



THE JOHNSON FOUNDATION  
Wingspread Conference Center

## *The Johnson Foundation Environmental Forum Working Session #1: Impact of Climate Change on Freshwater Resources and Services in the US*

*March 17-18, 2009*

### *Meeting Highlights*

#### **Background**

The Johnson Foundation Environmental Forum is being designed to catalyze a national dialogue on how we manage our freshwater resources and services in the face of daunting challenges. This event, planned for May 2010, is intended to bring visibility to the most pressing freshwater issues facing the US, shed light on possible solutions and catalyze a wide range of actions that together can result in change. To ensure that the Forum reflects the latest thinking on critical issues, the Johnson Foundation (the Foundation) is convening a series of preparatory working sessions of scientists, policy makers, and practitioners to lay the groundwork for the finalization of a national agenda at the Forum.

The first working session focused on understanding the available science and relevant expertise at the intersection of climate change and freshwater resources. The overarching goal was to explore 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 meeting was also intended to determine which freshwater issues are particularly urgent and ripe for the Johnson Foundation and key decision makers to address in the coming years. A diverse group of scientific and technical experts covering a range of freshwater disciplines and expertise participated in the meeting, representing perspectives of the federal government, academia, corporations and NGO's. Specifically, participants in the working session explored the following questions:

- What key problems are we facing in the US with freshwater systems and services, and what secondary issues develop as a result of these challenges?
- Which of these challenges are driven or exacerbated by climate change?
- Is the climate change lens useful relative to freshwater resources?
- How are these problems manifesting themselves in different regions of the country?
- Are some groups of people disproportionately disadvantaged by projected changes?
- What innovative solutions or adaptation strategies are being implemented in different regions to address these problems? Are the solutions experimental or proven, and is there an opportunity to adopt them more broadly?
- Where are the gaps? What challenges are not being addressed?
- What is the time frame within which these changes need to occur?

The session increased the understanding of the Foundation about these critical questions and distilled important insights generated through the thoughtful exchange of this diverse group that hopefully will be

of use to others who did not have the opportunity to participate in this gathering. This white paper summarizes highlights from the meeting and is intended to serve as a tool for moving the national dialogue forward on these critical issues. The paper is organized around the following themes:

- Understanding the Nature of a Complex Problem
- An Integrated Look at Addressing the Problem
- Exploring Opportunities for Change
- Provocative Questions for Further Investigation
- Next Steps

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

### **Understanding the Nature of a Complex Problem**

There is a need for a more sophisticated understanding of the complex and interrelated problems that are emerging for freshwater resources, hydrologic systems, and associated human-made infrastructure and ecosystem services. To initiate the deliberations, several meeting participants offered opening perspectives on the broad challenges to the sustainability of freshwater systems and services, the impact of climate change on freshwater resources and the range of regional implications. They hypothesized that the conventional assumptions science has relied upon to understand current conditions and develop future projections are no longer sufficient. Given this reality, decision makers must adapt to making decisions about freshwater systems under conditions of increased uncertainty about what the future will bring.

The group focused on several defining characteristics of freshwater systems and the challenges they face.

***Major changes are controlled by thresholds*** – There are tipping points in freshwater systems beyond which major changes may occur. These changes are often big, fast and unexpected. As these thresholds are crossed, the magnitude and rate of change throughout the rest of the system also accelerate. As a result, a system that was once organic and adaptable can become rigid and brittle. Our capacity to understand the nature of thresholds is evolving and while we will be able to improve our ability to predict and understand resulting changes, it is important to recognize that such knowledge will never be complete – surprises are expected. Scientists can tell that climate change is altering environmental thresholds, but do not understand how or what the implications will be. The challenge before the scientific community is to learn fast in a rapidly changing environment so that society can avoid reaching those thresholds. Gaining a better understanding of which thresholds are the most critical in terms of impacts on human or ecosystem health will help create a compelling means of conveying complex issues or problems to the public in an understandable and meaningful way. Meeting this challenge will help mitigate the societal tendency to ignore the value of ecosystems until environmental problems adversely affect human populations.

