ST. LOUIS | SEPT. 22-25, 2013

ANNUAL FORUM

Groundwater Protection:
Reflecting Progress & Responding to the Future

Event Handbook: Agenda

Abstracts & Bios

List of Attendees

Chase Park Plaza Hotel
St. Louis, Missouri

30 GROUNDWATER PROTECTION COUNCIL ESTABLISHED 1983

Acknowledgements: *Event Sponsors and Contributors*

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Ground Water Research & Education Foundation
Spotlight series

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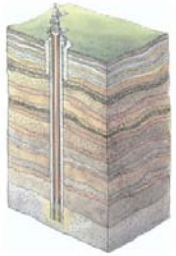

UNDERGROUND INJECTION TECHNOLOGY COUNCIL

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Thank you for caring about Groundwater!

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GROUNDWATER RESEARCH & EDUCATION FOUNDATION

Monday, September 23 -- 7:00 Registration and Morning Reception --

8:00–10:00 *Groundwater Protection: Reflecting Progress & Responding to the Future* *Lindell C&D*

Mike Paque, Executive Director, GWPC (Moderator) -- Opening Remarks, Jamie Crawford, MS DEQ & GWPC President

Partnering for Resource Protection: Environmental Protection Agency -- Peter Grevatt, EPA - Director Office of Ground Water and Drinking Water, EPA

Department of Energy -- Nancy Johnson, DOE – Director, Environmental Science and Policy Analysis, Office of Fossil Energy

Association of Clean Water Administrators -- President – Shellie Chard-McClary, OK DEQ, GWPC Board Member

Association of Drinking Water Administrators -- President – Sarah Pillsbury, NH DES, former GWPC President

National Groundwater Association -- Executive Director – Kevin McCray

National Rural Water Association -- Assistant Director – Sam Wade

Interstate Oil & Gas Compact Commission -- Assistant Director – Gerry Baker

10:20 – 12:00 *Groundwater: The Critical Water Resource for the Future* *Lindell C&D*

Abstract 19 Long-Term Groundwater Depletion in the United States - Leonard F. Konikow, USGS

Abstract 44 What we know, what we don't know and what we need to know about "Deep" Groundwater – Mike Wireman, USEPA Region 8

Abstract 5 Groundwater Management: A Policy Perspective - Sharon B. Megdal, Water Resources Research Center, University of Arizona

Luncheon: *30 Years of Ground Water Protection Council Development* *Khorassan West*

Plated Lunch Provided Dave Bolin, AL Oil & Gas Board, GWPC Founding Board Member

1:30-5:30 Nutrients in Groundwater *Lindell A&B*

Moderator – Marty Link – Nebraska DEQ

Abstracts 9 New Electronic System Monitors Groundwater Impacts Near Runoff Holding Ponds - H. Gordon Minns, AgraTek

Abstract 18 Nutrient Sources and Pathways to Groundwater in Minnesota - David J. Mulla. Univ. of Minnesota.

Abstract 29 Wisconsin Groundwater & Nutrients - Jill Jonas, Wisconsin's Bureau of Drinking Water and Groundwater

Abstract 42 Evaluating Nitrates in the Ambient Probability Based Network of Community Water Supply Wells Rick Cobb, Illinois EPA

Abstract 50 Nutrients and Ohio's Public Water Systems Michael Eggert, Ohio EPA

Abstract 39 Nebraska Groundwater Management Plan for the Bazile Creek Area – Ryan Chapman and Marty Link, NE DEQ

Abstract 45 Nutrients Roundtable Discussion: Marty Link - NE, Sonja Massey - MS, and John Barndt - DE

1:30-6:00 Assessing & Managing Risk of Induced Seismicity by Underground Injection *Lindell C&D*

Spotlight series

(A SPECIAL session for seismologists, regulators, and other stakeholders)

· *Studies*: Researchers presenting findings and research strategies

Moderator – Lori Wrotenbery, Oklahoma Corporation Commission

Abstract 47 Induced Seismicity from Fluid Injection and Draft Best Practices - Austin Holland, Seismologist, Oklahoma Geological Survey, Univ. of Oklahoma

Abstract 21 Seismic Response to Power Production at the Salton Sea and Coso Geothermal Fields, CA: Using Operational Parameters to Study Anthropogenic Seismicity Rates - Lia J Lajoie, Fugro Consultants, Inc.

Abstract 22 Enhanced Remote Earthquake Triggering at Fluid Injection Sites in the Midwestern U.S. - Nicholas J. van der Elst, Columbia University

Abstract 7 USGS Earthquake Research on Injection-induced Seismic Activity: a Progress Report - Evelyn Roeloffs, USGS

· *Strategies*: Initiatives and technology used to limit risk

Moderators – Jeff Bull Chesapeake Energy

Abstract 38 Technical Considerations Associated with Risk Management of Induced Seismicity in Waste-Water Disposal & Hydraulic Fracturing Operations - Kris J. Nygaard, ExxonMobil Production Co.

Abstract 33 Compiling and Interpreting Class II Injection Well and Seismicity Data in the U.S. Mid-Continent to Identify Zones of Induced Seismic Hazard - Matthew Weingarten, University of Colorado-Boulder

· *Regulatory*: Developments to limit risk

Moderators – Lori Wrotenbery, Oklahoma Corporation Commission

State Panel: Larry Bengal, Arkansas; Thom Kerr, Colorado; Leslie Savage, Texas; Tom Tomastik, Ohio; Joe Lee Pennsylvania

6:00-8:00 *Starlight Ballroom*

GWPC 30th Anniversary Celebration Reception

30 GROUNDWATER PROTECTION COUNCIL ESTABLISHED 1983

Special Thanks to our Event Sponsors!

Tuesday, September 24 -- 7:00 Registration and Morning Reception --

8:00-9:20 State / EPA Roundtable *(State & Federal Employees ONLY)* Moderators:Ann Codrington, USEPA & Mike Baker, OH EPA *Maryland*

Items may include: Aquifer Exemption; National Technical Workgroup – Induced Seismicity; CAFO Rule – OGWDW Input
UIC National Database; Class VI – new applications? - program updates?; Source Water Collaborative – groundwater related initiatives
Diesel Guidance; Stormwater Rule – OGWDW Input; Brainstorm – agenda/session topics for 2014 UIC Conference

9:40-12:20 Water Availability Sustainability Track *Lindell A&B*

Moderator - Jamie Crawford, Mississippi DEQ & GWPC President

Abstract 8 Making Use of Groundwater as Part of an Alternative Water Supply Strategy - Jamie Crawford, Mississippi, MS DEQ & GWPC President

Abstract 3 The National Ground Water Monitoring Network Data Portal: From Pilot to Production - Jessica M. Lucido, USGS Center for Integrated Data Analytics

Abstract 36 Streamflow Depletion by Wells–Understanding and Managing the Effects of Groundwater Pumping on Streamflow Leonard F. Konikow, USGS

Abstract 26 Groundwater Prospecting – Looking Beyond Today's Groundwater Supply Fred Rothauge, Hydro Resources

Abstract 27 Status of Arkansas Groundwater Resources and Update of the Arkansas Water Plan - D. Todd Fugitt, Arkansas Natural Resources Commission

Abstract 16 Balancing Environmental Risks with Recycling of Produced Water- Brian Bohm, ALL Consulting

Abstract 40 Impacts of Potential Future Droughts on ERCOT Thermoelectric Generation Y. Eugene Yan, Argonne National Laboratory

9:40-12:20 Water/Energy Track -- Water Quality and Oil & Natural Gas Development *Lindell C&D*

Moderator - Mark Bohrer, North Dakota Industrial Commission

Abstract 23 Overview of State Pre-drill Water Quality Testing - Robert W. Puls, OK Water Survey

Abstract 10 Evaluation of Common Cement and Bentonite Products Used in Water and Monitoring Well Construction/Drilling for Gglycols, Alcohols, and Phenolic Compounds - Donald Siegel, Syracuse

Abstract 14 Considerations in Selecting Hydraulic Fracturing Chemicals: Management of Health and Environmental Risks - H. William Hochheiser, All Consulting

Abstract 35 Collecting Water Samples for the Determination of Dissolved Gas Concentrations Dennis Coleman, Isotech Laboratories, Inc.

Abstract 11 The Occurrence of Methane in Shallow Groundwater from Extensive Pre-Drill Sampling in the Marcellus / Utica Shale Play - John Boulanger, AECOM

Abstract 12 Real-Time Monitoring for Evaluating Long-Term Variability in Methane in Domestic Water Wells in Northeast Pennsylvania - Richard Wardrop, GES

Abstract 15 Developing Analytical Tools and Practices for Groundwater Quality and Production Well Integrity Investigations in Situations of Alleged Stray Gas Migration - Dan Arthur, ALL

Professional Development Luncheon
-- Box Lunch Provided --

The Social Media EXPLOSION: The Busy Professional & Getting Measurable Results Using LinkedIn

Ground Water Research & Education Foundation Spotlight series

Lindell A&B

Presented by -- Professional Development Session with Social Media Expert Chrystal Washington Abstract 41

With more than 225 million users, LinkedIn is the premier social networking site for business professionals. Discover practical ways to leverage LinkedIn, be discovered by influencers and create meaningful business relationships. Attendees learn how to identify their brand strategy, use LinkedIn to save time, use keywords, and make key connections.

Learning Objectives: --- Discover how to create a LinkedIn ritual to save time --- Utilize LinkedIn's advanced search capabilities to find and connect with people --- Uncover the #1 secret for getting found by influencers

2:00-3:50 Water Quality Track Moderator – Evan Kane, North Carolina DENR *Lindell A&B*

Abstract 20 How do States Define "Usable Quality" Groundwater? - Steve Musick, GWPC

Abstract 37 Preventing New Groundwater Pollution from Old Oilfield Areas - Patricia Billingsley, Oklahoma Corporation Commission

Abstract 34 Factors Affecting Public-Supply-Well Vulnerability to Contamination: Understanding Observed Water Quality and Anticipating Future Water Quality - Sandra M. Eberts, USGS

Abstract 25 Clean Water Act - Safe Drinking Water Act State/EPA Workgroup - Holly Green, USEPA Office of Ground Water & Drinking Water

2:00-3:50 Water/Energy Track (continued) *Lindell C&D*

Moderator - Stan Belieu, Nebraska OGCC

Abstract 31 EPA's Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources - Jeanne Briskin, USEPA

Abstract 32 RBDMS and the National Oil & Gas Gateway: Integrating Data to Manage Environmental Programs - Paul Jehn, GWPC

Abstract 13 Revised API Well Numbering System - Donald J. Drazan, NYS DEC

Abstract 24 FracFocus 2.0: Focus on Transparency - Mike Nickolaus, GWPC

Break

4:10-5:40 Water Quality Track (continued) Moderator – Evan Kane, North Carolina DENR *Lindell A&B*

Abstract 2 Forming a Statewide Collaborative to Protect Drinking Water: Where We Are Today and What We've Learned Along the Way - Amy Axon, NC DENR

Abstract 30 Creating Grassroots Solutions to the Collection of Unused Pharmaceuticals - John Hoagland, MO Rural Water

Abstract 28 How to Establish a Regional Source Water Collaborative for Drinking Water Utilities: A Case Study of the New England Watershed Managers (NEWMAN) Collaborative - Kira Jacobs, USEPA R-1

Abstract 43 Class III In-Situ Uranium Injection Wells and Aquifer Exemptions in Texas: Multiple Levels of Permitting Protection for USDWs - David Murry, TCEQ

4:10-5:40 Water Quantity and Oil & Natural Gas Development *Lindell C&D*

Abstract 6 Water Consumption for Fossil Fuel Exploration and Production - Christopher Harto, Argonne National Laboratory

Abstract 4 Hydraulic Fracturing Water Use in the Eagle Ford Shale Play: A Systems Dynamics Approach - Jeanne Eckhart, U. of Texas

Abstract 17 Potential Environmental Impact of Produced Water - John Veil, Veil Environmental, LLC

Abstract 51 Regulatory Framework to Promote Carbon Capture Utilization and Storage – Bob Van Voorhees, Carbon Sequestration Council

Wednesday, September 25 -- 7:00 Registration and Morning Reception --		
8:00-11:20 *Regency* *FracFocus 2.0 Training* Instructor - John Veil, Veil Environmental, LLC Abstract -Bio 48 Over the past year, the highly successful chemical disclosure registry portion of FracFocus was updated to incorporate a new, more efficient mechanism for entering chemical data into the system. Since June 1, 2013, the new system, referred to as FracFocus 2.0, is now the only mechanism that can be used to enter data. This training is designed to explain the steps that those persons who have responsibility for entering data into FracFocus 2.0 must use and the screen views they will see. The target audience is representatives from oil and gas companies, service companies, and consultants who will assist the oil and gas companies in data entry. The training may also be helpful for state regulators whose agencies require submittal of chemical disclosure data. FracFocus 2.0 contains capabilities for state regulators to gain direct access to the data.	*8:00-11:20* *Lindell A&B* *Media & Public Communication Training:* Dealing with a Contentious Public Instructor - Russ Florence, President & COO Schnake Turnbo Frank Abstract -Bio 46 We live in an age of skepticism. The media, public officials, advocacy groups and the public won't take your comments at face value. They'll doubt you until you earn their trust. The technical and scientific nature of your work makes this even more challenging. After all, people don't trust what they don't understand. During this practical, interactive workshop, you'll learn how to represent your organization effectively and deliver a message that resonates – whether it's an interview with a reporter, a meeting with an elected official, or a long series of hotly-debated public meetings.	*8:00-11:20* *Lindell C&D* *Underground Injection Control Financial Responsibility* Joe Tiago, US EPA Office of Groundwater and Drinking Water Abstract –Bio 49 In 2011 and 2012, EPA Headquarters conducted a multi-phased effort to improve its understanding of on-the-ground implementation of Underground Injection Control (UIC) financial responsibility (FR) requirements. The effort consisted of roundtable discussions, remote file reviews of FR demonstrations, and site visits to state and direct implementation UIC programs in four EPA Regions. In this session EPA summarizes the findings of this effort and identifies best practices and recommendations for FR file management and review, instrument language and provisions, and coverage criteria. Based on the results of this effort, EPA Headquarters has developed two new tools designed to assist UIC FR programs implement FR requirements: (1) FR instrument review checklists, and (2) Geologic Sequestration Cost Estimation Tool. The session will review these tools in a workshop-style setting to provide a detailed description of how to use the tools answer questions from participants.

