The Johnson Foundation Freshwater Forum Working Session #4: Examining U.S. Freshwater Systems and Services: Reducing Conflicts at the Water-Energy Interface

November 16–18, 2009
Wingspread Conference Center, Racine WI

Meeting Highlights

Background

The Johnson Foundation Freshwater Forum (Forum) is designed to focus national attention on how the U.S. manages freshwater resources and services. Through a series of in-depth meetings, The Johnson Foundation is working to build a platform of broad understanding, collaboration and cooperation around priorities for addressing the challenges that threaten our nation's freshwater resources and the health of our communities. The Forum will bring visibility to the complex issues facing the nation's freshwater resources, illuminate possible solutions and catalyze a wide range of actions that together will result in change.

A cornerstone of the Freshwater Forum will be The Johnson Foundation Freshwater Summit, to be held on June 9th, 2010, at the historic Wingspread Conference Center. At the Summit, national leaders will convene to deliberate and highlight the priority goals the U.S. must meet to attain freshwater resilience by 2025. A national call to action on freshwater is expected to be issued at the end of the meeting.

To ensure that the deliberations at the Freshwater Summit are based upon the best possible information and options, The Johnson Foundation is convening a series of working sessions comprised of eminent scientists, policy makers, and practitioners of diverse perspectives. The outcomes of these sessions will inform discussions at the Summit and build the platform for creating a national agenda. The first session, "Impacts of Climate Change on Freshwater Resources and Services," focused on understanding the available science and relevant expertise at the intersection of climate change and freshwater resources. Participants explored what we

know and where the gaps are in our understanding of the challenges emerging for freshwater resources and how climate change does or does not exacerbate them.

The outcomes of the first working session informed The Johnson Foundation's determination of which freshwater issues are particularly urgent and ripe for our nation's leaders to address in the coming years. Working Session #2 focused on water infrastructure and the built environment and Working Session #3 concentrated on the intersection of freshwater with agriculture and food production. This document provides highlights from Working Session #4, which focused on reducing conflicts at the water-energy interface. The fifth working session will focus on human health impacts of freshwater problems.

The detailed results of Working Session #4 captured in this meeting summary will inform a framework for actionable steps that The Johnson Foundation can carry forward into future working sessions and the Summit. Additionally, this document is intended to serve as a tool for sharing the content and results of the discussions at Working Session #4 with others who did not have the opportunity to participate in this gathering and for moving the national dialogue forward on these critical issues. The meeting summary is organized into following sections:

- Work Session #4 Overview
- Summary of Meeting Outcomes
- Challenges at the Interface of Freshwater and Energy
- Opportunities for Addressing Challenges at the Water-Energy Interface
- Conclusions: Building Support to Advance Solutions

Working Session #4 Overview

Working Session #4, Reducing Conflicts at the Water-Energy Interface, focused on addressing challenges at the intersection of water and energy. The discussion was specifically focused on achieving the following objectives:

- Identify opportunities to address challenges that exist at the intersections of U.S. freshwater systems and the energy sector, including:
    - Reducing energy needs and carbon footprint associated with all sectors of water use, treatment, and delivery; and
    - Minimizing conflicts between water demand from energy generation and water needed for other human and ecological purposes.
- Identify priority solutions that need to be included in a national agenda to achieve more resilient freshwater systems while also providing energy to the American public and economy.

The meeting program and list of participants are included in Attachments A and B, respectively.

Summary of Meeting Outcomes

Only recently has the inextricable link between water and energy begun to gain attention from U.S. decision makers, which may be due to the fact that the nation's major energy systems were built decades ago when energy was inexpensive and water was abundant. Today, decision makers and resource managers in the public and private sector are being forced to pay attention to the water-energy interface as energy costs increase and water becomes scarce in many parts of the country. Moreover, concern about environmental issues such as the water quality and ecosystem impacts of "water for energy" and "energy for water" activities is on the rise, as is interest in clarifying the true cost of water in terms of externalities such as the greenhouse gas emissions associated with managing, transporting, treating and heating the water.

Work session participants emphasized the need to raise awareness among decision makers and resource managers as well as the public, about the important linkages between freshwater and energy. The water implications of energy decisions and the energy implications of water decisions must be acknowledged explicitly and accounted for in short-term and long-term planning and development decisions. Much of the discussion centered on catalyzing policy action at the federal level, but participants also stressed the need to coordinate federal policy action with action at the regional, state, and community scale. Finding ways to link federal and state and/or regional policy actions to grassroots efforts in communities was a key theme of the work session and is reflected in the structure of the outcomes. The group sought to identify ways in which to align and direct action at all scales to influence and change people's everyday behavior in terms of water and energy use.

