulic fracturing or fracking, a drilling technique that involves injecting...
Areas of Concern

- Water Quantity Impacts
- Use of Fracking Chemicals and contamination risks
- Industrial activity in source water locations
- Generation of large volumes of industrial wastewater
Water and Chemical Usage

- Two to nine MG of stimulation water per well
- Hundreds of tons of chemicals per well
  - (approx 1% to 2% of total fracture fluid volume are chemicals)

http://www.toxiclitigationblog.com/tags/fracking/
Surface Activities

http://www.hydraulicfracturing.com/Process/Pages/Information.aspx
Subsurface Activities

- Activities include: drilling, casing, fracturing, completion, maintenance, rehabilitation, etc.
- Risk of subsurface migration of contaminants from unexpected subsurface conditions or operator error
- Specific to local geology and individual operators
Subsurface Migration, cont’d

- Is subsurface migration possible? **Yes**
  - Punxautawney Hunting Club 36H Clearfield County, PA
  - Schwartz 2-15B Well Garfield County, CO
  - Multiple wells Dimock, PA

- Are these incidents common? **No**

- Do we understand all the factors that increase risk of subsurface migration? **Maybe**
  - Human error and failure to take proper precautions or use proper equipment cited in most documented incidents
Wastewater Disposal

- Wastewater produced varies per well, ~30-90% of injected fluids

- 1.3 BG produced in last 3 years in PA
  - ~500,000 gallons produced per well
  - ~1.2 mgd of drilling wastewater

- Water quality concerns
  - TDS ~100,000 ppm
  - Radionuclides
  - Residual drilling chemicals
Regional Drilling Wastewater Disposal Capacity

- Underground injection is most typical in other regions, limited in NY and PA

Current Capacities
- Commercial injection wells
  - PA: ~0.03 mgd
  - NY: 0 mgd
- Industrial treatment: ~0.57 mgd (PA, WV)
- Municipal treatment capacity: unknown

Future Capacity Needed
- Estimated at 6 to 28 mgd
Federal Regulatory Context

Oil and gas development is covered by many of the major environmental regulations, but with some key exemptions:

- **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**
  - Crude oil and petroleum are excluded

- **Resource Conservation and Recovery Act (RCRA)**
  - Many oil and gas wastes are exempt from classification as hazardous

- **Safe Drinking Water Act (SDWA)**
  - Injected frac fluid is not considered a discharge to the environment and is not regulated by the SDWA

- **Clean Water Act (CWA)**
  - Injected frac fluid is not considered a discharge to the environment and is not regulated by the CWA
  - NPDES permits are still required for stormwater discharges similar to construction activities
Many state regulations

- Severely limit local regulation of oil and gas exploration and development (e.g. LA, NY, PA)
- Lack requirements for communication protocols with downstream water utilities

Some states, such as PA and NY, have no regulatory framework for surface or ground water withdrawals for non-potable uses
Local Regulatory Context

- Regulations cannot prevent all spills, but also generally limit a local utility’s control over oil and gas activities within their watershed, making utilities unable to:
  - Enact source water protection strategies;
  - Review permits and inspect facilities; or
  - Get notification in the event of a spill.

Therefore, some utilities have pursued voluntary agreements with operators absent regulatory controls.
Needed Research

- Improved Methods for Predicting Chemical Characteristics of Flowback Water and Produced Water (Brine)
- Water Supply Monitoring Protocols/Methods and Best Management Practices
- Perception and Communication of Hydraulic Fracturing Risks
- Identifying the Subsurface Risks, Risk Mitigation Measures and Appropriate Areas of Concern for Utilities to consider from Natural Gas Production Activities
Improved Analytical Chemistry Methods

- Identify, adopt, adapt analytical methods for flowback water and produced water
  - High TDS (> 100,000 mg/L) interferes with traditional analytical techniques especially when target substances are dilute (e.g. EDCs)

- Characterize fate of chemicals during the fracturing process (dilution, degradation and degradation byproducts)
  - Comparison of what is injected with what is brought back to the surface or what remains in the formation

Source: NYCDEP
Water Supply Monitoring and Emergency Response

- **Water Supply Monitoring Protocols**
  - Define appropriate screening parameters, location, and frequency for both surface water and ground water
  - Develop relative cost-value analysis of monitoring protocols
  - Evaluate the affects of hydrogeological variations and hydrologic variability (e.g., drought) on monitoring programs

- **Existing emergency response programs may lack critical elements that are necessary for utilities to effectively respond to incidents unique to natural gas development and hydraulic fracturing.**

Source: NYCDEP
There is a need to understand and quantify perceptions of the risk associated with hydraulic fracturing and the factors that drive this perception for both the public and water utilities.
Subsurface Processes

- What factors contribute to movement of fluids away from the well bore and target formation?

