April 5th Water Conference
Participant List

Question 4 & 5 (now combined) Conservation and Technological Developments/ Knowledge of Water Resources

Question 4: What potential exists and what should be the federal government's role in enhancing the available water supply through the development of new technologies, conservation, metering, more efficient storage, water banking and other water transfers?

Question 5: Given the fundamental role that water plays in dictating the quality of life and economic opportunities in our communities, do we have the level of scientific understanding needed to assess accurately the sustainability of the surface and groundwater resources upon which we depend? Do we have an adequate scientific understanding to address potential water use conflicts? What initiatives should be undertaken to improve our scientific understanding in these areas?

Participants:

- Awwa Research Foundation
- General Electric
- Environmental Defense
- National Groundwater Association
- City of Albuquerque
- Texas Water Development Board

Senate Energy and Natural Resources Committee
Water Conference

Awwa Research Foundation

4. CONSERVATION AND TECHNOLOGICAL DEVELOPMENTS

Introduction

Established in 1966, the Awwa Research Foundation (AwwaRF) is a member-supported, international, nonprofit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers. Resources to fund research come from voluntary contributions from nearly 900 public water utilities, Congress, federal and international agencies, and other research organizations.

Since 1983, Congress has provided support to the AwwaRF, helping it become the centralized coordinator of studies that focus on the challenges faced by U.S. water suppliers. This congressional support has come in the form of earmarks in the VA-HUD Independent Agencies appropriations; 18 separate earmarks have provided $52 million in seed funding. Research lays the groundwork for cost-effective solutions to such issues as new technologies to control emerging water contaminants, aging infrastructure, finding new sources of water, conservation strategies, and keeping water supplies secure. Many of these same issues are described in the conference topic "Conservation and Technological Developments."

As the leading organization for drinking-water studies, AwwaRF has partnered with 30 organizations worldwide in it research activities. Partners include federal and state agencies, research organizations from eight countries, foreign environmental and health agencies, and international drinking water organizations. Through these partnerships, the Foundation is able to leverage resources, maximize research efforts, and develop and disseminate broad-based knowledge to the drinking water community. By leveraging the $52 million provided by Congress, AwwaRF has funded a total research effort of over $360 million on topics such as arsenic removal, disinfection byproducts, *Cryptosporidium* control, security, infrastructure renewal and replacement, perchlorate, and new technologies to address emerging contaminants in drinking water.

Research supported by AwwaRF and its partners has resulted in development and validation of new treatment technologies that are effective, reliable, and affordable for removing drinking water contaminants of concern.

Examples of the positive impact of AwwaRF research are:

- AwwaRF's pioneering research showed that ultraviolet treatment was effective against *Cryptosporidium* so that the EPA could recommend it as a treatment when developing regulations for surface and groundwater regulations.

- Since the 1990s, many water utilities are now installing membrane treatment processes as a result of the AwwaRF's research that demonstrated that

membranes are cost-effective and reliable in meeting increasingly stringent regulations for both large and small water utilities.

- In anticipation of lowering of the arsenic action level and the emergence of perchlorate as a drinking water contaminant, AwwaRF leveraged federal funds to perform multiple pilot- and full-scale studies that will enable water utilities to confidently select appropriate treatment technologies.

- AwwaRF research has impacted other areas important to water utilities and consumers including energy conservation practices, water conservation practices, cost-effective desalination processes, aquifer storage and recovery of treated drinking water, and automated metering to promote conservation.

Proposal

This proposal responds to the Senate Energy & National Resources Committee's request for comment as to the role of federal government in addressing the challenge of meeting the nation's ever-increasing demand for water.

AwwaRF is submitting a proposal on the topic "Conservation and Technology Developments." This topic addresses the development of new water technologies and operational strategies that can be used by the drinking water community to meet future water challenges, a primary focus of AwwaRF. The other topics focus on national policy issues.

The U.S. water supply community, particularly in the arid Southwestern states, is increasingly challenged by limited water supply. In many areas this challenge is being amplified by persistent drought and significant population growth. Water utilities are being compelled to manage resources more cooperatively on a regional level, pursue conservation measures and rate-based incentives, and leverage appropriate technology advancements to develop alternative water supplies (e.g., desalination and reuse). These measures place significant financial burden on water suppliers and, in turn, their customers, the U.S. public. The federal government can help to ease this burden through public education regarding the realities of limited water supply, the cost and value of water, the public's role in water resource management, and through continued sponsorship of research and development on key water supply issues and technologies.