Opening lines of communication and improving understanding of interests and end goals across scales was identified as a critical task for overcoming disconnects on water-energy issues between different scales of society. One way to facilitate this could be to establish common principles across scales of governance and agencies for making water and energy policy and management decisions. For example, focusing on increased water and energy efficiency should be a priority strategy for addressing challenges at all scales of the water-energy interface. Policy change is likely to stimulate, and manifest in, the development of new water and energy efficient technologies, which will also help bridge gaps in awareness and understanding of water-energy issues across societal scales.

Through the process of identifying opportunities to address water-energy challenges and priority solutions for a national agenda to achieve more resilient freshwater systems, the group identified broad assumptions about the state of the freshwater-energy interface, principles for decision making along different axes of the interface, and vision statements outlining characteristics a resilient freshwater-energy system should possess. 2025 was set as the target year by which the U.S. should strive to attain a resilient U.S. freshwater system in which energy and water management decisions are considered in conjunction. The intent of the assumptions, principles and vision statements is to help build a common foundation for water-energy decision making at the federal, state and regional, and community scale. Together, they

illuminate critical dimensions decision makers should consider now and in the future as they make policy and manage resources at the freshwater-energy interface.

Assumptions about the State of the Freshwater-Energy Interface

- Freshwater resources are essential for the health of both humans and ecosystems yet many of the ways in which they are currently being used are unsustainable in terms of quantity and/or quality.
- Climate change will exacerbate existing freshwater resource problems, both quantity and quality, in many areas of the U.S.
- Population growth and associated water needs will continue to exacerbate the freshwater challenges facing the U.S. if they continue on their current trajectory.
- Decision making processes in a carbon-constrained future must be robust enough to facilitate the reduction of carbon dioxide emissions from energy production while ensuring the sustainability of freshwater resources in the face of climate variability and change.

Suggested Decision Making Principles for Different Axes of the Freshwater-Energy Interface

<u>Smarter Policy and Management</u>

- Integrate water and energy resource planning and development so that agencies and stakeholders consider water and energy needs and impacts in conjunction.
- Explicitly take water availability and quality impacts into account in energy policy and investment decisions, considering multiple scales and implications throughout the supply chain.
- Analyze life cycle assessment and net environmental benefits as part of water-energy decisions.
- Account for temporal factors when making water-energy decisions (e.g., climate change impacts over time).
- Incorporate consideration of the full range of energy resources impacting water resources, including transportation fuels.
- Incorporate measures to reduce greenhouse gas (GHG) emissions into water management decisions across scales.
- Ensure understanding and enforcement of existing water laws and regulations related to energy production and resource development.

<u>Water Systems Design</u>

- Incorporate current science, data and forecasts, to ensure water systems are resilient, adaptable, reliable and scalable.
- Select the best water and/or energy systems design for a certain context based on the merits, rather than inherently favoring centralized or decentralized/distributed systems. Focus on water efficiency and conservation as top priorities for garnering significant energy savings and reducing GHG emissions at water facilities.

- Employ full-cost pricing when evaluating the cost-effectiveness of water systems.[1]
- Utilize biological waste and wastewater as assets for reuse and energy generation rather than system "waste."

Human Dimensions

- Account for local water conditions and availability, and involve local communities in defining water-energy problems and creating solutions to them.
- Consider basic human and ecosystem needs that are sometimes overlooked by market systems.
- Ensure consideration of social equity issues.

Characteristics of a Resilient U.S. Freshwater-Energy System in 2025

- Water policy and management decisions and energy choices reflect an understanding that saving water saves energy, and saving energy saves water and reduces GHG emissions.
- Attention to the water-energy interface is significantly improved for different economies, communities, and natural systems, with the value of energy embedded in the water supply and water embedded in the energy supply, routinely accounted for in policy and management decisions.
- Robust and integrated water and energy systems exist and incorporate the following dimensions as appropriate and where possible: decentralized systems, water reuse and resource recovery, ecosystem protection and restoration, source water protection, and community resilience.
- Enhanced water efficiency makes a quantifiable contribution to ensuring adequate water supply and reducing energy consumption in the water sector.
- The price of water better reflects its true value, creating incentives for actors at all scales to make more sustainable choices in how water is used and managed.
- Water resources sustainability is a key variable in energy use and urban land use planning decisions.
- Agricultural water use and water-related subsidies are considered rationally, and evaluated and accounted for accurately in water-energy decisions.

The group identified a number of policy and management actions U.S. decision makers could pursue at the federal, state and regional, and community level to alleviate conflicts and challenges at the water-energy interface. In addition, the group outlined a range of potential solutions related to new technologies, as well as enhanced data and information for technical advancements and public education. Key scales and arenas for action on water-energy interface issues that will be detailed below include:

[1] Full cost pricing is usually interpreted to mean factoring all costs [of water and wastewater services] - past and future, operations, maintenance and capital costs - into prices [such that all costs are recovered through prices. From U.S. EPA, Office of Water, www.epa.gov/waterinfrastructure/pricing/About.htm.

