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Abstracts & Presenter Biographies

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Produced Water

Turning Produced Water from a Pain to an Asset: Optimizing Water Recycling

With increasing development and flourishing agriculture, the pressure is only increasing in constraining the availability of our local water resources. The oil and gas industry's rapid development is only escalating the pressure on water and other natural resources. The surging water handling challenges are clearly having a profound impact on unconventional oil and gas operators. Managing fluids in shale plays is a dynamic challenge requiring the integration of multiple factors such as changing water chemistry, variable flow rates, regulations and public concerns. Hence, the need for a dynamic fluids management tool is indispensable. The Water Research Foundation is working on various projects to develop a platform for successful industrial water reuse for beneficial purposes. There are various cases for water use and production with respect to different characteristics such as type of fracturing fluid used, formation being tapped into and spatial variability. Produced and flowback water is also being analyzed by their water quality to assess the level of treatment it requires before being reused for fracing. Public concerns about safety and protection of the environmental during hydraulic fracturing of unconventional shale resources is not limited to water supply issues but also include surface and ground water quality concerns, air quality impacts, and community impacts such as noise, truck traffic and road damage. While the focus is on water, there is also a need to understand the socio-economic impacts of produced water reuse in agriculture. In order to comply with current and future regulations, as well as economic viability, operators should optimize their water management strategies. Future research like this will help make the framework for successful reuse much easier, while also ensuring they address public concerns to safeguard long-term resource development.

Ashwin Dhanasekar | Research Manager | The Water Research Foundation

Ashwin Dhanasekar is a Research Manager at The Water Research Foundation handling Energy Management projects. Prior to WRF, he was a Research Scientist at Colorado State University and former Assistant Director for the Center for Energy-Water Sustainability at the Energy Institute at CSU. He has over 6 years of experience working in the Water-Energy sector primarily focusing on integrated water management, climate change and produced water management in the oil & gas industry.

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Leveraging Economic Models to Minimize Challenges and Create Opportunities for Effective Produced Water Management

Produced water presents a host of challenges and opportunities for oil and gas operators developing onshore fields. Water supply and disposal issues affect each stage of oil field development and operation. Sourcing water and production of produced and flowback water have important implications on water availability and unique environmental risks. Treatment can enable produced water reuse, minimizing volumes requiring removal using saltwater disposal wells and attenuating subsequent induced seismicity risk. Unfortunately, all produced water decisions come with costs. The cost of water treatment and re-use on a per-well or small area basis can be prohibitive, making saltwater disposal wells appear as a reasonable alternative.

It is difficult to compare options on an equal basis and arrive at appropriate solutions to manage produced water safely, efficiently, and cost-effectively in onshore operations with this limited scope. There is advantage to considering water as a valuable resource and considering water management decisions on a whole-of-asset basis considering all interactions in a water cycle. Doing so can enable operators to arrive at creative solutions that achieve technical, regulatory, environmental, and cost goals.

Evaluating produced water management options across a whole asset based on economics of the water cycle can enable oil and gas operators to relieve uncertainties and select solutions that not only achieve safety, regulatory, and cost objectives, but which drive toward water resource conservation as well. In this paper, GHD will use field specific data, such as well-to-well distance and travel time between them, to identify and compare produced water management options. GHD will use these indicators to demonstrate how alternative ways to assess produced water options, based on economics, can reveal creative management strategies that achieve a variety of goals at every stage of field development, including maximizing re-use and minimizing disposal.

Holly Churman | Lead Water/Wastewater Engineer | GHD

Holly Johnson Churman is a Lead Water and Wastewater Engineer with GHD in Houston, Texas. Ms. Churman is dedicated to helping municipal and industrial clients solve complex problems, specializing in water treatment technology and water management. She received the 2016 – 2017 International Desalination Association (IDA) Fellowship Award, and is an active member of the IDA's Young Leaders Committee and the Produced Water Society's Technical Committee. Ms. Churman is a licensed professional engineer in Texas and West Virginia, and has earned M.S. and B.S. degrees in Environmental Engineering and Science from Stanford University and the Massachusetts Institute of Technology, respectively.

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The Water Challenge Program Pilot - Helping Industry Advance Water Management Strategies

Energy development requires and yields significant amounts of water. Sometimes, this water can be recycled/reused. Sometimes it can't. Industry has been doing this a long time and knows the value of water. The Water Challenge (WC) Program was created recognizing that continuous improvement is essential for operational and environmental sustainability. The WC Program structure supports technical/operative water management strategies to reduce fresh water usage, increase produced water recycling/reuse, research beneficial reuse of produced water, and foster transparent water management reporting. By advancing these strategies (referred to as most applicable practices [MAPs]) and identifying opportunities to continuously improve operational performance, companies can increase shareholder value, enhance products/services for stakeholders and demonstrate sustainable water management commitments. Operators participate in the Water Challenge (WC) Program by implementing and transparently reporting water management strategies the company knows to be most effective/applicable. The Environmentally Friendly Drilling Systems (EFD) Program, managed by HARC, works with industry, academia, regulators, environmental organizations and other stakeholders to provide unbiased science addressing environmental/societal aspects associated with petroleum drilling and production operations. A Pilot of the Water Challenge was initiated in the Permian Basin in mid-2017 with the objective to identify improvements that could be made, provide feedback from industry and state regulators, and begin recruiting participation for the full Water Challenge Program.

Key results as of May, 2018 are:

- Major challenges revolve around logistics
- Opportunities include common infrastructure and regional collaboration
- Beneficial reuse of water is very important to industry and warrants further research.
- Definition of value.

By documenting most applicable practices, the WC Program promotes adoption of expanded, voluntary commitments to address water management while offering flexibility so companies can utilize paths that align with their capabilities and operating priorities. Deliverables from the Pilot include a comprehensive list of MAPs detailing methods being successfully utilized in the Permian Basin.

