WORKFORCE EDUCATION, DATA, & RESEARCH

2016 Texas Water Roadmap Forum

"Vigorously defend the integrity of data and evidence in the management of water resources."

- Dr. Cynthia Matson

Welcome Address

President, Texas A&M University–San Antonio

Report of the

2016 Texas Water Roadmap Forum

Held at
Texas A&M University–San Antonio
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Acknowledgments

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Host

Institute for Water Resources Science and Technology
Texas A&M University–San Antonio

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Foreword

The Texas Water Development Board (TWDB) and National Science Foundation Research Coordination Network on Climate, Energy, Environment and Engagement in Semiarid Regions (NSF/RCN-CE3SAR) co-sponsored the 2016 Texas Water Roadmap Forum. Focusing on workforce education, data, and research, the forum was hosted by the Institute for Water Resources Science and Technology on the campus of Texas A&M University–San Antonio on November 29, 2016. The forum brought together Texans from diverse technical, academic, research, management, and business backgrounds in water to participate in the third in a series of water roadmap forums facilitated by NSF/RCN-CE3SAR. By envisioning a future Texas where water security is assured for people, industry, food production, and nature, forum participants sought to develop solid plans to set priorities for action and frame key milestones with an overall goal of securing Texas' water future.

"Solutions will require coordinated efforts by many in the water sector acting in trust and single-minded purpose through partnerships, consortia, and networks."

- Dr. Andrew Sansom

Keynote Presenter

Executive Director, Meadows Center for Water and the Environment

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Summary

The Texas Water Development Board (TWDB) and National Science Foundation Research Coordination Network on Climate, Energy, Environment and Engagement in Semiarid Regions (NSF/RCN-CE^{3}SAR) co-sponsored the 2016 Texas Water Roadmap Forum, held on the campus of Texas A&M University–San Antonio on November 29, 2016.

Focusing on workforce education, data, and research, the 2016 Texas Water Roadmap Forum was hosted by the Institute for Water Resources Science and Technology, Texas A&M University–San Antonio. The forum brought together Texas water experts from diverse technical, academic, research, management, and business backgrounds to participate in the third in a series of water roadmap forums held in San Antonio and facilitated by NSF/RCN-CE3SAR.

By envisioning a future Texas where water security is assured for people, industry, and nature, forum participants sought to develop solid plans for action to help secure Texas' water future.

In the area of data management, forum participants listed their vision for the future and actions to achieve the endpoints envisioned through enhanced data storage, use, and access. They concluded that government entities, but not any single one, are best suited to build and maintain the requisite data platforms. They suggested a measured evolution by working through large-scale collaborations to create data repositories, develop standards and norms for databases, and use big data analytic platforms and dashboards for data interpretation and visualization.

For workforce education, participants sensed little effort by universities to realign curricula to meet the needs of an industry rapidly evolving as new technologies and regulatory requirements change water workforce education requirements. They suggested students be offered a broader curriculum than generally available through traditional civil engineering degree programs. They supported internships to provide students with experiential learning opportunities. They also advocated locally offered education for local water industry jobs to address the need for the water workforce to be reflective of the society it serves and to meet the varying nature of water infrastructure of differently sized and rural communities.

Participants listed research underway versus research that industry and government currently need. The two lists were markedly different, with only one broad area of overlap: desalination technologies and energy demand. They proposed follow-up response by forum attendees in 10 areas of water-related research.

For funding and partnership development, participants felt that it will be more effective to work through existing partnerships than to create new ones. They agreed to explore a series of collaborations, including (1) a large-scale collaboration on improving dataset use and access, with discussion to be hosted initially by the TWDB, and (2) forming partnerships with small communities for new work on capital-related projects to be supported by financing available through SWIFT and the state revolving fund.

Plenary Sessions

"If one small community in Texas runs out of water, Texas is out of water."

- Ms. Kathleen Jackson

Keynote Presenter

Member of the Board, Texas Water Development Board

Dr. Cynthia Matson, President of Texas A&M University–San Antonio, welcomed forum participants by stating how inspired she was to see water experts from so many different segments of the water sector coming together to share their experience and advance the water agenda in the state of Texas. She also cautioned the audience about a growing dialogue challenging the importance and integrity of science. She asked Texas' water leaders to vigorously defend the integrity of data and evidence in the management of water resources.

Dr. Matson then introduced, TWDB Board member, Kathleen Jackson, morning plenary session keynote speaker.

Ms. Jackson explained the roles of the TWDB, and emphasized Texas' unique approach to water management. Using a locally-driven process, Texas relies on members of 16 regional water planning groups, the TWDB, and other state agencies to determine the status of current water resources, population and water demand projections, forecast future needs for projects, and develop strategies to meet water needs. The 16 regional plans combine to form the state water plan. The TWDB serves communities as a technical resource in this planning. Teams go across the state and meet with community water leaders, assist with defining needs, and then provide ideas on moving forward with implementation, which is also locally-driven.

Texas is fortunate to have funding and access to technology to enhance community water infrastructure, but it's up to local communities to initiate project development and implementation. This is where the State Water Implementation Fund for Texas (SWIFT) comes into play, by providing low interest financing for projects identified by local communities in the planning process.

Ms. Jackson suggested a role for water experts in the project implementation process, with 2,500 projects and 5,000 strategies contained in the 2017 State Water Plan. Many of the projects in the plan have been proposed for many years, but local sponsors are looking to move forward on new projects using today's best solutions which may involve new technologies or innovative ideas. A role for researchers and other water experts is to work with local sponsors in communities to help develop the projects and find innovative solutions. Innovation will include use of technology, but solutions must also focus on enhancing water project operational integrity, reliability, and efficiency (including projects for water conservation).

Ms. Jackson was asked what forum attendees could do to reach rural communities more effectively with support. She stated that rural communities are diverse with diverse needs, but it's not always lack of funding that constrains progress. Instead it may be a lack of effective planning by local communities to identify objectives and real needs. Only after a plan is in place can a community effectively move forward on projects and seek SWIFT or other funding. Water experts can engage with communities to help develop the ideas and detailed plans for projects.

Ms. Jackson concluded her remarks by stating that we don't just need water for the big cities, we also need water for rural Texas. She said, "Coming from a manufacturing background, I know you are only as good as your poorest performer. If one small community in Texas runs out of water, Texas is out of water. It's up to all of us to make sure that the rural communities of Texas have the water they need."

Afternoon keynote speaker, Dr. Andrew Sansom, Executive Director of the Meadows Center for Water and the Environment at Texas State University, addressed the idea that only through effective partnerships will Texas progress toward water security. Of great concern is over-allocation of Texas' flowing waters as well as policies that often conflict with science and thwart implementing realistic solutions. For the most part in Texas, taps have continued to flow in our kitchens and toilets continue to flush, masking the underlying threat posed to the economy and environment by weather's widening swings from parching drought to sharp flooding. Solutions will require coordinated efforts by many in the water sector acting in trust and single-minded purpose through partnerships, consortia, and networks.

Following comments from Dr. Sansom, plenary session speaker Dr. Robert Mace, Deputy Executive Administrator for Water Science and Conservation of the TWDB, focused on his dreams for the future for education and information sharing, and then challenged participants to come together to help meet needs for research and find means to finance advances in water science.

Master of Ceremonies and charrette facilitator, Dr. Jorge Vanegas, Dean, College of Architecture, Texas A&M University-College Station and Professor, Texas A&M Engineering Experiment Station laid groundwork for the day's charrettes by stating the goals and aspirations. He asked participants to envision a future Texas where water security is assured for people, industry, food production, and nature – and then asked, "How do we get there?"

Points of Departure

This forum is the last in a series of three water roadmap forums building from a point of departure initially focused on new water-related technologies and how to accelerate technology's rise from lab bench through marketing and on to industry application.

It seemed like a relatively simple undertaking at the first water roadmap forum to design a water technology roadmap. But we were soon confronted with the complexity of water. The water sector is affected by economic, historic, social, environmental, political, regulatory, and legal, as well as technological challenges. Further, the water sector exists in a context of complexity, volatility, uncertainty, and ambiguity. We heard that many – perhaps most – of the problems we face in the water sector will not be solved through use of new technology. Critically important to Texas' water future is addressing obstacles such as undervaluation of water, counter-productive policies, old and failing infrastructure, investment and market challenges, and siloing of just about everything water. All were considered impediments to achieving water security in Texas, while technology development was seen as providing new tools of value to achieve incremental gains.

Building on results of the first forum, the second focused on the intersection or "nexus" of water, food, and energy. Participants heard about how water, energy, and food programs are inextricably linked. But programs in these areas in our agencies, institutions, and industries are fragmented and unconnected. We also heard how education systems are too slow in responding to need for more integrated teaching about sustainability, and are failing in delivery of job-ready workers for water industries. We heard clearly a deep concern expressed about a growing information gap in public understanding about water matters, about a need to better address general information and outreach about water to all sectors of society, and about need for improved technical data storage and delivery industry wide.

This third forum explores challenges identified in the first two forums. This last forum will further define communication, information management, data access and associated research as highlighted in previous forums. It is also an opportunity to further define improvements in education and training of a water workforce that will see considerable turnover and repositioning in the near future.

Dr. Jorge Vanegas, in his instructions on the charrette process asked participants to think in terms of their current and future projects, funding, and partnerships. The subject matters are of interest to all partners hosting the forum, including to the Texas Water Development Board. There is a need to understand in greater detail what university researchers are doing now, relative to what water experts in government and industry may feel needs to be done now.

The main goal of the forum stated by Dr. Vanegas is to prioritize and frame key milestones, with the overall objective of securing Texas' water future while accelerating growth of Texas' water infrastructure, technologies, industries, and sustainable water use.

We are seeking a few tangible action plans to move forward. We won't and can't solve all the issues around water with a series of one-day forums, but we will be successful if we are able to set a path to address one, two or three of the matters that come from participants. We should be able to do that because participants represent leading experts in Texas' water sectors.

The Water Forum Agenda

A plenary session in the morning was followed by four breakout sessions, with participants able to choose which session to attend. An afternoon plenary session was then followed by two breakout sessions. Each breakout allowed participants to engage in intensive planning (charrette) in which various "stakeholders" (including participants from academia, industry, government, and nonprofit organizations) collaborated in creating a vision for action. A final plenary session was held after all breakouts concluded to summarize the days results and provide a charge and challenge to forum participants.

The full forum agenda is provided as Appendix III

Four morning breakout charrettes:

- Data, Information, Communication, Sharing, Expertise
- Workforce, Education Needs
- Research Needs I: Water Sources and Transport
- Research Needs II: Water Use and Enabling Technologies

Two afternoon breakout charrettes:

- Funding Opportunities
- Partnership Opportunities

Introduction to Roadmapping

The objective of 2016 Water Forum roadmapping was to find consensus among water experts on a pathways (plans) to enhance data handling, workforce education, and research partnerships and funding in the water sector.

The 2016 Texas Water Roadmap Forum was designed as a charrette bringing together invited water sector leaders committed to addressing issues surrounding collection and use of data, workforce education, and research, including partnerships and funding. The NSF/RCN-CE^{3}SAR served as an independent facilitator.

Participants focused on defining the most critical problems facing the industry in the areas of workforce education, data, and research.

Barriers and solutions were discussed. Participants also considered roles of the various water sectors and opportunities for cooperation. From this, a pathway for promoting a better understanding of how to move forward is proposed.

Roadmaps

Setting the stage to better define data, education and research in the context of a roadmap are two previous roadmapping charrette forums: http://TexasWaterTech.org and https://www.tamus.edu/research/tamus-resource-nexus-water-forum/

Roadmaps are much like strategic plans. At the outset, roadmaps require clear vision of the goal and objectives.

The roadmap displays a continuum of steps to take to achieve stated outcomes. It outlines links among tasks and priorities for action. Stakeholders help create a consensus around performance targets, pathways, assets, priorities, obstacles, and time frames for research, development, demonstration, and deployment.

Roadmaps are often used as a means to help display and simplify understanding of complex systems. The process itself engages and aligns stakeholders in a common course of action.

Building a roadmap is a dynamic process. Over time, the roadmap must evolve and be adapted, accommodating the successes and failures of implementing roadmap-guided actions, with stakeholders remaining engaged.

Water Forum Charrettes

Water forum roadmapping was done through an intensive facilitated process called a charrette which involved people working together under compressed deadlines.

