Water Acquisition Modeling Technical Workshop Participants

Bruce Baizel, Energy Program Director, Earthworks

Bruce Baizel is the Director of the Energy Program for Earthworks. He has participated in numerous state rulemakings in New Mexico and Colorado related to oil and gas exploration and waste management. He has advised local governments on regulation of natural gas in Colorado, New Mexico, Washington, Alaska and Pennsylvania. He is one of three environmental representatives on the board of directors of the multi-stakeholder national organization STRONGER, the State Review of Oil and Natural Gas Environmental Regulations. He was an appointed member of the Governor's Pit Rule task force for the state of New Mexico. During the past two years, he was invited to make presentations on water quantity, natural gas and hydraulic fracturing issues to the Brookings Institute, American Bar Association national environmental conference, utility regulators in Canada, state environmental agency enforcement personnel from 15 western states, the district attorney association of California and the Colorado Rural Electric Association. Baizel received his law degree and Master's degree in International Relations from the University of Denver.

Michael Baker, Chief of the Division of Drinking and Ground Waters, Ohio Environmental Protection Agency

Michael Baker is a nationally recognized expert in water resource regulation and policy. He is Chief of the Division of Drinking and Ground Waters at the Ohio Environmental Protection Agency where he has worked for 27 years. He has served as Chief for over 13 years where he is responsible for characterizing and protecting Ohio's ground water resources and ensuring Ohio's citizens have access to adequate supplies of safe drinking water by administering the State of Ohio's Public Water Supply Supervision Program, Ground Water Characterization and Protection Programs, Class 1 and 5 Underground Injection Control Programs, Source Water Protection Program, the Drinking Water State Revolving Loan Program and the Water and Wastewater Operator Certification Program. He has advised and directed numerous State drinking water and ground water protection initiatives including currently serving on an inter-agency work group established to ensure safe development of Ohio's unconventional oil and gas resources. Baker has also helped establish national water policy having served two terms on US EPA's National Drinking Water Advisory Council and is active in both the Ground Water Protection Council and the Association of State Drinking Water Administrators, having served as president of both associations. He has twice been invited to provide testimony on water-related issues to the US Senate Environment and Public Works Committee. He graduated from the Ohio State University with a BS in Natural Resources.

Lily Baldwin, Senior Environmental Engineer, Water Quality Team Environmental Unit, Chevron Energy Technology Company

Lily Baldwin is a Senior Environmental Engineer in the Water Quality Team -Environmental Unit of Chevron Energy Technology Company; she has over 20 years of experience in water resource management in industry and consulting. Her current focus area at Chevron is sustainable water management practices, including research on source water selection for hydraulic fracturing.

She has managed several produced water discharge modeling projects and is currently conducting research which considers different modeling programs. Her other related work at Chevron include National Pollutant Discharge Elimination System permitting and compliance with other discharge requirements. Prior to joining Chevron six years ago, she worked for Lawrence Livermore National Laboratory where her relevant work included managing and providing hydrology/water quality subject matter expertise on environmental impact assessments for relicensing nuclear power plants. She also provided technical leadership in mitigating creek maintenance projects using restoration principals, which resulted in presentation and publication of these projects at American Society of Civil Engineers/Environmental Water Recourses Institute (ASCE/EWRI) congresses. Prior to working at the Laboratory, she was a consultant for municipal and industrial clients implementing Phase I of the stormwater regulations. She has served as an officer in the Emerging and Innovative Technologies Committee of ASCE/EWRI and is currently Secretary of its Performance Based Sustainability Indicators Task Committee. Baldwin is a Registered Civil Engineer in California; she has a BS in Civil Engineering from the University of California, Berkeley and a MS in Civil and Environmental Engineering from Stanford University.

Laura Belanger, Water Resources Engineer, Western Resource Advocates

Laura Belanger is a water resources engineer with Western Resource Advocates (WRA), a non-profit policy organization that works to protect the West's land, air and water. She is the lead author of a 2012 report which examines water demands associated with oil and gas development in Colorado, puts these in context of other demands and considers localized impacts. She also recently worked on the Colorado Oil and Gas Conservation Commission's baseline ground water monitoring rulemaking. Prior to coming to WRA, Belanger was an engineering consultant for Headwaters Corporation (which is implementing the Platte River Recovery Implementation Program) and Hydrosphere Resource Consultants. She has more than a decade of experience evaluating water availability and modeling operational and infrastructure options to meet and balance the water requirements of existing and proposed water supply projects, interstate compacts, and endangered species and other environmental flows. She also has a background in water quality sampling, analysis and regulations development and compliance. Belanger is a licensed professional engineer in Colorado and has a MS in Civil Engineering from the University of Colorado.

Thomas Chambers, Senior Facilities Engineer, Southwestern Energy Company

Thomas Chambers has 24 years of experience in a variety of fields: municipal, surveying, transportation, water treatment, land planning and development. He has worked in the oil and gas industry for the past four years, first with a research and development group tasked with developing a cost-effective method of treating and recycling flowback and produced water, and secondly as an engineer for Southwestern Energy. Chambers has a BS degree in Civil Engineering from Memphis State University.