Andra Wilcox | Research Scientist, Energy Production | HARC

Andra Wilcox (MSc, PMP), a Research Scientist in Energy Production at HARC, works with the Environmentally Friendly Drilling Systems (EFD) Program, with the objective to provide unbiased science addressing environmental and societal issues associated with oil and gas development. She works with industry, universities, national laboratories and environmental organizations across the US to mitigate impacts of O&G. Miss Wilcox works with regional partners to address regional issues and optimize technologies to fit local needs. These partners have worked to incorporate such systems into operations in various shale plays, including the Eagle Ford, Permian, Niobrara, Uinta, Bakken, Utica, and Marcellus.

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Water for Hydraulic Fracturing - Use, Challenges and Solutions in Alberta

The oil and gas sector in Alberta, Canada has a long history of using produced water within its operations. For example, in 2016, over 85 per cent of the total water used for enhanced oil recovery (i.e., water floods) and thermal in-situ bitumen operations (i.e., oil sands) was from reused/recycled sources. For hydraulic fracturing operations, the Alberta Energy Regulator (AER) developed thorough fluid reporting requirements; this publicly-available data provides information on chemical use through FracFocus.ca, and offers an unparalleled understanding of how the industry is using water in that subsector - the use of produced water is lagging behind other subsectors and is consistently less than 10 per cent.

Policy and regulatory challenges have been identified as a main cause of the limited use of alternatives to nonsaline water for hydraulic fracturing, as opposed to economic factors. While various operators seek to use alternatives like produced water, lack of clear requirements for storage and transportation of such waters is currently a barrier to increased use. The AER has piloted several projects for using alternative waters for hydraulic fracturing, gaining information and learnings and demonstrating economic and environmental benefits. As a result, the AER is advancing efforts to provide regulatory clarity and direction in these areas. The goal is to develop risk-informed, outcome-based regulatory tools to help facilitate the use of poor quality waters for hydraulic fracturing operations, while maintaining its mandate of safe, efficient, orderly and environmentally-responsible development of hydrocarbon resources.

This presentation will discuss the AER's hydraulic fracturing water data, efforts to increase the use of alternatives to nonsaline waters, and some of the benefits realized through a water storage pilot project.

Michael Bevan | Senior Advisor, Water | Alberta Energy Regulator

Michael completed B.Sc. Geology and M.Sc. Hydrogeology degrees at the University of Waterloo. He worked for five years in the environmental consulting field before joining the Alberta Energy Regulator in 2007, where he still works as a Senior Advisor - Water.

Michael has gained broad exposure to groundwater concerns related to energy development, including conventional drilling/completions, coal and oilsands mining, in-situ bitumen production, and has a current focus on hydraulic fracturing. He represents the AER at various committees, professional conferences and public meetings and believes increasing awareness about groundwater is important to ensuring its protection and responsible use.

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Innovative Process to Recycle Shale Gas Produced Water Utilizing By-Product Recovery from the Permian Basin and Marcellus Shale

Mr. Lewis' presentation will summarize field and laboratory treatment results upgrading shale gas waste water via the ENVIRO-SHALE Process (ESP) and by-product recovery. The case studies will highlight the successful recovery operations from the Permian Basin and Marcellus Shale Plays. The presentation will detail frack water operation parameters and the recovery of salable inorganic by-products such as barium, strontium and calcium and upgraded effluent quality. The ESP effluents were tested and met water requirements to supplement fresh water volumes to drill new wells in the above mentioned plays as an alternative to disposal via deep well injection. The presentation will highlight the improvements in water quality and analysis of recovered by-products. Economic advantages of recycling shale gas waste water over disposal via deep well injection will be reviewed.

Tom Lewis | President & CTO | Lewis Environmental Services

Mr. Lewis is President and Chief Technology Officer of Lewis Environmental Services and a graduate of Carnegie-Mellon University with a B.S. in Chemical Engineering. He has over thirty-seven (37) years of technical expertise in the areas of environmental, energy and resource recovery technologies. He is a leader in using activated carbon for nontraditional applications and has successfully treated over 700,000,000 gallons of waste water with this core technology. He is currently commercializing the patented process known as the "ENVIRO-SHALE PROCESS" to recycle and reclaim frack and produced waters from shale gas operations. The company offers fixed site treatment and mobile recycling services.

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Upstream Optimization of Full-Water Cycle Costs

To enable upstream oil and gas asset development on optimal economic terms, all components of the water life-cycle (from sourcing to disposition) must be understood and quantified. The economic drivers for water are largely driven by logistic, regulatory, and technical considerations and many producers manage each aspect of the water life cycle independently of one another. When viewed holistically, it becomes evident that the full water life-cycle is a complex interdependent system. Once these variables and their interdependencies are fully understood, opportunities to capitalize on cost savings can be realized. Key components of the water life cycle will be identified as well as quantitative approaches to determine the viability of alternative water management and treatment strategies. Within this framework, practical examples will be used to highlight the importance of advanced planning and well timed investment in infrastructure to minimize overall costs in the longer term.

Mark Kidder | Senior Program Manager | ALL Consulting

Mr. Kidder has a BS from the University of Louisiana-Lafayette, majoring in Business, Chemistry and Biology. He has 29 years of experience in environmental, water management engineering, and program management experience. Prior to joining A.L.L., Mark was the Global Business Manager of Water Management at Schlumberger, where he led a technical team and the upstream water management strategy across the global Schlumberger enterprise.

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Refinery Wastewater Reuse and Fresh Water Preservation in New Mexico to Support Oilfield Production

HollyFrontier Navajo Refining LLC (Navajo) and regulatory agencies within the State of New Mexico are exploring a plan to reuse the Artesia Refinery's treated wastewater effluent for oilfield production activities in an arid southwest environment. The refinery's wastewater treatment system yields a non-hazardous wastewater stream with water quality suitable for dual discharge dispositions to either a publicly owned treatment works or to Class I (non-hazardous) underground injection control (UIC) disposal wells owned and operated by the refinery. In an area of finite or scarce fresh water resources, Navajo's proposed reuse of 15,000-20,000 bbls/day of refinery wastewater in the oilfields of New Mexico preserves fresh groundwater for other uses (e.g., municipal, agricultural) and provides for waste minimization through reuse and recycling under the framework of New Mexico's oil & gas, environmental, and water rights regulations. The presentation will include a review of the current and future refinery water budget, business, regulatory, and legal considerations as well as the technical aspects of the proposed water reuse.