Select sessions are part of the Spotlight Series…
…the technology transfer initiative of the
Ground Water Research & Education Foundation

The GWPC provides a forum for stakeholder communication and research in order to improve governments' role in the protection and conservation of groundwater.

Ground Water Protection Council * *13308 N. MacArthur Blvd., Oklahoma City, OK 73142, * 405 516 4972 * www.gwpc.org **

Abstract 1 (opening session presenter bios)

Peter Grevatt, Ph.D is the Director of the USEPA Office of Ground Water and Drinking Water (OGWDW). The Office of Ground Water and Drinking Water in collaboration with states, tribes and its many stakeholders, is responsible for safeguarding America's drinking water. Over 300 million Americans nationwide rely daily on public water systems to provide them with safe drinking water in the convenience of their home. He is responsible for the development and implementation of national drinking water standards, oversight and funding of state drinking water programs and the implementation of source water protection and underground injection control programs to protect public health nationwide.

Prior to joining the OGWDW in October of 2012, Peter Grevatt served as the Director of the Office of Children's Health Protection and served as the Senior Advisor to EPA's Administrator for Children's Environmental Health. Peter has held leadership roles in EPA's national hazardous waste and water quality programs. Peter received his M.S. and Ph.D degrees in Basic Medical Sciences from New York University Medical Center and earned his bachelor's degree in Biology from Earlham College.

Nancy L. Johnson, Ms. Johnson currently serves as Director for Environmental Science and Policy Analysis, Office of Oil and Natural Gas, within the U.S. Department of Energy Office of Fossil Energy. Her responsibilities include advising senior DOE officials on technology and policy issues related to U.S. oil and natural gas supply; managing the Department's interactions with the National Petroleum Council which is an advisory body to the Secretary of Energy; and leading efforts to enhance collaboration with States. Ms. Johnson has over thirty years with the Department of Energy, primarily within the Fossil Energy and Policy offices. Her tenure has included policy analysis, research program management and DOE-wide initiatives and interagency activities (e.g., organizational restructuring, regulatory streamlining, State and Federal interface on oil and gas supply, and oil, gas, and coal environmental issues).

Shellie Chard-McClary is a 1992 graduate of the University of Oklahoma with a Bachelor's Degree in Chemical Engineering and Biotechnology. She currently serves as the Water Quality Division Director and the Oklahoma Department of Environmental Quality. She has 21 years of experience implementing the Clean Water Act, Safe Drinking Water Act, comparable state statutes and operator certification programs. She has served as officers, on the board of directors and committees for organizations including: Association of Clean Water Administrators, Association of State Drinking Water Administrators, Groundwater Protection Council, and many others. She is a lifelong Oklahoman who takes a common sense approach to complex environmental regulations.

Sarah Pillsbury is the Administrator of the Drinking Water and Groundwater Bureau at the New Hampshire Department of Environmental Services. She has been with the DES for twenty-eight years, serving in a variety of capacities. Sarah is the current president of the Association of State Drinking Water Administrators, a past president of GWPC and a current board member of New England Water Works. For the last several years, Sarah has served as lead staff on state-wide water planning initiatives.

Kevin McCray, CAE, is the Chief Executive Officer of the National Ground Water Association (NGWA). In addition to executive director of NGWA, McCray is the chief executive of the National Ground Water Research and Educational Foundation.

McCray has served on a number of water-related advisory groups, including the U.S. Water Resources Export Council, Water Systems Council, U.S. Department of Commerce mission to Australia and New Zealand, U.S. EPA/AWWA Comprehensive Integrated Resource Cooperative Blue Ribbon Panel, Kellogg Foundation Ground Water Education Consortium, the Great Lakes Commission Ground Water Education Roundtable, The American Ground Water Trust and the Ground Water Remediation Technology Analysis Center Advisory Board.

At the National Ground Water Association he has led initiatives to develop industry standards, best suggested practices, and significant upgrades to the voluntary certification program. He led an award-winning effort to develop computer-based business management tools for water well drilling and pump installation contractors.

Sam Wade, Assistant Director National Rural Water Association -- Sam's background includes management and training experience in the private and public sector. His public sector experience includes city management and the operation and management of water and wastewater utilities. In 1982 he accepted the position of Association Manager for the Minnesota Rural Water Association. In 1985 he became the Training Director for the National Rural Water Association and assumed his current duties as Deputy Chief Executive and Chief Operating Officer in 1987.

Gerry Baker is the Associate Executive Director of the Interstate Oil and Gas Compact Commission, which represents the governors of virtually every state that produces oil and gas. His education is in journalism. He was an award-winning reporter and commentator in a prior life while covering the Oklahoma State Senate, office of the governor and various agencies, boards and commissions.

After subsequent employment in the oil and gas industry, a 10-year labor of love as a consultant to high profile clients, and three years of non-profit management, he now serves the states through the IOGCC. In his role as a consultant to and later as an employee of the IOGCC, Baker has worked for 20 governors. He speaks fondly of them all.

Abstract 2

Forming a Statewide Collaborative to Protect Drinking Water: Where We Are Today and What We've Learned Along the Way

Amy Axon, NC DENR

Amy Axon, Source Water Assessment Program Manager for the Drinking Water Protection Program, Division of Water Resources, NC Department of Environment and Natural Resources. Ms. Axon has a total of 27 years of experience working for state environmental programs. Past responsibilities include being the North Carolina UIC program manager, an enforcement coordinator for Ohio EPA, and a TSCA inspector for the State of Kentucky. She has a BA in Geology from Guilford College in Greensboro NC and studied graduate level Hydrogeology at the University of Kentucky in Lexington.

The NC Drinking Water Protection Program implements strategies to protect our 9000 plus public water supply sources, which serve 8.2 million people. Our team works to evaluate the vulnerability of the sources and to develop protection strategies that improve and protect the quality of these sources. Given the exceptional amount of data involved and the diverse geographical characteristics present in NC, it was recognized that a mechanism to extend our efforts needed to be developed.

It was from this need that the concept of a state wide collaborative was conceived. A diverse team of representatives was recruited from government agencies, professional organizations, nonprofit organizations, university programs, and regional councils of government. The NC collaborative is made up of approximately 40 volunteers who have committed their time and expertise to the objectives of this group. To date, multiple facilitated brainstorming sessions have culminated in the development of a statement of purpose, mission and vision, and a prioritized atlas of initiatives. Two breakout teams, an awards team and an education team, are also currently working on specific initiatives.
In addition to the progress that is being made and goals that are being achieved, many lessons have been learned along the way. Several issues including funding, group dynamics and management, control/ownership of the group, as well as overall group structure, have been encountered. Information about how we have dealt with these and other challenges may be useful to other states considering a similar strategy for protecting their drinking water sources.

Overall, between the relationships and networking that are occurring and the work products being produced, the NC Source Water Collaborative is making great strides in the protection of our drinking water sources.

Abstract 3

The National Ground Water Monitoring Network Data Portal: From Pilot to Production

Jessica M. Lucido, Nathaniel L. Booth, Roger L. Hayes, Daryll A. Pope and William L. Cunningham

Jessica Lucido is an IT Specialist for the U.S. Geological Survey's Center for Integrated Data Analytics (CIDA), which has been charged with the development of the National Ground Water Monitoring Network Data Portal. In that role she coordinates the development of the web application and the data exchange mechanism that drives the portal and works with participating state agencies to aid them in making their data available through the portal. Jessica holds a Bachelor's degree from the University of Illinois at Urbana-Champaign in Mechanical Engineering and a Master's degree in Civil and Environmental Engineering from the University of Wisconsin – Madison.

The need for national groundwater monitoring is profound and has been recognized by organizations outside the government as a major data gap for managing groundwater resources. To meet this need the Subcommittee on Ground Water, established by the Federal Advisory Committee on Water Information, created a National Ground Water Monitoring Network envisioned as a voluntary, integrated system of data collection, management and reporting that will provide data needed to address present and future groundwater management questions raised by Congress, Federal, State and Tribal agencies and the public.

The Ground Water Data Portal facilitates access to groundwater data through one seamless web-based application from disparate sources. Data systems in the United States exist at many organizational and geographic levels; however differing vocabulary and data structures have prevented data sharing and reuse. A pilot scale portal was completed in 2011, which functioned as a proof of concept for enabling the retrieval of and access to groundwater data on an as-needed basis from multiple, dispersed data repositories in a standard format. The system was also designed to allow for the data to continue to be housed and managed by the data provider while being accessible for the purposes of the National Ground Water Monitoring Network.

As the portal moves from the pilot phase toward full implementation, a need for a more robust and performant infrastructure was recognized. In order to address this requirement, the existing service based infrastructure was supplemented with an automated cache that serves as a secondary source for data when services are unavailable, improves data retrieval performance, and facilitates advanced querying and calculation of statistics. In addition a flexible map-based user interface was developed to aid users in discovery, access and retrieval of groundwater data through the web portal.

Abstract 4

Hydraulic Fracturing Water Use in the Eagle Ford Shale Play: A Systems Dynamics Approach

Jeanne Eckhart , University of Texas

Jeanne Eckhart is a graduate student at the University of Texas at Austin and is getting her Masters of Science degree in Energy and Earth Resources. Through this multi-disciplinary program, Jeanne has grasped many different opportunities, including a fellowship with the American Water Works Association (AWWA). Through this fellowship, Jeanne was able to research water usage as it is related to hydraulic fracturing in the Eagle Ford, a South Texas shale play. Jeanne also has a Bachelors of Science in Environmental Geosciences from Texas A&M University. Jeanne plans to graduate in this coming December.

The process of extracting oil and gas through hydraulic fracturing utilizes a significant amount of water per an event. The Eagle Ford shale play uses anywhere between about 1 million gallons to about 13 million gallons per a hydraulic fracturing event, and that can cause significant impacts. Relatively speaking hydraulic fracturing is a small portion of the water usage in the state of Texas, but it is important to consider how large of a portion it is for a regional area. This research examined water usage in counties, hydraulic fracturing events, and the impacts of the drought to the area. The uneven distribution of water has led to drought stricken regions that are negatively impacted from the oil and gas industry that are using large amounts of water within their county. This research examines the sources of water that oil and gas companies use in the area, and other impacts that water usage may have. A significant portion of water utilized in this region is from groundwater, and is vital to understand the effects that this may have on other industries, like agriculture. The holistic systems dynamics approach of this research allows for collaboration with the many different stakeholders in the region to understand the water usage needs more, as well as to understand how the energy companies, local regulating entities, and others involved interact. The need to recognize the impacts that hydraulic fracturing has on water sources in a regional manner are important for the general public and policy makers thus a comprehension of technological improvements in hydraulic fracturing is required. The information pulled from collaborating with stakeholders can be seen in an online model that allows users to interact and learn about this important issue in the Eagle Ford shale play

Abstract 5

Groundwater Management: A Policy Perspective

Sharon B. Megdal, Ph.D. Director, Water Resources Research Center, The University of Arizona

Sharon B. Megdal is Director of The University of Arizona Water Resources Research Center (WRRC) and C.W. and Modene Neely Endowed Professor in the College of Agriculture and Life Sciences. Her work focuses on water resources management and policy, on which she writes and frequently speaks. She also holds the titles Professor, Department Soil, Water, and Environmental Science, and Distinguished Outreach Professor. She serves as Director of the Water Sustainability Program and Co-Director of The University of Arizona Water, Environmental and Energy Solutions Program, both of which are funded by the Technology Research Initiative Fund (TRIF).

Dr. Megdal places particular emphasis on how to achieve desired policy objectives in terms of institutional structures and possible changes to them. Current projects include: comparative evaluation of water management, policy, and governance in growing, water-scarce regions; meeting the water needs of the environment; groundwater management and governance, water pricing; and transboundary aquifer assessment. She is the lead editor of the book, *Shared Borders, Shared Waters: Israeli-Palestinian and Colorado River Basin Water Challenges*, (co-edited by Robert G. Varady and Susanna Eden, CRC Press/Taylor & Francis Group, in coop. with UNESCO-IHE, 2013). Dr. Megdal teaches the multi-disciplinary graduate course Arizona Water Policy. As an elected member of the Central Arizona Water Conservation District Board of Directors, she is responsible for the policies, rates and taxes associated with delivering Colorado River water through the Central Arizona Project. Dr. Megdal has served on numerous state boards and commissions, including the Arizona Corporation Commission, the State Transportation Board and the Arizona Medical Board. She holds a Ph.D. degree in Economics from Princeton University.

Groundwater availability, utilization and quality are world-wide concerns. The speaker will discuss some world-wide efforts related to groundwater governance and transboundary groundwater assessment in which she is involved. Dr. Megdal will also present the methodology utilized and results from an initial nation-wide survey conducted on groundwater governance and summarize additional research and analysis the team would like to conduct. She is very interested in interacting with attendees to solicit feedback and suggestions regarding this research. Her remarks will draw upon her experience as a water manager as well as a member of the academic community.

The report, Groundwater Governance in the U.S. – Summary of Initial Survey Results, can be found at wrrc.arizona.edu/groundwater

Abstract 6

Water Consumption for Fossil Fuel Exploration and Production

Christopher Harto, Robert Horner, Corrie Clark, Todd Kimmel

Christopher Harto is an energy and environmental analyst at Argonne National Laboratory. His work focuses on evaluating the environmental impacts of energy technologies and recently has concentrated on a range of issues surrounding the energy-water nexus. Recent work has involved: estimating risks to electricity production from drought, evaluating produced water treatment and management systems, studying potential environmental impacts from shale gas production, and life cycle assessment for geothermal electricity, shale gas, and carbon sequestration. He has a MS in sustainability from Arizona State and a BS in chemical engineering from Ohio State.

Robert Horner is an energy and environmental analyst at Argonne National Laboratory. He studies environmental impacts of energy technologies, including shale gas, arctic offshore oil and gas, geothermal, and solar. He has a MS in Sustainability from Arizona State University, a BS in Industrial and Systems Engineering from North Carolina State University, and a BA in Science, Technology, and Society also from North Carolina State University.