- Federal policy and action;
- State policy and action;
- Community policy and behavioral change; and
- Technology, data and information.

Challenges and Opportunities at the Interface of Freshwater and Energy

Two overview presentations initiated the deliberations by illustrating examples of inextricable link between water and energy and associated challenges and opportunities at the water-energy interface. Robert Goldstein, Electric Power Institute, covered water use for energy needs and Shahid Chaudhry, California Energy Commission, focused on energy use for water needs. Participants then discussed and added to the challenges and opportunities outlined in the opening presentations. This section summarizes key points from the overview presentations and the subsequent plenary discussion.

Water for Energy Challenges and Opportunities

Mr. Goldstein opened his presentation with a conceptual schematic of sustainability illustrating that the economic system is created by the social system while both are constrained by ecosystems, and all exist within the biophysical environment. Given these dynamics, Mr. Goldstein suggested that water sustainability must be approached from both the top down (watershed-based, inclusive of all stakeholders, matching aggregate water demands to supply) as well as from the bottom up (facility-based measures aimed at water use efficiency and conservation). All regions of the U.S. are vulnerable to water shortages with population growth driving increased demand for clean freshwater while concerns about environmental protection are increasing and climate change poses challenges yet unknown.

Mr. Goldstein highlighted that cooling to remove waste heat from thermoelectric energy generation is the greatest demand for freshwater within the energy sector. He showed graphically that thermoelectric power generation in the U.S. has increased dramatically since 1950 while thermoelectric water use efficiency has decreased as the percentage of plants with recycled wet cooling systems has increased. Growing demand for water and energy is driving several related issues:

- Pressure on the electric power industry to reduce water use;
- More intensive management of water resources;
- Greater integration between water and energy planning;
- Emphasis on watershed/regional planning; and
- Demand for new science and technology to support planning and management needs.

Thermoelectric energy generation plants are employing or researching four major strategies to increase freshwater withdrawal efficiency:

- Implementing dry/hybrid cooling;
- Using degraded/reclaimed water for cooling;
- Recycling water within plant by;
    - Increasing closed cooling cycles;
    - Treating and reusing blowdown water;
    - Capturing vapor in wet cooling tower and stacks;
- Increasing thermal conversion efficiency.

Mr. Goldstein suggested a tiered water resource assessment and management approach that could help increase water use efficiency using a combination of simple indices, detailed management area water budgets and dynamic watershed modeling. In conclusion, Mr. Goldstein noted that the potential for increased water use efficiency and conservation in the energy sector is significant. He suggested that research can enhance efficiency potential and reduce costs (energy and financial) and that there is value in creating a toolbox of diverse technologies and practices, since the relative benefits of individual technologies and practices are site and plant dependent. Bottom up approaches are a critical piece of sustainability, but need to be coordinated with top down approaches for optimal impact. Lastly, risk managers should consider the combined influences of population growth, land use change, technological advances and climate variability when making decisions at the water-energy interface.

Building on Mr. Goldstein's presentation, participants identified additional challenges associated with the use of freshwater for energy development and generation. Additional challenges include:

- Accounting for the upstream water used for energy resource extraction, production and processing activities and the associated quantity and quality impacts of these activities;
- Incorporating upstream water impacts of, and risks associated with, energy resource extraction into the value of municipal bonds in an accurate manner;
- Balancing agricultural water use for food production and use for biofuels production;
- Development of metrics for measuring the water footprint of energy use, which is highly complex because one must parse out impacts at the site of resource extraction or production from impacts at the site of energy generation;
- Determining the extent to which alternative water sources such as recycled, reclaimed or reused water reduces overall demand on freshwater resources;

Energy for Water Challenges and Opportunities

Mr. Chaudhry's presentation focused on energy use for water pumping, extraction and transfer as well as water and wastewater treatment, distribution, and disposal. He noted that water pumping accounts for approximately three percent of all energy use in the U.S. and 45 million tons of GHG emissions, while one percent of total U.S. electricity use is dedicated to water and

wastewater treatment. In California, an extreme case, 19.2% of the state's electricity use is for water-related purposes. Focusing on water and wastewater utilities, Mr. Chaudhry explained that energy costs comprise 40 to 50 percent of their annual operating budgets and is one of their top five concerns. Water utilities also face several emerging challenges such as delivering water to a growing population and while supplies dwindle, quality deteriorates, new contaminants pose threats and regulation is increasingly stringent. Meanwhile, several potential solutions to water supply and quality (treatment) issues are based on new energy-intensive technologies such as desalination and membrane bioreactors (MBRs).