With three decades of experience in successfully leveraging public and private resources to fund research that benefits the public, the AwwaRF supports the critical role of the federal government in helping to identify drinking water challenges facing the nation's public water systems, and providing resources to address these challenges. The AwwaRF believes that the most effective approach to solving these challenges is through cooperative efforts between federal agencies and the private sector. This approach helps ensure that the world-body of knowledge and national expertise are brought together to develop and implement reach strategies.

Therefore, AwwaRF proposes the Senate Energy & Natural Resources Committee consider public-private partnerships as a cost-effective approach for developing efficient long-term solutions to the many challenges facing the drinking water community. The following information provides the basis for this proposal.

Partnership Approach

Provisions should be made in future legislation to encourage and/or require the participation of nonprofit organizations, such as the AwwaRF. Nonprofit research organizations offer distinct advantages over a purely federal program.

First and most importantly, nonprofit organizations can and will provide matching funding for research of interest to the water community. This leverage can be significant—documented six to one 1 funding leverage for AwwaRF earmarks—and can be in many forms including a cash match, management fee contribution, and contractor contributions.

Secondly, funding from the federal government can take advantage of the extremely low overhead rate provided by most nonprofit organizations. For example, the AwwaRF has a general administrative cost factor of 11 percent, which means that the great majority of funding is spent on research.

In general, nonprofit research programs have excellent research management systems and processes in place. The AwwaRF operates one of the most efficient and internationally competitive processes available in the global water community. This process ensures that research issues are examined from different perspectives and that the most competent researchers for a specific issue are utilized.

Industry-sponsored research programs, like AwwaRF, are closely connected to the user of the technology - water suppliers themselves - thus ensuring the rapid dissemination and implementation of research developments. AwwaRF research is peer-reviewed, and the results are used by researchers, federal agencies, and the drinking water community.

Moreover, AwwaRF members, primarily public water utilities, help determine appropriate research topics necessary to address their actual needs. The identification of "real-world" needs is the essential ingredient in producing research results that can be applied by water suppliers.

Lastly, existing research organizations have a large network of researchers, both national and international, who have worked extensively on water issues. This network allows immediate access to the best talent in the world without creating the need to create a new institution and/or import of expertise. Results can produce better and faster without the lag-time inherent in creating a separate organization. Additionally, the international research community has the opportunity to provide technical and funding leverage to

issues of common concern. Since many of the issues transend national boundaries, a nonprofit organization with extensive international reach provides a mechanism for cooperation on a global basis.

In summary, public and private partnering is a "win-win" for the federal government, water suppliers, and the public through leveraging of limited resources to develop the best knowledge to produce high quality, affordable, and consistently safe drinking water.

Senate Energy and Natural Resources Committee
Water Conference

General Electric

DEVELOPMENT OF ENABLING TECHNOLOGIES FOR ENHANCING WATER AVAILABILITY IN THE UNITED STATES

General Electric – Global Research Center, Niskayuna, NY
General Electric – Infrastructure, Water and Process Technology, Minnetonka, MN

NATIONAL NEED

Worldwide water needs have been increasing rapidly due to population and industrial growth. In the past, water was seen as mainly a Middle-East or African issue, however, with the rapid growth in North America this view point is changing. In contrast to many areas of the world, the United States has enjoyed abundant supply of freshwater at a relatively low cost to the end user. Over the next few decades, however, factors such as population growth, increased industrial usage, and pollution of existing supplies may place a strain on the nations capability to supply the necessary quantities of safe freshwater. A case in point is the recent and projected growth in southeastern and southwestern regions of the country where safe freshwater shortages occur routinely during drought years. These regions may also face daily shortages in the not so distant future. The potential inability to meet the growing needs for freshwater will adversely impact public health and various economic sectors of the United States. To ensure adequate supply of safe freshwater at a reasonable cost, a combination of water conservation, reuse and recycling, as well as development of new water resources is critical. Since conventional water resources are limited, the development of new water resources will most likely come from existing impaired resources such as brackish water and seawater, in addition to water generated during energy production (oil, natural gas or coal bed methane production). It is imperative the US government recognize this growing need and act quickly to fund research and development of enabling technologies in areas such as industrial water reuse, generation of potable water from non-potable sources using desalination powered by renewable energy, and low-cost seawater desalination. In all of these areas it is clear that various membrane technologies can play a significant role in helping the US to protect and increase one of its most valuable resources.