Corrie Clark, Natural Resource Economics and Systems Analysis Team Lead, Argonne National Laboratory

Corrie Clark is an environmental policy analyst and sustainable systems engineer and the Natural Resource Economics and Systems Analysis Team lead for the Environmental Science Division at the US Department of Energy's Argonne National Laboratory. She develops interdisciplinary solutions that combine engineering, finance, and policy to solve complex environmental challenges. Her expertise includes developing tools for cost-benefit analysis, multi-media probabilistic environmental models, and life cycle analysis to inform energy and environmental policy. She has worked on environmental issues in the oil and gas industry for five years including produced water generation and management, greenhouse gas emissions associated with natural gas development and life cycle water consumption for conventional and shale natural gas development. She was an invitee by the National Academy of Engineering to the Indo-American Frontiers of Engineering Symposium in 2010, and she was recognized as a 2012 Society of Petroleum Engineers Cedric K Ferguson Medal nominee for her work on produced water management. She earned a BS in Chemical Engineering from the University of Virginia, and a MSE in Environmental Engineering and a PhD in Environmental Engineering and natural resources from the University of Michigan.

Bruce Curtis, Hydrology and Hydraulics Practice Group Leader, Kleinfelder, Inc.

Bruce Curtis is the Hydrology and Hydraulics Practice Group Leader at Kleinfelder, Inc. He specializes in hydrology, hydraulics, hydrogeology and geomorphology and has more than 29 years of experience in performing numerous hydrologic and hydraulic modeling studies, hydrogeologic modeling and analysis, water supply analyses, water treatment facility design, water rights, well design, aquifer storage and recovery projects, reservoir dredging studies, stormwater quality best management practice design, stream restoration, sedimentation and detention basin design, erosion estimates, erosion control design, sediment transport studies, scour analyses, channel stabilization and flood control design, energy dissipation features, drop structures, road (paved and unpaved) drainage and alluvial fan mud and debris flow analyses. Curtis' client list includes federal agencies, state agencies, municipalities, developers, private individuals and corporations. Curtis has recently begun expanding his work to include the oil and gas industry, designing pipelines and pipeline stream crossings and reviewing Spill Prevention, Control, and Countermeasure plans and Stormwater Pollution Prevention plans for oil and gas pads. He has also contributed to an environmental impact statement for oil and gas development in the Uintah Basin in Utah. Curtis provides a very broad perspective on water resources, having extensive experience and knowledge of ground water modeling, hydrologic modeling and hydraulic modeling and performing numerous water supply studies. He is especially interested in the conjunctive use of ground water and surface water supplies and the development of efficient strategies to use these resources while minimizing their effects on the surrounding environment. Curtis has a BS from the University of Illinois in Civil Engineering (Water Treatment and Water Resources), a MS from the University of Nebraska-Lincoln in Civil Engineering (Hydrogeology), and a PhD from the University of Nebraska-Lincoln in Civil Engineering (Hydrogeology).

R. Jeffrey Davis, Senior Hydrogeologist and Professional Engineer, Cardno ENTRIX

Jeffrey Davis is a Senior Hydrogeologist and Professional Engineer with over 20 years of experience in ground water and geographic information system modeling and software and model development. He has provided consulting services for local, national and international clients pertaining to modeling and visualization projects. He has extensive knowledge of ground water flow and transport principles and has lectured and taught numerous workshops and classes worldwide. He currently works in the oil and gas industry in the areas of hydraulic fracturing and ground water protection and produced water management. He is part of the National Ground Water Association (NGWA) Hydraulic Fracturing Task Force and serves on another group active in encouraging implementation of a National Ground Water Monitoring Network. Davis has given a number of presentations recently for Continuing Legal Education International, Energy & Mineral Law Foundation and the American Bar Association on hydraulic fracturing and ground water protection and is a sought after speaker with many other organizations. He also is active in the mining industry in water management and remediation and other ground water-related activities. Besides NGWA, he is actively involved with the International Water Association, International Mine Water Associaton and the Energy and Mineral Law Foundation. He has graduate and undergraduate degrees in Civil and Environmental Engineering from Brigham Young University.

Michael Dunkel, Director of Sustainable Development, Pioneer Natural Resources

Michael Dunkel is the Director of Sustainable Development for Pioneer Natural Resources. He is responsible for corporate water and air initiatives that promote long term sustainability. A major focus of the initiatives is finding an economically viable alternative to using fresh water for drilling and hydraulic fracturing. The study includes transportation, storage and treatment of produced water for recycling. Dunkel has presented on water management for the Texas House Hearing on Water, the Eagle Ford Task Force, the US EPA Water Acquisition Roundtable and other oil and gas conferences. Dunkel has held positions with Pioneer Natural Resources in engineering management, project management and business development over the last 15 years. His experience with Pioneer includes projects and developments in Tunisia, South Africa, Gabon and Argentina, before joining the Sustainable Development Group. Prior to Pioneer, Dunkel was employed at Marathon Oil in a variety of engineering and business development roles for 15 years. His involvement in successful developments covered Texas, Louisiana and North Africa. As a 30-year member of the Society of Petroleum Engineers (SPE), he was a founding member and officer of the SPE Section in Tunisia. Dunkel earned a BS in Mechanical Engineering from Rose-Hulman Institute of Technology.