***Averages matter less than extremes*** – To understand the stresses on our systems we must focus on understanding the extremes because our systems are increasingly functioning at the extremes (e.g. drought and flood state). One of the most significant shifts in the nature of the freshwater system is the “death of stationarity.” The typical data analysis tools used by researchers and forecasters focus on historical data and trends. These tools do not apply in a system that is not defined by stationarity. Similarly, baselines become less relevant and insufficient in a system that does not conform to historical norms.

***Human impact on freshwater is significant*** – The human impacts on freshwater resources relative to other resources like carbon is very significant. Science has measured the impact of humans on freshwater

resources to be an order of 2 or 3. This level of impact is an order of magnitude greater than the estimated human impact on atmospheric carbon – the driver of climate change. This correlation offers a compelling message for understanding the significance of human impacts on natural systems.

***Population growth is creating unsustainable stresses on the system*** – Population growth drives demand for resources essential to human society like food, energy and drinking water, which find their nexus in water quality and quantity problems. The most populated and fastest growing portions of the US are verging on or have exceeded the carrying capacity of their existing water systems. Current demand scenarios are leading to the depletion of water supplies because growth is outpacing the capacity of the hydrologic system to replenish itself. Poor growth management and planning, unwise land use patterns and other shortsighted urban planning practices have exacerbated the impacts of population growth on freshwater systems and other natural resources. Some of the challenges associated with overuse are due in part to the interrelationship between water quality and quantity. The tendency is to focus on addressing water quantity needs (the hydro-regime) sometimes to the detriment of water quality and ecosystem health. However, a healthy system contributes a greater quantity of clean water. Degraded and impaired water bodies equate to diminished supplies.

***Regional Considerations*** – Water “sustainability” is a regionally specific state characterized as water use relative to water recharge. In many parts of the US, demand is exceeding the “renewable” portion of the freshwater resources that are available. In other words, use exceeds the ability of the hydrologic system to process and recharge the water supply. The Colorado River Basin and the New York City water supply system offer examples of particularly problematic challenges and promising solutions (respectively) that are materializing in regionally specific ways.

### **The Climate Change Lens**

The national dialogue on climate change provides a broad context and motivational lens through which experts and decision makers can engage public debate about the stressors on US freshwater resources. Water is arguably the primary delivery mechanism for the effects of climate change. Humans will “feel” the effects of climate change most significantly through freshwater and marine resources.

Changes associated with increased greenhouse gas levels in the atmosphere and resulting temperature increases seem to be exacerbating the freshwater challenges and altering the thresholds that regulate the hydrologic system. For example, the timing of spring snowmelt is changing due to shifting weather patterns associated with climate change, which affects the ability of existing water storage facilities and reservoirs to capture runoff effectively and efficiently. Storm intensity is increasing in some areas of the country, resulting in increased pollution loads being washed into waterways. Aquatic ecosystems are also highly sensitive to shifts in water temperature. Rising water temperature is pushing many species toward critical thresholds and allowing other (invasive) species to displace indigenous ones. This increase in invasive species is considered one of the leading causes of degraded ecosystems and ecosystem services. Moreover, human responses to climate change may further exacerbate adverse effects on aquatic life and biodiversity (e.g. building additional dams and reservoirs). This phenomenon is known as maladaptation.

Notwithstanding these impacts, climate change is not considered the sole driver of the most significant problems materializing in the hydrologic system. However, it is impacting the intensity and scale of freshwater problems and if business continues as usual, the impacts of climate change will accelerate and amplify changes we are already experiencing. The potential of that amplifying effect makes human adaptation to climate change a critical public policy issue that will require an adaptive management approach to deal with an uncertain future. Real-time information that helps make better decisions about how to address challenges will be key to adaptive management because the effectiveness of existing mitigation and adaptation strategies are poorly understood. At the same time, decision makers must be

aware that adaptation to climate change can be an excuse for bad decisions with negative long-term consequences for freshwater and other ecological systems and biodiversity.

## **The Most Pressing Issues**

When looking beyond the data, to better understand how the scientific problems in the freshwater system are manifesting themselves – several important linkages exist. Often, the average person does not “see” the problems we are experiencing with freshwater. With the exception of drought and flooding, many of the most urgent problems become apparent through links to other issue areas. These linkages are critical to understanding the complexities associated with freshwater.