Charrettes provide an interactive process in which a diverse group of stakeholders, representing pluridisciplinary perspectives (i.e., multi-, inter-, cross-, and trans-disciplinary) are brought together. Participants follow a rigorous, facilitated vision-driven process to achieve specified outcome-oriented goals and objectives. Charrettes are well-suited to encourage discussions that go beyond conventional thinking, and stretch the envelope of the status quo into the realm of new possibilities.

Participants had opportunity to organize and express their thoughts in advance of the charrette by completing a "pre-charrette survey." Survey information was used to form charrette questions and inform facilitators about areas of possible discussion in their small groups.

Upon arrival at Texas A&M University–San Antonio, participants received a welcome from the president of the university and an objective-setting presentation by TWDB Board Member, Ms. Kathleen Jackson. Participants then received a briefing on the charrette process and were asked to attend any one of four charrette sessions in the morning and any one of two in the afternoon.

Discussions during charrette sessions offered participants an opportunity to contribute and learn from others. Discussion is an essential element of the charrette, because it begins the vitally-important process of developing a common understanding among participants. While in subgroups, participants brought forward the most critical issues regarding data, workforce, and research. They focused on identifying barriers and the roles of the private, government, academia, and research sectors.

Moving from generalized to more detailed considerations, participants established agreements on solutions, near-term needs, gaps, and scenarios for collaboration, coordination, funding, and alignment of opportunities. After breakout discussions, a closing session provided participants an opportunity to hear highlights from each breakout.

Breakout group facilitators presented the summaries. A presentation by lead facilitator Dr. Jorge Vanegas during the final plenary session offered participants an opportunity to contribute to possible next steps. Participants were asked, "[I]f you had the power to ask the water professionals assembled at the forum to do one thing, what would it be that you would ask us to do?" Time limited the number of participants able to contribute. All were invited to provide answers in a "post-charrette survey."

Results - Data & Information

This breakout session focused on Data, Information, Communication, Sharing, Expertise. Participant attention turned to discussion about overcoming impediments to communicating, transmitting, and accessing data, research needs, expertise, and other information about Texas water science, policy, and research to increase and improve its use by decision makers, agencies, and others. Questions posed to the group included the following: How can information be shared most effectively and efficiently? Ideally, who should lead efforts to develop information sharing resources?

Participants first agreed that the term "data" has a broader definition today than ever before. Traditionally, data has generally been thought of as the quantitative and qualitative results of studies, often restricted to numerical values. Today, the term "data" includes so much more than just numbers from a study, i.e., primary data. Secondary data includes reports, analysis, and communications about data (e.g., on social media). Additionally, there is the context surrounding data, the metadata, as well as tools to process the data or organize the data in a way that changes the meaning of the data. Data is stored in a variety of locations, both on- and off-line, existing in a fashion that often keeps similar data sets fragmented, isolated, and maintained through differing standards and platforms. This condition or "state of the data" was a recurring point of discussion throughout the session. Extreme variation and fragmentation in form and format of stored data affects how efficiently data can be located, accessed, used, understood, validated, and communicated.

Participants sought means to better organize data storage and access, and to lessen the siloing of data, or to design a means to effectively manage across silos. It was noted that everyone in the audience potentially is working within an organization that already has its own way of managing and storing data produced internally, including how data gets accessed by others. Some organizations may expressly prohibit access to data, except under highly controlled circumstances while others depend on immediate access and control of the data for their operations (e.g., a public utility). The variety of organizations in the water sector naturally creates a variety of silos. Participants expressed an interest in moving past existing conditions, or at least in creating bridges between the silos.

Participants were asked to imagine a future where existing concerns and issues surrounding data and communication were resolved. What would that look like and what could be done with it?

Here are some of the ideas of participants who recommended an ideal state of affairs for data, information, sharing, expertise, and communication. The exercise generated sentences beginning with "Wouldn't it be great if..."

- ...all data is open to access and legal barriers restricting access to and use of date were reduced. So much data is proprietary making it virtually useless in addressing Texas' water problems, or anything else."

- ...there is a statewide database available through standard internet connections with indexing that is easily searchable by scientists and the public."
- ...technical people are better trained to better communicate about data and information to the decision makers and to the general public."
- ...there are norms and standards for types of data reporting, including a process to resolve conflicts in data formats across organizations."
- ...there is a single place to find out who is doing what in water. Everyone has lists that they look at, but it's difficult to say there is just one place to look for an expert."
- ...there is expert design "views" or "dashboards" for specific audiences, revealing linkages between primary, secondary and meta data, including information about why the data is created and how data is funded."

Participants agreed that if your job is to deal with any of the above issues that there is no easy resolution or route to achieve the endpoints envisioned. They then suggested that there are significant and instant benefits to working toward improved coordination and communication of data sets. For example, there are substantial opportunities to reduce costs of programs through increasing efficiency and reducing need to duplicate data already existing if one can locate, access, use, and consolidate existing data sets. There also would be increased opportunity to communicate with decision makers and the general public – and to do so with greater credibility – if everyone understands scientists and communicators are all working from a single (or synchronized) and reliable data set.

Participants looked at the area of risk management. There was agreement that there needs to be greater clarification or methodology to identify the risk level associated with certain datasets for specific uses. This accentuated the notion that not all data are equal in terms of quality, timeliness, and other important factors that determine the level of usefulness or reliability. Pending use, there can be risk, for example when data are use in applications that carry risk to human health or safety, such as water treatment or watershed modeling. There should be developed a means to promote standards and norms, as well as evaluate the relative quality and timeliness of data across various data sets. As a component of this evaluation, there was concern that the quality or usefulness of data can change over time. Some kinds of data get "old" very fast. For the purpose of evaluation, participants suggested that originators of data may have the best perspective on the usefulness of any particular data set over time, so linkages or bridges back to originators of data are essential in any comprehensive data storage platform.

Following along this line, participants also suggested that some effort be made to predict the types of data that would be required in the future.

Participants suggested a role for the private sector in helping verify source data, as a means to expand data quality assessment beyond the academic and institutional research community. This was thought to help introduce evaluations of economic, social and natural systems value. This may bring into play factors that may be beyond the scope of the intent of originators of a data set. It will increase the level of complexity, but such evaluations may provide a more realistic, real-world evaluation, especially if there is any intent for data to be used in industry, utility, water district, or government applications.

Participants concentrated efforts on explaining how to establish standards and norms that facilitate data sharing, improve use, evaluate risks, and assess social and economic considerations, including how to make the data more available and useful to diverse audiences. In the course of this more focused examination, participants concluded that government entities, but not any single one, would be best suited to build platforms for data sharing. This was concluded despite participants agreeing to the ideal of having one open source for data. Participants felt such an ideal was probably currently unrealistic to expect to actually happen. Government entities were considered best suited to build data storage platforms and bridges between platforms. Participants reasoned that many government entities, for example most federal agencies, are required to maintain information in an open source fashion, make data accessible to the public, and many have both experiences and requirements to design, build, and maintain information for public use.

Participants also suggested a way to move the recommendations forward. Instead of an instant restructuring, they suggested evolution toward data repositories on a priority basis and by building case studies, using as examples small existing database platforms that are accessible and performing in a satisfactory fashion for users. By building on current success stories for smaller data sets, more complex databases can be added through the action of groups working through consortia and collaborations. To support such progress, participants suggested the overwhelming amount of data now available requires application of big data analytic platforms to advance assimilation, including creating dashboards for visualization of what data is where and visualization of potential applications. In other words, participants felt that there is such a large and varied amount of data now available in Texas, that it's not just better placement and linkages of data that's needed. Also needed is a better means to distill all that data into, or through something that can be understood or visualized for use.

Results - Workforce Education

This breakout session focused discussion on the need for more highly educated, skilled, and degreed water workers for the future. What are current and future water workforce needs? How do we address these needs to the benefit of Texas' water industries, groundwater conservation districts, utilities, and others?

Participants evaluated the notion that people's faith in water managing institutions is dwindling in the aftermath of the publicity surrounding recent water quality events that were harmful to public health in Flint, Michigan. The result has been a heightened public recognition of a need for education and workforce development in the water treatment industry.

Continuing to use examples in the public health system as an analog, participants stated that there is need for a more liberal education for people who work in water management. In the past, most water management workers who held four-year degrees were trained as civil engineers. Participants agreed that future education of students seeking employment in areas of water management and conservation needs to be broader than that generally available through a civil engineering degree program. Students should receive training in ethics, policy, business, sociology, and communication.

University Training. It appeared clear that maintaining a relevant curriculum for water workforce training and education requires university educators and administration to understand and be responsive to industry needs for workers. Industry need is now driven by regulatory requirement changes and by advancing technologies and rapid incorporation of new technologies into facility design, operation, and renovation. However, there appears to be little or no rapid alignment between university curricula, changing technologies, and regulation changes. There needs to be more timely alignment between policy makers, educators, and workforce providers. This discrepancy exists despite the fact that there is little likelihood that yesterday's curricula offered to students who wanted to work in the water industry will provide the best training for the jobs of today and tomorrow. No longer is the water industry a sleepy static industry. Universities need to wake up and respond if their degree programs and graduates are to remain relevant. University curricula need to be flexible and adapt.

Further, as a person moves forward in their career, while they may start on the operational side of the business, many workers eventually end up on the planning and management side of the business. Sometimes this may not be by choice. Participants questioned if students in today's water programs learn what they need to know to make this transition efficiently and effectively. Students should at least have the option to receive basic training useful in moving into management and administration.

During plenary discussions, all participants were asked if any university programs are now providing a more holistic, or diverse education. In answer, it was stated that there are some graduate level programs that allow students to design interdisciplinary programs for themselves. The graduate program in "Water Management and Hydrological Science" at Texas A&M is an example. It was stated that there are few, if any programs adapting to today's needs at the undergraduate level.

The proposed undergraduate program at Texas A&M University–San Antonio was mentioned as a step in the right direction.

There appeared to be a feeling among participants that most universities are completely missing out on an opportunity: water industry needs are not being met, thus students are missing the opportunity to train for jobs in a good paying stable industry that is often located right in their backyard. There was agreement that internships are critically important as a way to gain experiential learning in the water industry. Such experience can only be obtained by working at or around a water plant, not just by reading about a plant or taking a tour

Diversity. There was discussion about need for greater diversity in the workforce and the role of universities in achieving such diversity. Participants described diversity as more than just diversity of ethnicity, race, and gender of water workers, however, because they felt there also needs to be greater diversity in leadership ranks and in the disciplines students are exposed to. This continues the discussion about universities offering a broader education, going beyond the general model of water workers coming from a traditional civil engineering program. There was a feeling workers also need to come with backgrounds in water management, water resources, water conservation, and more.

Participants advised that the water workforce should be reflective of the society it is serving. Thus, managers/directors of water utilities or districts should take into account the social and economic nature of the community and people they serve. Managers should support educating people in the local area to take the jobs that will eventually appear in the utility managed. Participants advise this will help ensure the utility meets the technical needs of stakeholders for services as well as the social and political needs for ensuring transparency and openness to stakeholder opinion, public education and perception of understanding of stakeholder needs.

Workforce Longevity. Participants recognized that the notion that workers will stay in a position for decades, which may have been the model in the past, will no longer hold up. It is more likely that current trends in other industries, where worker tenure is only a few years, will become the new model in the water industry as the coming wave of retirements ushers in a new generation of water workers. There is an expectation that this will help bring in a continual stream of new ideas and new ways of doing things.

Public Outreach-Education. Participants described a growing dichotomy in need for education of the public and need for educational outreach by members of the workforce, educators and educational institutions. While the need to educate the workforce is well defined, there also is a critical and growing need to educate members of the general public. In defin-

ing what they meant by "general public," forum participants felt that educational programs need to be directed to everyone – all segments of the public – because need for water, use of water, and disposal of water affect everyone. Participants felt that if the public doesn't understand the value of water, then water managers and managing agencies will face continuing and growing challenges managing water and continuously improving water management infrastructure.

Serving the Needs of Rural Texas. Participants pointed out a need to recognize and account for the fact that differently sized communities are going to have different needs for water workers and education about water. Large-scale water works are more complex, with more demands for treatment and on the workforce, requiring larger better trained workforces. There will be greater demand for additional skills in a larger versus smaller community as water workers advance in their careers.