Water and wastewater treatment utilities do utilize a number of energy saving methods including water use efficiency and conservation measures and detecting and repairing system leaks. Utilities are also taking steps to increase their energy efficiency and to integrate renewable energy generation into their operations such as extracting gas from biosolids (treated wastewater sludge) and converting that biogas into energy, as well as photovoltaics and wind power. Another emerging trend is the treatment of high-strength organic wastes from food processors, dairies and wineries, etc. Mr. Chaudhry highlighted a range of opportunities for water and energy savings. He noted that water savings programs are more effective overall in conserving energy than energy savings programs because they cost less to implement and result in permanent savings. In addition, conserved water equates to conserved energy and reduced GHG emissions. A range of approaches for energy savings are also emerging in the water sector, including:

- A holistic water and energy management approach focused on:
    - Developing local water sources instead of transferring water great distances;
    - Use of demand and constraint-based advanced transport and treatment management systems;
    - Energy efficient water system products such as premium efficiency pumps and motor systems, new types of low pressure membrane filtration, more energy efficient ultraviolet disinfection technology, advanced aeration equipment, and energy recovery systems for desalination;
- Behavioral changes including the incorporation of sustainability considerations and new design, management and operational philosophies;
- Research and development on innovative and energy efficient water treatment processes and technologies such as:
    - Membranes to desalt at much lower pressures, or to yield more freshwater with the same level of energy use;
    - Ultraviolet disinfection that requires less energy;
    - Systems to monitor real time raw water quality for instantaneous treatment process control and optimization;
    - Decentralized treatment systems that improve energy and water use efficiency;
    - Advanced sensors used in combination with energy management software to enable optimization of operations and management;
- Better coordination among resource management agencies to identify and address energy implications of water policy decisions; and

- Learning from the lessons of other industries such as the oil industry in terms of exploring alternative ways of operating.

Mr. Chaudhry concluded by stating that government can help accelerate the implementation of new water and energy saving measures by providing funding for research and development, technology transfer, and public education and outreach.

Building on Mr. Chaudhry's presentation, participants identified additional energy demand challenges associated with water use, development, transport and treatment. Additional challenges include:

- Raising the public's awareness about the amount of energy used for residential water heating and influencing more conservative and more efficient water use;
- Generating better data on the energy intensity of water usage as well as associated GHG emissions;
- Ecosystem impacts of water transfers and water reuse, recognizing that intact and properly recharged ecosystems provide water purification, storage, and transfer services;
- Energy use associated with water transfers;
- Provision of water for agricultural uses; and
- Lack of clear water quantity standards (with exception of household appliances and residential uses), which could drive energy conservation through water conservation.

Potential Solutions to Challenges at the Water-Energy Interface

Water and energy are the two driving forces of human life and society. While freshwater challenges are greater in some parts of the U.S. than others, overall the country is facing many current and impending challenges at the water-energy interface. Decision makers and the public must be made aware of the potentially severe human, ecosystem and economic consequences of inaction. Fundamentally, there needs to be a more widespread sense of urgency to act quickly and a louder collective voice calling for change. The group identified the following overarching elements as keys to accelerating solutions to water-energy challenges:

- Generation and dissemination of better information to motivate behavioral change;
- Establishment of true water pricing and appropriate use of market forces to affect policy and behavioral change;
- Increased use of alternative sources of water including reuse and on-site rainwater harvesting; and
- Use of wastewater and wastewater by-products (e.g., biosolids) as an energy generation asset.

The potential solutions identified during the course of the work session are organized below according to the scales and arenas in which the group thought action is necessary to raise awareness and catalyze change so that water concerns are explicitly considered in energy-related decisions and vice versa:

- Federal policy and action;
- State policy and action;
- Community policy and behavioral change; and
- Technology, data and information.

In the spirit of breaking down conceptual barriers and sparking creative thinking, the solution options described within each building block cover both water for energy and energy for water challenges.

Federal Policy and Action – There is a clear need to integrate water and energy policy and decision making more explicitly at the federal level so that the long-term implications of water and energy policy making are considered in conjunction. Improvements are also necessary to streamline, harmonize and improve the regulatory framework for water-energy decisions. Existing regulatory tools such as National Pollutant Discharge Elimination System permits may be able to serve as vehicles for smarter water-energy management.