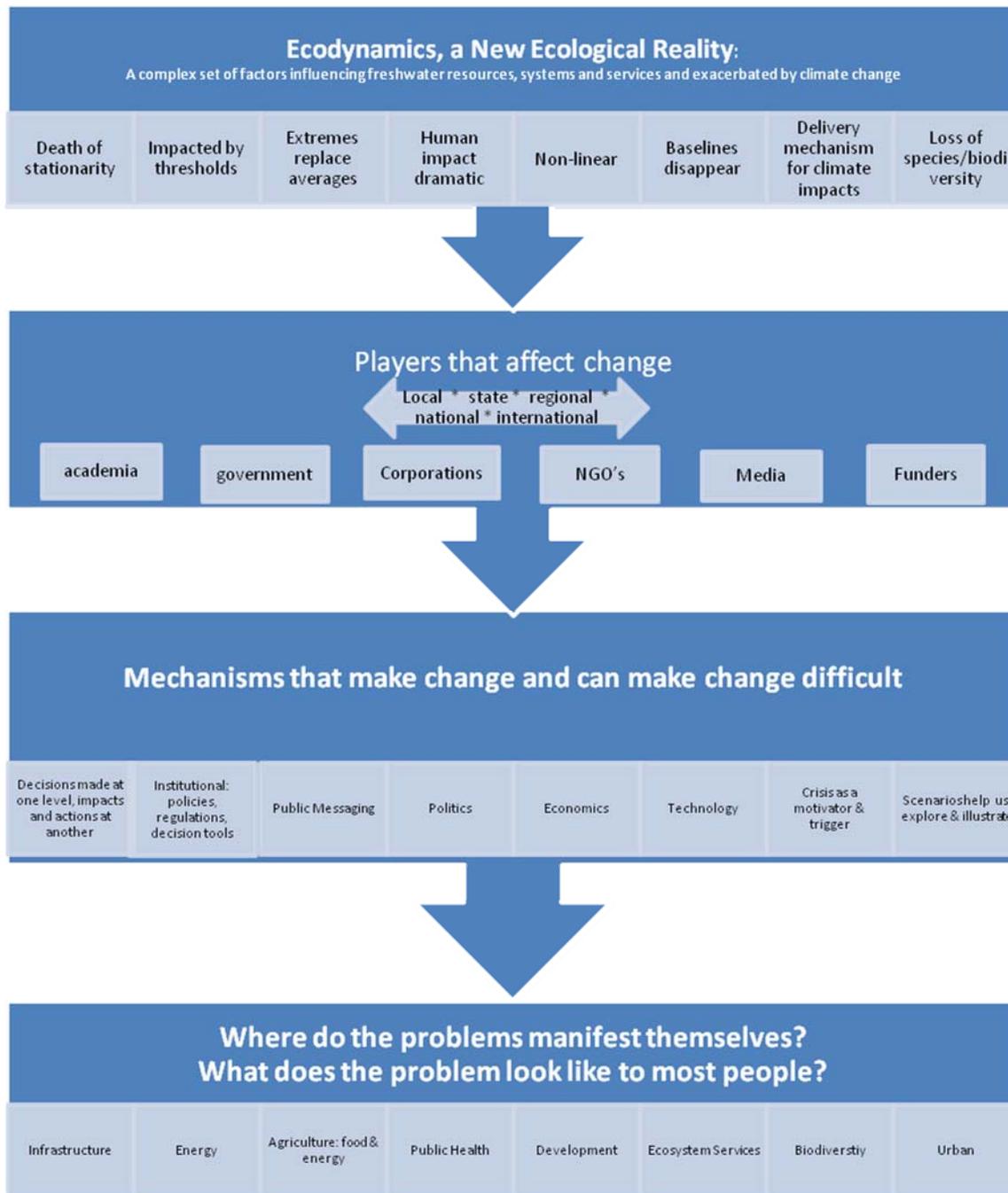
***Infrastructure and water*** – While the US water infrastructure system is one of the world’s most developed, signs of aging and disrepair are widespread. Infrastructure concerns focused on urban drinking water supply, sewerage and stormwater management systems. The pipes and plumbing of many cities around the country are degraded, resulting in both the wasting of freshwater and the contamination of clean water supplies. Combined sanitary sewer and stormwater systems are a particularly egregious problem with implications for human health and the health of aquatic ecosystems.