Dr. Corrie E. Clark is the Natural Resource Economics and Systems Analysis Team lead for the Environmental Science Division at Argonne National Laboratory. Dr. Clark develops interdisciplinary solutions that combine engineering, finance, and policy to solve complex environmental challenges. Dr. Clark's research interests are on environmental issues related to oil, gas, and geothermal energy production, and she has been working on produced water issues in the oil and gas industry since 2008. She holds a B.S. in Chemical Engineering from the University of Virginia, and an M.S.E. and Ph.D. in Environmental Engineering from the University of Michigan.

Todd A. Kimmell is a Principal Investigator with the Argonne National Laboratory's Environmental Sciences Division. He has extensive experience in solid/hazardous waste management and clean-up programs, emergency planning/management and homeland security, and in water programs related to power and energy. Water programs include investigation of production well contributions to hypoxia in the Gulf of Mexico, sustainability assessments, examination of the relationship between water use and energy production, and evaluation of power production issues that may be experienced during drought. He holds a MS in Environmental Science from George Washington University.

While much is known and understood about the water consumption implications of electricity generation, less effort has been dedicated to understanding water consumption from fossil fuel extraction processes. Many papers still rely on aging and outdated information on these processes. Two recently completed and one ongoing research project at Argonne National Laboratory have sought to help improve understanding of the quantity and location of water consumption for fossil fuel production in light of new technologies, such as hydraulic fracturing, being employed.

This presentation will synthesize the results of these projects. The first effort involved a water life cycle assessment of shale gas production in four different shale plays as compared to conventional natural gas production. The second effort involved estimating and mapping water consumption from coal, oil, and natural gas production in the Western United States. The third, ongoing project involves understanding the full water life cycle for shale oil production in the Bakken formation, focusing on quantifying and mapping water consumption, recycling, and produced water management. The key findings of these efforts will be presented within the context of the general state of knowledge surrounding water consumption for fossil fuel extraction while highlighting key uncertainties and remaining research questions.

Abstract 7

U.S. Geological Survey Earthquake Research on Injection-induced Seismic Activity: a Progress Report

Evelyn Roeloffs, U.S. Geological Survey, Vancouver, WA

Evelyn Roeloffs is a research geophysicist with the U.S. Geological Survey Earthquake Science Center and a member of that Center's Induced Seismicity Project. She has had a career-long interest in topics involving earthquakes (or volcanoes) and groundwater, including induced seismicity. Evelyn has an M.A. in Mathematics and a Ph.D. in Geophysics from the University of Wisconsin-Madison.

This talk will summarize research progress by earthquake scientists at the U.S. Geological Survey who are actively investigating seismic events induced by fluid injection. Increased seismicity, including earthquakes exceeding magnitude 5, in areas with abundant subsurface fluid injection has necessitated objective evaluation of whether the seismicity is naturally occurring or induced by human activities. Detailed reviews of past seismicity and precise relocation of ongoing sequences have been fundamental to investigating possible relationships of injection and earthquakes. These

studies add to a knowledge base needed for our scientific goal of assessing the probability that a given injection well will be one of the small percentage that induces earthquakes large enough to be felt. Criteria for determining whether earthquakes are natural or induced are being updated as case histories accumulate.

We are using numerical models to simulate the subsurface fluid pressures and stresses produced at specific well-characterized sites of induced earthquakes, seeking to identify geologic structures, stress states, and hydrogeologic characteristics that promote induced seismicity. Using these models, we can investigate how geodetic monitoring may help characterize subsurface fluid-flow paths, and we can simulate the effects of different injection protocols or cessation of injection.

Even though only a very small percentage of injection wells will induce earthquakes that cause concern, the large number of injection wells now active has the potential to significantly increase estimated seismic hazard, especially in the central and eastern United States where natural seismicity is low. Given the present lack of evidence that injection-induced earthquakes are limited in magnitude, approaches are being developed for incorporating ground motions from possible induced earthquakes into updates of the USGS National Seismic Hazard Map.

Abstract 8

Making Use of Groundwater as Part of an Alternative Water Supply Strategy

Jamie Crawford, Mississippi, MS DEQ & GWPC President

Meeting increasing demands for water is a constant challenge at all levels of government, and pressure to find both short-term and long-term water supply solutions has never been as urgent in many regions of the country as it is today. States, tribes, municipalities, industry, and water supply entities are engaged in water resource planning to meet current and future challenges posed by climate extremes (both the short and long term), increasing pressures on existing resources from population growth, competition for resources among various industries, and quantity and quality issues associated with current supplies. To facilitate the use of alternative water resources as part of an overall supply strategy, the GWPC is releasing a new chapter in its Ground Water Report to the Nation series titled, *Groundwater & Alternative Water Supplies.* This talk will review key elements of the new chapter.

Water conservation and repairs to leaky infrastructure are usually the first steps taken to help stretch existing resources; however, the hunt is on to identify new water sources to meet increasing demands. Alternative water resources can be an important part of this strategy. Untapped or underutilized groundwater sources may be available locally to supplement or provide needed capacity to water systems. Switching to "undesirable" water for industrial and agriculture purposes, brackish groundwater desalination, stormwater harvesting, aquifer storage and recovery, and water reuse are five groundwater-related resources that are either currently used or being considered for development in many areas of the nation.

As water supplies become less reliable, all levels of government will need to evaluate the potential to use alternative water resources and if the management of alternative groundwater resources can help meet future demands. Federal, state, tribal, and municipal governments will need to encourage and facilitate the use of alternative water resources and help users to overcome the perception that these resources are “wastes." One of the key challenges to using alternative resources is getting local-level acceptance that these are viable, long-term water supplies that justify the expense associated with investigation and characterization, as well as development of the infrastructure needed to utilize them.

Abstract 9

New Electronic System Monitors Groundwater Impacts near Runoff Holding Ponds

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Roger A. Eigenberg and Bryan L. Woodbury Environmental Management Research Unit, USDA-ARS, USMARC,

Mineral and organic salts from beef manure contained in precipitation runoff from feedyard pen surfaces can alter the conductivity properties of soil and water receiving it.

Typically, holding ponds are constructed to control runoff from concentrated animal feeding operations. The integrity of these holding ponds has come under increased scrutiny since leakage has the potential to affect soil and groundwater quality. Traditionally, ponds are monitored by installing monitoring wells at key locations to evaluate the impact of these ponds on the environment. These monitoring wells are expensive and subject to ambiguous interpretation, because samples are taken infrequently and in only a few locations.

A subsurface resistivity array was installed at a beef cattle feedyard located at the U.S Meat Animal Research Center, Clay Center, Nebraska (Feedyard A) and at a cattle feeding cooperator site (Feedyard B). Array probes were permanently installed at Feedyards A and B at a depth of approximately 30 cm and spanning a length of 94.6 m. Periodic readings from each site were evaluated to monitor the stability of the zone of hydration near the pond. The low hydraulic conductivity soils at Feedyard A provided a very quiescent environmental system to evaluate the resistivity array’s inherent measurement stability. Seasonal changes could easily be accounted for by variation in seasonal soil temperatures.

The Feedyard B site was typified by coarse textured parent material that had high hydraulic conductivity properties. This site experienced dynamic changes week to week and throughout the season. An automated resistivity array system developed by AgraTek, LLC* was installed at Feedyard B. The remotely accessed automated system recorded daily values of subsurface soil conductivity. Additional analysis using difference maps and pattern identification methods improved the illustration of the conductivity dynamics. The results of this study indicate that resistivity array systems have the potential to improve monitoring of runoff holding ponds and quickly detect leakage associated with similar impoundment structures.

Abstract 10

Evaluation of Common Cement and Bentonite Products Used in Water and Monitoring Well Construction (or drilling) for Glycols, Alcohols, and Phenolic Compounds

Donald Siegel (Syracuse University), Bert Smith (Chesapeake Energy), Charlie Carter (TestAmerica Laboratories, Inc.), and Chuck Neslund (EurofinsLancaster Laboratories, Inc.)

Recently, much attention has been focused on the evaluation and testing for glycols, alcohols, phenols, benzoic acid, and 2-butoxyethanol in groundwater samples from water and monitoring wells during investigations of potential impacts. New analytical methods are being developed that have allowed the detection levels for many of these compounds to be achieved in the low parts per billion (ppb) range contrasted to the conventional methods' parts per million (ppm) range. At least one analytical method that allows ppb-range measurement of glycols is not yet widely available in the commercial analytical sector. Most, if not all, of the materials deemed to be acceptable for use in environmental monitoring well or water well construction have either not been tested for these previously mentioned compounds of concern, or to the low ppb ranges now achievable. Such products include lubricants, drilling muds and additives, cement and bentonite annular sealants, and well development additives. Environmental sample preservatives, such as reagent-grade acids, have likewise not been tested for these parameters to the low ppb ranges. To prevent false-positives during investigations, it is necessary to determine the potential contribution these materials may exhibit during laboratory analyses of samples. This presentation will discuss preliminary finding from analytical testing of common bentonites and cements used in water and monitoring well drilling and completions. Further, information will be presented that discusses the testing of certain reagent-grade preservation acids for some of these compounds.

Abstract 11

The Occurrence of Methane in Shallow Groundwater from Extensive Pre-Drill Sampling in the Marcellus / Utica Shale Play

John Boulanger, P.G., AECOM, Pittsburgh, PA; Elizabeth Perry, P.G., AECOM, Chelmsford, MA; Bert Smith, P.G., Chesapeake Energy Oklahoma City, OK; Mark Hollingsworth, Chesapeake Energy, Oklahoma City, OK

Mr. Boulanger is a geologist at AECOM with 12 years experience and will present. He is a professional geologist and holds a MS in hydrology from New Mexico Institute of Mining and Technology and a BS in Environmental Geology from the University of Pittsburgh. Ms. Perry is a hydrogeologist at AECOM with 26 years experience. She is a professional geologist and holds a MS in Engineering Geology from Drexel University and a BA in Mathematics/Geology from Hamilton College. Mr. Smith is a Senior Hydrogeologist with Chesapeake Energy and Mr. Hollingsworth is an Environmental Manager at Chesapeake Energy.

On behalf of Chesapeake Energy, sampling of over 20,000 water wells has been conducted from 2009 to the present from shale-gas development areas across Pennsylvania, Ohio, and West Virginia. Sampling was conducted prior to Marcellus/Utica Shale-related exploration, drilling, and production activities in the vicinity of the water wells. The pre-drill samples have been analyzed for methane as well as many inorganic parameters.

This presentation will explore the occurrence and distribution of methane in groundwater prior to unconventional gas development. GIS-based mapping and statistics will be presented demonstrating the geographic distribution and relationship to bedrock geology amongst other factors. The relationships between methane and other inorganic parameters will be reviewed to help explain methane occurrence. In addition, this presentation will review methane occurrence as a function of distance to the nearest gas well.

Gaining a better understanding of methane in shallow groundwater will lead to improved decision-making when evaluating potential impacts of shale-gas development on water supplies and stray gas occurrence.

Abstract 12

REAL-TIME MONITORING FOR EVALUATING LONG-TERM VARIABILITY IN METHANE IN DOMESTIC WATER WELLS IN NORTHEAST PENNSYLVANIA

Charles B. Whisman, P.E.[1], Bert Smith, P.G.[2], Debby Yost[2], Charles Olmsted, P.G., CPG[2], Denise Good, P.E.[1], and Richard Wardrop, P.G.[1]

Charles Whisman, P.E. is GES' Chief Technical Officer and has 18 years of industry experience. He leads GES' business strategy, engineering, and technology initiatives. He holds a BS in civil engineering and a certificate in environmental engineering from the University of Pittsburgh.
Bert Smith, P.G. is a Hydrogeologist and Regulatory Specialist at Chesapeake Energy Corporation.
Debby Yost is a Senior Corporate Environmental Specialist at Chesapeake Energy Corporation.
Charles Olmsted, P.G. is the Supervisor of Regulatory Compliance at Chesapeake Energy Corporation.
Denise Good, P.E. is a Principal Engineer at GES.
Richard Wardrop, P.G. is a Principal Hydrogeologist at GES.

Rick Wardrop is a Principal Hydrogeologist for Groundwater & Environmental Services (GES) and a professional geologist licensed in Pennsylvania. He has his Bachelor's degree from Bucknell University and his Master's degree from Penn State. Rick is a past President of the Pennsylvania Council of Professional Geologists and currently serves as a member of the Penn State Geosciences Advisory Committee. Rick has been consulting to natural gas operators within the US shale plays to investigate the potential effects on groundwater quality from exploration and development activities and how best to manage water resources. Over the past couple of years Rick has been working with clients to investigate the natural occurrence and variability of methane in domestic water supply wells.

Naturally-occurring methane is present in many domestic water wells in northeast Pennsylvania. A significant amount of data is currently being collected by the oil and gas industry as a result of sampling efforts and investigations, much of which is from pre-drilling ("baseline") sampling conducted prior to any drilling activity. However, gaps remain in understanding and quantifying the natural temporal variation in methane concentrations in these wells. This is of significant importance in assessing claims of gas migration when there is nearby anthropogenic activity. This presentation will discuss a research project developed and implemented to gain an understanding of the long-term variability of methane in domestic water wells.

Real-time remote monitoring and data trend analyses are being utilized to understand natural dissolved methane fluctuations in groundwater and correlations between methane headspace concentration in the well annulus and other physical and chemical parameters which could correlate to changes in headspace concentration. Significant efforts were made to select, evaluate, and prepare the wells for the study including borehole geophysics, well equipment upgrades, and installation of water-treatment systems. Descriptions of the customized real-time remote monitoring equipment, array of well headspace and water-quality sensors utilized, and equipment setup will be presented, as well as the associated challenges and logistics. Barometric pressure, water use, water quality, well recharge, water-level fluctuations, and pump cycling are examples of the variables monitored.
Interim results from the on-going study will be presented, including discussion of well construction, geologic settings, water quality, initial trends and findings, and real-time display of data. The usefulness of the data and the accuracy/precision of sensors will be discussed. The long-term study will provide further information to better understand the occurrence and potential causes of methane fluctuations in groundwater and associated water well quality issues in northeast Pennsylvania.