H. Thomas Fridirici, Division Chief, Operations and Monitoring Division, Bureau of Safe Drinking Water, Pennsylvania Department of Environmental Protection

Tom Fridirici is the Division Chief for the Operations and Monitoring (O&M) Division in the Pennsylvania Department of Environmental Protection's Bureau of Safe Drinking Water (BSDW). The BSDW administers the fourth largest drinking water program in the nation with

nearly 9100 public water systems that serve drinking water to more than ten million people statewide. The O&M Division provides program support for the six Regional Offices in Pennsylvania. The Division is responsible for development of Safe Drinking Water regulations and policy, operator certification and public water system compliance and enforcement. In addition the Division is responsible for program data management, collecting nearly 100,000 self-monitoring sample results on a monthly basis. Prior to this he worked in the Department's Southcentral Regional Office as a hydrogeologist and as the Operations Chief in the Regional Safe Drinking Water program. Fridirici is a Professional Geologist, licensed in Pennsylvania. He received a BS in Geology from Indiana University of Pennsylvania and a MEPC from the Pennsylvania State University in Harrisburg.

Rowlan Greaves, Senior Facilities Engineer, Southwestern Energy Company

Rowlan Greaves is a Senior Facilities Engineer at Southwestern Energy in Houston, Texas. Greaves has 14 years of engineering experience in two different fields: water resources (nine years) and industrial heat tracing (five years). Over the last three years Greaves has been a key member of Southwestern Energy's Water Resources Team for the Fayetteville Shale, focused on the planning, analysis and execution of water projects to supply water for shale fracturing operations. He has been integral to the development of new proprietary water management applications to facilitate water planning and tracking; building economic and volumetric analyses for new water sources; forecasting future water supply and demand for freshwater and recycled water; permitting and permit compliance of freshwater sources. Greaves also has past experience scoping, building and calibrating a variety of hydraulic and hydrologic models pursuant to floodplain modeling for FEMA map revisions, instream flow modeling for hydroelectric relicensing, drainage and subsurface infiltration analyses and precipitation studies. He has a BS in Civil Engineering from Texas A&M University.

Christopher Harto, Energy and Environmental Analyst, Argonne National Laboratory

Christopher Harto has been an Energy and Environmental Analyst at Argonne National Laboratory since 2010. His work focuses on quantifying the environmental performance of energy technologies. Much of his recent work is related to the energy-water nexus. Recent projects have included estimating the life cycle water footprint of geothermal energy, life cycle assessment of produced water treatment and disposal systems and quantifying the risk to electricity generation from severe drought in the Western US. In the area of shale gas development and hydraulic fracturing, Harto has co-authored two white papers for the Department of Energy on the environmental impacts of shale gas development, one of which was recently released as a peer reviewed journal article. He is also a co-author of a life cycle assessment of water consumption for natural gas from conventional and shale plays that is currently being submitted for peer review publication. In 2009, as a student at Arizona State University, Harto was awarded the Central Arizona Project award for water research for his work on quantifying the water intensity of low carbon transportation fuels.

David Hollas, Global Director of Sustainability and Environmental Performance, Halliburton Energy Services, Inc.

Throughout his career, David Hollas has maintained a strong interest in water conservation issues. He currently represents Halliburton, where he holds the position of Global Director of Sustainability and Environmental Performance. Before joining Halliburton in 2012, David held various environmental roles in other oilfield service companies, including National Oilwell Varco, Schlumberger and Smith International. He has published and presented numerous technical papers around water quality and aquatic ecology. In his work in the industry, Hollas specializes in water consumption, recycling and treatment and spill prevention. In his role at Halliburton, he directs the overall company strategy for water consumption around activities such as hydraulic fracturing and manufacturing. For these issues in particular, Halliburton has focused on technological solutions that have proven quite effective. Hollas is a member of the National Association of Environmental Professionals, and he also works frequently with the Society of Petroleum Engineers. Hollas' educational background is rooted in aquatic ecology, and he holds a MS in Environmental Science.

Robert Jeffers, Research Scientist, Idaho National Laboratory

Robert Jeffers is a research scientist at Idaho National Laboratory in Idaho Falls, Idaho, where he has worked for over six years. He is primarily a systems analyst with expertise in dynamic modeling of the interactions between hydrologic, energy and agricultural systems. At Idaho National Laboratory he has served as the Principal Investigator on three diverse projects ranging from simulating the energy-water nexus to novel concepts for integration of intermittent renewable energy to the power grid. Robert specializes in developing computer models for cross-sector, integrative, long-term dynamic problems that have clear and relevant management, planning or policy implications. Most recently he developed the Water and Energy Simulation Toolset (WEST), a simulation environment for integrated resource planning of water and energy systems with low data requirements and fast turnaround times. The proof-of-concept WEST model for the Snake River through Idaho determines the coupled behavior of hydropower, agriculture and water availability given assumptions about resource management practices and climate change. Robert has a BS and MS in Electrical Engineering from Virginia Tech and is expecting his PhD in Environmental Science from Washington State University in spring of 2013.