Because responsibility and decision making about water and energy policy are currently diffused across many different federal agencies, a central coordinating body is needed to facilitate coordination and integration across agencies. Such a coordinating body could be established by the White House and championed by the Council on Environmental Quality (CEQ). CEQ has the coordinating capacity and authority to lead an inter-agency working group on the water-energy interface to develop recommendations and guidance for an integrated U.S. water-energy policy. Building on the overall water-energy principles developed during the session, any effort to integrate federal water and energy policy should aim to: avoid low carbon energy choices that have severe water impacts; avoid water choices with severe energy and/or GHG impacts; generate better understanding of water-energy tradeoffs; improve public involvement in problem definition and decision making; expedite wise high priority water and energy projects; develop and utilize sustainability measures that include water and energy efficiency; and seek to formulate win-win solutions.

There are a range of specific mechanisms that should be explored to facilitate integrated water resources planning at the federal level so water planning explicitly considers energy concerns. Potentially effective mechanisms include attaching water-energy conditions to state and federal funding, focusing on watershed-scale management, and shifting from funding projects to funding proper management that considers long-term water-energy impacts. One possible policy change could be to make the 20 percent set aside in the American Recovery and Reinvestment Act of 2009 for the State Revolving Fund (SRF) permanent and dedicate a portion of the funds to green infrastructure. Subsidies and appropriations currently built into federal energy (e.g., Federal Power Act) and water policy (e.g., Farm Bill) should be linked with

conditions that incentivize application of new technologies and best practices for water and energy efficiency and conservation. Bureau of Reclamation facilities should also be required to use shorter-term contracts and optimize water-energy use.

Federal agencies could model efficient technologies and conservation best practices through their energy and/or water purchasing decisions and facilities management approaches, while incorporating related messaging into public education and outreach activities. The federal government could also promote efficiency and conservation to the public by establishing national water efficiency standards for appliances similar to the Energy Star program. The EPA-sponsored partnership program, WaterSense, brings together local water utilities and governments, product manufacturers, retailers, consumers, and other stakeholders to create water efficiency performance criteria and help consumers identify water-efficient products and programs. This effort could serve as a basis for the creation of national standards. Another option could be to institute Federal Housing Administration loan conditions that require certain water and energy retrofits for home resale.

Other policy areas in which the federal government could improve management of water and energy resources include exploring options to promote the use of low-carbon energy sources to power water facilities, and creating mechanisms to facilitate the financing of decentralized water and energy facilities. Any forthcoming carbon management regulations that Congress passes should incorporate water considerations. California Assembly Bill 32 could serve as a model for such regulations. Standardized federal policy and/or regulations for handling produced water from oil and gas, coal bed methane and gas shale production, possibly through EPA's Underground Injection Control Program, should also be explored. Lastly, federal policy could be developed to encourage utilization of natural systems for water treatment rather than energy-intensive treatment plants.[2]

State Policy and Action – State-level decision makers and resource managers must be involved in the development and implementation of water-energy solutions for them to be effective. States could take a range of actions to complement federal measures to address water-energy interface issues. First, state agency personnel should coordinate with federal agencies when developing water and energy policy. States should also update state plumbing codes and other relevant codes to promote water efficiency, and work with municipalities to encourage water and energy savings through implementation of green infrastructure using the SRF and other mechanisms. States could incorporate population projections and their anticipated impact on water resources vis à vis energy use, including ecosystem water needs, into land use and growth policy. State water agencies should work to establish watershed-scale management

[2] On December 1, 2009 the House of Representatives approved H.R. 3598, the Energy and Water Research Integration Act, a bill which seeks to "ensure consideration of water intensity in the Department of Energy's energy research, development, and demonstration programs to help guarantee efficient, reliable, and sustainable delivery of energy and water resources." A Senate version of this bill, the Energy and Water Integration Act of 2009, was introduced by Senators Bingaman (D-NM) and Murkowski (R-AK) in March 2009, which is still in committee. The full version of the H.R. 3598 is available here: http://www.govtrack.us/congress/billtext.xpd?bill=h111-3598.

entities, as well as flood management and water supply plans that reflect water impacts and carbon emissions.

To explore and advance infrastructure-oriented solutions to water-energy challenges such as expanding the use of decentralized systems, states and utilities would need leadership, technical assistance and funding. State-level leaders and agencies have roles to play in raising awareness of energy needs/impacts among water plant operators to a level commensurate with that at which energy facilities recognize their water needs and impacts. Governors' associations and/or the U.S. Conference of Mayors could provide leadership to raise awareness and catalyze actions to develop water-energy solutions. Federal incentives and technical assistance, as well as public-private partnerships, could help spur water and energy infrastructure innovation and development.

States should seek to increase the use of renewable and low-carbon energy sources to power water and wastewater facilities, as well as consider decentralized alternatives to meeting state and regional water and energy needs if water and carbon footprints are reduced as a result. State legislatures could mandate that public utility commissions integrate water considerations into their decision making about energy projects, rate setting and permitting. Such a measure would go beyond voluntary measures to ensure action. In addition, state water managers should be consulted about state energy decisions.