Dr. Robert Combs | Environmental Specialist | HollyFrontier Navajo Refining LLC

Robert Combs, Ph.D., is an Environmental Specialist with ten years' experience in the petroleum refining industry. HollyFrontier Navajo Refining LLC processes locally produced crude oil from the Permian Basin to produce gasoline, diesel, fuel oil, and asphalt for use in the southwestern and Rocky Mountain regions. Robert has responsibilities in various aspects in the environmental disciplines for the refinery, including water rights, waste water monitoring, and waste minimization.

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Advancing Research and Analysis of Produced Water

Produced water is the largest waste stream associated with oil and gas production, and its efficient management and disposal is often challenging. The vast majority of this waste is deep-well injected for enhanced oil recovery and disposal; however, factors including drought and induced seismicity have led to the consideration of its use outside the oilfield. There remain significant gaps in our understanding of potential risks to human health or environmental impacts from such practices. To understand and mitigate potential impacts, the Environmental Defense Fund is working to advance the science on produced water. Improved data are vital for better decision-making on produced water management in order to both identify and address risks to public health and the environment. This presentation will provide an overview of ongoing and collaborative research with universities across the country on subjects including analytical methods for the identification and quantification of chemicals in produced water, and application of novel bioassays for its toxicity assessment. Such research efforts will increase understanding of the quality of produced water and inform stakeholders and decision-makers on the risks that produced water may pose, and indicate research and regulatory improvements to better understand and reduce those risks.

Cloelle Danforth | Postdoctoral Research Scientist | Environmental Defense Fund

Areas of expertise: Biocatalysis and bioremediation, water and wastewater quality and treatment

Cloelle Danforth is a Postdoctoral Science Fellow in the office of the Chief Scientist and has been working primarily with the Oil and Gas Team, working to minimize impacts of oil and gas development on surface and groundwater.

Cloelle is currently involved in a two-pronged research effort: (1) to understand and improve oil and gas wastewater characterization techniques, and (2) to create viable, fit-for-purpose biological treatment methodologies to remove organic constituents of concern.

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Groundwater Monitoring

North Carolina's Groundwater Quality Assessment Efforts

The North Carolina Department of Environmental Quality (NCDEQ) continually assesses the quality of state groundwater resources. NCDEQ monitors permitted facilities and areas that may be impacted by any facility or incident, and assesses whether naturally occurring constituents may potentially or currently impact groundwater, possibly due to groundwater withdrawals. Various assessment efforts are being performed to determine the impact of certain constituents, including PFAS and other man-made compounds, and those that may be increasingly derived from various soil and rock types including arsenic and uranium. Increased efforts are being made to determine the importance and impacts of various newly "emerging" constituents that may not have received adequate assessment before. Groundwater quality assessment tools are also being made available as a priority to the North Carolina public and government entities.

This presentation will discuss NCDEQ's and other's efforts to address man-made and naturally occurring impacts to water quality in groundwaters used for drinking, and recent legislation meant to address North Carolina groundwater.

Craig Caldwell | Hydrogeologist | North Carolina Department of Environmental Quality, Division of Water Resources

Craig Caldwell, P.G. is a hydrogeologist in the Planning Section of North Carolina's Department of Environmental Quality / Division of Water Resources. He works with private well owners and studies the impacts of naturally occurring and manmade impacts to groundwater quality. He also helps coordinate groundwater related activities within DEQ, and between North Carolina agencies and county governments. Previously he worked at the Texas Water Development Board, the Texas Commission on Environmental Quality, and as a consultant.

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RBDMS ENVIRONMENTAL DATA MIGRATION – Wyoming's Groundwater Data Warehouse

One issue plaguing many state governments is the lack of sharing environmental data between an agency's departments. Having a comprehensive environmental database allows for a more complete understanding of groundwater conditions and contaminates, leading to better regulator decision making for the regulated community. The Wyoming Department of Environmental Quality has groundwater quality data available in multiple state and federal programs (i.e., Storage Tank, Voluntary Remediation, Solid and Hazardous Waste, Land Quality, Groundwater Pollution Control, Underground Injection, and US Geological Survey). Many departments manage their data in individual databases, and the databases are not generally shared between departments or agencies. In order to compile groundwater quality data from the various existing databases, the State of Wyoming selected RBDMS Environmental as a data warehouse for groundwater quality data. The Wyoming RBDMS Environmental data warehouse includes data visualization and an electronic data deliverable for users to upload water quality data to their projects, and is being developed in stages as various state programs begin supplying data to RBDMS Environmental.

Nicole Twing | Geology Supervisor | Wyoming DEQ – GPC/FUDS Program

Nicole Twing, P.G. is the Geological Supervisor for the State of Wyoming Department of Environmental Quality (WDEQ) Water Quality Division Groundwater Section's Groundwater Pollution Control Program (GPC), Federal Facilities program, and Special Projects. She received her B.S. in Geology from the University of Minnesota– Duluth and an M.S. in Civil Engineering from the South Dakota School of Mines and Technology. Prior to joining the GPC, she worked in the WDEQ Underground Injection Control Program. Before joining the WDEQ in 2012, she worked in environmental consulting in Texas and Wyoming overseeing various environmental clean-up projects.

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An Overview of the National Ground-Water Monitoring Network Data Portal

The need for consistent information about groundwater quality and quantity across the nation is critical for effective management of this resource, however these data are often distributed and represented in disparate formats, posing significant challenges for use. To coordinate the integration of this data the Subcommittee on Ground Water, established by the Federal Advisory Committee on Water Information, designed and guided the development of a National Ground-Water Monitoring Network (NGWMN) and Data Portal. The Portal was envisioned as a single publicly accessible, automated system to relay groundwater levels, groundwater quality data and associated well characteristics from distributed databases through a map-based web application.