Stephen Jester, Senior Principal Environmental Engineer, ConocoPhillips

Stephen Jester is a Senior Principal Environmental Engineer with ConocoPhillips. He is recognized in the oil and gas industry for his experience in water issues related to hydraulic fracturing. He has 29 years of experience in managing projects related to characterization and remediation of soil and ground water, and water and wastewater treatment, including 15 years in the oil and gas industry. He is currently responsible for managing water issues related to hydraulic fracturing for ConocoPhillips Lower 48 region, including evaluating recycle and reuse opportunities, fresh water and alternative water sourcing and regulatory changes. He formed and led the Eagle Ford Water Consortium, a group of experts from 18 oil and gas companies who manage water issues for hydraulic fracturing in the Eagle Ford Shale. This group funded

and provided more accurate and timely water use data to the University of Texas Bureau of Economic Geology to enable a more robust analysis of water use in hydraulic fracturing in Texas. He has studied and presented on the water supply and demand for hydraulic fracturing in Eagle Ford, including presentations to the US EPA and various conferences and groups in Texas. He is currently working with the American Petroleum Institute to update the "Water Management Associated with Hydraulic Fracturing" guidance document to include recommended practices on baseline water sampling. He has extensive experience in ground water contamination and remediation throughout the Lower 48 states, with past responsibilities that included a large project portfolio and remediation technology development. Jester has received no external research grants from either government agencies, private companies or foundations. He holds a BS in Civil and Environmental Engineering from Cornell University and a MBA from Villanova University.

Mary Kang, Department of Civil and Environmental Engineering, Princeton University

Mary Kang is a subsurface flow modeler with expertise in ground water and geologic storage of CO_2, with over eight years of research and professional experience. Her current research focuses on developing multi-scale models using analytical and numerical solutions for two-phase subsurface flow, specifically for leakage through subsurface pathways. Prior to arriving at Princeton University in Princeton, NJ, she was a Water Resources Engineer at HydroGeoLogic, Inc., an environmental consulting firm based out of Reston, VA, and worked on water resources and ground water contamination projects in the United States and Canada. She is a student member of the Society for Industrial and Applied Mathematics, the Canadian Water Resources Association and the American Geophysical Union and is the student committee chairperson of the Princeton Energy and Climate Scholars. In the area of hydraulic fracturing and drinking water, she is especially interested in baseline water quality monitoring and the potential transport of formation fluids and chemicals used in hydraulic fracturing to ground water and surface water resources. She has a BS in Civil Engineering and a MS in Civil and Environmental Engineering from the University of Waterloo. Kang is a fourth year PhD student in Civil and Environmental Engineering at Princeton University, and is supported by the National Sciences and Engineering Research Council of Canada's Postgraduate Scholarship and the Princeton Environmental Institute's Science, Technology, and Environmental Policy Fellowship.

Ben Kerr, President, Foundry Spatial Ltd.

Ben Kerr is the President of Foundry Spatial Ltd. in Victoria, BC, Canada. He is a geographer with over ten years broad experience in the upstream oil and gas industry in both the public and private sectors in Canada and internationally. This has included applied analysis in play scale estimation of shale gas resource potential and infrastructure development, but for the last three years his work has focused primarily on water acquisition issues. He has been the lead analyst for surface water and integration on the Montney Water Project in Northeast BC (2010-2012) and the Integrated Assessment of Water Resources for Unconventional Oil and Gas Plays, West-Central Alberta Project (ongoing) in the Duvernay/Montney areas of Alberta. Both of these projects are regional studies that have brought together 5-10 oil and gas operators, non-

profit groups, government and communities to provide an integrated view of water resources at the surface, in shallow unconsolidated sediments, and in deep saline aquifers. He is also the technical lead in the development of the Northeast Water Tool (NEWT) in BC (ongoing). The NEWT project led to the release in October 2012 of a publically available decision support tool that provides information on water availability and allocations across an 175,000 km^2 area of BC. He has worked with numerous oil and gas operators to assist in the identification of sustainable water sources and the implementation of regional water management plans considering the range of sourcing options including recycled water. In the area of hydraulic fracturing, he is especially interested in the application of data integration and big data analytics to support clear and open discourse on the water needs of industry, framed in the context of existing stakeholder needs and natural availability. He has a BS in Geography from the University of Victoria.

Daniel Luecke, Environmental Consultant

Daniel Luecke is an environmental scientist and hydrologist who has worked for more than 30 years on water resources, aquatic habitat protection and other environmental issues. Before coming to the Rocky Mountains in 1980, he worked as a senior environmental engineer with a Cambridge, Massachusetts, environmental firm and taught at Harvard University's Center for Studies in Education and Development. He is currently a consultant to the US Department of Justice, Western Resource Advocates, Trout Unlimited and Dividing the Waters, an organizations of federal and state judges who deal with water in the western US, and has been an adviser to the National Wildlife Federation and the *Pueblo Chieftain* newspaper. Over the past several years, he has been an environmental representative on both the Platte River and Upper Colorado River recovery programs. Luecke has served on several advisory committees including the Colorado Water Resources Research Institute Advisory Committee on Water Policy Research; Denver Metropolitan Water Roundtable; California Department of Water Resources Technical Advisory Committee on Desalination; Advisor to the Food and Agriculture Organization of the United Nations; the Advisory Board of the Wirth Chair at the University of Colorado at Denver; the Natural Resources Law Center (University of Colorado at Boulder) and Ruckelshaus Institute of Environmental and Natural Resources at the University of Wyoming. He is the past President of the Board of the High Country News Foundation. He is a graduate of the University of Notre Dame and he received his PhD in Environmental Sciences from Harvard University.