States should also consider water facilities for energy storage as a means of increasing the reliability of low-carbon energy sources. For example, a pump hydropower facility could use wind energy to move water up into a holding facility and then release it to generate power when wind power is not available. This would in effect translate into storing renewable energy. There may also be opportunities to co-locate or integrate renewable energy facilities with water facilities. States could also consider establishing renewable portfolio standards and/or energy efficiency standards specifically for water treatment facilities. Studies are needed to understand the potential barriers and benefits for water facilities of these types of water-energy solution possibilities.

Community Policy and Behavioral Change – Policy and management decisions made at the federal and state level must ultimately translate to the community scale and into citizens' households for them to generate broad results in terms of water and energy efficiency and conservation. Water consistently polls as a top priority environmental concern among the public, which provides an opportunity to motivate behavioral change. However, the water-energy dialogue must allow lay people to participate. Local leaders should promote transparency, information, education and outreach on water and energy issues so that they are able to make better decisions and influence policy through an informed public.

There are a number of actions that could be taken at the community level to address water-energy challenges. Local governments could apply smart growth principles to water and energy planning and identify local mechanisms to increase residential energy and water efficiency.

Local codes and zoning could be adjusted to allow for alternative water supply and treatment options including rainwater harvesting, gray water use, wastewater reuse, decentralized water systems, use of natural systems for water treatment, green infrastructure, and low impact development (LID). Agency personnel and local service providers should be encouraged to develop practical knowledge of these practices, as well as water and energy efficiency expertise. Communities that do not currently have water meters should install them, while more developed communities should consider smart water meters if/when they become available. In terms of funding innovative water-energy initiatives and projects, communities could benefit from public-private partnerships as well as placing public financing conditions on municipal bonds that take into consideration water and energy sustainability. Leaders could also capitalize on political statements such water pledges by elected officials and/or citizens to expedite approval of permits for efficient water projects.

Grassroots organizations working in communities can serve a critical role in advancing broader policy objectives by engaging citizens directly, and delivering understandable information from a trusted source. Grassroots activists should aim to make water-energy issues real and tangible to local people and encourage personal awareness and responsibility to attend to water efficiency and conservation. For example, residential water bills can serve as a teaching tool to illustrate the link between water and energy. Students at all education levels should be a prime target audience for these messages so that future generations become aware of water-energy issues.

The key is for public education efforts to focus on messaging that gets people's attention and has the potential to change their behavior. Key areas of focus include water and energy efficiency, acceptance of water reuse and decentralized systems, building political will on issues such as land use regulations, promoting a trained workforce, and understanding of additional costs associated with wise water-energy decisions. Successful community or state-level models for building awareness of the water-energy interface and stimulating behavioral change among citizens should be examined by federal policy makers and scaled up when and where appropriate.

Technology, Data and Information – To address resource conflicts at the water-energy interface, the U.S. needs to ramp up research and development on high efficiency technologies, develop more effective strategies to motivate behavior change among consumers, and produce better data about water-energy connections and tradeoffs. While more information is needed on these fronts, the water-energy interface is understood well enough to know that it is time to act.

The public sector should partner with private business to help drive technology research and development and market development to address challenges at the water-energy interface. Research and development investments should focus on technologies that reduce the water impacts of low-carbon energy generation options, and reduce the energy intensity of drinking water and wastewater treatment. Specific technologies that warrant greater investment include energy storage, desalination (reducing energy-intensity), advanced biofuels such as algae and

high-efficiency irrigation systems. Studies on the potential capacity of water facilities to generate or store energy on-site would also be useful.

Water reuse is likely to be a critical part of addressing the water-energy interface and research is needed to find ways to recover energy from biological waste and/or make treated wastewater usable for non-potable purposes. Matching the water of differing quality to the right application or use will be important to public acceptance of water reuse technologies as well. End-user technologies that help consumers better monitor and manage water and power consumption, hold promise for increasing household and commercial water and energy efficiency. Smart electricity and water meters, smart buildings, smart appliances, smart rates and smart billing all need to be developed and deployed to help customers make good decisions. Ideally, the U.S. would develop a "smart water grid" that would be integrated with a smart energy grid, and mirror the tiered structure of the U.S. highway system (interstate, state, and local connections). However, social science research is required to determine the extent to which smart technologies actually alter consumer behavior, and what other strategies drive behavior change with regard to water and energy practices. Currently, smart electric meters tend to produce information that is more helpful to utilities than consumers.