***Interrelationship of energy policy and water demand*** – There is a strong correlation between energy use and water use. High consumption of water is needed to produce many forms of energy. In some cases, energy uses are in direct competition for the same limited resources that are supplying regions with drinking water. Furthermore, a high consumption of energy is needed to deliver water to most populations. The compounding effect of this relationship poses a future threat to some urban centers in particular. For example, dwindling water levels are threatening power supplies in certain regions of the country (e.g. Georgia and Las Vegas, Nevada). Some energy alternatives that are being considered to reduce carbon emissions are extremely water intensive. In addition, as air pollution and carbon emissions decrease, water use significantly increases. For example, carbon capture and sequestration doubles water use in power plants. A key question raised is whether we understand the long-term consequences of our energy choices and how we can make more sustainable decisions that consider water impacts.

***Agriculture use and water demand nexus*** – Agriculture accounts for over 80% of the freshwater we consume as a nation. The complex relationship of agriculture and freshwater resources was discussed in terms of both the food and energy aspects of agriculture. Agricultural runoff is also one of the most significant non-point sources of water pollution, particularly increased concentrations of nutrients and chemical pollutants from herbicides and pesticides. These water quality impacts correlate with the threats to clean drinking water (e.g. source water) and healthy aquatic ecosystems. Whereas the agriculture-water relationship was once a food issue, it is now also a fuel issue given the dramatic increase in water-intensive production of corn-based biofuels.

## **An Integrated Look at Addressing the Problem**

Participants discussed how this landscape of freshwater systems and services reflected a complex set of “ecodynamics” or a new “ecological reality” that does not conform to conventional assumptions. This shifting reality shapes the challenges facing the US on many levels. This new reality also feeds into the potential solutions. Better understanding these ecodynamics will help to identify the mechanisms necessary to advance change as well as those that can act as barriers to change. As reflected in the figure below, the group discussed the importance of first understanding the complex characteristics of the problem, then identifying the players and mechanisms that can catalyze change and impact the problems as they are recognized by the average person.



## Exploring Opportunities for Change

As reflected in the figure above, key players from all sectors are critical to affecting change: academia, NGO's, corporations, funders and all levels of government. Local, regional, national and international scales are relevant given the global nature of the problem and the local impacts. While many of the problems occur at one level, decisions may be made at another level and actions implemented at yet another. Often decision makers at multiple scales (e.g., national, regional, state and local) affect ability to

adapt effectively. There is a need for integrated approaches that involve multiple levels of government and other sectors to define the problems, develop solutions and implement them.

### **Mechanisms that make change and make change difficult**

Mechanisms for affecting change and minimizing obstacles to change were discussed.

***Better institutions*** – Overall, there is a need for institutions throughout the U.S. to manage freshwater systems and services in a way that is more sustainable and resilient. This includes managing for variability and extremes rather than averages. It includes managing for the health of the ecosystem in addition to human health interests. More resilient institutional policies need to address needed technological changes (e.g. to improve water efficiency of agriculture); management changes (e.g., Boston, where engineering improvements, price incentives, and public education reduced water use by 31% from 1987-2004); and ecological change: (e.g. restoration and creation of wetlands to provide ecosystem services). Additionally, interaction among institutions requires increased cooperation and collaboration across disciplines, geographic regions and political scales. As explained previously, many of the freshwater problems require multi-disciplinary approaches that integrate decision makers at one level and implementation at another. Currently, communications among institutions on freshwater issues are limited and ad hoc.

***Climate change offers a compelling framing tool to motivate improved water management and policy*** – The high visibility of climate change as it is manifested in freshwater challenges offers a compelling frame for conveying critical challenges that need to be addressed through improved management and policy. Crisis, both in terms of current economic conditions and the climate change “crisis,” is a mechanism or motivational tool for spurring action. The public is more inclined to act in response to a crisis. If the challenges to freshwater resources and services can be appropriately linked to these critical concerns and reasonable solutions can be presented, then the public is more likely to act on them. Anticipating and preparing for climate change for example, may offer an opportunity to shape the future of freshwater systems in a positive way.