Participants raised concerns about supply and demand for appropriately educated and experienced water workers in Texas' small and rural communities. In the future, should regulatory requirements or other necessities demand use of higher tech water solutions in small and rural communities, then water workers with high levels of training may be required to operate such plants using more complex, new technologies. Workers having high levels of training will likely expect higher levels of compensation and benefits than has been generally associated with water workers in rural Texas. Participants raised questions about small rural communities being able to afford and retain highly trained workers. But it was not just the challenge of meeting compensation expectations that was discussed. Workers will need continuing education and will need to be comfortable living in small, possibly remote communities with possible limited educational and social opportunities for a family. One participant suggested this may present an opportunity to design small water facilities for operation and management through a virtual interface.

Legacy Infrastructure: Training and Education. In many locations in Texas there remains old infrastructure that continues to provide day-to-day water treatment services. From dams, to treatment plants, to underground water and wastewater pipe there is old infrastructure in place that is unlikely to be replaced for many years, regardless of how far water technology advances. Participants advise that there will remain a need to train water workers to operate systems that have been in place for tens of decades. Elsewhere in this report we advise that there is not always timely alignment with what the water industry needs, what policy makers are looking for, and what educators provide.

Concerns about training for operation and management of legacy infrastructure does not conflict with the need for responsive forward progress on defining new curricula, because the legacy infrastructure may be so old that only site-by-site training will address the need. At best, this is stop-gap training, as eventually all systems fail and will need to be replaced. In the meantime, there will continue to be a need for education and training for old facilities, but participants asked, "what kind of training should it be?" Should training modules be developed while there are still operators in place? If not, what happens when existing plant operators retire, or more to the point, leave suddenly? There is going to be a wave of retirements in the near future which has been the subject of considerable discussion within the water industry. Will all that knowledge go away? And then what happens in the affected communities? There is a need to store knowledge and train people when needed. As such there will continue to be a need for some two-year associate degrees and licensing programs, but there also will be a need for the more liberal, more expansive four-year degree described earlier. Students who seek to enter the water industry now will most likely eventually end up managing water resources, as opposed to just operating a water plant as may have been the pattern in the past.

Results - Research Needs I

This breakout session focused on discussion of the most pressing current and future research needs in the areas of water sources and transport. This included but was not limited to the following: conventional sources, reservoirs, groundwater, aquifer storage and recovery, gray water, reuse, pipelines, monitoring, rainwater harvesting, energy usage, aging infrastructure, and loss/leakage.

Research Needs

Climate. There is a need to assess and model future climate with an increased focus on the existing past record and how that record can be used as a basis for making future decisions. This includes work to understand and account for climate extremes that have happened beyond the last 100 years, looking back at variabilities and probabilities, as well as the likelihood of recurrence of historic climate events.

Water Availability. Participants recommended new work to expand current water availability models to integrate surface water and groundwater data. There already are good separate models for surface water and for groundwater availability. But, researchers are only at the edge of understanding how to integrate those water models into a single model that takes into consideration the complex interactions between water sources and factors that affect those interactions (e.g., evapotranspiration, soil profiles, subsurface geology, faulting and fracturing). This works needs to continue and expand.

The Unknown. Workers in the water sector grapple with many regulatory requirements affecting water management in Texas. The regulatory environment drives workers in the research community to study and model what is currently known to satisfy present-day regulatory requirements and constructs. Participants felt that the research community must move beyond what we already know to make incremental improvements in understanding what we don't know that may impact Texas water in the future. An example is examination of what might happen as a result of an extreme drought of historic proportion. How can we manage such an occurrence? Just this one possible example opened a wide range of discussion among participants. They posed new and clever ways to draw on currently unused or unusable water sources. They also suggested attention be given to how to integrate new water with water treatment and delivery infrastructure, to avoid water quality driven public health impacts such as occurred in 2016 in Flint, Michigan.

Community Needs

Meeting Needs of Society. Participants agreed that the water research community needs to do a better job at addressing the broader needs of society. Water stakeholders in urban, suburban, and rural communities tend to see only short-term impacts and immediate needs for solutions to water issues. In contrast, members of the water research community (academia/research institutions) may not sense as much urgency in finding

solutions to day-to-day matters of importance, even though almost everyone may agree on basic matters that need to be better understood and addressed. Some longer-term issues may be perceived as speculative or even irrelevant to current requirements or needs that are perceived to be important by some urban, suburban, and rural community stakeholders. Despite the direction of the research community there may remain a sense of urgency among stakeholders that research meet real-world real-time community needs. Participants suggested that there is an important role for the research community to more directly meet those broader community needs, and to change the academic/research model to make it more focused on technical assistance. This should include more applied R&D activities and problem solving, which at times can be driven by shorter-term needs. Participants did not suggest abandoning a role of researchers to look ahead. However, participants felt that researchers need to better communicate research results and must help water stakeholders in communities understand that residents and decision makers need to be thinking beyond immediate needs. Participants stated that if water stakeholders in urban, suburban, and rural communities want to maintain their lifestyles and live in communities that can sustain their populations and economies, then they must think beyond just the next few years for a sustainable water future.

Local Supply and Demand. Participants felt that research should be conducted to develop a much better understanding of local (community-level) water supply and demand.

Available Information. There is a large body of information about water that "everyone" in the water sector knows about, but that few people in local communities are aware exists or know how to access and use to address the issues they confront. Participants recommended that water researchers need to do a much better job informing

people about what kinds of and how much information is already available about water, as well as how to use the available information or request assistance in using it effectively.

Global Issues

Water Policy and Regulation. There is a disparate set of legal and permitting requirements associated with groundwater and surface water. In particular, the statewide policy on groundwater use does not consider the connectivity between sources of, and interactions between, surface water and groundwater, and the complex processes that effect these sources and related interactions. Although attempts to reconcile policy matters that confound effective groundwater management have up to now been largely futile, the matter needs to be dealt with in a scientifically sound and objective fashion.

Information Gaps. Participants spoke about a clear gap between past and current university research, and what research is perceived by decision makers and other stakeholders to be needed in urban, suburban, and rural communities. Participants recommended having the water community, including researchers, engage in a more consistent and continual way through outreach and public information programs. This includes university extension, visitations, professional groups inviting public officials to meetings and other outreach activities designed to (1) provide information about issues important to communities, and (2) better inform stakeholders about the realities of water in Texas, such as about surface and groundwater interactions, drought and flood cycles, and so on.

Baseline Data. There is a critical need to define baseline data sets, and integrate the available data in ways that are tractable for informing decision makers and the general public. These baseline data would then be vetted and made available freely and generally as information that decision makers and stakeholders in local communities can trust. This also will help establish "who" the local community can trust for its information about water, further building a greater level of confidence and certainty in information delivered and its future use.

Results - Research Needs II

This breakout session focused participant attention on a discussion of the most pressing current and future research needs in the areas of water use and enabling technologies. This included, but was not limited to the following: agriculture, municipal, industrial, new technologies, membranes, user behavior and perceptions, valuation, infrastructure and aging, regulatory environment, managed wetlands, education, "big" data, information management, and smart systems.

Research Underway

Participants remarked that there was a good cross-section of water sectors represented by members of the group. They first listed areas of research now underway and existing research capabilities. Those research areas and capabilities are here:

Water Conservation. Potential for water savings through conservation, low impact planning and development, cost/benefit of modified water practices, water urban and agriculture allocation ('smart').

Environmental Flows. Adaptive management techniques for environmental flows, market based strategies for enhancing environmental flows.

Desalination. Energy demand reduction in desalination processes, TWDB catalog of research in desalination.

Data/Sampling Technologies. Soil moisture sensing, use of UAVs in remote sensing, decision support tools ('earth genome' example).

Water Treatment. On-site wastewater processing, constructed wetlands for water treatment.

Nexus. Several area of multi-disciplinary research related to the "nexus" of water, energy and food, including modeling climate impact on agriculture to optimize crop selection for climate, lowered water-energy use in residential application, water use savings in agriculture through new or improved irrigation techniques, and water-energy emission impacts. Two added areas where partnering in research now underway was identified, but which were not tied to any particular area of research are EPA Environmental Innovation Clusters and a Multi-State Study of Barriers to Adopting New Technologies sponsored by EPA in the northeast US.

Needed Research

Participants next turned to a listing of research that industry and government currently needs to have addressed. This included the following research areas:

Desalination. Energy demand reduction in desalination processes, desalination concentrate management.

Socio-Economic Studies. Assessment and communication of water value, mechanisms to better communicate results of research and other information to stakeholders, economics of treating surface water versus brackish water; research into methods that yield the best results in terms of economics and conservation.

Regulations. Create adaptive regulatory framework for water: surface versus ground water and fresh versus treated water.

Drought and Flood Response. Water supply resilience in response to disasters, improved plant genetics for drought tolerance, precision agriculture.

Public Health in Pollution Control. Emerging contaminants from non-traditional sources, human effects research for treated water consumption (e.g., direct potable reuse), management of by-products from treatment, improving culture of conservation.

Moving Forward

Participants focused discussion on a few research areas, but not in any order of importance and not all areas were discussed in detail due to time constraints. Participants mentioned the Texas Water Conservation Advisory Council's report of research needs and best management practices at www.savetexaswater.org.

Participants mentioned a growing awareness in the water community of "drowning in data, but starving for understanding." With sampling technologies available today, masses of data can be acquired rapidly. But assembly and interpretation requires application of "big data" decision support tools that may not be readily available for one purpose versus another. Such tools are needed to allow for effective use of the growing amounts of data available for use in decision making. Participants questioned what types of methods of big data assessment and visualization can apply in various situations to yield best results at understanding and using data effectively.

The Lone Star Unmanned Aircraft Systems Center at Texas A&M University - Corpus Christi was brought up as a new statewide test bed for sensors and research support. Collaborations through this new center could aid researchers working on precision agriculture and other areas related to water and the environment.

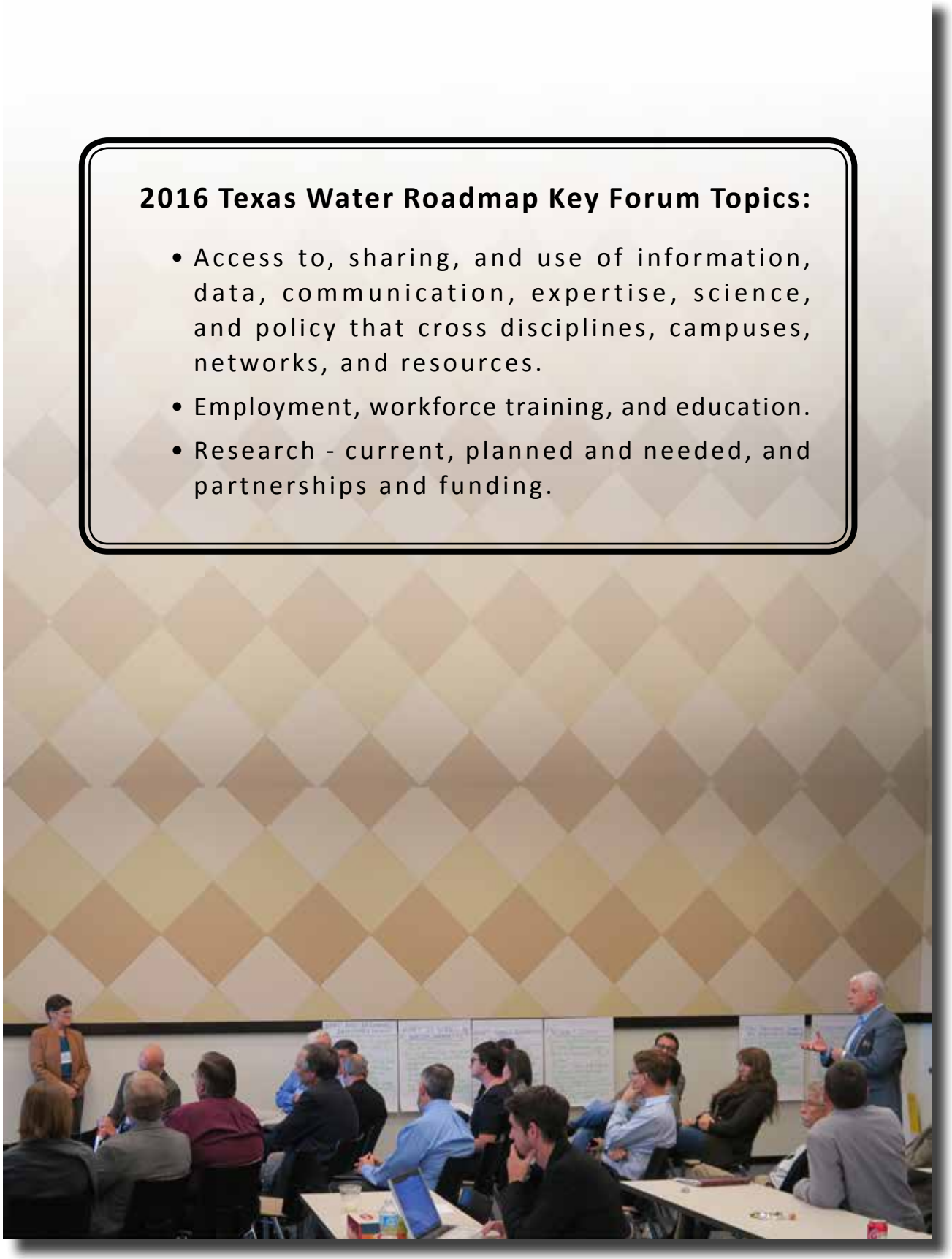
While industry and government participants described need for research in communicating information to the public, there appeared to be little or no research cited as underway. As an immediate response to improve public understanding of various water industry matters, it was suggested that the current citizen science and sensor program of the National Science Foundation, which may include mobile device apps for monitoring water information, might provide an example of how to enhance public understanding. Participants suggested that there is need for a whole new set of human and economic factors research on communication of water information, for example to address communication challenges with direct reuse and value of water.