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Abstract 13

Revised API Well Numbering System

Donald J. Drazan, NYS Dept. of Environmental Conservation

The American Petroleum Institute (API) created the well numbering standard D12 in the early 1960's. Since that time several modifications have been made to the standard. In early 2010, the API transferred stewardship of the API Well Number to the Professional Petroleum Data Management Association (PPDM). PPDM is a global, not-for-profit professional society that provides data management standards and best practices for the petroleum exploration and production industry. PPDM formed the Well Identification Project. Industry participants, along with regulators formed the team. The goal was to create a new version that would honor existing standards but allow industry to identify and catalogue new well technologies in a consistent, universal manner.

PPDM released the revised standard in September 2013 as a formal 12 digit number with the goal to accurately track the information regarding drilled footage to limit the potential of subsurface collisions. 13 + options will support state programs to allow for regulatory requirements. PPDM is working with states and the Risk Based Data Management System in formalizing adoption of the standard.

Abstract 14

Considerations in Selecting Hydraulic Fracturing Chemicals: Management of Health and Environmental Risks. Authors: J. Daniel Arthur, H. William Hochheiser, Brian Bohm, Mark Layne (All Consulting)

H. William Hochheiser is an environmental scientist specializing in technical, environmental, and regulatory issues related to all facets of energy development. He has over 35 years of diverse experience in government service and consulting. His work has primarily involved research and analysis of the potential environmental impacts of oil and gas development, including impacts to surface water, groundwater, air, land, and wildlife. Mr. Hochheiser serves as the trainer and communications coordinator for the FracFocus database developed and maintained by ALL Consulting.
In choosing the chemical additives to use in a given hydraulic fracturing job, it is tempting to use the most effective ingredients to get the job done from a purely engineering and cost perspective. However, operators should be cognizant of other factors that can expose them to risks and liabilities that could greatly increase their costs down the road. Increasingly, emphasis has been placed on the use of products that are safe and environmentally responsible as well as effective. The use of some products or chemicals can even expose the operator to regulatory requirements that are easy to avoid just by choosing an alternative. For example, the use of diesel in fracturing fluid could place a well under EPA's Underground Injection Control (UIC) Program. The Energy Policy Act of 2005 excluded hydraulic fracturing from that program except when diesel fuels are used, and EPA has developed draft UIC Class II permitting guidance specific to oil and gas hydraulic fracturing activities using diesel fuels.

Some companies and industry associations have developed programs to screen the products that are used in hydraulic fracturing based on their potential health and environmental impacts. For example, Encana has implemented a Responsible Products Program that prohibits use of products containing diesel, 2-BE, benzene, and certain heavy metals. The Canadian Association of Petroleum Producers has established an operating practice that requires well-specific risk management plans for hydraulic fracturing fluid additives. In addition to being environmentally responsible, such measures reduce liability from possible future claims of contamination where these substances might be found in nearby water wells. In addition a number of states now require public disclosure of the chemicals used in hydraulic fracturing and operators must be aware that they will likely be publicly disclosing their fracture fluid contents through such databases as FracFocus or various state operated databases. Analysis of these disclosures by NGOs and others could expose companies to negative publicity or even state and federal inquiries if toxic or carcinogenic constituents are used.

This presentation will give an overview of the considerations in choosing products for use in hydraulic fracturing fluids. It will cover regulatory, health, and environmental reasons to avoid certain ingredients or classes of ingredients, with examples of concerns and negative consequences that have occurred in the past. The presentation will be especially useful to smaller operators who may not be aware of the possible cost and liability impacts of these choices.

Abstract 15

Developing Analytical Tools and Practices for Groundwater Quality and Production Well Integrity Investigations in Situations of Alleged Stray Gas Migration. Authors: Dan Arthur, Damian Zampogna, Brian Bohm (ALL Consulting), Steve Lakeman (INFICON)

J. Daniel Arthur is a registered professional petroleum engineer specializing in fossil energy, planning/engineering analysis, and environmental issues. He has over 25 years of diverse experience that includes work in industry, government, and consulting. Mr. Arthur served as the primary expert for the largest well integrity evaluation program in the United States related to wellbore methane intrusion. As part of the program, several innovations related to well integrity analysis were developed. Mr. Arthur is a founding member of ALL Consulting and has served as the company's President since its inception in 1999.
Methane in the shallow groundwater has been identified to occur naturally in aquifers throughout North America. Understanding the source of methane in groundwater can be complex. Furthermore, determine whether groundwater has been impacted from oil and gas development activity rather than other anthropogenic sources requires a holistic approach using multiple data sources. Such generally requires multivariate statistical analyses to identify deviations in baseline (or "Pre-Drill") versus post-complaint data sets, which may involve extensive well integrity evaluations. Building upon the existing baseline water quality data and using historical state and federal data sets, regional and localized groundwater trends can be established and geo-referenced. As part of a groundwater contamination investigation, the water source in question can be fingerprinted and compared against a larger data set. Traditional analytical methods, including isotopic analysis and

laboratory analytical results, are able to provide “snap-shot” views of the geochemical composition of an aquifer within weeks of initial sample collection. However, with advances in technology, real-time continuous monitoring of the geochemical composition is possible and provides instantaneous results. For example, a mobile gas chromatography (GC) and mass spectrometer (MS) unit can have the potential for real-time isotopic analysis in a variety of sampling locations (e.g., basements, wells, ponds, fields, rivers, etc.) in a much more cost effective and thorough manner. By using a mobile GC/MS unit as part of an aquifer characterization, the water quality range can be measured and used to provide historical data assurances, quantify relationships between aquifer stage and water quality, and to direct an ongoing investigation. Continuous monitoring with GC/MS units may also allow for a more thorough investigation of a production well’s integrity and its potential relationship to alleged stray gas incidents. Mobile GC/MS units can be integrated into existing well integrity investigation practices, including pressure build-up tests and vent rate testing to provide a more comprehensive understanding of well integrity. Additionally, using the portable GC/MS allows for the continuous monitoring of gas composition at both the production well and the reported stray gas location throughout remedial actions to evaluate any potential correlations and the effectiveness of well remedial activity. This paper will present developments with regard to stray gas analysis in groundwater and related production well integrity analysis, including the use of developing technologies, including mobile GC/MS, continuous GC water sampling instruments, and other tools that have the potential to significantly aid in analysis of alleged stray gas incidents. Although some technologies are still under development, understanding prospective benefits of new and development technologies should be a major consideration for both government and industry.

Abstract 16

Balancing Environmental Risks with Recycling of Produced Water.

Authors: J. Daniel Arthur, David Alleman, Brian Bohm, Damian Zampogna (ALL Consulting).

Brian Bohm is a professional geologist with more than 14 years of experience in the oil and gas industry. He has managed, performed, or contributed to a variety of oil and gas environmental projects with an emphasis on shale gas and coal bed natural gas development. His work has included alternative analysis for managing produced water, beneficial use of produced water, water treatment analysis and selection, and produced water disposal alternatives.

A key aspect of shale resource development is water used in hydraulic fracturing. Several resource development companies have noted that without water, there would be now oil or gas produced from deep shale formations. In fact, in areas such as Saudi Arabia, scarce water resources is a severe impediment to successful resource development. Furthermore, the use of fresh water can be challenging in some areas, thus prompting many companies to consider options for pursuing treatment, recycling, and reuse of produced water. In several instances, developers have also utilized brackish or saline water sources, industrial water sources, and other waters that are generally lower in quality than fresh water (e.g., acid mine discharges).

Although the use of low quality water for hydraulic fracturing (including recycling of produced water) has many potential benefits, it also creates risks and potential liabilities that simply are not an issue when fresh water is used. The logistics of the water reuse for shale development requires the balancing of regulatory requirements, environmental risks, and produced water demands with the collection, transportation, storage, and treatment of produced or low quality water. Environmental risks associated using low quality or produced water can include environmental impacts resulting from pipeline or wellhead failures, incidents associated with the storage of produced water in impoundments or tanks that are subject to flooding or leakage, and the challenges of handling and transporting the byproducts associated with the treatment of produced water (including the disposal of concentrated fluids and water with potential concerns of NORM and TENORM). Simply put, managing low quality water has the potential to create very different environmental impacts and also safety concerns than a release of fresh water. Moreover, many service companies are very skilled at completing wells where the carrier fluid is freshwater. Using low quality water adds complications and increases the chances for human error.

Considering what appears to be an expanding emphasis on the use of low quality water, water treatment, and the reuse/recycling of produced water, clear consideration of risks involved is critical. This presentation will summarize the risks as well as offer recommendations and best practices that should be considered when moving away from fresh water for hydraulic fracturing.

Abstract 17

Potential Environmental Impact of Produced Water

John Veil, Veil Environmental, LLC, Annapolis, MD

Produced water is the largest byproduct stream associated with oil and gas production. In the United States, on average, more than 10 barrels (bbl) of produced water are generated for each bbl of crude oil. Management of that large amount of produced water creates significant costs and challenges for the oil and gas companies. Produced water contains various constituents that pose a risk to the environment if the produced water is not handled, stored, treated, and disposed correctly. This presentation describes the characteristics of produced water and the types of environmental impacts the produced water can cause if it is not managed properly.

The presentation describes the pathways by which produced water can impact the environment. It also includes a description of risk assessment principles as they apply to evaluating produced water impacts. The presentation includes an example of using a decision tree to evaluate potential hazards in a risk analysis. It also includes one noteworthy example showing how science can positively influence a produced water regulatory outcome.

John Veil founded Veil Environmental, LLC, a consulting practice specializing in water issues affecting the energy industries, upon his retirement from Argonne National Laboratory in January 2011. Mr. Veil spent more than 20 years as the manager of the Water Policy Program for Argonne National Laboratory. Before joining Argonne, Mr. Veil managed Maryland's regulatory programs for industrial wastewater discharge and injection and served as a faculty member of the University of Maryland. Mr. Veil has degrees in Earth and Planetary Science, Zoology, and Civil Engineering. Mr. Veil has been recognized by the Society of Petroleum Engineers as a Distinguished Lecturer in 2008-2009 and 2013-2014 and as the recipient of the 2009 international award for Health, Safety, Security, Environment and Social Responsibility. Mr. Veil has published many articles and reports and is frequently invited to make presentations on environmental and energy issues.

Abstract 18

Nutrient Sources and Pathways to Groundwater in Minnesota

David J. Mulla, University of Minnesota

David Mulla is a Professor and Larson Chair for Soil & Water Resources in the Dept. Soil, Water & Climate at the Univ. of Minnesota. Dr. Mulla received a B.S. degree in Earth Sciences from the Univ. of California Riverside, and M.S. and Ph.D. degrees in Agronomy from Purdue University. He studies water quality, soil conservation and precision agriculture. Mulla served as an associate editor for SSSAJ and Precision Agriculture, and was elected as a Fellow of the Soil Science Society of America (1997) and the American Society of Agronomy (1999).

Minnesota's groundwater resources are threatened by nitrate contamination. Drinking water in public and private wells is extensively tested by a variety of state and federal agencies. Drinking water from public groundwater wells in deep sandstone or dolomitic aquifers is relatively free of nitrate contamination, with 1% of wells exceeding the 10 mg/L maximum contaminant level (MCL) for nitrate-N. Shallower private drinking water wells have a higher risk of nitrate-N contamination than deeper public wells, with roughly 5-10% of the private drinking water wells exceeding the MCL for nitrate-N. The highest risks occur in shallow sand and gravel aquifers located in central Minnesota and in karst topography in southeast Minnesota.

Minnesota recently completed a comprehensive study of nitrogen sources and pathways for water pollution. Nitrogen inputs to land surfaces are dominated by soil mineralization and agricultural fertilizer. Smaller sources include N-fixation by legumes, land applied animal manure and atmospheric deposition. Negligible sources include septic systems, feedlots, point sources and lawn fertilizer. Nitrate-N transport to groundwater is dominated by leaching losses from fertilized cropland.

A model was developed to estimate nitrate-N leaching losses from agricultural land. This model was based on experimental data for different cropping systems collected at numerous locations throughout Minnesota at sites receiving a wide range of N fertilizer and rates of precipitation/irrigation. Leaching losses to groundwater were larger at sites without subsurface tile drainage than at sites with tile drainage. Leaching losses to groundwater were larger in wet years than dry years. Leaching losses to groundwater increased as rates of N fertilizer increased. In aggregate, 163 million lb of nitrate-N are lost to groundwater in an average climatic year. 80% of this loss is from fertilized annual cropping systems on soils overlaying sand and gravel aquifers or karst deposits.

Abstract 19

Long-Term Groundwater Depletion in the United States

Leonard F. Konikow, USGS

Lenny Konikow is a research hydrologist with the U.S. Geological Survey in Reston, VA. His research interests include the development and application of simulation models for groundwater flow and contamination problems, and groundwater depletion and its contribution to sea-level rise. He is a Fellow of the American Geophysical Union and has received the O.E. Meinzer Award from the Geological Society of America. He also served as the Vice-President for North America for the International Association of Hydrogeologists during 2008-2012. Lenny received a B.A. in geology from Hofstra University, and an M.S. and Ph.D. from Penn State University.

Development of groundwater resources for agricultural, industrial, and municipal purposes greatly expanded in the last century, and economic gains from groundwater use have been dramatic. In many places, however, groundwater reserves have been depleted to the extent that water levels have declined tens to hundreds of meters, well yields have decreased, pumping costs have increased, detrimental environmental impacts have become evident, and the sustainability of groundwater development has been reduced. A natural consequence of groundwater withdrawals is the removal of water from subsurface storage, but the overall rates and magnitude of groundwater depletion in the United States previously were not well characterized. This study evaluated long-term cumulative depletion volumes in 40 separate aquifers or areas and one land use category in the United States. Depletion is directly calculated using calibrated groundwater models, analytical approaches, or volumetric budget analyses for multiple aquifer systems. Estimated groundwater depletion in the United States during 1900–2008 totals approximately 1,000 km^3—about twice the volume of water in Lake Erie. Furthermore, the rate of groundwater depletion has increased markedly since about 1950, with maximum rates occurring during the most recent period (2001–2008)

when the depletion rate averaged 23.9 km^3 per year (compared to 13.6 km^3 per year during 1951–2000). The U.S. aquifer with the largest cumulative volume of depletion since 1950 is the High Plains aquifer, but the Central Valley of California shows the largest depletion intensity (which factors in the areal extent of an aquifer) during 2000-2008. Although groundwater depletion rates will ultimately be self-limiting, data show that we have not yet reached that point in most areas. Groundwater depletion must be confronted on local and regional scales, where water managers in areas of continuing depletion will sooner or later have to take actions to reduce demand and/or increase supply through managed aquifer recharge, desalination, and developing alternative sources.