***Shifting Political forces*** – Overall, the challenges we face are moving faster than the political and management system through which we must address them. Politics have a significant impact on our ability to affect change. While the current Administration offers an opportunity for addressing many of the complex issues associated with freshwater resources and infrastructure needs, enduring solutions will require policies and procedures that are attuned to the current political landscape while rising above the politics of the day to drive long-term implementation and behavior change. Furthermore, while the national political stage is important, local government is the level at which many changes happen or are blocked. Local agencies also control water pricing. Thus, successful policies will appeal to a wide range of interests and political persuasions and allow for regional and local flexibility that takes into consideration community-level interests and needs.

***Improved management tools*** – While change is needed, the group recognized many tools that currently exist to improve management of freshwater systems.

- Ecosystem-based decision-making structure exists at the watershed level and institutional arrangements exist to support it.
- Jurisdictions such as Seattle are successfully implementing water policies and pricing structures that help to shape more sustainable behavior.
- New York City continues to provide a model for watershed protection as an alternative to water treatment.
- NGO’s play a key role in integrating interests at the local level, often helping move local governments toward higher levels of cross-jurisdictional integration. NGOs are providing

institutional leadership to build integrated government institutions with revenue authority, links to formal legal mechanisms and the means to create incentives. NGO's also possess the capacity to tap into the public imagination which can help affect change.

***Public education and messaging*** –Influencing public opinion and better educating the public on the issues so that they can make more informed decisions is key to catalyzing behavior change and institutional and political reform. Leaders will need to see the shifting will of the public for them to make different kinds of decisions about freshwater issues. The group suggested the possibility of developing compelling science-based scenarios to capture public imagination and affect behavior. Another effective avenue could be to better educate journalists about freshwater issues so that the media provides better information to their audiences.

***Opportunities for technological innovation*** – Investigating some of the most promising technological solutions under development and helping to shed light on existing opportunities or bringing funding and attention to promising ideas that need further research and development is needed.

### **Defining a vision and roadmap for water resilience**

Overall, freshwater issues are particularly urgent and relevant for the Johnson Foundation and key decision makers to address in the coming years. There are critical gaps in what is already being done and there are issues that need to be addressed in a new way or from a different angle to gain a better understanding. Many tough issues are in need of a multi-disciplinary approach. Much research and action is occurring in silos, but long-term solutions will require a comprehensive approach that considers the science, engineering, social and economic factors and integrates a range of perspectives. The group believed that the Johnson Foundation at Wingspread is positioned well to facilitate such dialogue.

Increased clarity and sophistication about the meaning of long-term sustainability and resilience with respect to freshwater resources is needed. The best way to build common ground on such a complex and controversial issue is to have various sectors in the room working together toward a common goal. The group recommended working toward a bold goal that can galvanize the various voices that need to be engaged. “Water resilience by (a date certain such as 2025)” was identified as one such aspirational goal that could serve to unify focus for all of the “pillars” of the effort going forward. The following example was offered: “We will inform and prepare the world to protect and enhance human health and well being and the sustainability of freshwater ecosystems through strategies and actions to adapt to the inevitable impacts of climate change in the next 30 years.”

There are three key elements of water resilience:

- Persistence – to avoid known thresholds.
- Adaptability – to manage variable systems by moving away from the threshold, moving the threshold farther away, or accepting transgressions of small, “cheap” thresholds in order to avoid big, catastrophic thresholds.
- Transformability – to switch to a fundamentally new system when the old system is untenable.

Furthermore, there is a need to revise our definitions and understanding of sustainability and well-being to include access to clean water – including for ecosystem services.

Several of the most pressing problems are worthy of further exploration, potentially through additional working sessions, in order to map out a path toward more resilient freshwater systems and services. In some cases, work on and attention to the issues is already underway through other venues. However, an

integrated and unique look at the issue holds value. Issues that seemed particularly well suited to further exploration were:

- Water infrastructure challenges;
- The water/energy nexus; and
- Agriculture/water nexus.