Desalination holds the potential for addressing the shortage of safe freshwater in the United States by processing vast inland brackish water supplies and coastal seawater. While desalination has the potential to address existing and future water needs, it has been plagued by high cost, making it non-competitive with natural resources used today. Of the available desalination techniques, reverse osmosis (RO), multi-stage flash, multi-effect distillation, and vapor compression, RO consistently has the highest demonstrated energy efficiency, typically 3-8 kWh/m3. Even at this higher efficiency, energy cost still accounts for roughly 45% of the cost of water in RO based systems. For many projected water starved regions of the country and remote, inland areas where grid connectivity is limited, the retail cost of energy ranges from $0.08-$0.12/kWh. While the cost of energy generation has dropped, for remote areas, the cost associated with transmission and distribution makes up a large percentage of the retail energy cost. Hence, alternative solutions are required for the production of safe freshwater.

Two prevailing concepts for reducing energy cost associated with RO are to 1) reduce overall operating costs ($ per 1000 gallons of water produced) of desalination systems and 2) couple RO with renewable energy sources, such as wind and photovoltaics. Research and development focused on high recovery, low energy desalination systems would include efforts on high efficiency energy recovery devices and pumps, vertically nested signature system designs, enhanced pretreatments (antiscalants and filters), and finally low energy, high rejection membranes. The table below shows the dramatic improvement made in the industry to increase the permeability of RO membranes, which results in a decrease in the required power consumption of desalination systems. Membrane permeability, denoted by A-value, correlates directly to the operating pressure required for desalination. Cellulose acetate membranes require around 28 bar of driving pressure to achieve common flux targets, the most common polyamide membranes operate at only 15bar. In the past ten years there has been significant development of RO membrane technology that has lead to the commercialization of membranes with about twice the permeability. GE has presently working to develop RO membranes with even greater permeability, with a target driving pressure around 4bar. Combining the improvements in RO membranes with energy recovery devices and pretreatments could lead to an overall reduction in operating cost per 1000 gallons of at 30%, and a reduction of capital and land cost of 25%.

Membrane	Permeability (A-value)*	Driving pressure (bars)
Cellulose Acetate	3.5	28
1993 state-of-the-art polyamide RO	10	22
1997 state-of-the-art polyamide RO	17	15
2002 state-of-the-art polyamide RO	22	11
New GE polyamide RO	30–50	2.8–4.8

* A-value has units of 10^{-5} cm/(sec*atm)

Table: Industry improvement in RO membrane permeability

Desalination via a hybrid approach, where renewable energy sources (RES) such as wind energy or photovoltaic are coupled with RO desalination, is another attractive alternative to conventional RO systems. It is apparent from investigating the cost structure of a traditional desalination system that energy, capital, and operation and maintenance cost are major factors. The advantages of a combined RES-RO system would address these factors. Coupling the energy generation directly to RO systems through the use of renewable energy sources the energy cost associated with transmission and distribution is avoided. In addition the RES resources throughout the nation correlates to potential impaired water resources that can be used for the development of new, safe freshwater, as shown below. Specifically, the plain states have abundant saline aquifers, which if cultivated, can yield freshwater for the agricultural economy. In the plain states, both wind and photovoltaic sources are prevalent and can be used for desalination. In the southwest, specifically New Mexico, Texas, and Colorado,

significant growth in population is projected. These areas not only face the challenge of meeting the ever-increasing water demand, but also the restrictions of water rights on the use of available freshwater sources. The development of novel membrane materials and modules, energy recovery devices, and operating strategies in a flexible, modular RO configuration coupled with renewable energy sources offers an excellent opportunity to provide cost-effective freshwater.