Abstract 20

How do States Define "Usable Quality" Groundwater?

Steve Musick, Ground Water Protection Council

Steve Musick received his Bachelors Degree in Geological Sciences from the University of Texas at Austin in 1976. He worked with the Texas Commission on Environmental Quality and its predecessor agencies for 26 years. He has worked in the areas of Class I and Class V underground injection control, groundwater management, groundwater districts, groundwater protection, and program development. His work included Priority Groundwater Management Area Studies, water quality protection and water supply issues for the Edwards Aquifer, and support for the Texas Groundwater Protection Committee. He has consulted with and represented the Ground Water Protection Council on technical and policy issues since 2008.

The presentation will provide an overview of current regulatory programs of 26 states relative to groundwater protection. The review included regulations of Oil and Gas, Water and Environmental state agencies. Our work describes generally the definitions of usable and fresh groundwater, policy statements and state protection requirements. The scope of state groundwater classifications, applicable quality standards and relationships to permitting and corrective action are identified.

Abstract 21

Seismic Response to Power Production at the Salton Sea and Coso Geothermal Fields, CA: Using Operational Parameters to Study Anthropogenic Seismicity Rates

Lia J Lajoie, Emily E Brodsky, Daniel R H O'Connell, and Robert J Creed, Jr., Fugro Consultants, Inc

Geothermal power is generated at several major volcanic fields in California. As efforts to monitor seismicity increase, methods to understand the anthropogenic component need to improve. Ideally, induced earthquake rate should be forecast based on publicly reported volumes of fluid injection or other operational parameters. We focus specifically on the Salton Sea and Coso geothermal fields in California, which are characterized by both high seismicity rates and relatively high aftershock triggering. At the Salton Sea geothermal field, the total volume of fluid extracted or injected tracks the long term evolution of seismicity. However, for recent years net fluid volume (extracted minus injected) is better correlated with seismicity. The seismic response at the Coso geothermal field is not so apparent. After correcting for the variable aftershock rate using an Epidemic Type Aftershock Sequence model (ETAS), we fit the background earthquake rate with a linear combination of injection and net production rate that allows us to track the secular evolution of the field. The number of earthquakes per fluid volume injected decreases gradually over time in the Salton Sea Geothermal Field, and we show that the background seismicity rate at both geothermal fiels can be approximated from our linear model during many time intervals at the 90% + confidence level. The new analysis of induced seismicity provides a template for future evaluation of hazard directly based on measureable, controllable operational quantities. The interactions of these anthropogenic events with the larger scale tectonic and volcanic systems remains to be investigated.

Abstract 22

Enhanced Remote Earthquake Triggering at Fluid Injection Sites in the Midwestern U.S.

Nicholas J. van der Elst[1], Heather M. Savage[1], Katie M. Keranen[2], Geoffrey A. Abers[1]

Dr. van der Elst is a postdoctoral research fellow at the Lamont-Doherty Earth Observatory of Columbia University, New York. His research focusses on the mechanics of earthquakes and faulting, with an emphasis on how earthquakes get started. Current research topics include seismological studies of triggered earthquakes and laboratory studies on the effect of vibration on fault strength. He holds a PhD in Earth and Planetary Science from the Univ. of Calif., Santa Cruz, and a BA from the Univ. of Calif., Berkeley. Prior to his PhD, he spent two years as a seismologist with Pacific Gas and Electric Co. in San Francisco. He is currently supported by a grant from the National Science Foundation.

A dramatic increase in seismicity in the Midwestern United States may be related to increased deep wastewater injection. We have systematically examined the last several years of seismographic data at several sites of suspected anthropogenic seismicity, in order to resolve previously undetected small earthquakes and offer a clearer picture of the onset and evolution of induced seismic swarms. Importantly, we found advanced warning signs at three sites that experienced moderate magnitude earthquakes in 2011, in the form of remotely triggered earthquakes. Remote triggering is a phenomenon whereby small swarms of earthquakes are set off by the passing seismic waves of distant very large earthquakes. This phenomenon has been well established for the last several decades, particularly in natural hydrothermal and volcanic settings, where circulating pressurized fluids play a role in generating earthquakes. Remote earthquake triggering can only operate on faults

already very near failure, so this observation strongly suggests the presence of critically stressed, fluid-filled faults. Remotely triggered swarms appear to be an advance indicator of larger induced earthquakes, at least in some locations. Unfortunately, current earthquake monitoring capability in most continental regions is inadequate to detect these small earthquakes on a consistent basis. Improved seismic station density, with long-term monitoring over the duration of injection, would go a long way toward establishing which injection sites are the best candidates for continued pumping, and which have reached capacity with respect to fault stability.

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Abstract 23

Recommendations for pre-drill water quality testing that is both reasonable and effective

Robert W. Puls, Oklahoma Water Survey

Dr. Robert Puls is Director of the Oklahoma Water Survey and Associate Professor at the University of Oklahoma. Dr. Puls was employed by the USEPA for almost 25 years. He was the Technical Lead for the USEPA Study on Hydraulic Fracturing and Drinking Water Resources prior to his retirement in early 2012. As Technical Lead, he met with numerous industry representatives, non-governmental organizations, federal and state agencies responsible for oil and gas regulatory oversight as well as private citizens. He has a Ph.D. from the University of Arizona and degrees from the University of Washington and the University of Wisconsin.

Several states and other groups have recently put forward guidelines for sampling private water wells where oil and gas operations are occurring as public service information (e.g. Penn State Agricultural Extension; Oklahoma State Agricultural Extension; NGWA/GWPC; Louisiana Department of Health and Hospitals). Several states have recently promulgated regulations that address pre-drill sampling of drinking water supplies/wells (CO, OH, PA, WV). While these are steps in the right direction, there continues to be variation in what is covered under these rules and guides as well as gaps. While leading the field technical portion of the USEPA Hydraulic Fracturing Study in 2010 and 2011, the single most glaring deficiency I noticed in all state programs for oil and gas operations was the absence of any rules or guides for baseline water sampling. When complaints were lodged with state agencies, there was almost never any pre drill data to compare to post drill suspected impacts. The best available data was typically historical regional water quality collected by the USGS, some of which could be decades old. Because of the natural variability of subsurface systems, this data was usually insufficient to allow for comparisons between pre and post drill water quality data.
This presentation will compare and contrast some current state requirements related to the collection of baseline water quality and identify additional needs. The presentation will highlight the following issues:

- Who is paying for and responsible for data collection?
- Who receives the data?
- Who collects the samples?
- What are the sampling objectives?
- What constituents are sampled for?
- Where are the samples collected?
- When are the samples collected?
- How are the samples collected?

Abstract 24

FracFocus 2.0: Focus on Transparency

Mike Nickolaus, Ground Water Protection Council

Mike received his Bachelor's degree in Geology from Indiana University and has been a Licensed Professional Geologist since 1986. He is also a member of the Society of Petroleum Engineers. Mike has worked as the Special Projects Director for the GWPC since May, 2005. In this capacity he is responsible for development and management of projects related to water/ energy issues and underground injection control. Prior to joining GWPC, Mike worked for the Indiana Division of Oil and Gas for nearly 20 years in program enforcement, permitting, and underground injection control. In his final two years with the division, Mike served as the state Director of Oil and Gas.

The FracFocus 2.0 system; which replaced the previous version of FracFocus has numerous updates that make it easier for operators to enter their disclosure records in compliance with state laws. Changes to the search capability, record entry format, file uploading, validation and submission system and the addition of new user groups has made the new FracFocus 2.0 a comprehensive means of reporting hydraulic fracturing chemicals on a nationwide basis. The new FracFocus 2.0 system allows operators to easily enter records onto web based pre-designed forms and to save, modify, and submit records to the system with ease. Service companies can now upload records directly to their clients queue for review and submission. The addition of Registered Agents as a user class now allows smaller operators to farm out the task of disclosure submission to third parties. In addition state agencies now have the capability of uploading disclosure records and downloading disclosure files in xml format for their state. This presentation will include a background discussion of FracFocus and the new features of the FracFocus 2.0 system.

Abstract 25

Clean Water Act - Safe Drinking Water Act State/EPA Workgroup

Holly Green, USEPA Office of Ground Water & Drinking Water

Holly Green currently serves as the Associate Branch Chief for the Prevention Branch in the US Environmental Protection Agency's Drinking Water Protection Division, Office of Ground Water and Drinking Water. In that role she manages the national Source Water Protection Program and works closely with the Underground Injection Control Program. Previously, Holly held leadership positions in EPA's national Water Quality Standards Program, focusing on water quality criteria implementation in Clean Water Act programs and national nutrients policy. She also spent three years with the EPA Office of Inspector General. Prior to EPA, Holly served as a Peace Corps Volunteer in Honduras working with communities to build, sustain and protect rural drinking water systems. Holly received a B.A. in Environmental Planning from Binghamton University (State University of New York) and a Master of Environmental Management degree from the Yale School of Forestry and Environmental Studies.

The Association of State Drinking Water Administrators, the Association of Clean Water Administrators, the Ground Water Protection Council, and their state members, together with EPA OW and Regions, are working to improve linkages between the source water protection program and Clean Water Act programs at the federal, state, and local levels to enhance drinking water protection and improve water quality for all uses.

The Workgroup consists of representatives of both Safe Drinking Water Act (SDWA) and Clean Water Act (CWA) programs from EPA Headquarters, Regions, states, and state associations and we have organized into three sub-work groups:

1. Water Quality Standards and Impaired Waters Listing (CWA 303(d))
2. Point Sources (National Pollution Discharge Elimination System) and
3. Total Maximum Daily Loads (TMDLs) and Non point sources (CWA 319)

For each of the topic areas above, the work groups will produce a short support document designed to facilitate the efforts of a state agency or a Region to collaborate in these program areas. The documents will describe:

- The nuts and bolts of the CWA Tools
- How the tools can be used to protect drinking water
- How they have been used successfully in practice
- Any stumbling blocks and how those were/could be overcome, and
- Opportunities identified by the group as to how/where individual states or Regions may apply these tools and utilize the work group process to begin to take action.

Abstract 26

Groundwater Prospecting – Looking Beyond Today's Groundwater Supply

Fred Rothauge, Hydro Resources

Fred Rothauge is Business Development Manager for Hydro Resources and past owner and of Quality Drilling Fluids, a company he started and owned for 26 years. He has over 31 years' experience in Oil and Gas, Mining, Water Well Drilling and Well Rehabilitation. He has co-authored papers on Drilling Fluid products and is a co-author for Johnson Screen 3rd edition of Groundwater and Wells. His primary interest is in Groundwater Resources Development and Well Rehabilitation. Fred holds Water Well Drillers License's in Arizona, Colorado, Montana, New Mexico, South Dakota, Utah and Wyoming. He is Certified by the NGWA in Air Rotary Drilling, Mud Rotary Drilling, Reverse Circulation Drilling and Well Servicing and Maintenance. Certification # 192034

In recent years due to draught and water quality issues the trend has been to look for deeper water sources in what was once considered non potable or non-economical aquifers. With the help of MT4 Geophysical Imaging, and USGS mapping systems potential aquifers can be identified and followed with a test well and zone sampling to determine water quality and quantity potential. The Ogallala formation extending from Nebraska to Texas is a primary water supply and thru many years of use and miss use has now become a primary focus and center of attention as depletion of the aquifer is being threatened. In some areas of Texas and New Mexico Underlying the Ogallala is the Santa Rosa and Trinity formation which ranges in quality from fresh to brackish to well over 10,000 ppm TDS. These aquifers can be highly productive producing several hundred gallons per minute. Today we are looking for the best quality water within these aquifers. Thru RO and Desalination these deeper aquifers can contribute valuable water resources to users with otherwise depleting resources. Waste water from the RO or Desalination system becomes an issue as where to go with it and the use of deep injection wells have become a solution to many operators. The USEPA regulates these injection facilities and classifies which formations can be used for injection purposes. These rules may need re-evaluated to protect the ground water for future generations as we need to look past today and even the next 100 years and look to protect the worlds water for several thousand years.

Abstract 27

Status of Arkansas Groundwater Resources and Update of the Arkansas Water Plan

D. Todd Fugitt, PG -- Geology Supervisor, Arkansas Natural Resources Commission

Todd attended the University of Arkansas at Little Rock and Arkansas Tech University where he received a B.S. degree in Geology. He is a registered professional geologist and is Geology Supervisor for the Arkansas Natural Resources Commission where he has supervised the Arkansas Water Well Construction Commission program, and worked with water resources research, conservation, and protection programs for over 28 years. Todd has had direct authority over the designation of the State's three critical groundwater areas, and is a recipient of the U.S. Department of the Interior Cooperative Conservation Award, and has been recognized for outstanding cooperation and assistance provided to the Federal Bureau of Investigation (FBI) in 2010.

The Arkansas Natural Resources Commission (ANRC) is currently updating the Arkansas Water Plan. The Arkansas Water Plan is the State's comprehensive planning process for the conservation, development, and protection of the State's water resources, with a goal of long-term sustainable use for the health, well-being, environmental and economic benefit of the State of Arkansas.

The existing plan has been in place since 1990, and remains as the State's water resources policy and guidance document. The water plan goal of conservation, education, and the use of excess surface water in a conjunctive-, sustainable-use pumping scenario has proven to be most efficient. However, water resources issues have shifted over the last 20 years, and it is widely recognized that this plan should be updated. The ANRC is working closely with the US Geological Survey, Water Sciences Center in Arkansas, CDM Smith and Associates, as well as with other State, Federal, and stakeholder groups to develop the updated water plan, which is scheduled for completion in November of 2014. This plan is based on an evaluation of the existing water plan and programs, and an update of the State's water demands, availability, and gaps. A strong emphasis is placed on forecasting, sustainable yield, and the use of groundwater flow and optimization modeling. Once completed, the Arkansas Water Plan will be the State's water resources guidance document through the planning horizon of 2050, though updates to the plan are recommended on a more frequent basis. This plan will be a comprehensive evaluation and planning document considering intrastate and interstate issues and recommendations.