Additional topics of future working sessions included:

***Water management policy, specifically economics and pricing of water is a major obstacle to improved decision making at multiple levels*** – Many inter-related angles were suggested for further exploration:

- Realizing the true costs of water services and communicating the real value of delivering safe drinking water and wastewater treatment, because pricing schemes typically hide or distort the costs;
- Illuminating impediments to more effective water pricing including arcane state water laws, politically inflexible water compacts, etc.;
- Understanding and capitalizing on the role of the financial markets;
- Alternative models for managing and financing systems, such as corporatized utilities;
- Strategizing national investment/funding for needed enhancements to municipal water infrastructure;
- Exploring market-oriented approaches to water pricing and trading, and strategies for implementation; and
- Better understanding how long-term resilient water systems can translate into benefits for our economy.

***Regulatory reform is needed to address outdated systems that do not address the current problems*** – The Clean Water Act was a very successful tool for a limited purpose, focusing on pipes and point sources of water pollution. Under the more complex challenges of the day, our freshwater systems are not protected by the regulatory mechanisms that exist within the Clean Water Act and the system should be revisited. Furthermore, the conditions of climate change provide a motivation for doing so.

***Adaptation and mal-adaptation to climate change needs to be better understood in terms of impact on freshwater resources*** – There is a need to better understand the trade-offs when multiple systems are at stake – to illuminate the negative long-term consequences and maximize the opportunities presented by of some of the alternatives being considered. There is a need to clarify the economic impacts in addition to the ecological and social impacts.

***The role of specific sectors in affecting change*** – The group felt that the Johnson Foundation was uniquely suited to convene groups around the role of specific sectors to advance change, such as foundations and corporations. This would create an opportunity to inform and collaborate on critical issues in a way that leverages their efforts.

## **Next Steps**

Overall, there was broad agreement that the issues outlined over the course of discussion warranted further exploration and The Johnson Foundation was well positioned to advance elements of the dialogue. Many participants emphasized the need for action – rather than exclusively continuing to discuss the problems. The group saw this conversation as laying the groundwork for conversations with other communities, sectors, experts that can help to build agreement on an agenda for action and catalyze change.

A strategy, informed by what we know about freshwater resources, would help to improve decision making that is impacting the systems and services in the long-term. Additionally, they agreed that it would be helpful to work toward a bold goal such as “Water resilience by 2025” as a unifying focus for all the “pillars” of the effort.

The group thought it made sense to hold an event in 2010 with senior-level people to help shed light on critical problems and promising solutions. Furthermore it would be valuable to lead up to that event with a series of meetings to explore key issues further focus and narrow the suite of topics. The main event in 2010 could be seen as the kick-off to the implementation of an integrated national agenda – rather than the culmination of events. Identifying actionable items that CEO’s and other senior leaders can take back to their boards and staff to implement will help them to capitalize on the event.

Several grounding elements were identified over the course of the discussion. First, that it is important to maintain a connection to sound science and an appreciation for the evolving understanding of that science in an uncertain future. Additionally, the group recognized the importance of maintaining a sense of place, and that public understanding of an issue is influenced heavily by perceptions of how it affects people in their communities. Finally, the group recognized that given the “messy” space that these complex issues create, there is a need to ground the discussion with a focus on a reasonable number (e.g. five to eight) of important sub-issues. The Johnson Foundation will take the next step to identify which issues they are best positioned to address in a more significant way and will work with individuals as appropriate to explore them through additional work sessions.

## ATTACHMENT A: MEETING PROGRAM

# *The Johnson Foundation Environmental Forum*

## *Working Session #1: Impact of Climate Change on Freshwater Resources and Services in the US*

March 17-18, 2009

### Tuesday, March 17, 2009

Guests arrive Tuesday morning. Check in at the Guest House.