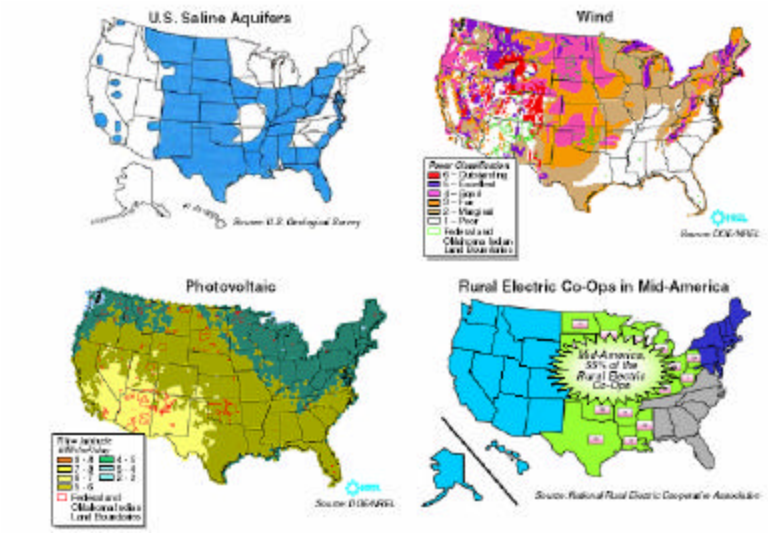

Figure: Renewable energy resources availability correlated with potential impaired water resources and potential beneficiaries of government grants.

POTENTIAL PROGRAM SCOPE

GE Global Research in conjunction with its Infrastructure and Wind Energy business units will collaborate in the development of flexible, modular RO configurations. The key objectives of the program are:

-Design and fabricate advanced membrane materials

-Establish optimal efficiency through fluid dynamic modeling of module designs

-Develop system level energy integration to design flexible, modular RO configurations

This program allows for the complete system development of cost-effective desalination strategies that can be commercialized to meet the growing freshwater needs in the US. GE Infrastructure has state of the art membrane research and fabrication capabilities in its Osmonics facility located in Minnetonka, MN. Osmonics employees ~700 people in areas including membrane research and development, design of modules and filters, and complete membrane systems fabrication. They have recently completed the construction of a 50,000 sqft building to house a new $7 million state of the art membrane coater for desalination.

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Water Conference

Environmental Defense

Topic 4: Conservation and Technological Developments.

There is growing recognition that a future of scarcity, conflict and environmental degradation in the West is not inevitable. By relying more on water conservation and properly structured markets, western water resource managers can meet future competing demands for water—including environmental protection and restoration—even in the face of new challenges. The transition to a more nimble and efficient water management framework also affords opportunities to address historic inequities and take into account the socioeconomic impacts on rural communities that may result from voluntary water transfers. In addition, there are many opportunities for major restoration projects that will enhance water supply, reduce conflicts over endangered species and bring back whole ecosystems, which will in turn generate economic benefits for local communities.

Some of the challenges western water managers face in meeting water supply needs in the future include:

Growing Municipal Demand: Without significant policy changes, rapidly escalating municipal demand associated with projected population growth, particularly in California, Nevada, Arizona, New Mexico, Utah, Colorado and Texas, will put significant pressure on existing water supplies. Most of the U.S. cities with high projected growth rates are in drought-prone regions of the country. In fact, all but 2 of the 10 fastest growing cities are in arid areas of the western U.S.

Potential effect of climate change: On a broader level, recent droughts in the Colorado and Rio Grande basins have given us a small preview of changes in water availability patterns that could be associated with climate changes predicted by various credible scientific models. Even if the cause of the current droughts affecting various portions of the western U.S. is uncertain, they vividly demonstrate the severe economic and political challenges in meeting societal and environmental needs for water in times of scarcity.

More frequent droughts and changing rainfall and snow patterns could stress water supply systems reliant on fixed structural components, and could spur further efforts to appropriate the last remaining flows in streams in order to exert more management control over the river systems. For example, the availability of water supplies from New Mexico's complex storage and delivery systems is highly dependent on established patterns of precipitation, snowmelt, and rates of evaporation. Significant variation in any of these factors, as New Mexico is experiencing during the current drought affecting the upper Rio Grande basin, can have a cascade of adverse economic and environmental impacts.

Lack of flexibility in irrigation water rights: Agricultural irrigators divert by far the largest share of western rivers. Many of these farmers are willing to implement appropriate water conservation measures, but they do not have the financial capacity to invest in technologies and management schemes that are cost-effective for society as a whole. Others are interested in leasing or selling water to meet municipal or environmental needs, but those transfers, if not properly structured, can divide rural

communities and threaten local economies dependent on agriculture. Flexibility, even with voluntary changes, in the use of agricultural rights, especially those in federal reclamation projects, is constrained by outdated project authorizations and overly bureaucratic procedural requirements.