- What mitigation measures are available in the event of contamination due to subsurface incidents?

- What is the potential for cumulative impacts to confining layers from intensive drilling and hydraulic fracturing?

- How should well casing integrity be evaluated during construction and over the life of the well?
Impacts to POTWs and Downstream Impacts to Water Utilities

- Impacts to POTWs accepting fracturing wastewater
  - Concentration of toxics in biosolids (radium, heavy metals, etc.)
  - Disruption of biological processes from salts, metals, biocides, etc.

- Downstream impacts to water utilities
  - Many constituents pass through POTWs; treatment by dilution only (TDS, hydrocarbons, radionuclides)
  - Increased disinfection byproduct forming material (specifically bromine)
  - Unknown toxicity of many fracturing chemicals and their degradation byproducts
Resources

- STRONGER (strongerinc.org)
- U.S. EPA Hydraulic Fracturing Research Study
- Research Partnership to Secure Energy for America
  An Integrated Framework for Treatment and Management of Produced Water
- U.S. DOE Sustainable Management of Flowback Water during Hydraulic Fracturing of Marcellus Shale for Natural Gas Production
Acknowledgements

Research Team
Ben Wright, P.E.
Grantley Pyke, P.E.
Frank Getchell, P.G.

Project Manager
Kim Linton
The Marcellus Shale is approx 95,000 sq mi, underlies parts of six states.
Potentially more than 500 trillion ft³ of gas reserves.
Moratorium on high volume hydraulic fracturing in NY and the Delaware River Basin as regulations are developed.
Drilling is active in PA, with 1,368 Marcellus wells drilled in 2010 compared with only 196 in 2008.
Environmental Impacts of Increased Agricultural Production

By Marc Andreini

Groundwater Foundation National Conference
October 4 to 6, 2011 Omaha, NE
Water for food is a global challenge

- 40% increase in population by 2050, doubling the demand for food
- By 2025, 2/3 of the population will be affected by scarcity
- Agriculture is responsible for 70% water withdrawals
There is a growing gap

Source: Farm Foundation, NFP calculations (2010) based on USDA ERS data.
High Plains Aquifer contains more than 2.5 million cubic kilometers of water

From USGS (2007)
Pre-development to 2005

Water tables are being drawn-down (Wen & Chen, 2006)
Main atrazine groundwater contamination is in shallow wells, often those contaminated via backflow from filling farm equipment tanks (containing atrazine)
Huge antimicrobial use in US for livestock production

Large quantities of antibiotics are used in industrialized livestock.

Often identical or belong to the same classes as human antibiotics.

These conditions favor selection, persistence and spread of antibiotic-resistant bacteria capable of causing infections in both animals and people.

Sources:
Nitrogen and phosphorous lead to algal blooms and large hypoxia zone in Gulf of Mexico

In 2007, dead zone was 21,000 km²

Mississippi River meets the Gulf of Mexico
(Source: http://www.gulfhypoxia.net)
Sustainability implies both high yields that can be maintained, even in the face of major shocks, and acceptable environmental impacts...

Crop and livestock production must increase without an increase in the negative environmental impacts associated with agriculture, which means increases in the efficiency of nitrogen, phosphorus, and water use, and integrated pest management that minimizes the use of toxic pesticides.

Softening the environmental impacts will require substantial increases in knowledge-intensive technologies for scientifically sound decision making at field level.
Established in April, 2010 with a $50 million gift from the Robert B. Daugherty Charitable Foundation

Vision: The Water for Food Institute is a research, education, and policy institute committed to helping the world efficiently use its limited freshwater resources, with particular focus on ensuring the food supply for current and future generations.
Growing more food with less water
Large-scale and small holder production
Irrigated and rainfed agriculture
The sustainability of water and agriculture systems
Water for Food Institute Programs

- Cooperative research programs
- International research fellows and visiting scholars
- Graduate and undergraduate programs
- Online delivery of academic programs
- Water for Food scholarly journal
- Annual Water for Food Conference

UNL wheat breeder Steve Baenziger and students
• Quantify agricultural system productivity, yield potential, and impact on the environment
• Model how high yields could rise while using natural resources sustainably
• Provide basis for predicting food security trends, food production capacity, and land use change
Soil and Water Resources Engineering

- Evapotranspiration (crop water use)
- Water productivity
- Irrigation and yield relationships
- Measurement and modeling of surface energy balances
Aquifer Characterization