Several participants stated that there is a need for a "water plan for the future." They suggested that we are planning for and managing water the way we have for many years in the past. Recent and current acceleration of technologies applicable to water management, public perceptions, increasing climate variability, and data available have left the past long behind.

They felt that we continue to repeat past inefficiencies and mistakes. This includes failing to take such seemingly simple and logical actions as acknowledging and managing connections between groundwater and surface water, recognizing changing climate, asserting the value of water, and so on. Participants suggested adapting and ensuring that water planning and related actions be more responsive, use "adaptive management" processes, and be fully scientifically honest.

2016 Texas Water Roadmap Key Forum Topics:

- Access to, sharing, and use of information, data, communication, expertise, science, and policy that cross disciplines, campuses, networks, and resources.
- Employment, workforce training, and education.
- Research - current, planned and needed, and partnerships and funding.



Results - Funding Opportunities

This breakout session focused on a discussion of funding opportunities available to address needs identified in earlier sessions. Are there partnerships that can be created to access opportunities, now or in the future? In particular, how does SWIFT funding factor into addressing the needs identified in earlier breakout sessions?

Available Funding

Participants first focused their attention on the SWIFT program. They quickly expanded discussion to include the state revolving fund. Both sources of funding have basic criteria for eligibility, foremost of which is that funding only covers capital projects. As a result, there is significant opportunity now for new work on capital-related projects. Participants also indicated that the current interpretation of what constitutes an acceptable project is flexible enough to allow for some innovation. The TWDB has emphasized that funding is not just for "infrastructure for traditional water projects." Also allowed, for example, are conservation projects that include the need for investment in capital infrastructure. Additionally, the TWDB has some grant funds available for use in economically distressed areas and to support small systems.

Discussion among participants turned to the practical accessibility of funds. In particular, smaller communities may face challenges in accessing funding through the programs. Although small communities throughout Texas have demonstrable needs for and opportunities to improve infrastructure, install new systems, and implement capital intensive conservation strategies, there are obstacles to securing required funds. Perhaps the greatest challenge is that the funds from the SWIFT and state revolving fund programs come as loans, not as grants made available with no expectation of repayment. Consequently, a community must not only define a qualifying project, but also must have the financing or a viable financial plan to repay the loan. Repaying a loan, even one having very favorable repayment rates and options, may be unattainable for some communities with a limited tax base or taxing authority. In addi-

tion, application for funding from the programs is a complicated process. The TWDB maintains ongoing outreach efforts throughout the state, particularly for small and rural communities, including monthly informational sessions on SWIFT funding and how to apply. Some communities require assistance in completing application requirements, including working out financing plans. Thus, there may be costs to submitting a valid application that create difficulties for some communities. As a result, to pull together the application and commit to financing repayment, a small community needs to want a project badly enough, or have no other alternative. Participants considered ways to assist communities. Several ways were identified and are detailed in the following section.

How the Water Community Can Help Small Communities

Repeating the Original SWIFT Outreach. Participants recalled a strong and effective outreach program delivered by the TWDB when SWIFT first kicked off. Participants suggested that the TWDB or another entity/partnership should revisit that initial outreach initiative, revise it to meet current requirements for information and support, and repeat it to increase community awareness. In doing so, other funding sources and related information could be added, to include federal funding available to communities in addition to funds in the two state programs mentioned earlier.

Training and Teaching Grant Writing. Stakeholders, and especially ratepayers, may see technology as costing them money without benefit. Provide incentives to stakeholders for adopting/accepting new technology. Concerns about financial impact may be reduced with effective incentives.

Case studies. Water-energy-food relationships need to be established through formal and informal education means as early as possible. As an example, participants mentioned the common knowledge about food-energy pyramids created in the past by inclusion of the principles of such pyramids in middle and high school curricula. Today, new examples are needed to ingrain principles of conservation of water and energy throughout education. This can be cast as an annual event. An example is creation of a "Water Day," similar to Earth Day created in 1970 and still practiced annually.

Partnerships

Research project co-funding and funding partnerships are often talked about as means to an end, but where to get funding often remains the key question. To be competitive for many grant programs, there is an advantage to leveraging and combining research institution expertise in technical and financial aspects of the relevant programs. Partnering in this manner can produce a stronger and more technically sound proposal, whether for a grant or loan application.

Partnerships through small business initiatives are often part of federal programs. The Small Business Innovation Research (SBIR) program was discussed, where research partnerships with small business focus on innovation and commercialization. The SBIR university partnership program is not something with which participants had much experience. One participant in the discussion has found the program productive, but finding suitable partners is difficult. The U.S. Army Corps of Engineers and some other federal agencies have programs for small communities that are designed to level the playing field with larger communities, creating opportunities to partner and infuse new water technologies into projects. These programs may provide an opportunity to co-partner a community with universities, research institutes and industry, especially where there may be co-funding or leveraging requirements.

Results - Partnering Opportunities

This breakout group focused on a discussion of partnership opportunities that are available to address identified needs. Are there funding opportunities that can be sought using these partnerships? In particular, how does SWIFT funding factor into addressing the needs identified in earlier breakout sessions?

Participants mentioned several large-scale consortia or collaborative research networks in Texas. These included the forum host, NSF/RCN-CE3SAR, as well as the South Central Texas Water Research Interest Group, Texas Water Research Network hosted by the University of Texas, and the Texas Water Resources Institute and the Food Energy Water Nexus Initiative, both at Texas A&M University.

Data Integrity. More effectively dealing with data was a common topic of participants in most sessions. Participants expressed concern about the interoperability of data and data integrity. While there is a great deal of data available, there is no ready way to determine the relative quality of one data set versus another, or the integrity of any single data set. Properties of data such as source, interpretation and potential for inference are all subject to little or no quality control. Thus, participants generally agreed that there is a wide range of issues in need of resolution around data and what needs to be done to improve data use and usefulness, including improved visualization of large data sets by using new decision support tools. Participants noted that the TWDB volunteered to host a meeting of participants from the forum to talk about data.

Environmental Flows. There is considerable work underway on environmental flows in different river basins in Texas, with many best practices in use. Participants recommended capturing what is being done now in these different river basins as examples and case studies, and adapting or replicating the most successful best practices. Doing so would address participants' concerns in this and other sessions about consistency of data collection and integrity of data. A reliable and dependable database can be developed over time by consistently using methods to collect and evaluate data that have been used and validated in one or more locations, and then replicated in other locations. This will provide users an assurance of reliability and ability to use the data in a commonly accepted way.

Technology Transfer. New water technologies are being developed and water data are being collected in different parts of the state. For example, large amounts of data and technology application came forward as a result of the recent events of drought and then flooding. Considerable project work and research was focused on establishing resiliency to such events. Partnerships in projects and research were formed, in response. Participants suggested there may be lessons to learn in how emergency response proceeded and how collaborative work came about. It was mentioned that federal and state emergency management agencies could be a potential funding source during and in the aftermath of periods of emergency. An example is funding available through the RESTORE Act, a response to the Deepwater Horizon disaster. Participants also mentioned possible opportunity for researchers to partner with local offices of federal agencies (e.g., U.S. Army Corps of Engineers) as a means to fast-track additional federal funding to come to Texas for water research.

Closing Session, Conclusions & Recommendations

Participants reconvened in a closing session following completion of breakout group discussions. They heard summaries of results of those discussions. Facilitator, Dr. Jorge Vanegas, identified themes that cut across breakout sessions and asked questions of the entire group to probe for areas of possible future action.

Data and Information

Charrette participants addressed the term "data" in broad terms. Data alone was considered of limited value until it was assembled in some fashion to create information, with information then used to impart knowledge, with knowledge leading to experience, and with experience accumulated over time then creating wisdom. Data was described as more than just the numbers. It includes reports, analysis, and communications about data, and even information on social media. Also included in the definitions was the data surrounding data, often called metadata.

Participants felt that much data in Texas is stored in a fragmented, isolated and nonstandard fashion making it hard or impossible to find, access, or use. They connected to the phrase, "drowning in data, starving for understanding." Everyone in the audience potentially worked for an organization that has its own way of managing, storing, and allowing access to data. Some organizations may prohibit access to data. The diverse variety of organizations in the water sector creates this variety of silos. Participants expressed an interest in moving past these existing conditions, or at least in creating bridges between the silos to find better ways to organize data storage and access. They envision a future where,

- all data is open to access,
- there is a statewide database assessable and searchable,
- technical people are trained to communicate about data,
- there are norms and standards for data,
- there is a place to find out who is doing what in water in Texas, and
- there are "dashboards" to better view and understand large datasets.

Participants agreed there is no easy route to achieve the endpoints envisioned, even though doing so will create opportunities to increase efficiencies in achieving program goals and enhance the credibility of communications to decision makers and the general public.

Participants felt there is opportunity now to establish standards and norms that will facilitate data sharing and use, help validate the relative quality of data, evaluate risks of use, and provide ways to assess social and economic considerations. This would include making water data more available and useful to diverse audiences. Participants concluded that government entities, but not any single one, are best suited to build platforms for data sharing. They suggested a measured evolution toward data repositories on a priority basis by building first on current success stories for smaller data sets, and then later adding more complex databases through the action of groups working through collaboration. To support this transition, participants suggested use of big data analytic platforms and creating dashboards for data visualization and interpretation.

Workforce Education

Participants evaluated the notion that people's faith in water managing institutions is dwindling in the aftermath of publicity surrounding recent water quality events that were harmful to public health. The result has been a heightened public recognition of a need for education and workforce development in the water treatment industries.

University Training. Maintaining a relevant curriculum for water workforce education requires university educators and administrators to understand and be responsive to industry needs. Participants stated that there appears to be little effort by universities to realign curricula to meet the needs of an industry rapidly evolving as new technologies and regulatory requirements change workforce education requirements. They could think of no programs that are adapting to today's needs at the undergraduate level, although the proposed undergraduate program at Texas A&M University–San Antonio was mentioned as a step in the right direction. Universities are missing an opportunity to educate students for jobs in a good paying stable industry that is located in any student's backyard.

Participants agreed that future education of students seeking careers in water management and conservation needs to be broader than that generally available through a civil engineering degree program. Students should receive training in ethics, policy, business, sociology, and communication.

Participants strongly supported internships to provide students with experiential learning opportunities in the water sector.

Diversity. Participants advised that the water workforce should be reflective of the society it serves. Participants advise this will help ensure the water workforce meets the technical needs of stakeholders for services, as well as the social, economic, and political realities of the community served.

Serving the Needs of Rural Texas. Differently sized communities have different kinds and scale of water facilities, differing needs for water workers, and different training requirements for the water workforce. Participants raised concerns about the current educational system supplying the demand for appropriately educated and experienced water workers, especially for Texas' small and rural communities. This is a challenge to be met by flexibility, accommodation, and localization of training by Texas' educational system to train local for local jobs.

Workforce Longevity. Participants recognized that water workers may become more mobile in their careers than has been the case in the past, potentially resulting in workers bringing a continual stream of new ideas and new ways of doing things to the water workplace.