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 incorporates a service oriented hub-and-spoke architecture, which retrieves disparate data, mediates and aggregates it on-the-fly. Additionally, the system allows for the data to continue to be housed and managed by the data provider while being accessible for the purposes of the National Network. In the years following the pilot a system was developed to cache the raw web service data from the providers in order to perform statistical calculations and to improve performance and reliability in response to the growing Network. In addition, enhanced querying and site selection features have been implemented within the portal to ease data discovery and download. Furthermore, standard web services have been developed to serve the aggregated and mediated water levels (WaterML2 SOS) and well characteristics (GWML WFS) data for interoperable data sharing. This presentation will comprise an overview of the Portal design, the current state of the NGWMN Data Portal, a discussion of implementation challenges and future direction.

Candice Hopkins | Hydrologist | US Geological Survey

Candice Hopkins has a BS in Geology and Economics from Southern Methodist University and a MS in Hydrology from University of Arizona. She has worked for the US Geological Survey for 10 years as a hydrologist and currently serves as the Executive Secretary for the National Water Quality Monitoring Council and the Product Owner for the National Groundwater Monitoring Network.

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Class I Underground injection Control

Class I Wells – A New Generation

Opportunities and challenges have faced Class I UIC Program administrators, operators, and other stakeholders. GWPC has facilitated interaction and cooperation among all stakeholders willing to engage in dialogue to address issues such as the Resource Conservation and Recovery Act (RCRA) prohibition on land disposal of hazardous waste through methods not protective of human health and the environment (the Land Ban Program), identifying underground sources of drinking water (USDWs) and exempted aquifers, induced seismicity through underground injection, assuring nonendangerment of USDWs, avoiding forced closures resulting from administrative default when faced with legislated mandatory prohibition dates or self-imposed cessation dates, and other challenges. Throughout, the Class I UIC Program has retained its vitality in providing a means for safe and effective environmental management. Yet opportunities for program improvements, including some identified through a consensus process originally initiated by EPA, have been foregone in the absence of any crisis compelling reform.

This presentation will address Class I UIC program improvements by reviewing some of the methods and pathways that have been most effective in achieving positive results and will identify remaining opportunities for additional advancement. Among the areas discussed will be those identified through the GWPC Class I Work Group over the past several years: (1) HWDIR no migration exemption processing; (2) aging wells issues - lifespans and re-permitting; (3) pore space competition with class ii wells; (4) induced seismicity; (5) aging regulators - records retention issues; (6) guidance documents availability; and (7) achieving beneficial and cost-cutting regulatory reform.

Bob Van Voorhees | Executive Director | Underground Injection Technology Council

Bob Van Voorhees has practiced environmental and energy law since the 1970s. Over the past thirty 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). Currently, he serves as Executive Director to the Carbon Sequestration Council and the Underground Injection Technology Council. He is helping companies address geologic sequestration, experimental injection wells, hydraulic fracturing, and other advancing technologies. He has represented clients in permitting, compliance and enforcement for each of the current six UIC classes of injection wells with both state and federal agencies.

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Technical Factors Involved with the Demonstration of No-Migration to Support Land Ban Exemption Petitions

The injection of hazardous waste into Class I injection wells requires unique evaluations to justify permits and requires the US EPA to issue an exemption to the ban on the land disposal of hazardous wastes. A demonstration of containment or of "no-migration" is required to show that to a reasonable degree of certainty there will be no endangerment of human health or the environment. Geologic characterization of the injection zone (comprised of the injection interval and the arrestment interval) is required in addition to evaluation of the sufficiency of a confining zone above the formations used for injection. Reservoir engineering and hydrogeology principles are used to project the movement of waste constituents in the subsurface over the operational lifetime of the wells and over a 10,000 year post-injection period. In addition to typical characterization of rock properties common to Class I non-hazardous and Class II permitting, factors such as geologic dip, vertical permeability, system heterogeneity and dispersivity, fluid density, and waste constituent diffusion coefficients must be included to project fluid movement based on small concentrations and over long time periods. Efforts are made to project a boundary defined by where the injected waste cannot migrate based on worst-case scenarios rather than to precisely calculate a single prediction of the ultimate injected fluid distribution. Many factors influence the potential for the movement of waste in the subsurface. Several of the factors unique to evaluating 10,000 year migration are introduced and defined. This presentation provides an introduction regarding how injection zones and confining zones work to isolate waste in the subsurface and more specifically how geologic dip, vertical permeability, dispersivity, fluid density, and diffusion coefficients work, are inter-related, and how they influence a demonstration of no-migration. Overviews of these features and how they are applied to calculations and models are presented in terms and with graphics that will help both technical and non-technical staff visualize the process. Some examples are presented to illustrate generalized sensitivity to these parameters based on more than 30 years of experience preparing land-ban exemption petitions.

Aaron Payne | P.G., Senior Hydrogeologist | Petrotek Engineering Corporation

Aaron Payne is a Senior Hydrogeologist at Petrotek Engineering Corporation in Littleton, Colorado. He holds a B.A. degree in Geology from Bowdoin College and an M.S. degree in Geology from the University of Wyoming and is a registered professional geologist in Wyoming, Texas, and other states. Prior to joining Petrotek in 2008, he gained geology experience working in the petroleum industry for a major wireline service company and for an environmental consulting firm. Aaron has experience working with all classes of injection wells and specializes in characterizing formations and resources, investigating feasibility, permitting wells, and conducting reservoir/groundwater simulation studies to service the injection well, uranium mining and petroleum industries. Aaron has presented papers to the GWPC previously regarding injection wells, is a member of the National Groundwater Association and the Wyoming Geological Association.

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Protecting Groundwater at the Source

Louisiana's Drinking Water Protection Program: Protecting Drinking Water at the Source

The Louisiana Drinking Water Protection Program is a voluntary program designed by the Louisiana Department of Environmental Quality (LDEQ) to assist communities in protecting their drinking water by preventing contamination of drinking water sources. The program combines the elements of Louisiana's Wellhead Protection Program and Source Water Assessment Program (SWAP). The susceptibility analysis results obtained through the SWAP are used for a priority-setting approach to focus protection activities on those systems ranked as having a higher potential risk of contamination.