Matthew Mantell, Engineering Advisor - Environmental, Engineering Technology Group, Chesapeake Energy Corporation

Matthew Mantell serves as Engineering Advisor - Environmental in the Engineering Technology Group for Chesapeake Energy Corporation, working out of its headquarters in Oklahoma City. At Chesapeake, he is responsible for produced water management, water treatment and reclamation, environmental issues with hydraulic fracturing, green chemistry development, and chemical disclosure initiatives. Mantell presented in the first set of US EPA technical workshops in the water management section in 2011 on "Produced Water Reuse and Recycling Challenges and Opportunities Across Major Shale Plays." He has developed numerous papers and

presentations on the topics of water efficiency of energy resources and on produced water reuse and recycling and currently serves on a number of Society of Petroleum Engineers technical conference planning committees. Prior to joining Chesapeake in June 2008, he was a staff engineer in the water business group with the consulting firm CH2M HILL, working out of the company's Oklahoma City office. He earned a BS in Geography, a Master's of Regional and City Planning and a MS in Civil Engineering (with an environmental emphasis) from the University of Oklahoma. Mantell is a licensed professional engineer in Oklahoma, Texas and Pennsylvania.

Mike Mathis, Manager, Environmental and Regulatory Affairs, Chesapeake Energy Corporation

Mike Mathis works in Chesapeake Energy's Environmental and Regulatory Affairs group on water resources related issues across the company's operations area. He has had a 34 year career in water resources planning and management, primarily at the Oklahoma Water Resources Board (OWRB) where he was responsible for Oklahoma's state water plan and water rights management, as well as Oklahoma's technical advisor on four interstate water compact commissions. He retired after a 28-year career at the OWRB and now takes that background and experience to Chesapeake. He currently represents Chesapeake on the American Petroleum Institute's Upstream Water Issues Group and chairs the American Exploration and Production Council's Water Subcommittee. Mathis holds a BS in Meteorology from the University of Oklahoma.

Adam McDonough, Vice President, Shale Development Group, American Water Works Service Company, Inc.

Adam McDonough has over 25 years experience in managing and operating various projects in the municipal and industrial water and wastewater industry. His experience includes utilities and utility systems from very small to those serving a population over 500,000. Prior to assuming the role leading American Water Works Service Company's shale development team in early 2012, he led the company's municipal and industrial contract services group. Previous to that position, he was the business unit leader for the American Water's Military Services Group overseeing the company's contracts with Department of Defense. Additionally, McDonough held a series of progressively responsible positions in operations management and oversight within American Water including, director of operations, water plant superintendent and water quality supervisor. McDonough was a laboratory supervisory at Neville Chemical Company for several years. He holds a BS in Chemistry from California University of Pennsylvania and also holds a Pennsylvania - Drinking Water Operators Certificate - Class A Type 1.

Kenneth Nichols, Senior Technologist, CH2M HILL

Kenneth Nichols' background is in water resources and environmental engineering. After college he worked for a major oil field service company, Dowell Schlumberger, as a field engineer in Laredo, Texas. His responsibilities included supervising execution of oil and gas well cement jobs and serving as a field engineer, planning and overseeing execution of hydraulic

fracturing stimulations. Since working in the oilfield, Nichols has gained over 13 years of experience in the water industry, generally focused on ground water resource planning and development including feasibility analysis and cost estimating, deep well injection, aquifer storage and recovery, ground water and solute transport modeling, aquifer test analysis, well design, and well field construction. Over the past two years, Nichols has focused on water supply planning to meet the increased needs of oil and gas companies. Recent and current project highlights include water supply studies in Texas and New Mexico for hydraulic fracturing, permitting for produced water treatment and storage, a regulatory study for the use of brackish ground water as a fracturing base fluid, a regulatory study for the management of produced water across the country, a qualitative risk assessment of hydraulic fracturing operations near a municipal water well field and consulting research related to the water cycle as it relates to the oil and gas industry. Nichols is a member of the National Ground Water Association (NGWA). He is currently a member of the Ground Water Protection Subcommittee which serves the Government Affairs Committee. Nichols, as a member of the Association's Hydraulic Fracturing Task Force, contributed to the NGWA Hydraulic Fracturing Position Paper "Meeting the Nation's Energy Needs While Protecting Ground Water Resources" and served as spokesperson for the paper at the NGWA's 15th Annual Ground Water Industry Legislative Conference in Washington, DC, in February 2012 and during related Congressional meetings. In addition to his work with NGWA, Nichols has given several presentations at conferences on the subject of water management in the oil and gas industry. Nichols received his BS and MS degrees in Civil Engineering from the University of Illinois. During his Master's program, Nichols served as a research assistant for the Illinois State Water Survey studying the effects of agricultural runoff on surface water quality.

Jean-Philippe Nicot, Research Scientist, Bureau of Economic Geology, University of Texas at Austin

Jean-Philippe Nicot is a hydrogeologist by training and has been involved in the water resources side of water management for decades. He currently works for the Bureau of Economic Geology at the University of Texas at Austin, which he joined in 2002. As a full-time researcher, Nicot has worked on many water-related projects across the state of Texas and beyond. Previously, he was involved in the Yucca Mountain Project as a geochemistry/flow modeler and, earlier, worked many years as a mining and exploration geologist for base and precious metals. Nicot has been working on hydraulic fracturing related issues since 2006, in particular on understanding the impact of hydraulic fracturing water use on ground water resources. He is a member of the National Ground Water Association, the Society of Petroleum Engineers and the Geological Society of America. Nicot holds a PhD in Civil Engineering and a MS in Hydrogeology from the University of Texas at Austin (1998 and 1995) and a BS in Geological Engineering (1981).