- Modeling of groundwater-surface water interactions
- Characterization of the High Plains and other aquifers of interest
Agriculturalists are the managers of the most productive lands on earth. Sustainable agriculture will require that society rewards ranchers, and farmers for the production of food and ecosystem services.
Thank you

waterforfood@nebraska.edu
William A. McEllhiney
Distinguished Lecturer Series
Well Technology

Made possible by a grant from Franklin Electric Company to the National Ground Water Research and Educational Foundation.
To foster professional excellence in water well technology, the National Ground Water Research and Educational Foundation has established the William A. McEllhiney Distinguished Lecture Series in Water Well Technology. Initiated in 2000, the lecture series honors William A. McEllhiney, who was the founding president of the National Ground Water Association in 1948, and a ground water contractor and civil engineer from Brookfield, Illinois.
Effective May 2005, Franklin Electric Co., the world's largest manufacturer of submersible electric motors, has agreed to underwrite the next three years of this lecture series for presentations to organized groups of contractors and other qualified and interested parties. Meetings and conventions of state and regional associations are eligible. Foreign associations of ground water contractors, academic institutions teaching water well technology, gatherings of water well regulators, and other bodies with a direct and identifiable interest in water well design and construction are eligible as well.
The Nebraska Grout Task Force Research:
Unexpected Results-New Solutions
<table>
<thead>
<tr>
<th>Grout studies prior to 1999</th>
<th>State revised standards in 1999…</th>
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<tr>
<td>Laboratory controlled</td>
<td>to protect State Natural Resource…</td>
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<tr>
<td>Controlled Environments</td>
<td>adopts industry standard…</td>
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<tr>
<td>Segmented</td>
<td>constructs ultimate well.</td>
</tr>
<tr>
<td>In-situ</td>
<td>Bentonite cracks but will rehydrate</td>
</tr>
<tr>
<td>Limited depth</td>
<td>Is limited in how high % can be pumped</td>
</tr>
<tr>
<td>Historically destructive</td>
<td>Cementisious Grouts- Universal material</td>
</tr>
<tr>
<td>Bond logging</td>
<td>Cracks horizontally- bonds to everything</td>
</tr>
</tbody>
</table>
UNL Demonstration
In-situ Study

Visual component
- Allows full length perspective
- Studies differing geologic conditions
- Real world testing
- Dye testing
- Limitless time frame for study
- Non-destructive
- Effective for all types of grout materials
- Led to new discoveries beyond study
Visual Assessment

Rating System

0 = No Data
1 = Good
2 = Cracks and Small Inconsistencies
3 = Voids and Detachments
Visual Assessment
Overall Average Ratings

- Bentonite Chip
- Neat Cement with 6 gallons
- Cement with Bentonite
- Cement with Sand
- Bentonite Slurry >20%
- Neat Cement with 7 gallons
- Bentonite Slurry =20%
- Concrete
- Bentonite Slurry <20%
- Bentonite Geothermal-Sand
- Bentonite Geothermal ~20%
Original Dye Tests

0068.9F

0002.8F
Infiltration into Filter Pack
Hydrostatic Head
Water Phase Given Off
H₂O Acidic & High Ca
= Breaks Down Chip

Recommend blotter sand between materials
Neat Cement Penetrates Bentonite Chips
What do the Results Tell us?

Key Components - Critical Findings

Hydrogeologic Conditions

Bentonite slurry grouts appear to be reactive to conditions in the unsaturated zone

2005 Unsaturated Zone Study by Myers

Particle Size
Moisture Content
Annual precipitation
Vadose Zone Study 2008-2009
New recipes

Participants
State of NE
Wyo-ben
Cetco
Environmental drilling industry
Geoprobe (direct push)
Geothermal closed loop drilling industry

19 new recipes
9- high water slurries
10- high solids grout
   Bentonitic material plus sand & gravel
   Cementitious material additives
Maximum Depth Dye Detected in One-Hour
Grand Island Site

Depth (Feet)
Maximum Depth Dye Detected in One-Hour Pilger Site

Depth (Feet)

PU-1  PU-2  PU-3  PU-4  PU-5  PU-6  PU-7  PU-8  PU-9  PU-10  PU-11  PU-12  PU-13  PU-14  PU-15  PU-16  PU-17  PU-18

Dye Depth

Water Level
Maximum Depth Dye Detected in One-Hour Trenton Site


Depth (Feet)

0.0  5.0  10.0  15.0  20.0  25.0  30.0  35.0  40.0  45.0  50.0  55.0  60.0

Dye Depth  Water Level
HSA - All Mixes – Match Grout to Environment
Dry Borehole Use Dry Mix?