The goals of the program are to increase public awareness of the importance of protecting drinking water sources and to educate communities on actions they can take to protect it. To accomplish these goals, a public awareness campaign is initiated on a parish-wide basis. LDEQ staff meets with local officials and water system operators, provides drinking water protection area highway signs, solicits local volunteers to establish a drinking water protection committee, and assists the committee with projects to protect their drinking water source. Projects include visiting businesses identified as potential sources of contamination to educate them on pollution prevention best management practices and updating source water assessments. As well as focusing on public education, the program also encourages adoption of a local ground water protection ordinance and development of contingency plans by the water systems.

Community involvement is an effective and inexpensive means of protecting drinking water resources. An informed public is often a more responsible public. With education and guidance, local stakeholders can take actions to reduce or eliminate threats to the drinking water supply thereby benefiting their health, the economy, and the environment.

Mary Gentry | Geologist | Louisiana Department of Environmental Quality

Mary Gentry was born and raised in New Orleans and received her B.S. degree in Geology from the University of New Orleans in 1990. She has worked as a geologist in water planning and assessment at the Louisiana Department of Environmental Quality since February of 1991 and is a licensed Professional Geoscientist in the State of Louisiana. She was a co-developer of Louisiana's Source Water Assessment Program to assess the susceptibility of public water systems to potential contamination. She also serves on the Advisory Board of the Louisiana Water Resources Research Institute.

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The Private Well Class – A National Outreach and Education Program for Groundwater Protection

The Private Well Class is a national program for elevating private well issues among well owners, environmental health professionals, groundwater professionals, and other stakeholders. Developed at the Illinois State Water Survey, cooperatively with the Rural Community Assistance Partnership (RCAP), the Private Well Class provides distance learning, onsite learning, and in person technical assistance to both well owners and those that work with them, to promote best practices, educate on basic public health and source water protection issues, and create a consistent national dialogue around private well issues. The program is funded by USEPA and additional partners include the National Environmental Health Association (NEHA), the National Ground Water Association (NGWA), and the Water Systems Council (WSC). In this presentation, we will highlight what we have learned in the 5 years since the program started, share some of the most useful tools that have been developed, and demonstrate why everyone working in the groundwater profession should be engaged in providing support for private well owners. The highlights of the first ever national private well conference, held in May 2017, and a new tool developed to assess the vulnerability of a private well, will also be presented.

Steve Wilson | Groundwater Hydrologist | Illinois State Water Survey

Steve Wilson is a groundwater hydrologist who has been with the Illinois State Water Survey at the University of Illinois since 1983. He authored The Private Well Class, an online self-paced curriculum for private well owners, and manages WaterOperator.org, an online resource for water and wastewater operators geared toward supporting small systems. Steve has a M. S. in Civil Engineering from the University of Illinois at Urbana-Champaign.

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State-Level Groundwater Governance and Management in the U.S.

Groundwater is increasingly essential for meeting water demands within the United States. Forward-thinking governance and effective management is needed with measures to ensure sustainable use, thereby ensuring that groundwater remains at acceptable quantities and qualities to meet new demands. In the United States, groundwater governance (making laws, policies, and regulations) and management (actions to implement these laws, policies, and regulations) is left to the individual states. This decentralized system creates a considerable variability in practices across the country. We present the results of a nationwide survey designed to better understand groundwater governance strategies and practices in the United States related to water quality. A state water professional was recruited in each state to participate. The report was prepared as a project funded by the Ground Water Research and Education Foundation (GWREF) of the Ground Water Protection Council and benefitted from the involvement of GWREF representatives throughout the formation of the survey. Respondents identified a wide variety of groundwater concerns, including water quality and quantity impairment, staffing and budget issues, private well vulnerability, and aquifer overdraft. Most respondents indicated the existence of explicit groundwater quality management goals within their states and reported that their states have undergone significant changes to groundwater quality policy in the last 30 years. Most states have multiple funding sources for water quality programs. However, budgets for groundwater quality programs have decreased in the last 10 years, thereby limiting staff to implement new policies. Over half of respondents anticipate that changes in groundwater regulation are likely in the next five years within their states. Respondents indicate that water quality/water level monitoring and increased groundwater pumping will require more attention in the next 10 years.

Jacob Petersen-Perlman, Ph.D. | Research Analyst | University of Arizona Water Resources Research Center

Steve Wilson is a groundwater hydrologist who has been with the Illinois State Water Survey at the University of Illinois since 1983. He authored The Private Well Class, an online self-paced curriculum for private well owners, and manages WaterOperator.org, an online resource for water and wastewater operators geared toward supporting small systems. Steve has a M. S. in Civil Engineering from the University of Illinois at Urbana-Champaign.

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Class V Underground Injection Control

Slurry Injection

Slurry injection has been used for over 30 years to solve difficult environmental challenges, particularly in remote and sensitive environments. This talk will focus on both urban and industrial applications of slurry injection, as well as ways to broaden the adoption of the technology beyond oilfield and wastewater treatment contexts. Regulatory options will be discussed, as well as case examples of the value of application of the technology into new markets.

Omar Abou-Sayed, CEO, Advantek Waste Management Services, LLC

Omar Abou-Sayed's experience spans the global energy industry, including oil and gas, chemicals, oilfield services, and renewables. He has worked in a diverse set of engineering, business, and organization-wide leadership roles within SuperMajor oil companies, management consulting firms, private equity funds, and venture-backed startups. He currently serves as CEO of Advantek Waste Management Services, a waste management company which utilizes proprietary slurry injection technologies dispose of oilfield waste and organic waste sludges. Omar holds a Bachelors of Science in Mechanical Engineering from the University of Texas at Austin, and an MBA from the Harvard Business School.

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GENERAL SESSION: Updates from Partnering Organizations

Perspectives on Groundwater Policy Challenges in the 115th Congress

The 115th Congress is nearly complete, and the focus on water policy from both ends of Pennsylvania Avenue has not let up. From the Flint Water Crisis to WOTUS, priorities important to the management and use of groundwater resources has been top of mind in Congress, at EPA, and in the White House.