Mitchell Plummer, Research Scientist, Energy Resource Recovery and Sustainability Deparment, Idaho National Laboratory

Mitchell Plummer is a research scientist in the Energy Resource Recovery and Sustainability department of the Idaho National Laboratory (INL). His research interests and experience range from modeling the impact of changing climates on soil moisture distribution in thick vadose zones to using secular variations in the production of cosmogenic radionuclides as a ground water tracer. At INL since 2001, his work has generally focused on heat transport in the subsurface, with studies including determination of recharge from unsaturated-zone temperature profiles, analysis of thermo-sensitive reactive tracer behavior in geothermal systems and 3-D modeling of heat and ground water transport in the Snake River Plain aquifer. Plummer is an affiliate professor of Earth Sciences at Idaho State University. Plummer received his PhD and MS in Hydrology from the New Mexico Institute of Mining and Technology in Socorro, NM, where his research focused on long-term changes in water balance of surface water, glaciers and ground water in arid regions.

Jim Richenderfer, Director, Technical Programs, Susquehanna River Basin Commission

Jim Richenderfer is Director of Technical Programs at the Susquehanna River Basin Commission (SRBC). His responsibilities include oversight of all technical programs at the commission, which include Project Review; Compliance and Enforcement; Planning and Operations (including Flood Management and Drought Coordination); Monitoring and Protection; Grants and Research and Policy Implementation and Outreach. The SRBC has primary responsibility for regulating water acquisition by all water users throughout the Susquehanna River Basin, including the natural gas industry. In addition, the SRBC shares responsibility along with several other resource agencies for conducting various water quality monitoring programs throughout the Basin, including some areas in which hydraulic fracturing activities have occurred. To date, there have been approximately 2,000 unconventional natural gas wells hydraulically fractured within the Susquehanna River Basin, all of which have relied upon water acquisitions regulated by the SRBC. Before joining the SRBC in 2008, Richenderfer spent over 25 years working as a private consultant serving many Fortune 500 companies located throughout North America. The consulting company he co-founded conducted a wide range of investigations addressing both the quantitative and qualitative aspects of surface water and ground water resources. Richenderfer specialized in the investigation of ground water and surface water problems associated with petro-chemical manufacturing, materials storage, mining and mineral extraction, municipal and industrial waste disposal, and agricultural operations. Richenderfer's academic training includes BS degrees in Forestry (Paul Smith's College), Natural Resource Management (S.U.N.Y. College of Environmental Science and Forestry) and Geology (Dickinson College). He also holds MS and PhD degrees in Hydrology (Penn State University).

Andrew Ross, Senior Hydrogeologist, Water Quality Control Division, Colorado Department of Public Health and Environment

Andrew Ross is the senior hydrogeologist in the Water Quality Control Division of the Colorado Department of Public Health and Environment. He has 13 years of professional experience in water quality regulation, including both the Clean Water Act and Safe Drinking Water Act. Ross serves as the Department's representative on the Colorado Board of Examiners of Water Well Construction and Pump Installation Contractors, which governs the construction of all water wells in the state. In the area of hydraulic fracturing and drinking water, he is interested in baseline water quality monitoring, water acquisition for hydraulic fracturing and the fate and transport of fracturing fluids that are not recovered during the fracturing process. He has a BS in Geological Engineering from the Colorado School of Mines and a MS in Geology from the University of Utah.

Chantal Savaria, Owner, Savaria Experts-Conseils, Inc.

Chantal Savaria is the owner of Savaria Experts-Conseils, Inc., located in Sainte-Julie, Quebec. A geological engineer, Savaria has over 20 years of experience in the field of environmental consulting. Savaria has participated in studies for the Ministry of Sustainable Development, Environment, Wildlife and Parks (MDDEFP) within the framework of Strategic Environmental Assessment on shale gas. One study focused on the analysis of current and past behavior of the shale gas industry in Quebec and abroad, as well as social responsibility practices in the oil and mining sectors, applicability study of the social responsibility framework proposed by ISO 26000 and other international standards and, where appropriate, analysis of the relevance of their application to the shale gas industry in Quebec. She also collaborated on a study focused on the potential mechanisms (certification, disclosure, cross-compliance) ensuring the adoption of best practices by the operating companies in the mining sector. Savaria is a lecturer on environmental site assessments as part as the Master's in Environment program at the University of Sherbrooke. Recognized in her field, she obtained the titles of Certified Environmental Site Assessment and Certified Environmental Auditor. In addition, she is listed as an expert on the MDDEFP list of experts under section IV.2 of the Environment Quality Act and she is a member of the ASTM International subcommittee on hydraulic fracturing. For the last two years, she has been part of the technical review committee of the Green Municipal Fund. In addition, she acted as a corresponding syndic for Quebec Engineers Order and as an expert witness for many clients. Finally, Savaria had the opportunity to give a lecture on ecological and public health challenges of shale gas at the Fifth Conference of 2012 Conferences of the scientific Collective on the shale gas question in Quebec. Savaria is a graduate of Polytechnique Montreal.