12:00 – 2:00 p.m.	Buffet Luncheon Guests should feel free to tour the grounds	Guest House
2:00 p.m.	Plenary Session  <u>Welcome to Wingspread</u> Roger C. Dower, President Lynn Broaddus, Director, Environment Programs The Johnson Foundation	The House
2:15 p.m.	<u>Conference Goals, Agenda Review and Introductions</u> John Ehrmann, Facilitator Meridian Institute	
2:45 p.m.	<u>Freshwater Challenges for Sustainability</u> <ul style="list-style-type: none"><li>• Steve Carpenter, University of Wisconsin - Madison, Center for Limnology, Preliminary presentation of the priority challenges we face (15 minutes)</li><li>• Facilitated group discussion</li></ul> <p><i>Follow-up question for the group:</i> What other priority issues are we facing with freshwater systems and services in the U.S.? Are there secondary issues developing that compound these challenges?</p> <p><i>Outcome:</i> Preliminary list of priority challenges for further discussion later in the agenda.</p>	
3:45 p.m.	<u>How does climate change impact the challenges we face with respect to freshwater resources?</u> <ul style="list-style-type: none"><li>• Joel Scheraga, Director of the Global Change Research Program, Preliminary presentation on the climate change related impacts to freshwater systems and services (15 minutes)</li><li>• Facilitated group discussion</li></ul> <p><i>Follow-up question for the group:</i> Is the climate change lens useful relative to freshwater resources?</p> <p><i>Outcome:</i> Preliminary recommendations from the group on the benefits and limitations of the climate change lens.</p>	
4:45	Break	

- 5:00 p.m. How are these problems manifesting themselves in different regions of the country?
- Brad Udall, CU-NOAA Western Water Assessment, Preliminary presentation on how climate forecasts and regional vulnerability assessments are impacting decision making at the regional and local levels (15 minutes)
  - Facilitated group discussion
- Follow-up question for the group:* Are some groups of people disproportionately disadvantaged by projected changes?  
*Outcome:* Preliminary input from the group on the regional factors that can be discussed in more detail on Day 2.
- 6:00 p.m. Day 1 Wrap-up  
 Brief highlights of Day 1 and discussion of priority topics for Day 2 discussion
- 6:30 p.m. Adourn to Wingspread for hospitality and tour
- 7:15 p.m. Dinner Wingspread
- 8:30 p.m. Adourn to Guest House for hospitality and fireside conversation Guest House  
*Guests are invited to join The Johnson Foundation team for an informal planning session by the fireplace to organize ideas from the day's discussion into priority topics for the group to discuss on Day 2*

### Wednesday, March 18, 2009

*The agenda for Day 2 will be refined based on the results of Day 1.*

Breakfast will be available from 6:30 a.m. to 8:15 a.m. in the living room of the Guest House.

- 8:30 a.m. Plenary Session The House  
Welcome and review of the agenda for the day  
 John Ehrmann, Meridian Institute, facilitated group discussion of the key topics for the day and how the time will be prioritized
- 9:00 a.m. Discussion of key issues identified during Day 1  
 Facilitated group discussion
- 11:00 a.m. Break
- 11:15 a.m. Continued discussion of key issues identified during Day 1  
 Facilitated group discussion
- 12:15 p.m. Working Luncheon The House
- 12:45 p.m. Plenary Discussion of the Gaps and Needs  
 Facilitated group discussion  
*Possible topics: Where are the gaps in the science? What challenges are not being addressed?*  
*What time considerations need to be factored into the development of solutions?*
- 1:45 p.m. Plenary Discussion of Solutions  
 Facilitated group discussion  
*Possible topic: What innovative solutions or adaptation strategies are being explored in different regions? Are the solutions experimental or proven, and is there an opportunity to adopt them more broadly?*

2:45 p.m.

Plenary Discussion of Priorities for The Johnson Foundation

John Ehrmann, Meridian Institute, facilitated group discussion

*Discussion of priority recommendations for The Johnson Foundation to advance a national agenda for addressing freshwater challenges in the US:*

- *What are the key topics that can be addressed in future Wingspread Roundtables or the 2010 Environmental Summit?*
- *Who are the key people that need to be invited to make the Summit successful?*

3:30 p.m.

Next Steps and Final Round of Comments

4:00 p.m.

Conference adjourns

Transportation departs from the Guest House

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3/13/09