In light of significant rhetoric, what real policy change has taken place in the water space over the past two years?

Key legislative and regulatory activities in the 115th Congress will be explored in this presentation including effort to re-write the Waters of the United States rule, comprehensive water resources legislation, and how PFAS contamination is being address in Congress and the administration.

With the mid-term elections just a few months away, the presentation will also provide an outlook on the 116th Congress, highlighting key dynamics and possible changes to keep in mind in the groundwater arena.

Lauren Schapker | Government Affairs Director | National Ground Water Association

Lauren Schapker is the government affairs director for the National Ground Water Association. She joined NGWA in 2014, where she is responsible for all legislative and regulatory activities of the association. Her policy background has an emphasis on energy and environment issues, as well as transportation and infrastructure. Prior to joining NGWA, she spent time working in government affairs for the Portland Cement Association and also worked at Xenophon Strategies, a boutique lobbying firm, where she represented a range of clients on transportation, infrastructure, and water issues.

She is a graduate of Miami University in Oxford, Ohio, and she and her husband reside in Alexandria, Virginia.

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Emerging Groundwater Contaminants

PFAS Update: Managing Contamination from PFAS in Australia

This presentation will focus on real-world experience with projects related to the contamination of soil, groundwater and surface water that has occurred due to the use of perfluorinated alkyl substances (PFAS) in firefighting activities. Work that has been carried out in Australia has given insight in regards to respond to the potential challenges posed by the past use of PFAS. The level of expenditure has rapidly increased, and may increase to hundreds of millions of dollars per year before the most significant areas of contamination have been well characterized and satisfactorily controlled.

Some of the issues of importance are:

- Small quantities of PFAS compounds leaching from soil and travelling in groundwater or surface water can be concerning – the quantities traveling in groundwater may be 1000 fold less than the mass of PFAS compounds in the source soil and concrete. Fully treating source material to achieve reductions of 1000 fold or more may not be technically feasible, and would be prohibitive in terms of cost.
- The potential for problems at such low concentrations through bioaccumulation is driving a fundamental change to how we assess the effects of such contamination in Australia. Assessments are now being focused on the presence of these compounds in food that humans and animals consume, and adverse effects through "indirect" exposure (ie via food affected by contaminated soil or water) rather than "direct" exposure.
- Making judgements about the significance of possible effects continues to challenge human health-focused scientists - rather than considering only concentration and direct effect, these indirect exposures present unique questions in regards to the health significance of background exposures.

The difficulty of choosing treatment options, or whether even to consider treatment, will also be presented. Because many of the real world situations will relate to PFAS leaching from soil and travelling in groundwater at very low concentrations, and the PFAS compounds generally are highly persistent and difficult to treat, it may not be feasible or practical to remediate with treatment alone. Practicable options will be presented based on past experience, which necessarily have included management, interception and containment. Such strategies may not result in an immediate correction of the situation, and practically we may have to accept that effects that we normally consider to be unacceptable in regulatory terms, can be accepted. Such decisions can be made using the framework and principles of "sustainable management and remediation", in which stakeholders collectively agree on what solution provides the best balance in terms of remedial and management efforts and outcomes.

It becomes apparent from such considerations that achieving a complete "no risk" solution to the PFAS problem in Australia will not be feasible, and this has implications to the PFAS issues emerging in other parts of the world. This presentation will focus on the competing interests of regulatory policy settings, stakeholder interests, and financial and environmental costs which affect the desired outcomes, as well as the likelihood these outcomes can be achieved.

Lee Gedge | Principal Environmental Scientist | GHD

Relevance to project. Lee has almost 20 years' experience as an environmental scientist and hydrogeologist. He is experienced in all stages of contaminated land management from site investigation through to risk assessment and site remediation. He has carried out numerous large-scale environmental assessment and remediation projects throughout Australia involving a range of contamination issues and exposure settings. Having worked extensively with Department of Defence, Airservices Australia and a range of emergency services clients, most of the projects Lee has been involved with over the past seven years have been in relation to investigation and management of PFAS contamination. He has recently been the project director and technical lead for a number of significant investigation programs to delineate PFAS contamination at a host of major facilities across Australia, and has produced policy and guidelines on strategies for management of PFAS impacts that have been adopted by clients nationally.

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Shifting Treatment Costs from Ratepayers to Polluters-The California 1,2,3 Trichloropropane Story (TCP)

In 2018 California water utilities must comply with the new 1,2,3 Trichloropropane (TCP) MCL 5 ppt. This is the lowest MCL for any contaminant in the county.

In 2001, California gathered information on the presence of TCP in drinking water sources, they adopted a regulation that included it as an unregulated contaminant for which monitoring is required (UCMR). Given the number of sources with detections TCP under the UCMR sampling, the Drinking Water Program considered this chemical for future regulation. In July 2004 a public health goal (PHG) was requested of the Office of Environmental Health Hazard Assessment (OEHHA) and in September 2009, OEHHA established PHG MCL of 7 ppt.

Treatment will be expensive. Who will pay: the ratepayers or the polluters? A number of California water utilities have been successful in obtaining treatment costs from the polluters who caused the TCP contamination.

In this presentation, SL Environmental Law Group will review the processes involved to enact the MCL, geographic areas affected, causes of the pollution, best available treatment technologies and methods to get the polluters to pay for the damage that they have caused.
They will review the legal process that is undertaken by a utility interested in pursuing cost recovery options. The factors to consider when evaluating manufacturer liability will be reviewed. General resource commitments and timelines for undertaking this process will also be particularized.

Bill Kelly | Director of Client Engagement | SL Environmental Law Group

Director of Client Engagement for SL Environmental Law Group, PC. His firm helps water systems, municipalities, and states in litigation to shift treatment costs from rate payer to polluter. Bill is a veteran in the environmental industry, having held senior management positions with Severn Trent Services, Isle Utilities and Lucid Energy.