Daniel Soeder, Research Scientist in Geology and Hydrology, US Department of Energy

Daniel Soeder is a research group leader, laboratory manager and scientist with the US Department of Energy at the National Energy Technology Laboratory in Morgantown, WV. His research includes assessment, characterization and environmental studies related to the production of unconventional fossil energy resources such as shale gas, shale oil and tight gas

sands, assessments of water resource risks and impacts from hydraulic fracturing, the application of petrophysical data, pore geometry and imaging to oil and gas recovery in low permeability reservoirs and the geological storage of CO_2. His previous experience includes 18 years as a hydrologist with the United States Geological Survey (USGS) in Delaware-Maryland-DC and on the Yucca Mountain Project in Nevada. His research included ground water contamination studies, source water protection assessments, streamflow and surface water supply studies and management of a basic hydrologic data collection program. He served three years as chair of the Science and Technical Advisory Committee for the Delaware Estuary Program, which included interactions with representatives of state and local governments, academia and other Federal agencies such as the US EPA, Corps of Engineers, National Park Service and U.S. Fish & Wildlife Service. His recent collaborations with the US EPA and the USGS have focused on preparing cooperative environmental risk assessment plans for unconventional oil and gas at the national level, and specifically focused on the Marcellus shale in the Appalachian Basin. He received hi BS in Geology from Cleveland State University and his MS in Geology/Marine Geology from Bowling Green State University.

Andrew Stewart, Project Manager, Stewart Environmental Consultants, LLC

Andrew Stewart is a Project Manager for Stewart Environmental Consultants, LLC. Stewart has been involved in strategic engineering for water, energy and the environment for the past eight years. Stewart has been involved in the beneficial reuse of produced water for over seven years. Stewart was involved in the Wellington Water Works produced water treatment plant in Wellington, Colorado. This is the first facility in the United States to successfully treat produced water for beneficial reuse. This facility treats up to 5,000 bbl/day and has been in continuous operation since 2006. This project was initiated in 2001. This project treats produced water for sale as a new water resource. The effluent from this facility has been used for organic crop production as well as hydraulic fracturing fluid makeup water. It has the first vested water right in the State of Colorado for beneficial reuse that withstood the Colorado Water Court system. This facility is also the basis of the statues and law (House Bill 1303 and Senate Bill 165) for the beneficial reuse system of produced water in Colorado. Stewart received his BSCE from Carroll College in Helena Montana. He is currently pursuing his Masters in Environmental Engineering from Colorado State University.

Patrick Sullivan, Principal Geochemist, Aquilogic, Inc.

Patrick Sullivan has been an expert in the water quality of drinking water, sources of chemical contamination in water resources, geochemical modeling of contaminant fate and transport and water treatment for over 35 years. As an Environmental Engineering Fellow with the American Association in for the Advancement of Science in 1983, Sullivan worked for the US EPA Office of Drinking Water, Ground Water Branch, Washington, DC, on a national technical/policy evaluation of hazardous waste injection practices. Following this work he received a two-year contract with the US EPA to continue to assess the geochemistry of Class I waste injection in former petroleum reservoirs. Sullivan managed the Department of Energy's Oil Shale and Coal Gasification Solid Waste Research Program at Western Research Institute, Laramie, Wyoming, from 1985-1988. This program characterized the organic and inorganic

chemical contamination of water resources associated with the mining, processing and in situ resource extraction of oil shale and coal gasification projects and the application/evaluation of wastewater treatment technologies to extractions processes. He received his BS in Geology/Geochemistry, MBA and PhD in Soil Chemistry from the University of California, Riverside.

Brenan Tarrier, Environmental Engineer, Bureau of Water Resource Management, New York State Department of Environmental Conservation

Brenan Tarrier has worked for the New York State Department of Environmental Conservation since 2007 in the Bureau of Water Resource Management. He has been involved with the development of the narrative standard for flow alteration and the transition to a state-wide water withdrawal permitting system enabled by recent legislation. His experience in hydrological modeling includes the Hydrologics OASIS model for the Delaware River Basin, development of the New York City Operational Support Tool and Hydrologic Engineering Center software packages such as the Hydrologic Modeling System, River Analysis System and Reservoir System Simulation. He represents New York State on the Delaware River Basin Commission (DRBC) Regulated Flow Advisory Committee as well as several technical workgroups of the DRBC, Susquehanna River Basin Commission and Delaware River Decree Parties. He holds a MS in Nanoengineering from the University at Albany – State University of New York and a BS in Biological and Environmental Engineering from Cornell University.

Joel Thompson, Senior Hydrogeologist, Stantec, Inc.

Joel Thompson has more than 17 years of experience in conducting and managing hydrogeologic investigations including ground water, free phase and gas flow and transport modeling, water supply assessments, quantitative hydrogeology, ground water statistical analysis, hydraulic testing, ground water contamination and water resource studies. Thompson is a technical adviser, develops and reviews hydrogeologic programs and has provided support on numerous hydrogeologic projects throughout the United States and abroad. Thompson's current emphasis is on hydrogeology, baseline water quality, development of conceptual models and fate and transport issues surrounding oil and gas production and in particular, hydraulic fracturing practices. Thompson has advised clients in a number of environments including the Bakken, Marcellus, Utica shale gas plays. Thompson has extensive experience in ground water flow and contaminant transport in sedimentary bedrock, fractured and karsted limestone, complex glacial and hard rock environments and has worked multiple scales from site level up to the basin level. He has performed ground water modeling for water supply acquisition, assessing corrective action alternatives, development of ground water remediation systems, evaluation of natural attenuation and design of ground water dewatering systems. He has extensive experience in quantitative hydrogeology, ground water modeling, contaminant hydrogeology, vadose zone contaminant fate and transport, geophysical log interpretation and well design and installation. Thompson participated in the US EPA Hydraulic Fracturing Technical Workshop on Fate and Transport held in 2011. He received a BA from the University of Wisconsin, Madison in 1993.