Public Outreach-Education. Participants described a growing need for education of the public by water workforce members.

Legacy Infrastructure. Old infrastructure continues to provide day-to-day services in the Texas water industry. It must be operated and remain operational until replaced. Educational systems must accommodate this workforce need by supporting appropriate training.

Research

Participants in one session listed current research underway versus research that industry and government currently need. The two lists were markedly different, with only one broad area of overlap: desalination technologies and energy demand.

Areas of research listed as being underway were (1) water conservation, (2) environmental flows, (3) desalination energy demand, (4) data sampling technologies, (5) water treatment, and (6) the nexus of energy, food, and water. Areas listed as needed by industry and government were (1) desalination energy demand and brine management, (2) socio-economic studies, (3) holistic water management, (4) regulations, (5) drought and flood response, (6) communication of information, and (7) public health in pollution control.

Research project areas proposed for follow-up attention by forum attendees included the following, not listed in any order of priority:

Baseline Data. Participants recommended defining baseline data sets, and integrating the available data in ways that are tractable for informing decision makers and the general public.

Big Data. One participant mentioned a growing frustration of "drowning in data, but starving for understanding." Participants recommended use of "big data" decision support tools to more effectively access and use the ever growing amounts of data.

Climate. There is a need to model future climate with an increased focus on the past record.

Body of Information. Water workers must do a better job informing decision makers and the general public about the body of information that already exists about water, and how that information can be used. This includes informing stakeholders about the nature of Texas' water resources, such as about surface and groundwater interactions, drought, and flood cycles.

Local Supply and Demand. Participants felt that research should be conducted to develop a better understanding of local (community-level) water supply and demand.

Meeting Needs of Society. Water researchers must to do a better job addressing and communicating about the broader needs of society and communities for solutions to longer-term issues as opposed to short-term needs for maintaining current operations.

The Unknown. While the regulatory, political and funding environment drives researchers to study, what is already known, participants felt that researchers must take steps to better understand factors affecting water that we don't know, but which may impact Texas' future water security.

Water Availability. Participants recommended new work to expand current water availability models that integrate surface and groundwater data into a single model.

Water Policy and Regulation. The disparate set of legal and permitting requirements associated with groundwater and surface water must be addressed in a scientifically sound and objective fashion, including connectivity between sources of and interactions between surface and groundwater.

Water Planning. There is a need for a "water plan for the future" that takes into account connections between groundwater and surface water, recognizes changing climate, and identifies the true value of water. Participants suggested ensuring that water planning be responsive, use "adaptive management" processes, and be scientifically honest.

Funding and Partnerships

Participants mentioned several large-scale consortia or collaborative research networks in Texas. These included the forum host, NSF/RCN-CE3SAR, as well as the South Central Texas Water Research Interest Group, Texas Water Research Network, Texas Water Resources Institute, and the Food Energy Water Nexus Initiative. There are also many other and smaller partnerships in the water sector. Participants suggested that more effective use of existing partnerships will be more efficient than creating new ones. To be competitive for grant and loan programs, partnering can produce a stronger and more technically sound proposal.

Participants suggested partnerships and collaborations will be effective in addressing the following opportunities:

State Water Projects. There is significant opportunity for new work on capital-related projects through the SWIFT and state revolving fund, with funding criteria flexible enough to allow for innovation on traditional water projects as well as development of water efficiency/conservation efforts that include the need for investment in capital infrastructure. These opportunities will be most available through partnerships formed with smaller communities. To aid in formation of such partnerships, participants suggested that the TWDB repeat (or enhance) the original SWIFT outreach program to communities. Participants also suggested that water workers interested in partnering with communities should consider providing direct training and support in grant writing to communities.

Unmanned Aircraft Systems. New ways to conduct water research are available through collaborations with the Lone Star Unmanned Aircraft Systems Center at Texas A&M University - Corpus Christi.

Data Integrity. Large-scale collaboration will be needed to address the underlying reasons for interoperability of data sets. The TWDB volunteered to host continued discussions about data access and use.

Environmental Flows. Participants suggested a partnership to build a reliable database on environmental flows using case studies and methodologies already in use in various river basins in Texas, and then replicating best practices in other locations.

Emergency Response. Based on the example of new data collections and research projects initiated across Texas during recent drought and flood events, federal and state emergency management agencies may provide potential funding for water work during, and in the aftermath of, periods of emergency.

Federal Partnerships. Federal programs such as the Small Business Innovation Research program and other programs in various federal agencies may have funds available for use in smaller, more rural communities. Such programs may expand partnership opportunities and further leverage monies available through the state.

Forum Conclusion

In concluding the forum, Dr. Vanegas sought to find out what each participant would have the group do, if they could do one thing together. Not every participant had an opportunity to respond during the forum, but all were invited to answer this question by completing a post-forum survey. Here are some of the answers given at the forum and on the survey:

- Combine efforts to counter the political forces hampering progressive

science-based water resources management in areas such as climate change, groundwater connectivity to surface water, water valuation, and out-of-basin water transfer.

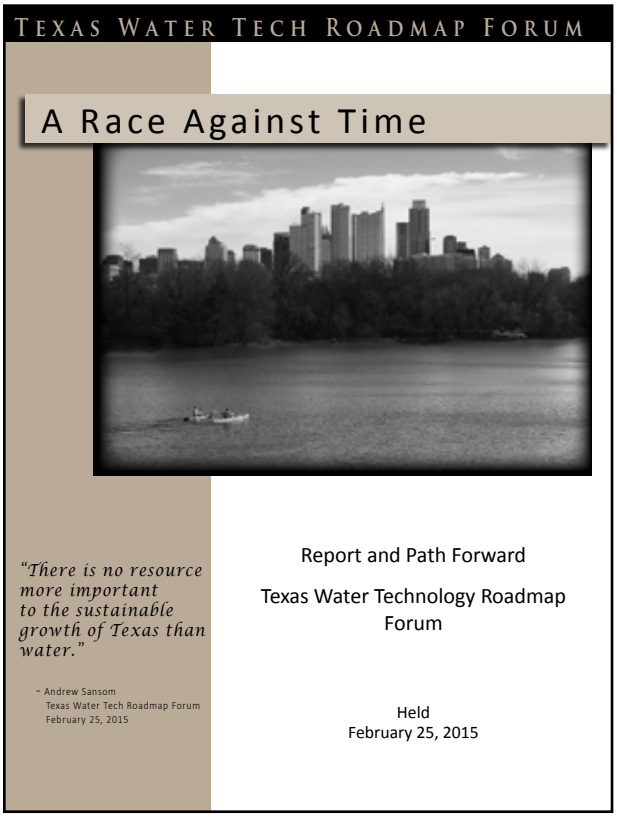
- Develop a centralized business intelligence tool for all things water in Texas.
- Continue to have charrettes that involve the major players in Texas water.
- Identify what the agencies/individuals represented at the forum can contribute toward a centralized source of information on water-related efforts in Texas.
- Help smaller communities better integrate water planning and funding efforts by offering technical and planning assistance.
- Form strategic partnerships targeting critical needs of water resource management, rather than carve out individual fiefdoms.
- Produce a report identifying "research areas of interest" of participants.
- Convey the urgency of water awareness to all we encounter.

Next Steps

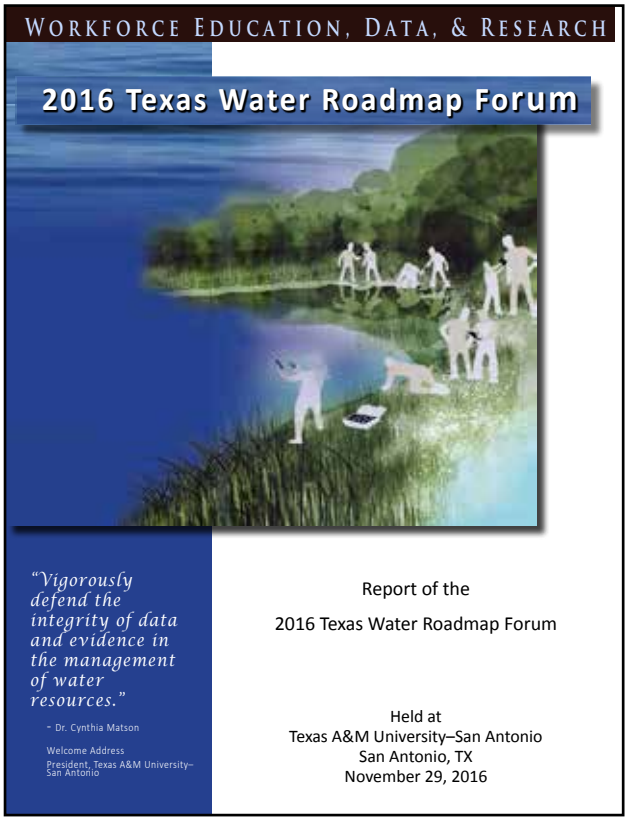
In response to the final question about having the group do one thing together, it was recommended that a document be drafted that sets a priority on needs for action on water. The next step for forum organizers will be to produce such a document drawing on the results, conclusions, and proposed actions coming from all three roadmap forums. However, it was pointed out that there is no means to list definitive priorities in a way that accurately reflects all discussions at the forums. It was clear that one participant's priorities may be very different than the priorities of others. Given the diverse backgrounds and current responsibilities of the water exerts assembled at the forums, diversity of opinion on the priority of taking one action versus any other is logical. However there was considerable agreement on what kinds of actions are needed.

Dr. Vanegas used the analogy of a salad bar when describing the results of the three roadmap forums. He said, the forums have created a sort of salad bar for roadmap directions we can take to address Texas' water issues, with a station offering directions to take for data, a station for research, a station for education, and stations for new technologies, outreach, partnerships, funding, and so on. Everyone can make the salad of their choice, but one person's salad may be quite different than any other's.

A concluding document will follow publication of this third, and final roadmap forum.



The roadmap forums have allowed Texas water experts in the various water sectors to offer what they believe to be important to secure Texas' water future. Now it's time for forum participants to pick what's most important and take responsibility for bringing together like-minded forum participants and other water stakeholders, and to take action.



Appendices

"We are drowning in data, but starving for understanding."

- Forum Participant describing the state of water data use and access in Texas.

Appendix I .... Participants
Appendix II .... Principals
Appendix III .... Agenda
Appendix IV .... Forum Presentation
Appendix V .... Website

Appendix I – Participants

James Abbey - Texas A&M University System

Ron Anderson - Lower Colorado River Authority

Jorge Arroyo - Consultant

Mirley Balasubramanya - Texas A&M University–San Antonio

Tony Bennett - USEPA Office of Research and Development

John Blake - Texas A&M University

Jay Bragg - Texas Farm Bureau

Luis Cifuentes - Texas A&M University-Corpus Christi

Jacquelyn Duke - Baylor University

Ali Fares - Prairie View A&M University

James Fischer - Texas A&M University

Joe Fox - Texas A&M University-Corpus Christi

Larry French - Texas Water Development Board

Marcus Gary - Edwards Aquifer Authority

Marcio Giacomoni - University of Texas at San Antonio

Juan Gomez - University of Texas at San Antonio

Ronald Green - Southwest Research Institute

Sam Marie Hermitte - Texas Water Development Board

Erin Hill - Texas A&M University-Corpus Christi

Bill Hoffman - H.W. Hoffman & Associates

Beth Hood - Texas Alliance of Groundwater Districts

Gwendolyn Hustvedt - Texas State University

Kathleen Jackson - Texas Water Development Board

Eric James - University of Texas

Ken Kramer - Sierra Club

Mike Lewis - Southwest Research Institute

Cindy Loeffler - Texas Parks & Wildlife Department

Tim Loftus - Texas State University

Marvin Lutnesky - Texas A&M University–San Antonio

Robert Mace - Texas Water Development Board

Howard Marquise - Alamo Colleges

Cynthia Matson - Texas A&M University–San Antonio

Alberto Mestas-Nunez - University of Texas at San Antonio

Rabi Mohtar - Texas A&M University

Rebecca Moyer - US Army Corps of Engineers

John Nielsen-Gammon - Texas A&M University

Alexandra Noronha - University of Texas

Mike O'Brien - Texas A&M University–San Antonio

Jamie Olson - Cynthia and George Mitchell Foundation

Wesley Patrick - Southwest Research Institute

Steve Raabe - San Antonio River Authority

Susan Roberts - Texas Center for Applied Technology

Rudolph Rosen - Texas A&M University–San Antonio

Andy Sansom - Texas State University

Stefan Schuster - SWCA Environmental Consultants

Robert Shelton - Texas A&M University–San Antonio

Robert Thompson - Harris-Galveston Subsidence District

John Tracy - Texas Water Resources Institute

Rudolfo Valdez Barillas - Texas A&M University–San Antonio

Jorge Vanegas - Texas A&M University

Sam Vaugh - HDR Engineering

Todd Votteler - Guadalupe-Blanco River Authority

Cindy Wall - Texas A&M Engineering Experiment Station

Ralph Wurbs - Texas A&M University

Hua Zhang - Texas A&M University-Corpus Christi

Appendix II – Principals

2016 Texas Water Roadmap Forum

A Facilitated Interdisciplinary and Multi-Stakeholder "Charrette"