Abstract 28

How to Establish a Source Water Collaborative for Drinking Water Utilities: A Case Study of the New England Watershed Managers (NEWMAN) Collaborative

Kira Jacobs, EPA Region 1

The City of Manchester (NH) Water Works and EPA Region 1 have partnered to establish a regional collaborative for helping New England surface water suppliers address the myriad of challenges they face.

This session will address the following questions:

- What IS a source water collaborative?
- How do I establish one in my watershed/county/state/region?
- Where can I find information and access resources in order to develop a collaborative?
- Why is the NEWMAN Collaborative successful?

The national Source Water Collaborative (http://www.sourcewatercollaborative.org/) is developing resources for individuals interested in launching source water collaborative at the state, regional, and local levels. This online resource will include tips and materials for identifying members, initiating a collaborative, managing the first few years, and maintaining momentum.

This presentation will also discuss the unique approach used to develop a source water collaborative for drinking water utilities. Protecting the drinking water supply through maintenance of a forested buffer around lakes, rivers, streams, and wetlands is a priority to many water suppliers. However, the land management of these properties comes with many costs and many challenges. Unfortunately, growing populations and demand for recreation near urban areas have caused additional pressure on the land around surface water supplies. These challenges are dealt with in a variety of ways and have their shares of successes and failures.

This talk will describe a successful regional model for protecting water supply watersheds, the New England Watershed Managers (NEWMAN) Collaborative. The NEWMAN Collaborative focuses on four areas: 1) Forestry; 2) Land Management; 3) Land Acquisition; and 4) Recreational Access. The 15 members of the NEWMAN Collaborative include the largest surface water suppliers in New England and collectively
represent 4 million of the 16 million population served by public water in the region.

Abstract 29

Wisconsin Groundwater & Nutrients

Jill Jonas, Wisconsin's Bureau of Drinking Water and Groundwater.

Jill Jonas directs Wisconsin's Bureau of Drinking Water and Groundwater. The bureau implements both the Public and Private Drinking Water Programs along with the Groundwater and Water Use Programs. Jonas presently serves on the National Drinking Water Advisory Council and the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Administrators. She has served as president of the Association of State Drinking Water Administrators and co-chaired the Conservation Committee of State and Provincial representatives for the Council of Great Lakes Governors' Water Conservation and Efficiency Initiative.

Nitrate is the most pervasive groundwater contaminant in Wisconsin, with risk of serious, acute illness in infants and chronic effects for everyone who drinks nitrate-contaminated water.

Discussion will focus on various efforts including:

1. Wisconsin's nitrate project--- a) Purpose – See if we can attain safer drinking water through management practices that make the most efficient use of nitrogen; b) Principal activities; and c) Process;
2. Integrating groundwater and drinking water issues within the State Nutrient Management Plan; and
3. Opportunities for State and Environment Protection Agency integration of the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) programs to protect and restore the quality of water resources---a) Identifying specific prioritized areas where CWA and SDWA resources can be used jointly to prevent and mitigate contamination; b) addressing nitrogen delivery within the Mississippi River Basin TMDL benefiting public water systems; c) addressing source water protection in the state's nutrient reduction strategy; d) routinely analyzing for geographic overlap between nutrient trading and source water areas; and e) identifying other CWA and SDWA opportunities to integrate source water protection.

Abstract 30

Creating Grassroots Solutions to the Collection of Unused Pharmaceuticals

John Hoagland, Missouri Rural Water Association

John Hoagland is the Executive Director of the Missouri Rural Water Association representing nearly 900 water and wastewater utilities within the state of Missouri. He holds a Class "A" water certificate with the state of Missouri. His start in the water utility business came at the age of 16 when he was hired as summer help during a system expansion project in his county and eventually found him solvent welding PVC pipe for the project. (Whenever the inspector was not around) He eventually became manager of the water district holding that position for 10 years. In his 24 year career with Missouri Rural Water he has held the position of GECC Field Representative, State Circuit Rider, Deputy Administrator, and eventually assumed the position of Executive Director in 2007. Last year in 2012, Missouri Rural Water was recognized as National Rural Water's State Association of the Year.

The detectible presence of pharmaceutical drugs both of human and agricultural nature is an increasing problem for both surface and ground waters. While these agents can be removed by treatment, the expense and technical expertise involved is considerable. A better solution is the re-education of the public as to the problem, the proper disposal methods of unused pharmaceuticals, and the implementation of easy, convenient methods of disposal. Many challenges are faced. Chain of custody issues, ease of simply "flushing" medications, institutional barriers, and the proper

destruction of collected medications all create challenges to the problem. Using resources provided by FSA Source Water Specialists, EPA Source Water Specialists, and internal funding, Missouri Rural Water has partnered with numerous water utilities to create a grassroots effort to collect and properly dispose of unused pharmaceuticals. To date, MRWA systems have collected nearly 5 tons of unused medications at sites sponsored by MRWA.

Abstract 31

EPA's Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

Jeanne Briskin, USEPA

Jeanne Briskin is responsible for leadership, planning, coordination, and oversight of EPA's research related to hydraulic fracturing. In her 30 years' experience at EPA, Jeanne has also led programs and policy development at EPA in the areas of drinking water, climate change, stratospheric ozone layer protection, pesticides, and hazardous waste. Jeanne received her BA in Chemistry and Environmental Studies from Northwestern University and MS in Technology and Policy from the Massachusetts Institute of Technology.

At the request of Congress, EPA is conducting a study to assess the potential impacts of hydraulic fracturing on drinking water resources and to identify the driving factors that may affect the severity and frequency of such potential impacts. EPA has designed the scope of the research around five stages of the hydraulic fracturing water cycle: water acquisition, chemical mixing, well injection, produced water and flowback, and wastewater treatment and disposal. This talk will provide an update on EPA's work to answer the study's research questions, and our efforts to engage stakeholders in the research.

EPA is analyzing existing data, creating computer models, performing laboratory studies and toxicity assessments, and examining case studies. EPA released a progress report on the study in December 2012 and expects to release a draft report of results in late 2014. The progress report and detailed information about the study can be found on the study's website at www.epa.gov/hfstudy.

Abstract 32

RBDMS and the National Oil & Gas Gateway: Integrating Data to Manage Environmental Programs

Paul Jehn, GWPC

The Risk Based Data Management System (RBDMS), installed in 23 states contains millions of data points that help oil, gas and UIC managers conduct inspections, issue permits, analyze trends and track environmental compliance. These data can be viewed at the individual well level or be combined on a statewide or interstate basis. Available data include geology, well construction, injection, production, inspections, permits, some states include water quality. Available tools to view oil, gas and water data include: state RBDMS data miner sites, under development are an enhanced wellbore diagramming tool, smartphone wellfinder app and the national oil and gas gateway. States and the GWPC have teamed up with the Energy Information Administration to provide more accurate and timely information on the nation's oil and gas production and energy reserves. Emergency responders will be able to use these tools to locate oil, gas and injections well in the event of an emergency. The wellbore tool assists regulatory agencies in assuring proper well designs.

Abstract 33

Compiling and Interpreting Class II Injection Well and Seismicity Data in the U.S. Mid-Continent to Identify Zones of Induced Seismic Hazard

Matthew Weingarten, University of Colorado-Boulder

Matthew Weingarten is a doctoral candidate in the Department of Geological Sciences at the University of Colorado-Boulder. His research focuses on the interaction between fluids and earthquakes with specific emphasis on understanding injection-induced seismicity at the site-specific, basin-scale and national-scale. He holds a B.S. in Geology & Geophysics from the University of Wisconsin-Madison and is currently supported by a fellowship from the USGS John Wesley Powell Center for Synthesis and Analysis.

Academic and industry communities have known since the early 1960s that fluid injection can trigger or induce earthquakes. Over the past half century, injection-induced seismicity has been a relatively rare phenomenon in U.S. mid-continent, but a rapid increase in seismicity starting in 2011 has drawn increased scrutiny. To better understand the scope and scale of injection-induced seismicity I have compiled a national database of Class II injection wells and seismicity in the U.S mid-continent. Gathering data on Class II injection at the national scale is a difficult task due to the state-by-state monitoring of these wells. Homogenization of data collection and dissemination would greatly increase the ability of the research and regulatory communities to establish mitigation strategies and sites for safe injection of waste fluids. With the use of spatial and temporal analysis, the combined database is able to identify areas of documented induced seismicity from the past as

well as areas of potentially undiscovered induced seismicity. In addition, the database highlights the fact that several basins in the U.S. exhibit no induced seismicity to date despite large numbers of injection wells. Going forward, the scientific community needs to develop an understanding of the differences in geologic, hydrogeologic and geomechanical setting between basins which do and do not exhibit induced seismicity.

Abstract 34

Factors Affecting Public-Supply-Well Vulnerability to Contamination: Understanding Observed Water Quality and Anticipating Future Water Quality

Sandra M. Eberts U.S. Geological Survey

Sandra Eberts is a Professional Hydrogeologist with the U.S. Geological Survey (USGS) where she has worked for more than 25 years. She is Coordinator of the USGS National Water-Quality Assessment Program, Groundwater Modeling and Mapping Team, which uses models to evaluate, extrapolate, and forecast water quality in drinking-water wells (domestic and public supply) and in groundwater discharging to streams across the Nation.

As part of the U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program, a study was conducted from 2001 to 2011 to shed light on factors that affect the vulnerability of water from public-supply wells to contamination. The study was designed as a follow-up to earlier NAWQA studies that found mixtures of contaminants at low concentrations in groundwater near the water table in urban areas across the Nation and, less frequently, in deeper groundwater typically used for public supply.
The vulnerability of the water from public-supply wells to contamination is a function of contaminant input within the area that contributes water to a well, the mobility and persistence of a contaminant once released to the groundwater, and the ease of groundwater and contaminant movement from the point of recharge to the open interval of a well. The following measures, which are described in newly released USGS Circular 1385, are particularly useful for indicating which contaminants in an aquifer might reach an individual public-supply well and when, how, and at what concentration they might arrive:

- Sources of recharge—Information on the sources of recharge for a well provides insight into contaminants that might enter the aquifer with the recharge water and potentially reach the well.
- Geochemical conditions—Information on the geochemical conditions encountered by groundwater traveling to a well provides insight into contaminants that might persist in the water all the way to the well.
- Groundwater-age mixtures—Information on the ages of the different waters that mix in a well provides insight into the time lag between contaminant input at the water table and contaminant arrival at the well. It also provides insight into the potential for in-well dilution of contaminated water by unaffected groundwater of a different age that simultaneously enters the well.

Preferential flow pathways—pathways that provide little resistance to flow—can influence how all other factors affect public-supply-well vulnerability to contamination. Methods for recognizing the influence of preferential flow pathways on the quality of water from a public-supply well are presented in the Circular and will be discussed.

Abstract 35

Collecting Water Samples for the Determination of Dissolved Gas Concentrations

Dennis Coleman, Isotech Laboratories, Inc.

Dennis D. Coleman has spent his carrier specializing in the use of geochemical fingerprinting to differentiate gases from different sources. For 25 years he held different research and management positions at the Illinois State Geological Survey where he published numerous papers on gas identification using stable isotope analysis. In 1985 he co-founded Isotech Laboratories Inc., to provide analytical support for consulting activities related to gas identification. He served as President of that company until it was acquired by Weatherford International in 2011 and now holds the part-time position of Sr. Technical Advisor. Coleman received a BS in Chemistry and Geology from the Univ. of Wisconsin, an M.S in Geochemistry from the Univ. of Arizona, and a Ph.D. in Geochemistry from the Univ. of Illinois.

With the huge increase in onshore oil and gas exploration made feasible by horizontal drilling and fracking of shales, the need for accurate methods of monitoring dissolved gas concentrations in groundwater has greatly increased. Most gases of interest do not truly dissolve in water but instead simply partition themselves between the water phase and the gas. The method required for collecting water samples can vary depending on the gas concentration.

There are at least three methods currently being used for dissolved gas analysis. With the “headspace equilibration” method, a suitable bottle is completely filled with water and submitted to the laboratory. In the lab, some of the water is withdrawn with a syringe and replaced with helium forming a headspace. This method works well if the gas concentration is significantly below the saturation level. But if any gas is present at high enough concentrations to form bubbles, some gas will be lost while sampling and the amount of dissolved gas will be underestimated.
At least 2 different methods have been used for measuring dissolved gases when they exceed saturation at atmospheric pressure. With the “water displacement” method, a suitable container is filled with water and then inverted in a pail of water. A hose connected to the water supply is inserted into the inverted container such that any bubbles in the water will collect in the top of the container. This is a very imprecise method as the rate at which the gas escapes from the water can depend on the water flow rate, water temperature, size of orifice, and a host of other parameters.

A more precise and universally applicable method may be referred to as the “two phase” method. With this method both the water phase and any gas phase that forms are collected simultaneously. Newly developed sampling containers that are now becoming available, allow collection of samples by any of the above methods, using the same container. A review of gas solubility and a discussion of procedures for collection of water samples under different conditions will be included.

Abstract 36

Streamflow Depletion by Wells—Understanding and Managing the Effects of Groundwater Pumping on Streamflow

Leonard F. Konikow, Paul M. Barlow, and Stanley A. Leake

The authors all work for the U.S. Geological Survey. Lenny Konikow is a research hydrologist in Reston, VA. Paul Barlow is a hydrologist with the Office of Groundwater and located in Northborough, MA. Stan Leake is a research hydrologist in the Arizona Water Science Center in Tucson, AZ. Paul and Stan are co-authors of the recent USGS Circular 1376 on this same topic.

Groundwater withdrawals can lead to a reduction in streamflow, affecting both human uses and ecosystems. The first clear articulation of the effects of groundwater pumping on surface water was by the well-known USGS hydrologist C.V. Theis. In a paper published in 1940 entitled "The Source of Water Derived from Wells," Theis pointed out that pumped groundwater initially comes from reductions in aquifer storage. As pumping continues, the effects of groundwater withdrawals can spread to distant connected streams, lakes, and wetlands through decreased rates of discharge from the aquifer to these surface-water systems. In some settings, increased rates of aquifer recharge also occur in response to pumping, including recharge from the connected surface-water features. Associated with this decrease in groundwater discharge to surface waters is an increased rate of aquifer recharge. Pumping-induced increased inflow to and decreased outflow from an aquifer is now called "streamflow depletion" or "capture." Groundwater discharge is a significant component of streamflow, with groundwater contributing as much as 90 percent of annual streamflow volume in some parts of the country. In order to effectively manage the entire water resource for multiple competing uses, hydrologists and resource managers must understand the effects (magnitude, timing, and locations) of ground-water pumping on rivers, streams, springs, wetlands, and groundwater-dependent vegetation.