Overall, the U.S. needs more and improved data to understand trade-offs involved in water-energy decisions. For example, it would be useful to conduct a scenarios study to outline different ways to optimize the mix of centralized and decentralized water and energy facilities and maximize resource use efficiency. In any such cost-benefit analysis, water should be included as a variable so that the economic viability of decentralized energy systems is characterized fairly. Better data are also needed on the water use, demand and intensity of different energy extraction, production and generation methods. For example, the U.S. should conduct a comprehensive analysis of the water and land impacts of alternative transportation fuels being considered for major development as several alternatives to conventionally produced gasoline have water-related downsides including oil shale, tar sands, cellulosic ethanol, and grain ethanol. Further research and data collection are also required on water issues that ultimately relate back to energy, such as groundwater supplies, use and recharge rates, as well as climate change impacts on water supplies.

Conclusions: Building Support to Advance Solutions

During the concluding discussion of the work session, several participants emphasized the need to build broader political support for addressing water-energy issues specifically, as well as water sustainability issues in general. The heavy focus on energy issues in the current U.S. public policy landscape may provide an opportunity to incorporate and raise awareness about freshwater issues. For the community of scientists, advocates and policy makers concerned with water-energy issues to gain political momentum and have its voice heard in federal policy discussions, coalitions must be built, goals prioritized and actions sequenced carefully. The Sustainable Water Resources Roundtable (subcommittee of the Advisory Council on Water

Information) and the Alliance for Water Stewardship are examples of water-oriented collaborative efforts open to additional participation. Development of curriculum for public and school-based education through organizations such as the National Environmental Education Foundation was re-emphasized as a long-term strategy to build political will on water-energy issues. The group highlighted the Department of Energy as the key federal agency to approach about addressing the water-energy interface, while recognizing several other agencies with different missions and organizational cultures must also be engaged on the issue. A White House interagency working group could be an effective mechanism for overcoming organizational hurdles and sustaining coordination of federal agencies on water-energy policy and management.

The group stressed the importance of engaging private industry and investors, including the electric power industry itself, in solving challenges at the water-energy interface. It is the potential risks or costs of inaction that tend to motivate the private sector to take action. Organizations such as Ceres are working to frame water, energy and climate change issues in risk management terms so that businesses are able to translate the information into new and innovative practices. The goal is to foster competition among companies to enhance their operations by conducting water and energy use and efficiency assessments and developing annual performance reports. There is also a need to link the efforts of advocacy organizations and the private sector on water-energy issues, which could be addressed through dialogue. Incorporating water considerations into clean energy bonds could be an effective strategy to raise awareness and facilitate engagement of investors in water-energy solutions.

The inextricable link between water and energy can no longer be ignored or set aside by U.S. decision makers and resource managers. This work session outlined the range of challenges the U.S. faces at the water-energy interface, as well as a number of potential solutions for addressing them. To ensure the resilience of our freshwater systems vis à vis energy, actors at all scales must work to raise awareness and catalyze change throughout society through their activities and messaging. A national call to action to address U.S. freshwater challenges should firmly state the importance of involving all relevant stakeholders, and coordinating the execution of their commitments and actions across scales with an incremental adaptive management approach to allow for adjustments and enhanced effectiveness over time.

The Johnson Foundation Environmental Forum

Working Session #4:
Examining U.S. Freshwater Systems and Services:
Reducing Conflicts at the Water-Energy Interface

November 16–18, 2009

Racine WI

Background readings will be posted on the Johnson Foundation website at www.johnsonfdn.org/upcoming.html

Objectives:

- Identify opportunities to address challenges that exist at the intersection of U.S. freshwater systems and energy sector, including:
    - reducing the energy needs and carbon footprint associated with all sectors of water use, treatment, and delivery, and
    - minimizing the conflicts between water demand from energy generation and water needed for other human and ecological purposes.
    -
- Identify priority solutions that need to be included in a national agenda to achieve more resilient freshwater systems while also providing power to the American public and economy.

Outcomes:

- Working definition of freshwater-energy resilience;
- Recommendations for a national agenda to achieve a more resilient U.S. freshwater system that also ensures energy security;
- Topics to consider for future work sessions; and
- Topics to consider for the 2010 Johnson Foundation Environmental Summit.

"Most Americans do not realize that they use more water turning on lights and running appliances each day than they do directly through washing their clothes and watering their lawns."