Forum Host

Dr. Cynthia Matson – President, Texas A&M University–San Antonio

Master of Ceremonies and Charrette Facilitator

Dr. Jorge Vanegas – Dean, College of Architecture, Texas A&M University-College Station and Professor, Texas A&M Engineering Experiment Station

Organizer

Dr. Rudolph Rosen – Director, Institute for Water Resources Science and Technology, Texas A&M University–San Antonio

Morning Keynote Address

Ms. Kathleen Jackson – Board Member, Texas Water Development Board

Afternoon Keynote Address

Dr. Andrew Sansom – Executive Director, Meadows Center for Water and the Environment, Texas State University, San Marcos

Sponsor Welcome Messages

Dr. Robert Mace – Deputy Executive Administrator, Water Science and Conservation, Texas Water Development Board

Dr. Luis Cifuentes – Principal Investigator, National Science Foundation Research Coordination Network for Climate, Energy, Environment and Engagement in Semiarid Regions

Charrette Facilitators

Dr. Luis A. Cifuentes – Vice President, Division of Research, Commercialization and Outreach, Texas A&M University–Corpus Christi
(Charrettes: Workforce Education and Funding Opportunities)

Dr. Gwendolyn Hustvedt – Assistant Director for Graduate Studies and Research and Associate Professor of Textiles, School of Family and Consumer Sciences, Texas State University, San Marcos
(Charrettes: Data & Information)

Dr. Wesley Patrick – Vice President, Geosciences and Engineering Division, Southwest Research Institute, San Antonio
(Charrettes: Research Needs I and Funding Opportunities)

Dr. Susan V. Roberts – Director, Water Systems Division, Texas Center for Applied Technology, San Antonio
(Charrettes: Data & Information and Partnering Opportunities)

Ms. Cindy Wall – Assistant Agency Director for Regional Divisions, Texas A&M Engineering Experiment Station, College Station
(Charrettes: Research Needs II and Partnering Opportunities)

Contributors

Ms. Sam Marie Hermitte – Texas Water Development Board

Ms. Nuala Martinez – Texas A&M University–San Antonio

Report Editor-Author

Dr. Rudolph Rosen – Director, Institute for Water Resources Science and Technology, Texas A&M University–San Antonio

Appendix III – Agenda

Agenda

2016 Texas Water Roadmap Forum

A Facilitated Interdisciplinary and Multi-Stakeholder "Charrette"

Organized by:

The Texas Water Development Board

Texas Water Development Board

and

The National Science Foundation (NSF)
Research Coordination Network (RCN) on
Climate, Energy, Environment and Engagement in Semiarid Regions
(CE3SAR)

CE3SAR

Host, Location and Date:

The Vista Room

Institute for Water Resources Science and Technology

Texas A&M University - San Antonio

One University Way, San Antonio, TX 78224

Coffee, pastry and registration
8:15 a.m. to 8:55 a.m.

Forum
9:00 a.m. to 4:00 p.m.

November 29, 2016

1

The Forum Agenda & Charrette Activities
A&M-SA – Vista Room, 4th Floor, Central Academic Building Bldg.
8:15 a.m. – 4:00 p.m. • November 29, 2016

Registration and Breakfast
8: 15 a.m. – 8:55 a.m.

Plenary Session 1: "Establishing the Point of Departure for the Forum & Charrette Process"
9:00 a.m. – 10:00 a.m. (60 minutes)
Welcome, Introduction to charrette objectives and logistics, and TWDB opportunities

- Introduction of sponsors and background, examples, and significance of preceeding water forums - Rudy Rosen [5 minutes]
- Presentation of the charrette process, scope, pre-charrette survey results, and "*Rules of Engagement*" - Jorge Venegas [10 minutes]
- Facilitated plenary discussion on, and formal documentation of, *roles*, *drivers*, and *expectations* of the charrette participants - Jorge Venegas [10 minutes]
- Welcome to A&M-SA and Introduction by Dr. Cynthia Matson, A&M-SA President, and sponsors [5 minutes]
- SWIFT Funding and other opportunities – Kathleen Jackson (TWDB) [25 minutes: approx 15 min. presentation and 10 min. Q&A]

***Breakout Groups Assemble** 10:00 a.m. (groups may take short breaks as needed)*

Breakout Session 1: *"Breakout Group Discussions Round 1"*
10:00 a.m. – 12:00 a.m. (120 minutes)
Facilitated Breakout Group Discussions. Participants select their first choice of discussion topics.

- Breakout Group No. 1a: **Data, Information, Communication, Sharing, Expertise**
  This breakout group will focus on a discussion overcome impediments to communicating, transmitting, and accessing data, research needs, expertise, and other information about Texas water science, policy, and research to increase and improve its use by decision makers, agencies, and others. How can information be shared most effectively and efficiently? Ideally, who should lead efforts to develop information sharing resources?
- Breakout Group No. 1b: **Workforce, Education Needs**
  This breakout group will focus on a discussion of the need for more highly educated, skilled, and degreed workers for the future. What are current and future water workforce needs? How do we address these needs to the benefit of Texas' water industries, groundwater conservation districts, utilities and others?
- Breakout Group No. 1c: **Research Needs I**
  This breakout group will focus on a discussion of the most pressing current and future research needs in the areas of **water sources and transport**, including but not limited to the following: conventional sources, reservoirs, broundater, aquifer storage and recovery, gray water, reuse, pipelines, monitoring, rainwater harvesting, energy usage, aging infrastructure, and loss/leakage.
- Breakout Group No. 1d: **Research NeedsII**
  This breakout group will focus on a discussion of the most pressing current and future research needs in the areas of **water use and enabling technologies**, including but not limited to the

following: agriculture, municipal, industrial, new technologies, membranes, user behavior and perceptions, valuation, infrastructure and aging, regulatory environment, artifical wetlands, education, "big" data, information management, and smart systems

[Note: Depending on the number of charrette participants and their interest in specific topics, additional breakout groups may be formed, as needed]

***Lunch Break, Networking and Plenary Session 2** 12:00 p.m. – 1:00 p.m. (60 minutes)*

Plenary Session 2: "Setting the Stage for Action"
12:00 p.m. – 1:00 p.m.

- The National Science Foundation RCN-CE3SAR – Luis Cifuentes [5 minutes]
- Partnerships for action – Andrew Sansom (Meadows Center for Water and Environment) [25 minutes: approx 15 min. presentation and 10 min. Q&A]
- Texas Water Development Board expectations for the afternoon charrette – Robert Mace [5 minutes]
- Presentation of the charrette process, scope, and "*Rules of Engagement*" - Jorge Venegas [10 minutes]

***Breakout Groups Assemble** 1:00 p.m. (groups may take short breaks as needed)*

Session 3: *"Breakout Group Discussions Round 2"*
1:00 p.m. – 2:30 p.m. (90 minutes)
Facilitated Breakout Group Discussions. Participants select their choice of discussion session.

- Breakout Group No. 2a: **Funding Opportunities**
  This breakout group will focus on a discussion of funding opportunities that are available to address identified needs. Are there partnerships that can be created to access these opportunities, either now or in the future? In particular, how does SWIFT funding factor into addressing the needs identified in earlier breakout sessions.
- Breakout Group No. 2b: **Partnership Opportunities**
  This breakout group will focus on a discussion of partnership opportunities that are available to address identified needs. Are there funding opportunities that can be sought using these partnerships? In particular, how does SWIFT funding factor into addressing the needs identified in earlier breakout sessions.

[Note: Depending on the number of charrette participants and their interest in specific topics, additional breakout groups may be formed, as needed.

***Plenary Session 3** 2:45 p.m. – 3:45 p.m. (45 minutes)*

Plenary Session 3a: *"Plenary Presentations - Breakout Group Discussions Round 1"*
2:45 p.m. – 3:15 p.m. (30 minutes)
Each Breakout Group will present the highlights of their discussions in Round 1 to all participants in the charrette [7 minutes + 2 minutes Q&A each, strictly timed; length will be adjusted if there are more than four breakout groups]

Plenary Session 3b: *"Plenary Presentations - Breakout Group Discussions Round 2"*
3:15 p.m. – 3:45 p.m. (30 minutes)
Each Breakout Group will present the highlights of their discussions in Round 2 to all participants in the charrette [7 minutes + 2 minutes Q&A each, strictly timed; length will be adjusted if there are more than four breakout groups]

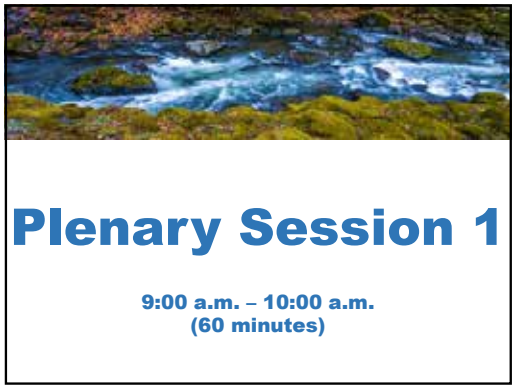
***Plenary Session 4** 3:45 p.m. – 4:00 p.m. (15 minutes)*

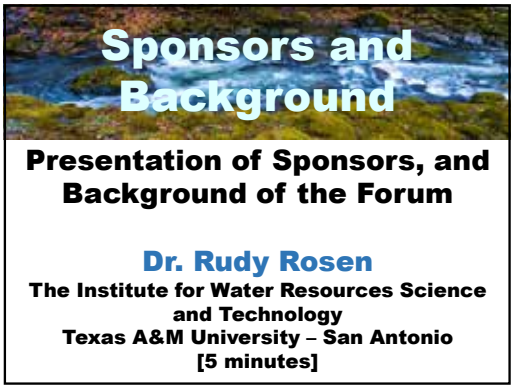
Plenary Session 4: *"The Path Ahead"*
3:45 p.m. – 4:00 p.m. (15 minutes)
Facilitated plenary discussion on, and formal documentation of, a preliminary consensus among charrette participants on the content of the presentations done in Plenary Sessions 3a and 3b.

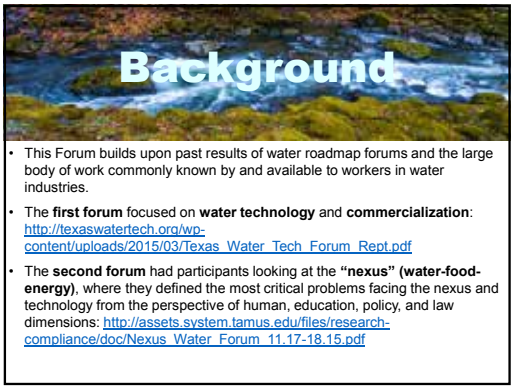
***Adjourn for the Day** at 4:00 p.m.*

Appendix IV – Forum Presentation

Forum facilitator Dr. Jorge Vanegas presented information and introduced forum hosts, speakers and session facilitators. This appendix displays presentation graphics used by Dr. Vanegas.