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The Impact of PFAS on Water Resources

Per- and Polyfluoroalkyl Substances (PFAS) have been detected in drinking water, surface water and groundwater all over the nation. Updates on the science of PFAS, its sources and occurrence, regulatory developments and legislative initiatives will be provided. Information about how PFAS has impacted New Hampshire and that state's response to these contaminants will be presented.

Brandon Kernen | New Hampshire Department of Environmental Services

Brandon Kernen is the Manager of the Hydrology and Conservation Program at the Department of Environmental Services. His responsibilities include oversight of programs associated with groundwater withdrawals, groundwater discharges, water use reporting, water conservation, water well construction and well driller licensing. He also has coordinated Department initiatives associated with the occurrence of emerging contaminants of concern in the environment, drought management and the impact of rock blasting on private and public drinking water supplies. He has over 25 years of professional experience and a graduate degree in Civil and Environmental Engineering from Tufts University and an undergraduate degree in Hydrology and Water Resources from the University of Arizona. He is a licensed Professional Geologist.

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Innovative Uses of Data for Groundwater Protection

Big Data for Managing Processing and Energy Management Schemes

Although there is a growing quantity of data at utilities, operators and managers are not always aware of the available data or fully understand what it means in terms of energy operations. Issues emerge every time models are applied to practice. We need to spend more time looking at data, making gradual changes, and monitoring impacts.There is a need to leverage big data for better outcomes in water/wastewater industry. The technology available to be implemented in a growing utility world is fast outpacing the knowledge capability of its operators. Data collected from low-cost sensors can be extremely beneficial in understanding the processes better, optimizing the water systems, and reduce energy consumed. There is a tremendous amount of research being managed by the Water Research Foundation on this. This will be an overview of all related research conducted by WRF in this sector and possible opportunities for future research.

Ashwin Dhanasekar | Research Manager | The Water Research Foundation

Ashwin Dhanasekar is a Research Manager at The Water Research Foundation handling Energy Management projects. Prior to WRF, he was a Research Scientist at Colorado State University and former Assistant Director for the Center for Energy-Water Sustainability at the Energy Institute at CSU. He has over 6 years of experience working in the Water-Energy sector primarily focusing on integrated water management, climate change and produced water management in the oil & gas industry.

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Automated Mapping and Processing Techniques Employed within the ECHO Algorithm: Reading "Big Data" to Protect Water Resources

To protect water resources, the catchments must first be known. The ECHO processing suite accomplishes this by comparing a user's time-series for any given water source to satellite data using the ECHO-GPM algorithm. By doing so, we can locate the spatial extent of the area feeding a given water source for the purposes of water resource protection, contaminant mitigation, and supply sustainability. Within this suite we also employ ECHO-ID, an event recognition algorithm capable of generating a unique signature for any given time-series independent of scale, shape, and noise. Together, ECHO-GPM and ECHO-ID allow for full automation, rapid delineation, and real-time monitoring of water resources, worldwide.

Jake Longenecker | Geophysics & ECHO Developer | Power 7 Corporation

Jake Longenecker received his BA from Franklin & Marshall College, where he was instrumental in developing what would become the initial version of ECHO-GPM. Working as an Environmental Scientist, Jake continued to refine his field work and data interpretation. In 2017, Jake was installed on the Karst Commission and awarded the "Young Karst Researcher Award" for his work on ECHO-GPM. In 2018, he joined Power 7 as a Geophysicist and ECHO developer. Since joining Power 7, Jake has advanced the ECHO-GPM science and is integral to the development of our proprietary technologies through his research, field work, and innovative collaboration.

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Prioritizing Inspection of Oil and Gas Wells

Research is currently underway to develop a RBDMS application to help states prioritize inspection of oil, gas and UIC wells. In this pilot GIS application, risk factors such as distance: to municipal and domestic water wells; populated areas, municipalities; surface water; depth to ground water; age of oi, gas or UIC wells; and history of violations are considered in a potential ranking scheme.

Paul Jehn | Technical Director | Ground Water Protection Council

Paul has twenty-five years experience in environmental assessment, policy development, evaluation, remediation, pollution prevention and management. His duties include providing technical assistance to states, local governments, citizen groups and individuals in ground water, Class V injection wells, wellhead, and source water protection. Paul is the lead staff person on all RBDMS projects.

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Class II / VI Underground Injection Control

Achieving Closure for CO2 Geologic Storage Projects

Numerous carbon dioxide geologic storage projects have been conducted at the pilot, demonstration and commercial scale, and a number of the pilot and demonstration projects in particular have been completed. Upon completion of CO2 injection, these projects have implemented a variety of post-injection procedures, including monitoring, modelling, decommissioning and well plugging to comply with closure plans initially developed before CO2 injection was even initiated. Often these closure plans were prepared, reviewed, updated, maintained, and implemented in accordance with applicable regulatory requirements for the various jurisdictions within which the projects were located. In other cases, the closure plans were prepared and implemented under research, development and demonstration programs operated by governments or public and private partnerships.

This presentation will compare and analyze the experiences of CO2 geologic storage projects that have entered the post-injection closure process regardless of whether the closure process has been completed. The analysis will include a review and comparison of the regulatory frameworks under which closure plans were developed to highlight both similarities and differences among the closure requirements. The significance of those requirements will be discussed in the context of the specific projects to reflect on what role a specific requirement has played in the project execution and in post-injection activities. That discussion will include whether any lessons can be drawn from the experiences of specific projects, both from the standpoint of project operators and from the standpoint of regulators having responsibility for project oversight and closure approval.

The lessons to be gather from experience conducting these projects will be most valuable if used to modify and improve the procedures used going forward. Accordingly, the paper will also consider what has been said by others based upon assessments of these projects and on presentations of best practices for the post-injection and closure processes. Appropriate recommendations will be provided based on a comprehensive consideration of the relevant experiences and commentaries.