**High Solids**
- Bent Sd 3: 3%
- Bent Sd: 24%

**High Water**
- Bent Poly: 58%
- Bent Catal: 67%
Direct Push
“The borehole cannot be sealed”…Dave Hansen Design Water Technology- 2001

Because the surrounding unsaturated zone isn’t sealed…

The unsaturated zone acts as filtration for ground water re-charge…

The protection of groundwater depends upon the protection of the filtration system…

And includes the reconstruction of conditions in the borehole that mirror the surrounding soils in the unsaturated zone
Better understanding of the unsaturated zone physical properties
More attention to unsaturated zone geology while drilling the borehole
  More accurate detail of the borehole recorded on well logs
  Logging every change no matter where it occurs
  Know the descriptive language for identifying formations
Matching the grout composition to the on-site conditions
  Unconsolidated vs. Consolidated unsaturated zones
In Summary- new truths

Bentonite slurries perform when they stay wet, sand improves performance, but will not re-hydrate once damaged…Bentonite chips perform in the saturated and unsaturated zone–but can be hard to place in a deep settings with narrow annular space…

Cement grouts crack above and below static water levels, but provide structural stability to the casing in the borehole, and will not bond to plastic PVC pipe…

Neat cement will intrude through bentonite chips, lowest water content and sand blotter is needed when used with chips…

The size of the bore hole is statically insignificant when analyzing grout performance
Grouting materials will perform within their properties…and they do not CHANGE!!!

EVER!!!!!
Where does Nebraska go from here other than the Big 10?

PWS wells are required to grout with chip bentonite above screened openings in addition to grouting any confining layers in the borehole...

Wells must have seals for surface protection (cement or bentonite chips)

Private well regulation revisions;
Surface seal plus aquifer seal...
Only high solids grouts for closed loop heat pumps...
Minimal screening and full length grouting in areas of water quality concerns...
Steel segment extending through the frost zone with cement seal...
Uniform minimum grouting standards
Focus is on water Quality…not Quantity.
Many thanks to the following…

NGTF Technical and Administrative teams…
  Sue Lackey, Jeff Gottula, Dave Hansen, Jack Daniel,
Bentonite Industry…Baroid, Wyo-ben, Cetco…
  Ed Anderson, Stewart Krause, Bob Oliver
Nebraska Well Drillers Association…Tom Downey, Sargent Irrigation, GSI, Layne Christiansen, Loop-Tech INT.,…

NGWA…
  Barbette Howell, Research and Educational Foundation…
Franklin Electric…
  For sponsoring the McElhiney lecture series.
Why we do what we do...

“Three times I left the planet and found no where else to go… please take care of the spaceship we call planet earth”
-Wally Shirra-NASA astronaut
2011
Groundwater Guardian National Designation Celebration

Celebrating groundwater stewardship for 18 years
Opening Remarks

Bob Kuzelka
The most innovative activity/practice my team/site implemented in 2011 was . . . because . . .

The most challenging activity/practice my team/site implemented in 2011 was . . . because . . .

The biggest groundwater issue my team/site faced in 2011 was . . . because . . .

If I could recommend one activity for all Groundwater Guardians or Groundwater Guardian Green Sites to try, it would be . . . because . . .

The best part about the Groundwater Guardian or Green Site program is . . . because . . .
Groundwater Guardian Longevity

- **Communities:**
  - 73% designated for 10 years or more
  - 92% designated for 5 years or more

- **Affiliates:**
  - 77% designated for 10 years or more
  - 86% designated for 5 years or more
Closing Remarks

Cathy Lotzer
2011
Groundwater Guardian National Designation Celebration

Celebrating groundwater stewardship for 18 years
Douglas County Health Center
Low Impact Development

The Health Center campus is entirely within an area of Omaha served by combined sewers. The primary goal of the campus stormwater management initiatives is to reduce the amount of stormwater runoff that enters the combined sewer and thereby reduce the potential for combined sewer overflow events. The following stormwater management practices have been implemented on the campus. The numbers correspond to the map locations on the reverse of this sheet.

1. Green Roof. Modular (4'x4' trays, 4” growing medium, 5 sedum varieties, experimenting with some native grasses and sedges)
2. Inlet filters. Screen out trash and vegetation; hydrocarbon socks capture oils and other fluids
3. Landscape development. Adding native trees, shrubs, and grasses. No pesticides or synthetic fertilizers on a portion of the campus – eventually expanding to the entire campus.
4. Front entrance rain garden. Captures runoff from the sidewalks and a portion of the front drive.
5. Rainwater collection system with overflow to a rain garden. Drip irrigation system utilizes the collected water.
6. Bioretention. Designed to capture 1” rainfall events which represent on average about 90% of annual precipitation.

A Stormwater Master Plan is currently under development. This Plan will identify future opportunities for additional stormwater management practices. Potential locations are noted with the #7 on the map.

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