Overview of the Agenda for the Charrette

Dr. Jorge Vanegas
Texas A&M University
[5 minutes]

Plenary Session 1
9:00 a.m. – 10:00 a.m.
(60 minutes)

Plenary Session 1: "**Establishing the Point of Departure for the Forum & Charrette Process**"
9:00 a.m. – 10:00 a.m. (60 minutes)
(Facilitator: **Jorge Vanegas**)

Welcome, Introduction to charrette objectives and logistics, and TWDB opportunities

- Presentation of sponsors and background for the forum – **Rudy Rosen** [5 minutes]
- Overview of the agenda – **Jorge Vanegas** [5 minutes]
- Presentation of the charrette process, goals, and "rules of engagement" – **Jorge Vanegas** [15 minutes]
- Facilitated plenary discussion on, and formal documentation of, roles, drivers, and expectations of the charrette participants – **Jorge Vanegas** [5 minutes]
- Welcome to Texas A&M University San Antonio and presentation of Keynote Speaker – **Dr. Cynthia Matson**, President [5 minutes]
- SWIFT Funding and other opportunities – **Kathleen Jackson** (TWDB) [25 minutes: 15 min. presentation & 10 min. for Q&A]

Breakout Group Discussions Round 1
10:00 a.m. – 12:00 noon
(120 minutes)

Breakout Session 1: "**Breakout Group Discussions Round 1**"
10:00 a.m. – 12:00 a.m. (120 minutes)
(**Facilitator**: **Gwendolyn Hustvedt**, Texas Tech)

- Breakout Group No. 1a: **Data, Information, Communication, Sharing, Expertise**
  This breakout group will focus on a discussion overcome impediments to communicating, transmitting, and accessing data, research needs, expertise, and other information about Texas water science, policy, and research to increase and improve its use by decision makers, agencies, and others.
  - ✓ How can information be shared most effectively and efficiently?
  - ✓ Ideally, who should lead efforts to develop information sharing resources?

Breakout Session 1: "**Breakout Group Discussions Round 1**"
10:00 a.m. – 12:00 a.m. (120 minutes)
(**Facilitator**: **Luis Cifuentes,** Texas A&M Corpus Christi)

- Breakout Group No. 1b: **Workforce, Education Needs**
  This breakout group will focus on a discussion of the need for more highly educated, skilled, and degreed workers for the future.
  - ✓ What are current and future water workforce needs?
  - ✓ How do we address these needs to the benefit of Texas' water industries, groundwater conservation districts, utilities and others?

Breakout Session 1: "**Breakout Group Discussions Round 1**"
10:00 a.m. – 12:00 a.m. (120 minutes)
(**Facilitator**: **Wesley Patrick**, Southwest Research Institute)

- Breakout Group No. 1c: **Research Needs I**
  This breakout group will focus on a discussion of the most pressing current and future research needs in the areas of **water sources** and **transport**, including but not limited to the following:
  - ✓ Conventional sources and Reservoirs
  - ✓ Groundwater, and aquifer storage & recovery
  - ✓ Gray water, reuse
  - ✓ Pipelines
  - ✓ Monitoring
  - ✓ Rainwater harvesting
  - ✓ Energy usage
  - ✓ Aging infrastructure, and loss/leakage

Breakout Session 1: "**Breakout Group Discussions Round 1**"
10:00 a.m. – 12:00 a.m. (120 minutes)
(**Facilitator**: **Cindy Wall**, Texas A&M University System)

- Breakout Group No. 1d: **Research Needs II**
  This breakout group will focus on a discussion of the most pressing current and future research needs in the areas of **water use** and **enabling technologies**, including but not limited to the following:
  - ✓ Agriculture, municipal, or industrial
  - ✓ New technologies & membranes, and artificial wetlands
  - ✓ Valuation
  - ✓ Infrastructure and aging
  - ✓ Regulatory environment
  - ✓ User behavior and perceptions
  - ✓ Education
  - ✓ "Big" data, information management, and smart systems

Working Lunch, Networking, and Plenary Session 2
12:00 noon – 1:00 p.m.
(60 minutes)

Plenary Session 2: "**Setting the Stage for Action**"
12:00 noon – 1:00 p.m.
(Facilitator: **Jorge Vanegas**)

- The National Science Foundation RCN-CE3SAR – **Luis Cifuentes** [5 minutes]
- Partnerships for action – **Andrew Sansom** (Meadows Center for Water and Environment) [25 minutes: 15 min. presentation & 10 min. for Q&A]
- Texas Water Development Board expectations for the afternoon charrette – **Robert Mace** [5 minutes]

Breakout Group Discussions Round 2
1:00 p.m. – 2:30 p.m.
(90 minutes)

Breakout Session 2: "Breakout Group Discussions Round 2"
1:00 p.m. – 2:30 p.m. (90 minutes)
(Co-Facilitators: **Luis Cifuentes** and **Wesley Patrick**)

- Breakout Group No. 2a: **Funding Opportunities**
  Two separate breakout groups will focus on a discussion of funding opportunities that are available to address identified needs.
  - ✓ Are there partnerships that can be created to access these opportunities, either now or in the future?
  - ✓ In particular, how does SWIFT funding factor into addressing the needs identified in earlier breakout sessions?

Breakout Session 2: "**Breakout Group Discussions Round 2**"
1:00 p.m. – 2:30 p.m. (90 minutes)
(Co-Facilitators: **Cindy Wall** and **Susan Roberts**, Texas A&M University System)

- Breakout Group No. 2b: **Partnership Opportunities**
  Two separate breakout groups will focus on a discussion of partnership opportunities that are available to address identified needs.
  - ✓ Are there funding opportunities that can be sought using these partnerships?
  - ✓ In particular, how does SWIFT funding factor into addressing the needs identified in earlier breakout sessions?

Plenary Session 3
2:30 p.m. – 3:30 p.m.
(60 minutes)

Plenary Session 3: "**Plenary Presentations Results from Breakout Group Discussions Rounds 1 & 2**"
2:30 p.m. – 3:30 p.m. (60minutes)
(Facilitator: **Jorge Vanegas**)

- Plenary Session 3a: "**Presentations Breakout Group Round 1**"
  2:30 p.m. – 3:00 p.m. (30 minutes)
  Each Breakout Group will present the highlights of their discussions in Round 1 to all participants in the charrette [5 minutes + 2 minutes Q&A each, strictly timed; length will be adjusted if there are more than four breakout groups]
- Plenary Session 3b: "**Presentation on Breakout Group Round 2**"
  3:00 p.m. – 3:30 p.m. (30 minutes)
  Each Breakout Group will present the highlights of their discussions in Round 2 to all participants in the charrette [5 minutes + 2 minutes Q&A each, strictly timed; length will be adjusted if there are more than four breakout groups]

Plenary Session 4
3:30 p.m. – 4:00 p.m.
(30 minutes)

Plenary Session 4: "**The Path Ahead**"
3:30 p.m. – 4:00 p.m. (30 minutes)
(Facilitator: **Jorge Vanegas**)

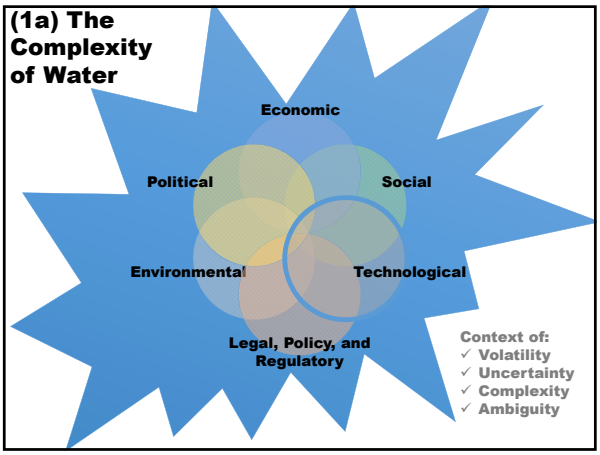
Final facilitated plenary discussion on, and formal documentation of, a preliminary consensus among participants

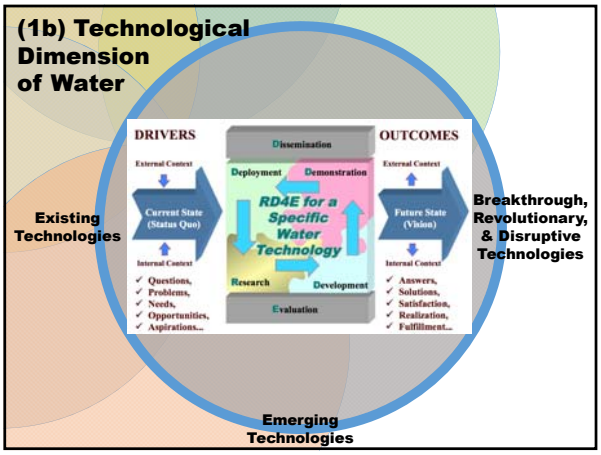
Adjourn at 4:00 pm

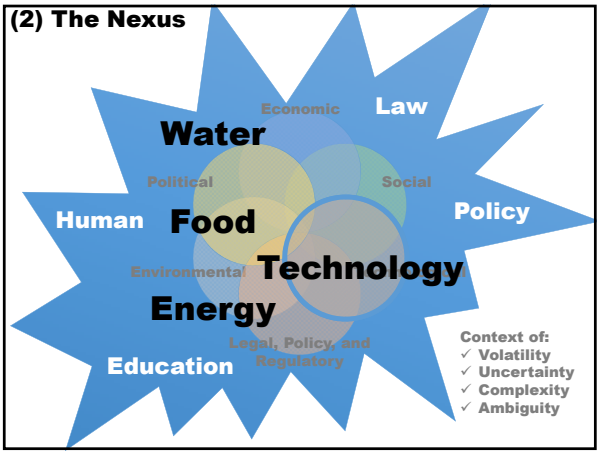
Charrette Process, Goals, and "Rules of Engagement"

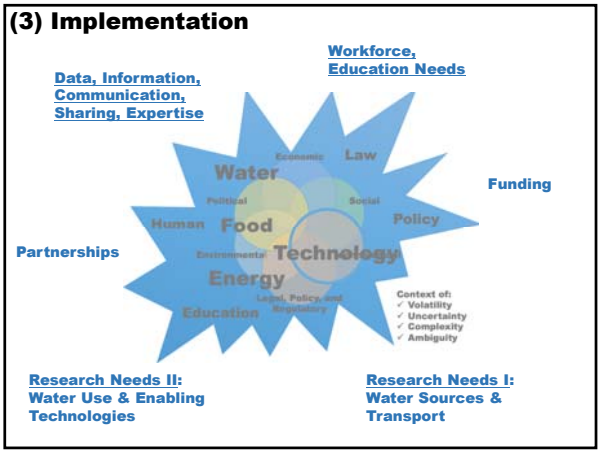
Dr. Jorge Vanegas
Texas A&M University
[15 minutes]

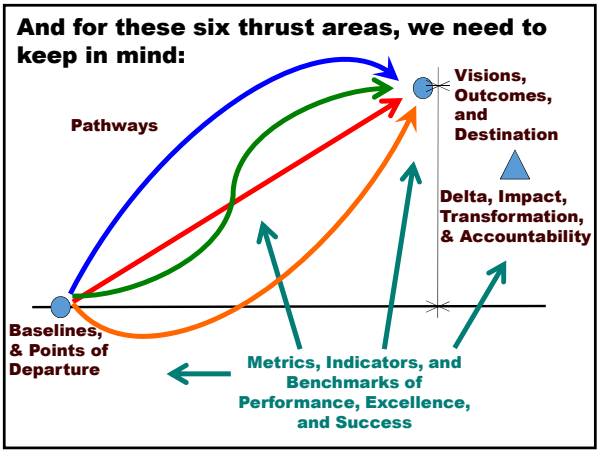
The process for this forum begins with the following points of departure...



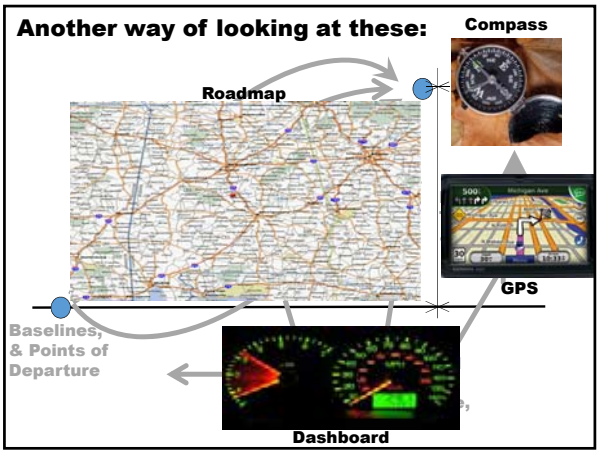








Another way of looking at these:



- **Previous work identified critical needs for water sustainability in Texas**, including finding significant opportunities for information sharing, improved workforce education, commercialization, and innovation in areas such as desalination, reuse, conservation, and 'smart-water' technologies.
- This **third forum** will
  - ✓ Further focus/refine needs and targets,
  - ✓ Define the current scientific and technical capacity of Texas' centers of research and the public sector to address these needs,
  - ✓ Dive more deeply into workforce issues,
  - ✓ Provide added basis for building a water roadmap in key areas for Texas, and
  - ✓ Emphasize funding, partnerships, research, and innovation-driven outcomes.