Abstract 37

Preventing New Groundwater Pollution from Old Oilfield Areas

Patricia Billingsley, Brownfields Manager, Oklahoma Corporation Commission; John Harrington, Director of Water Resources, Association of Central Oklahoma Governments

In the past 16 years the Corporation Commission has responded to many well water pollution complaints, and has taken over 2,000 ground water samples from wells, springs, borings and monitoring wells across the state. Corp Comm has worked with the Association of Central Oklahoma Governments and others to define and map the pollution sources, and seek solutions. We have found numerous groundwater pollution problems related to old (first drilled pre-1980, often abandoned) oil and gas fields.

In this talk we will show a few maps of where this groundwater pollution has been found and how it is occurring, but the main focus will be on legal and regulatory issues to help reduce risks from these old oilfield Brownfields and prevent additional groundwater pollution in the future. For example, since we have determined that one way near surface soil/perched groundwater pollution can be spread down into an aquifer is via inadequately sealed domestic water wells, we are working with the Oklahoma Water Resources Board to enact new state rules for water well construction in old oilfield areas. We are also working with Oklahoma’s Councils of Government and city planners to ensure that when there is new construction proposed in former oil and gas fields, the potential for pollution will be taken into consideration. Cities and towns can incorporate protective requirements into their development rules.

Patricia Billingsley manages the Oklahoma Corporation Commission’s Brownfields program. In addition, she handles Clean Water Act related activities for the Commission, represents the Commission on many interagency work groups regarding water quality, and oversees many oilfield remediation sites for the Oil and Gas Division, Oklahoma Corporation Commission. She has 16 years experience overseeing the assessment and remediation of brine and/or petroleum impacted exploration and production spill sites for the Commission, and another 10 years of environmental remediation and surface/ground water environmental work in Oklahoma, Massachusetts and Texas. She also worked in the oil and gas industry in Oklahoma for 7 years. Patricia has a B.A. degree in Geology from the University of Maine and an M.S. in Geology (environmental emphasis) from the University of Oklahoma, 1992.

John Harrington is the Association of Central Oklahoma Government Director of Water Resources. John’s technical background is in the fields of hydrogeology and geophysics, and has a regional and planning perspective working with a regional council of governments. John has over twenty years experience as a hydrologist and geophysicist in Central Oklahoma, with fourteen years working specifically on the Garber-Wellington aquifer.

Mr. Harrington received his Bachelor of Science degree from the University of California at Davis, and his Masters in Geology at San Diego State University. As an ACOG staff member, John has had the opportunity to work with several counties and numerous municipal governments. His professional interests include mathematical modeling of all sorts, including developing groundwater, surface water and stormwater models.

Abstract 38

Technical Considerations Associated with Risk Management of Induced Seismicity in Waste-Water Disposal & Hydraulic Fracturing Operations

Kris Nygaard, ExxonMobil Production Company

K. J. (Kris) Nygaard is the Senior Stimulation Consultant at ExxonMobil Production Company, responsible for coordinating ExxonMobil's Upstream Fracturing Center of Excellence. Kris holds a B.S. in Mechanical Engineering, an M.S. in Aerospace Engineering, and a Ph.D. in Mechanical Engineering all from the University of Arizona. He is relied upon widely across ExxonMobil for his expertise in stimulation technology and applications to new and existing business opportunities; advises the R&D program at ExxonMobil's Upstream Research Company; and works closely with business units on technology strategy, deployment, and applications. He is a member of the Society of Petroleum Engineers and the American Society of Mechanical Engineers.

With growing public attention to the potential risk of seismicity induced by waste-water injection and hydraulic fracturing, there is a need for better understanding of the technical elements associated with induced seismicity and the subsequent implications associated with management of the potential risks.

In this presentation, the potential technical elements of induced seismicity risk are examined including probability and consequence. Potential probability elements include volume of injected fluid, formation characteristics, tectonic/faulting environment and operating experience. Potential consequence elements include physical damage, environmental impact, economic disruption, social or community impact and public disturbance.

A potential approach for risk characterization is then presented and includes the definition of risk zones. The risk zones can be considered relative to potential "stoplight" approaches associated with risk mitigation. Various options of potential mitigation methods are discussed, such as well planning, design and ground shaking monitoring. This potential risk characterization framework is applied to recent well activities that have been the subject of studies by the United States Environmental Protection Agency and by regulators in Canada and the United Kingdom, and also applicable to hundreds of thousands of hydraulic fracture treatments and to tens of thousands of injection wells.

The results presented clearly delineate important seismicity drivers, demonstrate the extremely low likelihood associated with such events and are consistent with the major conclusions published in a recent United States National Academy of Science comprehensive report on the subject. The information presented will help to further inform policy makers, regulators, oil and gas companies, and service companies of potential technical and operational elements to consider for assessing and/or managing the potential risks associated with induced seismicity from injection operations.

Abstract 39

Nebraska's Groundwater Management Plan for the Bazile Creek Area

Ryan Chapman and Marty Link - Nebraska Department of Environmental Quality

Ryan Chapman is the Wellhead Protection program coordinator with the Nebraska Department of Environmental Quality since 2009. He also administers many of the groundwater related Section 319 Non-Point Source grants that the State awards annually. Ryan holds a Bachelor's degree in Agricultural Sciences and Natural Resources and from the University of Nebraska Lincoln, and Bachelor's and Master's degrees in Landscape Architecture from Iowa State University. His graduate work focused on urban groundwater, stream conditions, and landowner perceptions.

Marty Link has worked for the Nebraska Department of Environmental Quality since 1988. Her duties there have been in most aspects of both ground and surface water, budgeting, and working with EPA. She is currently the Associate Director of the Water Quality Division, essentially the Deputy Director. Ms. Link received her geology MS degree from UN-L in 1989, BS in geology from University of Kansas in 1982, and a BA in science education from University of Iowa in 1979. She is a licensed professional geologist in Nebraska.

Nebraska's 23 Natural Resources Districts (NRDs) have a unique set of authorities to manage their natural resources – including irrigation water management, fertilizer reporting and limits, well permitting, and the ability to require other Best Management Practices. They also have taxing authority and are led by locally elected Boards.

The Bazile Creek area, in northeast Nebraska, is 756 square miles, encompassing parts of three counties and four different NRDs. There are ten communities (nine PWS) and a population of approximately 7159, which is ~30% rural. As in the vast majority of Nebraska, the source of drinking water is groundwater. Elevated nitrates in groundwater have plagued the residents for many years – the City of Creighton has had RO treatment for nitrates since 1993.

One of the barriers to effectively addressing the groundwater nitrate issue has been the area's division between four different NRDs and varying approaches to groundwater management. In 2011, the four NRDs, the Nebraska Department of Environmental Quality, and the Nebraska Association of Natural Resources Districts convened a Community Based Watershed Planning approach to

address the high nitrate issue. The result was an "EPA – Alternative Nine Element Styled" Groundwater Management Plan in 2013, that was approved by EPA Region 7 and Headquarters as eligible for the newly created category of "Project" funds from the Clean Water Act Section 319 Program Guidance. Traditionally, EPA has only approved plans aimed at surface watershed restoration for "Project" funding (as opposed to "Program" funding, which also must pay for the majority of state staff and any education or groundwater projects).

The Bazile Groundwater Management Plan has both short and long term objectives for addressing farm operator education, nutrient management, and other appropriate measures to address nitrate concentration reduction in groundwater.

Abstract 40

Impacts of Potential Future Droughts on ERCOT Thermoelectric Generation

Y. Eugene Yan, Argonne National Laboratory

Dr. Yan is a principal hydrogeologist in Argonne's Environmental Science Division, leading large-scale, watershed-based hydrology research projects for the Upper Mississippi River and Ohio River Basins in the United States and for several water resource regions in Iraq and Egypt. His current research focuses on evaluating regional impacts of climate change on water availability and alternative energy development, quantifying renewable water resources in a large-scale watershed for sustainable development, and characterizing/simulating complex hydrologic systems and associated contaminant migration.

John Gasper, Argonne National Laboratory, Argonne, IL; Mark Wigmosta, Pacific Northwest National Laboratories, Richland, WA; Vincent Tidwell, Sandia National Laboratories, Albuquerque, NM; Carey W. King, University of Texas at Austin, Austin, TX

In 2011, the state of Texas experienced the worst single-year drought on record. This recent extreme climate event raised questions as to how future droughts might impact the operations of the Electric Reliability Council of Texas (ERCOT). To improve our understanding of potential risks of electricity generation curtailment due to drought, an impact analysis was performed with a series of modeling tools, and alternative water resources were evaluated by compiling data from various sources. This presentation will demonstrate the predicted effects of potential future droughts on power generation at the local level of the U.S. Geological Survey (USGS) 8-digit watersheds and power plants, as well as possible alternative solutions.

The study identified three potential drought scenarios (single- and multiple-year droughts) based on historical drought records and projected climate change from the Geophysical Fluid Dynamics Laboratory global climate model and the Parallel Climate Model, for greenhouse gas emission scenarios A1B, A2, and B1 defined by the Intergovernmental Panel on Climate Change. The potential impacts under these three drought scenarios were evaluated with a hydrologic model constructed for the Texas-Gulf river basin. The Texas-Gulf hydrologic model incorporates competitive water uses, climate forcing data corresponding to each of the drought scenarios, and 125 reservoirs that are currently supporting water withdrawal for various sectors and cooling water for power generation. The hydrologic responses to drought scenarios predicted for each of the USGS 8-digit watersheds provided a basis for assessing whether power plants potentially at risk of being of de-rated and watersheds are vulnerable to droughts. In addition, a decision support system tool was developed to investigate alternative water resources (e.g., industry discharges and groundwater) and their costs. The key findings will help to improve understanding of the spatial distribution of power plants at risk and of vulnerable watersheds, as well as the scale of potential reduction in electricity generation. Beyond impacts to the existing fleet of power plants, the results also provide insights into the siting of future power plants and the availability of alternative water resources (wastewater and brackish groundwater) and their costs, in support of ERCOT's long-term transmission planning.

Abstract 41

The Social Media EXPLOSION: The Busy Professional & Getting Measurable Results Using LinkedIn

Crystal Washington – Social Media Marketing Strategist

Crystal Washington – Hired by companies including Google, Microsoft and GE, companies in the USA, Africa and Europe book Crystal Washington when they want their teams to take action online! Crystal is known for her ability to take complex Web and social media topics and make them easy to understand and accessible for everyday people and small business owners. As the owner of CWM Enterprises and cofounder of Socialtunities, a social media instructional brand aimed at training everyone from Gen Y's to Baby Boomers in strategically using social media, Crystal educates consumers on the practical applications of social media networks like Facebook, Twitter, LinkedIn and YouTube.

Crystal hosts a weekly technology segment on Houston's Fox television affiliate and has appeared in Black Enterprise Magazine, Essence and CareerBuilder.com. She has been interviewed by ABC, NBC, FOX, CBS and numerous radio stations and magazines around the globe as a social media expert.
Crystal is the author of the new book, The Social Media Why: A Busy Professional's Practical Guide to Using Social Media Including LinkedIn, Facebook, Twitter, YouTube, Pinterest, Google+ and Blogs for Business.

Abstract 42

Evaluating Nitrates in the Ambient Probability Based Network of Community Water Supply Wells

Rick Cobb, Illinois EPA

Mr. Cobb has been employed with the Illinois Environmental Protection Agency for 28 years working with stakeholders at the federal, State, and local level to plan and implement groundwater and source water protection. Since 1985, he has worked on the development of legislation and regulations to protect and restore groundwater. He has also served as a witness in enforcement, legislative, and Illinois Pollution Control Board cases. Mr. Cobb received a *Groundwater Science Award* from the Illinois Groundwater Association in 1987, and a *Drinking Water Hero Award* from the United States Environmental Protection Agency at their Safe Drinking Water Act 25-Year Anniversary in Washington D.C. on December 16, 1999.

For the calendar year 2011, the Illinois EPA developed an inorganic chemical (IOC) Trend Monitoring Network consisting of three trend subsets with ten wells within each group. The 30 CWS wells were selected from the Probabilistic Sampling Network which provided wells with a history of IOC results. The subsets included Nitrate Trend wells. Each well was sampled once every two months at approximately the same time of the month to maintain an even temporal interval between sampling events. When available, the static and pumping water levels were obtained. The groundwater monitoring data was analyzed to determine if there were any fluctuations in the water chemistry during the next reporting period. The *Nitrate Trend* wells are distributed throughout the state and are largely situated within sand and gravel aquifers that are more susceptible to nonpoint source contamination. These wells were selected based upon their history of nitrate detections which ranged from an average concentration of 4-11 mg/L (milligrams per liter). A majority of the wells selected for the Nitrate Trend network are located within or directly adjacent to agricultural fields and are less than 100 feet in depth. Most of the sampling of the nitrate network spanned from January thru November of 2011. Some sampling of network wells were started later, one in February and one as late as June of that year. An important objective of the network was to collect six samples over the course of a year, one every two months, so all sampling events were considered valid for this network. The concentrations of nitrate found in a majority of trend wells remained the same for the calendar year of 2011, in general fluctuating one or two milligrams-per-liter throughout the overall sampling cycle.

Abstract 43

Class III In-Situ Uranium Injection Wells and Aquifer Exemptions in Texas: Multiple Levels of Permitting Protection for USDWs

David Murry, P.G., Lorrie Council, P.G., and Dale Kohler, P.G. Texas Commission on Environmental Quality (TCEQ)

David Murry (Primary Author) is a Senior Geologist and Project Manager in the Underground Injection Control (UIC) Permits Section of TCEQ. David reviews applications for Class I and Class III injection wells, and provides geologic assistance to other agency employees. He is a Texas Licensed Professional Geoscientist with 35 years of experience oil and gas exploration, minerals exploration, industrial and hazardous waste permitting, and UIC permitting. David received his B.S. and M.S in Geology from the University of Texas at El Paso.