Amy Tidwell, Engineer Specialist, ExxonMobil Upstream Research Company

Amy Tidwell is an Engineer Specialist at ExxonMobil Upstream Research Company. Following four years' experience as a research professor in the field of water resources, she joined ExxonMobil in 2010, where she serves in the Environmental and Safety Technology Section. Her current research interests include the application of lifecycle assessment techniques to questions related to oil and gas production, oil spill response, and arctic ecosystems modeling. She holds PhD and MS degrees in Civil Engineering from Georgia Institute of Technology and a BS in Civil Engineering from the University of Alaska Fairbanks.

Vincent Tidwell, Distinguished Member of Technical Staff, Sandia National Laboratories

Vincent Tidwell is a Distinguished Member of the Technical Staff at Sandia National Laboratories. He has over 20 years' experience conducting and managing research on basic and applied projects in water resource management, nuclear and hazardous waste storage/remediation and petroleum recovery. His efforts have helped establish a program at Sandia devoted to the creation and application of computer-aided decision support tools and stakeholder mediated decision processes. Applications range from regional to international and include long-term water planning, integrated energy-water planning, renewable energy, climate change and rural sustainability. Currently he is leading several studies that address issues concerning the energy-water nexus including support for long-term transmission planning in the Western and Texas interconnections, carbon capture and sequestration impacts on water use, regional study in the Great Lakes Watershed, and support of DOE's Office of Policy and Solar Program. He is an adjunct professor at the University of New Mexico, New Mexico Tech and the University of Arizona. He served on Governor Richardson's Blue Ribbon Task Force on water and is a Lead Author for the Water, Energy and Land Use chapter in the 2013 National Climate Assessment.

D. Steven Tipton, Operations/Completion Engineer, Newfield Exploration Company

D. Steven Tipton is a registered professional engineer in Oklahoma and Texas with over 45 years experience primarily in drilling, completion and production operations throughout the US, Canada, Trinidad and Yemen. He has engineered and supervised the drilling and completion of several hundred horizontal wells is Oklahoma, Texas, Louisiana, North Dakota and New Mexico.He is currently employed by Newfield Exploration in Tulsa, OK. His primary responsibilities have included drilling, completion, production and water management for the company's operations. Tipton is a primary mentor for newly hired engineers and summer interns, and provides technical expertise to the company's engineering staff. He has made presentations at numerous technical meetings and conferences on water management including the US EPA's Technical Workshops for Hydraulic Fracturing in 2011, Society of Petroleum Engineers Advanced Technology Workshops, the University of Tulsa, the Oklahoma Independent Petroleum Association Unconventional Resource Forum, Oil Sands Water Management Initiatives, Water Management for Shale Plays and in-house training at Newfield for new engineers and geoscientists.

Denise Tuck, Senior Product Champion for Production Enhancement, Halliburton Energy Services, Inc.

Denise Tuck is a Senior Product Champion for Production Enhancement. She provides technical support on chemistry and fluids for stimulation and hydraulic fracturing. Formerly, she held the positions of Environmental Compliance and Permitting manager and Global Chemical Compliance manager in Health, Safety and Environment for Halliburton. She joined Halliburton in 1990 and has over 30 years of experience in environmental pollution control systems design and regulatory permitting and compliance for the upstream and downstream oil and gas industry. She co-authored two sections in the National Petroleum Council report on Prudent Development "Realizing the Potential of North America's Abundant Natural Gas and Oil Resources." She has a BS in Chemical Engineering from Auburn University.

W. Joshua Weiss, Senior Principal Engineer, Hazen and Sawyer, PC

W. Joshua Weiss is a Senior Principal Engineer at Hazen and Sawyer, PC, in Baltimore, Maryland. He specializes in water resources modeling, water supply management and source water quality. He has extensive expertise in water supply planning and real-time management of reservoir systems to meet multiple objectives. He currently serves as Task Leader for implementation of New York City's Operations Support Tool, an innovative decision support system that links hydrologic and water quality models of NYC's water supply system and the lower Delaware River Basin with near-term and long-term meteorological forecasts in order to support both short-term system operations (e.g. diversion and release decisions) and long-term capital planning decisions. Weiss is part of the team of engineers and scientists that performed an award-winning study of the potential impacts of hydraulic fracturing on NYC's water supply.

Lloyd Wilson, Research and Special Projects Coordinator, Bureau of Water Supply Protection, New York State Department of Health

Lloyd Wilson is an environmental scientist with more than 25 years of research and professional experience focused on preventing human exposure to contaminants in the environment. His work has involved assessing potential sources of exposure to various compounds through different media. He has overseen projects investigating asthma emergency room visits and ambient air pollutants, polychlorinated biphenyls in public drinking water supplies that use the Hudson River as a source of water, mold and indoor air quality issues, climate change and numerous other drinking water quality issues. For the last five years he has been evaluating potential concerns with impacts of high volume hydraulic fracturing (HVHF) used in development of gas and oil wells. Specifically, he has been involved with reviewing all aspects of the New York State Department of Environmental Conservation's HVHF environmental impact statement. He received his PhD from the University at Albany School of Public Health in Toxicology and Occupational Health, where he also currently holds a position as an Assistant Professor.