Bob Van Voorhees | Principal | Robert F Van Voorhees PLLC

Bob Van Voorhees has practiced environmental and energy law since the 1970's. Over the past thirty 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). Currently, he serves as Executive Director to the Carbon Sequestration Council and the Underground Injection Technology Council. He is helping companies address geologic sequestration, experimental injection wells, hydraulic fracturing, and other advancing technologies. He has represented clients in permitting, compliance and enforcement for each of the current six UIC classes of injection wells with both state and federal agencies.

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Induced Seismicity

Beyond Common Induced Seismic Monitoring Practice; Real-Time Risk Mitigation Application

Induced seismicity-related regulations implemented to date in various jurisdictions typically focus on defining operator actions in response to seismicity large enough to be recorded by public seismic networks. The operators are required to establish operational protocols designed to minimize the likelihood of the occurrence of large magnitude events and are in some instances mandated to implement higher resolution seismic monitoring arrays. The ultimate goal of these seismic networks beyond simple regulatory compliance is to provide operators with a near real-time measure of the induced seismicity risk and an indication of the risk mitigation protocol effectiveness. In order to achieve this objective, the main requirement for local and near-regional arrays is to produce fast, accurate and complete seismic catalogs. This, in turn, allows timely synthesis and display of accurate catalog level data products that indicate the probability of occurrence of events large enough to trigger regulatory action. Fundamentally, induced seismicity risk management requires the creation of research-grade seismic catalogs in near real-time. Such earthquake catalog in combination with operational data could be used as an input to the forecasting seismicity models related to fluid injection.

The focus of this study is on highlighting the current state of technology to generate a high-quality seismic catalog in real-time and the application of the fine-tuned enriched catalog in risk management. Using the examples from local and near-regional arrays, we highlight the challenges associated with real-time seismic data processing and present some of the advanced methods that can be deployed to address those challenges. Moreover, we illustrate examples of near real-time risk management application for hydraulic fracturing operations and validate the predictions of different models by playing back the data and demonstrating how well each method could forecast expected maximum magnitude and future seismicity.

Sepideh Karimi | Research Scientist | Nanometrics, Inc.

Sepideh Karimi is a Seismologist with Nanometrics. She is a leading industry expert on the analysis and processing of data for Induced Seismicity risk management. She develops advanced processing techniques for induced and passive seismic monitoring. Sepideh graduated with a BSc in Mining Engineering from University of Tehran in 2004 and received an MSc from the same institute in 2006. She earned a PhD in 2013 in Engineering Seismology at IIEES. Prior to joining Nanometrics in 2014, Sepideh worked for two years at ESG Solutions, with a focus on advanced microseismic analysis of hydraulic fracturing and reservoir stimulation.

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Legal Developments Relating to Induced Seismicity

"Induced seismicity" refers to earthquakes that are triggered by human actions. This subject has attracted attention in recent years because of an increase in the frequency of earthquakes—an increase that scientists believe is attributable to induced seismicity. Some of the activities that can trigger earthquakes are activities associated with the oil and gas industry, such as fluid injections performed for the purposes of either wastewater disposal, hydraulic fracturing, or secondary recovery, though even the withdrawal of oil and gas from the subsurface can trigger seismicity in some circumstances. Of these activities, injection disposal is believed to be the leading cause of induced seismicity.

Concerns about induced seismicity have led several states to promulgate new regulations or adopt new policies relating to injection disposal operations and the evaluation of permits for new injection disposal wells. Further, numerous plaintiffs have sued, alleging that they have incurred damages that were caused by earthquakes induced by injection disposal operations.

These legal developments are significant because oil and gas activities in the United States generate large volumes of wastewater—an estimated 890 billion gallons of wastewater in 2012. Some of this is wastewater from hydraulic fracturing operations, but a larger portion is water that is naturally found in subsurface formations that also contain oil or gas, and which is then withdrawn from the subsurface in association with oil and gas during production operations. Injection disposal is one of the most common methods of managing this wastewater because such disposal typically is considered one of the most economical and environmentally safe methods of wastewater management.

This paper and presentation will review the legal responses to the apparent increase in seismic activity associated with oil and gas activities, with a focus on regulatory responses.

Keith Hall | Director | Mineral Law Institute

Keith B. Hall is Director of the Mineral Law Institute and the Campanile Charities Professor of Energy Law at Louisiana State University Law School, where he teaches: Mineral Rights; Advanced Mineral Law; Energy Law & Regulation; Civil Law Property; and a seminar on environmental issues that relate to oil and gas activity. Before joining LSU, he practiced law for sixteen years at a major firm in New Orleans, focusing on oil and gas law, environmental law, and toxic tort litigation. He also is a registered Professional Engineer who worked for eight years as a chemical engineer before attending law school.

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Hydraulic Fracturing Induced Seismicity – Risk Assessment and Mitigation Protocol

Felt seismicity associated with hydraulic fracturing is extremely rare. It is well understood that "microseismic" events are always expected during hydraulic fracturing operations, generally with magnitudes from M1 to –M3, and these are never felt at surface. However, under very unique geologic circumstances, hydraulic fracturing may induce surface-felt events. This presentation will discuss the current state of risk assessment and mitigation techniques for seismicity induced from fracturing operations. Science-based risk assessment methods can be used to proactively identify and mitigate potential seismic hazards prior to executing fracturing operations. Risk assessment methods should consider local geologic stress characteristics, the presence of faults, historic induced seismicity, wellbore geometries, proximity to critical infrastructure and the regulatory regime. Mitigation techniques are best tailored considering local conditions and target reduction of pore pressure buildup in areas that have elevated risk. Monitoring arrays can provide further risk mitigation by enabling early detection of anomalous seismicity. The underlying physics associated with hydraulic fracturing induced seismicity is complex and is subject of active research across the science community. As the science understanding continues to evolve, risk assessment and mitigation techniques will continue to be advanced.

Tim Tyrrell | Geoscience Technology Manager | XTO Energy

Thirty-five years of industry experience in exploration and production settings in a variety of basins and countries. Currently responsible for leading XTO's induced seismicity efforts including development of XTO's Induced Seismicity Protocol. Chair or Co-chair on Industry Seismicity Workgroups in Texas, New Mexico and Alberta.

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