Carl Bauer, Testimony before Congress, March 2009

Monday, November 16, 2009

12:30 – 2:30 p.m.	Buffet Luncheon Guests should feel free to tour the grounds	Guest House
3:30 p.m.	Gathering and Orientation to Accommodations Lynn E. Broaddus, Director, Environmental Programs The Johnson Foundation at Wingspread	Guest House
4:00 p.m.	Plenary Session	The House
	Welcome to The Johnson Foundation at Wingspread Roger C. Dower, President Lynn E. Broaddus, Director, Environment Programs The Johnson Foundation at Wingspread	
4:15 p.m.	Conference Goals, Agenda Review and Introductions John Ehrmann, Facilitator Meridian Institute	
4:45 p.m.	Introductory Presentation Presenter (TBD) Overview presentation of the priorities that define the challenges at the nexus of freshwater and energy issues.	
5:00 p.m.	Plenary Discussion: Freshwater Resilience in the Energy Sector Facilitated discussion of the priority challenges that need to be addressed at the intersection of the water and energy sector. What are the national priorities that need to be addressed to provide resilient freshwater systems and services while also providing energy security to the United States? What are the challenges to reducing the water and carbon footprint of the energy sector and reducing the energy demand from water systems and services. *Outcome:* Preliminary list of priority challenges for further discussion during the Working Session.	
6:00 p.m.	Day 1 Wrap-up Brief highlights of Day 1 and discussion of priority topics for Day 2.	
6:30 p.m.	Hospitality	Wingspread
7:00 p.m.	Dinner	Wingspread
8:30 p.m.	Adjourn to Guest House for hospitality	

Tuesday, November 17, 2009

Breakfast will be available from 6:30 a.m. to 8:15 a.m. in the living room of the Guest House.
The agenda for Day 2 will be refined based on the results of Day 1

8:30 a.m.	Plenary Session	The House
	Welcome and Agenda Review John Ehrmann, Meridian Institute	
8:45 a.m.	Plenary Discussion: Water for Energy Using the ideas generated from the Day 1 plenary discussion as background, the group will discuss in more detail the challenges associated with the use of water for energy development and generation. How will emerging energy sources impact the challenges we face with water demand - both as new fuel sources are developed and as power is generated through alternative technologies? *Outcome:* List of priority challenges	
10:15 a.m.	Break	
10:30 a.m.	Plenary Discussion: Energy for Water Using the ideas generated from the Day 1 plenary discussion as background, the group will discuss priority challenges with respect to the energy consumption and carbon footprint associated with the treatment, delivery and use of water. How do we optimize the energy we use and limiting the carbon emissions resulting from the movement and treatment of water? What are some of the future challenges we will face as climate change impacts our freshwater resources? *Outcome:* List of priority challenges	
12:00 p.m.	Luncheon	Wingspread
1:00 p.m.	Breakout Sessions: Opportunities and Solutions	The House
	Participants will break into small groups to identify priority opportunities and options to address challenges identified in the plenary sessions. Breakout discussions will focus on the following dimensions: o Most promising or highest priority solution options o Key challenges to developing or scaling up priority options o Strategies to overcome key challenges Group may be divided according to Water for Energy and Energy for Water	
3:00 p.m.	Break	The House

3:15 p.m.	Plenary Discussion: Breakout Session Results Reports back to the group followed by discussion.

Tuesday, November 17, 2009 (continued)

4:15 p.m.	Plenary Discussion: Integrated approaches to Resilient Freshwater and Energy Systems Facilitated discussion of integrated solutions to address both energy and water needs without compromising the other. How can the value of water be captured in both the energy and water systems? Is there a need to prioritize the value of one over the other or is there a way to integrate both systems as one?	
5:45 p.m.	Day 2 Wrap-up Brief highlights of Day 2 and discussion of priority topics for Day 3.	
6:00 p.m.	Leisure	
6:30 p.m.	Hospitality and Tour of Wingspread (optional)	Wingspread
7:00 p.m.	Dinner	Wingspread
8:30 p.m.	Hospitality	Guest House

Wednesday, November 18, 2009

Breakfast will be available from 6:30 a.m. to 8:15 a.m. in the living room of the Guest House.
The agenda for Day 3 will be refined based on the results of Day 2

8:30 a.m.	Plenary Session Welcome and Agenda Review John Ehrmann, Meridian Institute	The House
8:45 a.m.	Plenary Discussion: Synthesis of Top Priorities Facilitated discussion of the top priorities for a national agenda for addressing freshwater challenges at the intersection with the energy sector. Evaluate options for innovative technologies, integrated U.S. policymaking, private sector and NGO initiatives and other actions that will advance efforts to resolve conflicts and provide mutually beneficial solutions for the challenges at the intersection of the water and energy sectors. *Outcome:* Identification of policy opportunities, private sector and NGO initiatives and messaging for public awareness.	
10:30 a.m.	Break	
10:45 a.m.	Plenary Discussion: Next Steps What are the key topics that ought to be addressed in future Wingspread efforts or the June 2010 Environmental Meeting? Who are the key people that need to be involved to make these events successful?	

11:15 a.m.	Wrap-up and Final Round of Comments John Ehrmann, Meridian Institute	
12:00 p.m.	Work session adjourns/Luncheon	Guest House

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