- The forum brings together Texans from diverse technical, academic, research, management, and business backgrounds in water to participate in **envisioning a future Texas where water security is assured for people, industry, food production, and nature**.
- The main goal of the forum is to **prioritize and frame key milestones** with the overall objective of securing Texas' water future, while **accelerating growth of Texas' water infrastructure, technologies, industries, and sustainable water use**.
- Forum **participants represent Texas' leading water sectors**, including water associations and other non- governmental organizations, research institutes and universities, public agencies, industry, and water utilities, districts, and authorities.

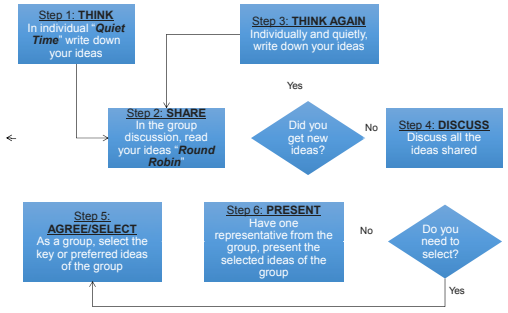
- The Forum is designed to:
  - ✓ **Bring forth partnerships** to complement, supplement, strengthen, enhance, and extend the work, efforts, and accomplishments of Texas' key water stakeholders.
  - ✓ **Establish collaborative models and solutions**, making use of new funding sources, such as through the SWIFT program, which are now available for financing rural and urban water infrastructure.
  - ✓ **Focus on areas identified in previous forums as critical or emerging and in need of actions** that can be accomplished:
    - Access to, sharing, and use of information, data, communication, expertise, science, and policy that cross disciplines, campuses, networks, and resources;
    - Employment, workforce training, and security; and
    - Research, current and planned

You can expect five specific takeaways…

- The results from the **pre-forum survey**, which will be shared with all
- What you contribute to the discussions in the **breakout groups**, and what you listen/learn from others
- What you listen/learn from the plenary **summaries of breakout discussions**
- What you contribute to the **final plenary discussion on the "Path Ahead"**, and what you listen/learn from others
- The **post-forum report**, which will be shared with all

The rules for this forum have three main components…

Think/Share Process



And within this process…

Driving Questions

For Breakout Group 1a:

- ✓ **How can we overcome impediments** to communicating, transmitting, and accessing data, research needs, expertise, and other information about Texas water science, policy, and research to increase and improve its use by decision makers, agencies, and others?
- ✓ **How can information be shared** most effectively and efficiently?
- ✓ Ideally, **who should lead efforts** to develop information sharing resources?

Driving Questions

For Breakout Group 1b:

- ✓ In light of the greying of the current workforce and the need for more highly educated, skilled, and degreed workers for the future, **what are current and future water workforce needs**?
- ✓ **How do we address these needs** to the benefit of Texas' water industries, groundwater conservation districts, utilities and others?

Driving Questions

For Breakout Groups 1c & 1d:

- ✓ What are the **most pressing current and future research needs** (from the agency and stakeholder perspectives) as compared to research that is currently underway in Texas' university and independent research institutions (from the researcher prospective)?

Driving Questions

For Breakout Group 2a:

- ✓ **What funding opportunities are available** to address identified needs?
- ✓ **Are there partnerships that can be created** to access these opportunities, either now or in the future?
- ✓ In particular, **how does SWIFT funding factor into addressing current and future needs**?

Driving Questions

For Breakout Group 2b:

- ✓ **What partnership opportunities are available** to address identified needs?
- ✓ **Are there funding opportunities that can be sought** using these partnerships?
- ✓ In particular, **how does SWIFT funding factor into addressing current and future needs**?

Roles, Drivers, and Expectations

Dr. Jorge Vanegas
Texas A&M University
[5 minutes]

Roles, Drivers, and Expectations

Roles

Roles, Drivers, and Expectations

Drivers

Jorge Vanegas

Roles, Drivers, and Expectations

Expectations

Jorge Vanegas

Welcome

Welcome to
Texas A&M University
San Antonio

Dr. Cynthia Matson
President
[5 minutes]

Funding

Presentation of SWIFT Funding and Other Opportunities

Kathleen Jackson
The Water Development Board (TWDB)
[25 minutes – 15 min. presentation & 10 min. for Q&A]

Breakout Group Discussions Round 1

10:00 a.m. – 12:00 noon
(120 minutes)

Breakout Groups Round 1

Breakout Groups Assemble at 10:00 a.m.

- ✓ *Participants select their first choice of discussion topics.*
- ✓ *Depending on the number of charrette participants and their interest in specific topics, additional breakout groups may be formed, as needed.*
- ✓ *Groups may take short breaks during breakout sessions, as needed.*

Breakout Groups Round 1

- ✓ Breakout Group No. 1a: Data, Information, Communication, Sharing, Expertise
- ✓ Breakout Group No. 1b: Workforce, Education Needs
- ✓ Breakout Group No. 1c: Research Needs I – Water Sources and Transport
- ✓ Breakout Group No. 1d: Research Needs II –Water Use and Enabling Technologies

Let's Move to the Breakout Corners...

2016 Texas Water Roadmap Forum

A Facilitated Interdisciplinary and Multi-Stakeholder "Charrette"

Texas Water Development Board

CE³SAR

TEXAS A&M UNIVERSITY SAN ANTONIO

Working Lunch, Networking, and Plenary Session 2

12:00 noon – 1:00 p.m.
(60 minutes)

The National Science Foundation RCN – CE3SAR

Dr. Luis Cifuentes
[5 minutes]

Partnerships for Action –

Dr. Andrew Sansom
Meadows Center for Water and Environment

[25 minutes: 15 min. presentation & 10 min. for Q&A]

Texas Water Development Board Expectations for the Afternoon Charrette

Dr. Robert Mace
[5 minutes]

Breakout Group Discussions Round 2

1:00 p.m. – 2:30 p.m.
(90 minutes)

Breakout Groups Assemble at 1:00 p.m.

- ✓ *Participants select their first choice of discussion topics.*
- ✓ *Depending on the number of charrette participants and their interest in specific topics, additional breakout groups may be formed, as needed.*
- ✓ *Groups may take short breaks during breakout sessions, as needed.*

Breakout Groups Round 2

- ✓ Breakout Group No. 2a: Funding Opportunities
- ✓ Breakout Group No. 2b: Partnership Opportunities

Let's Move to the Breakout Corners…

2016 Texas Water Roadmap Forum

A Facilitated Interdisciplinary and Multi-Stakeholder "Charrette"

Texas Water Development Board

CE³SAR

TEXAS A&M UNIVERSITY SAN ANTONIO

Plenary Session 3

2:30 p.m. – 3:30 p.m.
(60 minutes)

Plenary Session 3

Presentation Breakout Group No. 1a:
Data, Information, Communication, Sharing, Expertise

[5 minutes + 2 minutes Q&A each, strictly timed]

Plenary Session 3

Presentation Breakout Group No. 1b:
Workforce, Education Needs

[5 minutes + 2 minutes Q&A each, strictly timed]

Presentation Breakout Group No. 1c:

Research Needs I – Water Sources and Transport

[5 minutes + 2 minutes Q&A each, strictly timed]

Presentation Breakout Group No. 1d:

Research Needs II –Water Use and Enabling Technologies

[5 minutes + 2 minutes Q&A each, strictly timed]

Presentation Breakout Group No. 2a:

Funding Opportunities

[5 minutes + 2 minutes Q&A each, strictly timed]

Presentation Breakout Group No. 2b:

Partnership Opportunities

[5 minutes + 2 minutes Q&A each, strictly timed]

Plenary Session 4

3:30 p.m. – 4:00 p.m.
(30 minutes)

The Path Ahead…

Reflect

What are your main "takeaways" from any of the Plenary Speakers?

Share

Reflect

What are your main "takeaways" from the Breakout Group Discussions Round 1?

Share

Reflect

What are your main "takeaways" from the Breakout Group Discussions Round 2?

Share

Thank you!

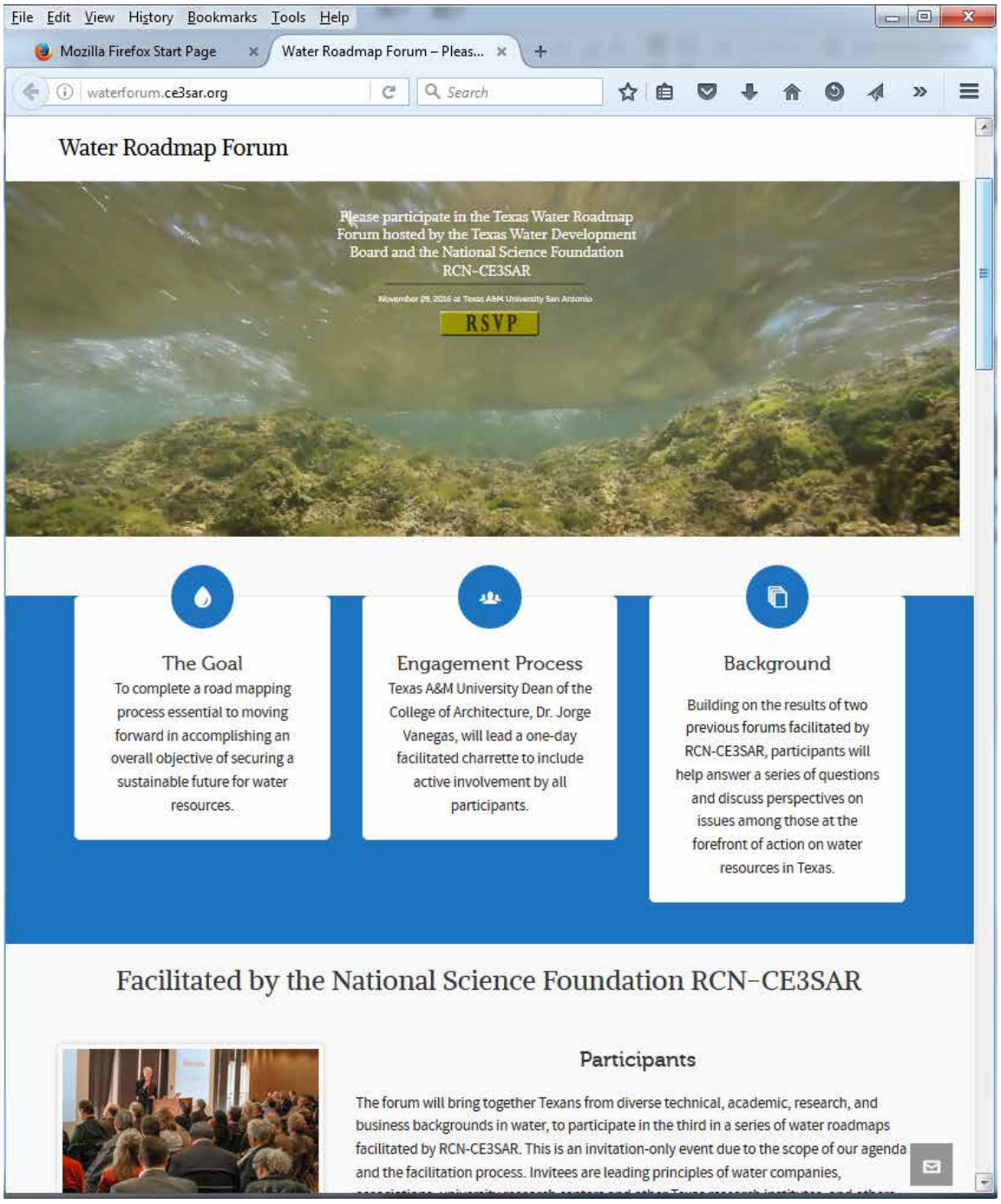
We are now Adjourned!

4:00 p.m.

Appendix IV – Forum Website

The forum was supported through a website. This site can be accessed at http://waterforum.ce3sar.org/

If no longer available, the website that was available to participants can be viewed on YouTube here: https://youtu.be/JOrddO5hiQQ



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