Lorrie Council (Secondary Author) serves as the UIC Permits Section Manager for the TCEQ. She manages professional geologists and engineers who review applications and write permits and authorizations for Class I, III, IV, and V injection wells in Texas. Ms. Council has 21 years of environmental consulting experience in groundwater protection and restoration and 11 years of Texas state government experience covering UIC permitting, waste disposal, and coastal erosion response. Ms. Council earned a B.S. in Geology from the University of Oklahoma and is a licensed professional geologist in Texas and Arizona.

Dale Kohler (Secondary Author) is currently the Executive Assistant to the Executive Director at the Texas Commission on Environmental Quality (TCEQ). Dale has worked at the TCEQ or its predecessor agencies for over 30 years on a variety of programs including UIC Class III permitting and enforcement, field operations, emergency response, and Homeland Security. Dale earned a B.S. in Geology from the University of Texas and is a licensed professional geologist in Texas

Commercially producible uranium ore is found in the shallow gulf coastal plain sedimentary deposits in South Texas. While historic uranium mining used traditional surface mining techniques, more recently, uranium has been extracted using in-situ recovery techniques using injection and extraction wells. In-situ mining is regulated in part through the Underground Injection Control (UIC) Program, which is administered by the Texas Commission on Environmental Quality (TCEQ). The agency's Class III UIC regulatory program for in-situ uranium recovery is conducted using a comprehensive permitting process, in order to ensure that the in-situ extraction of uranium is conducted in a manner that is protective of Underground Sources of Drinking Water (USDWs). Operators of proposed in-situ recovery operations apply for base mine permits and production area authorizations, as well as aquifer exemptions, which are necessary because the ore body is present within shallow formations that often contain relatively fresh groundwater. The permitting process is an extensive, stepwise process that includes multiple public notification and comment opportunities. Permits that are granted include a number of protective provisions, such as: 1) development of pre-mining groundwater quality baselines, 2) implementation of a monitoring well program within, adjacent to, and above the mineral production zone, 3) response and containment requirements in the event of a mining fluid excursion, and 4) post-mining groundwater restoration. Aquifer exemptions are used as an additional protective measure to ensure that groundwater in the mine area permit is not used as a source of drinking water.

Abstract 44

What we know, what we don't know and what we need to know about "Deep" Groundwater

Mike Wireman, US EPA Region 8

Mike Wireman currently serves as a National Ground-Water Expert for US EPA Region VIII in Denver, CO. In this position he provides scientific and technical support to EPA programs, other Federal agencies, International programs and ground-water protection / management programs in several western states. He has extensive experience in hydrogeology and remediation of hardrock mine sites, hydrology of mountain watersheds, DNAPL sites, fractured rock settings, nutrients in ground water, ground-water monitoring, ground-water sensitivity /vulnerability assessment, and source-water / wellhead protection. His position incvolves working closely with policy makers, decision makers and attorneys. He also teaches classes for the National Ground -Water Association and Geological Society of America and has developed and taught workshops in Eastern Europe and Middle East. He serves as an advisor to the World Bank and has significant international experience in Eastern Europe, the Middle east and China. He has served numerous times as an expert witness and advisory witness in federal court, State court, State Water Quality Control Commission and State Water court.

The term "deep" groundwater is poorly defined and to some extent in the eye of the beholder. There is growing interest in understanding groundwater beneath the typical depths of today's withdrawals for water supply. Shale oil and gas development, carbon sequestration, use of deep groundwater as a resource, underground injection of waste fluids, locating geologic repositories for nuclear waste, and geothermal energy all require an increasing knowledge about deep groundwater. Currently not enough is known about the hydrogeology of deep groundwater resources because of their limited use and the relatively high cost and technical challenges to characterize and develop them. The evolution of deep groundwater, its movement and its chemical behavior is poorly understood. For decades there has been prevailing paradigm that groundwater at depth is stagnant or very slow moving with poor hydraulic connection to shallow aquifers or surface water. It is increasingly recognized that deeper groundwater systems can be dynamic and influenced by both surface and crustal processes.

As availability of water for human and ecological needs becomes more critical, deeper groundwater will become a more realistic potential future water supply. TDS values less than 1000 mg/L have been reported for groundwater developed from carbonates and sandstones in deep sedimentary basins. The number of deep (> 2000 feet) public water supply wells increased significantly in the western US in the past two decades, including at least one public supply well greater than 8000 feet deep. During this time, desalination costs have dropped through improvements in membrane technology. Clearly, if deep sedimentary formations have well yields sufficient for public water supply, they may be developed sometime in the future to augment or replace existing water supply sources, thus requiring greater protection as potential future water supply. It is important that increased effort be made to more adequately characterize deep aquifers and the potential for development.

Abstract 45

Nutrients Roundtable Discussion

Moderators: John Barndt, DE; Sonja Massey, AL; Marty Link, NE

The nutrients roundtable is a chance for states and partners to share challenges, success stories, and other experiences related to dealing with nutrients in groundwater. Discussion will include prevention and remediation, working with non-regulatory partners, and options for the future. GWPC will give a brief overview of the draft Nutrients Section of the Ground Water Report, and will utilize feedback from participants for the next iteration of the section.

The dictionary defines "nutrient" as a substance that provides nourishment essential for the growth and maintenance of life." Yet high concentrations of nutrients, specifically nitrogen and phosphorus, in streams, lakes, and groundwater are having diverse, far-reaching, and costly impacts on public health, aquatic ecosystems, recreational access, and the U.S. economy. While cost data associated with these impacts is limited, particularly for the groundwater environment, what we do know presents a sobering and compelling reason for urgent and effective action.

Nutrient contamination matters; it has the potential to become one of the costliest and most challenging problems we face. Indeed, the very nutrients needed to make plants grow; that are natural components of soil and aquatic ecosystems; and, with regard to nitrogen, the most abundant element in the air we breathe, are also highly problematic drinking water and aquatic habitat contaminants.

Abstract 46

Russ Florence President and COO Schnake Turnbo Frank

With experience in journalism, nonprofit communications, corporate leadership and public relations counseling, Russ Florence brings a multi-faceted, balanced perspective to his clients. Florence's credentials include crisis communication, reputation management, media relations and strategic planning.

Florence joined Schnake Turnbo Frank in 2001, and since has advanced to president and chief operating officer. Florence is also partner of the firm along with Becky Frank and Aaron Fulkerson. In this role, he takes the lead on many of STF's clients and provides guidance and counsel to many more.

Before joining the firm, Florence managed corporate communications for the Bank of Oklahoma. A former editor of the Jenks Journal, he has been recognized by the Oklahoma Press Association for outstanding feature writing. He also was marketing manager for the Tulsa Area United Way, where he coordinated the award-winning Day of Caring, a citywide volunteer project.

Florence works with organizations tied to various areas of the Tulsa community including the Tulsa Ballet and Oklahoma Center for Community and Justice. He also is active in professional organizations, having served as president of the Tulsa Press Club.

Abstract 47

Induced Seismicity from Fluid Injection and Draft Best Practices

Austin Holland, Seismologist, Oklahoma Geological Survey, Univ. of Oklahoma

Austin Holland is a research seismologist with the Oklahoma Geological Survey (OGS). He has been with the OGS since January of 2010. Since arriving at the OGS Austin has worked on issues of triggered seismicity. He is currently finishing his Ph.D .at the University of Arizona where his focus was primarily on measuring deformation of the Earth using high precision GPS and earthquake seismology. He received his Masters of Science in Geophysics from the University of Texas at El Paso, and his Bachelors of Science in Geology from the University of Idaho. He worked at the Department of Energy's Idaho National Laboratory for 12 years in the seismic monitoring program.

Induced seismicity from fluid injection has become a greater concern over the past few years with a significant number of new possible cases. The causes of induced seismicity are generally well known and include either the diffusion of pore pressure or altering the stresses within the subsurface. Induced seismicity can occur when faults are already near failure and pore pressure is increased or the deviatoric stress is increased. We will examine some of the features of induced seismicity related to pore pressure diffusion from different case examples of induced seismicity. These observations include the potential for larger earthquakes associated with larger injection volumes, the evolution in time of the spatial distribution of earthquakes, and their temporal relationship to injection parameters. Well-known risk factors for injection induced seismicity include proximity to known faults, especially those already critically stressed, existing state of stress and pore pressure within the reservoir, and high injection pressures or volumes. These observations and a number of potential cases of induced seismicity in Oklahoma have caused the Oklahoma Geological Survey to develop a draft set of best practices regarding fluid injection induced seismicity. These best practices will be summarized.

Abstract 48

John Veil, Veil Environmental, LLC

John Veil founded Veil Environmental, LLC, a consulting practice specializing in water issues affecting the energy industries, upon his retirement from Argonne National Laboratory in January 2011. Mr. Veil spent more than 20 years as the manager of the Water Policy Program for Argonne National Laboratory. Before joining Argonne, Mr. Veil managed Maryland's regulatory programs for industrial wastewater discharge and injection and served as a faculty member of the University of Maryland. Mr. Veil has degrees in Earth and Planetary Science, Zoology, and Civil Engineering. Mr. Veil has been recognized by the Society of Petroleum Engineers as a Distinguished Lecturer in 2008-2009 and 2013-2014 and as the recipient of the 2009 international award for Health, Safety, Security, Environment and Social Responsibility. Mr. Veil has published many articles and reports and is frequently invited to make presentations on environmental and energy issues.

Abstract 49

Joe Tiago, US EPA Office of Groundwater and Drinking Water

Mr. Tiago holds a Bachelor's degree in Chemistry, Master of Science in Material Chemistry, and a Master of Public Health degree in Epidemiology and Environmental Health. Mr. Tiago spent seven years working as a chemist with the Texas Department of Health and the Texas Commission on Environmental Quality where he analyzed drinking water, air and other environmental samples. In

2008 he joined the US Environmental Protection Agency Headquarters in Washington, DC. He currently works in the Underground Injection Control Program, developing regulations for ground water. He worked on various drinking water issues associated with Geologic Sequestration, Hydraulic Fracturing, Class V mine backfill wells, mountaintop mining, and Aquifer Exemptions.

Abstract 50

Nutrients and Ohio's Public Water Systems

Michael Eggert, Ohio EPA

Ohio's public water systems face considerable challenges dealing with nutrient related effects to raw water sources. For public water systems using surface water sources, these nutrient related contaminants may be considered direct (nitrate) or indirect (e.g. cyanobacteria and associated toxins, disinfection byproducts). Public water system's using ground water also face nutrient source water quality issues for systems with water supply wells located in sensitive hydrogeologic settings. Removal of nitrates, cyanotoxins, taste and odor compounds, and disinfection byproducts place an economic burden on many Ohio communities resulting in increased capital expenses and annual operating costs. Case examples with cost estimates will be presented for a number of public water systems.

Michael Eggert is an Assistant Chief, Division of Drinking and Ground Waters, Ohio Environmental Protection Agency. Michael oversees the State's Ground Water Quality Characterization Monitoring Program, Underground Injection Control Program (Class I and V), and the Source Water Assessment and Protection Program. Michael received his B.S. in Natural Resources with an emphasis in Water Resources from The Ohio State University.

Abstract 51

Regulatory Framework to Promote Carbon Capture Utilization and Storage

Bob Van Voorhees, Carbon Sequestration Council

Bob Van Voorhees is the Manager of the Carbon Sequestration Council, a multi-industry association formed to provide a forum for inter-industry communication around key issues of carbon capture and sequestration (CCS). The Council works to promote policies, legislation and regulatory frameworks that foster the use of anthropogenic CO2 for enhanced oil recovery (EOR) as well as the early use and commercial deployment of geologic sequestration (GS) as a means of addressing greenhouse gas mitigation. Bob has practiced law in the environmental, safety, and health field since the early 1970's. Over the past twenty-five years he has represented individual companies in the chemical, petroleum, commercial waste management, uranium recovery and other industries in dealing with regulatory and legislative issues relating to underground injection control (UIC). The GWPC presented its Award of Excellence in Ground Water Protection to him in 1996 for his outstanding contribution in the development of sound national regulations for underground injection control. He also serves as Manager of the Underground Injection Technology Council.

In June 2013 President Obama issued his Climate Action Plan calling for "steady, responsible action to cut carbon pollution" and pledging the United States to coupling action at home with international leadership to combat global climate change. The President announced that the US will continue working with international partners to advance the development and deployment of clean coal technologies, including carbon capture and sequestration technologies. In particular, he indicated that US support for public financing of new coal plants overseas will be limited to "facilities deploying carbon capture and sequestration technologies."

More recently, the U.S.-China Climate Change Working Group recommended five new action initiatives to "combat climate change and to promote low carbon development." Specifically, the Working Group recognized current efforts on carbon capture utilization and storage (CCUS) and recommended that China and the US "cooperate to overcome previous barriers to CCUS deployment by implementing several integrated CCUS projects in both countries." They noted a particular need "to encourage the transition from research to commercial-scale demonstration" projects. This presentation will examine where current efforts to deploy commercial-scale projects stand, identify past and potential barriers to deployment and recommend steps that can be taken to overcome those barriers to move toward achieving demonstration at scale across major emitting sectors.

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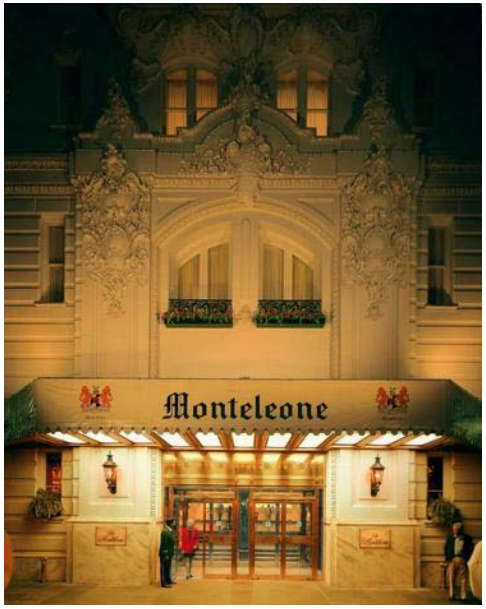

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