Proposal: Promoting conservation and rational pricing

Conservation must become a more prominent and consistent component of addressing water needs throughout the West. Along with more rational pricing of water, it will be a key element of the solution to many of our water woes. Many water users are making progress on this front. For example, El Paso has reduced single-residence per capita consumption to about 120 gallons per capita per day in a very short time frame; several western cities are using inverted block rate structures to discourage high water consumption; and Elephant Butte Irrigation District in Southern New Mexico is on the leading edge of using careful water management techniques to achieve increased efficiency in irrigation water use. But, there is still much to do. Single-residence per capita consumption in several major southwestern cities exceeds 150 gallons per day.[1] Inefficient flood irrigation is still used on millions of acres of crops in the west and, in some areas, metering or other measurement is so scarce that we don't really know how much water is being used.

Systematic conservation investments and pricing reforms could be encouraged both at the federal level and through statewide water policy and planning processes such as those that have been undertaken for California, Texas and New Mexico. The potential for federal omnibus water legislation in the next few years, as well as on-going efforts by the Department of Interior to resolve western water controversies, may provide further opportunities to address pricing policies, as will the growing need to repair and replace aging water supply and irrigation infrastructure throughout the West. Federal farm bill programs are increasingly being used for water conservation. This should be continued and expanded in the Farm Bill reauthorization, along with the establishment of adequate performance measures to document the success of these measures.

Reserving a portion of conserved water for environmental needs could go a long way towards ensuring healthy rivers and avoiding conflict over declining aquatic species populations. This should especially be the case where public funds are used to support the conservation investments, such as in the case of the Central Valley Project Restoration Fund, established in the Central Valley Project Improvement Act of 1992. More legal flexibility is necessary to accomplish this, however, particularly in the context of older reclamation projects.

[1] For a comprehensive study of municipal water use and conservation potential in major southwestern cities, see Western Resource Advocates, Smart Water: A Comparative Study of Urban Water Use Efficiency Across the Southwest (2004), available at www.westernresourceadvocates.org. Municipal consumption data in this paragraph is from that report and reflects 2001 use figures.

Proposal: Making water transfers work for communities and the environment

Increased reliance on water transfers, especially from farms to cities, is an essential component of a new vision for western water policy. The recent Quantification Settlement Agreement (QSA) on the Colorado River—built on the voluntary transfer of water from Imperial Irrigation District to southern California municipal water agencies—is an important model, though work remains to ensure that potential adverse affects on farmworkers, the local economy and the nearby Salton Sea are addressed. The recent settlement between New Mexico environmentalists and the City of Albuquerque also shows the potential for voluntary transfers to be part of the solution to complex disputes.

Many rural leaders and some in the conservation community, however, have lingering concerns about the potential adverse impacts of water transfers on the economic and ecological health of rural areas. Over the next few years, a major emphasis must be placed on developing new regulatory and institutional frameworks to ensure that transfers do not lead to these negative results. Establishing and documenting compelling, replicable models that show how transfers can make water available for critical ecosystem needs, provide new supplies for growing urban areas, *and* protect and improve rural communities and economies all at once is critical.

One option that should be given early consideration is allowing more across-the-board legal flexibility for dry-year option leasing of irrigation rights in federal reclamation projects. These leases, which would allow the water to be used for other purposes during dry years, can help assuage concern about permanent alienation of rights and potential third-party effects of voluntary transfers.

In addition, many potentially viable voluntary transfers are impeded by the lack of a final state water rights adjudication. This is true in New Mexico, for example, where, despite the recent settlement, water banking and transfers involving irrigation rights in the Middle Rio Grande Conservancy District are impeded by uncertainty associated with their un-adjudicated nature. A number of the on-going adjudication proceedings in the west are hampered by lack of resources to complete the underlying investigations and hearings, a factor that the federal government might be able to help address. What might be a relatively small investment from the federal perspective could lead to important long-term benefits associated with water banking and temporary or permanent voluntary transfers.

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National Groundwater Association

5. Knowledge of Water Resources

Given the fundamental role that water plays in dictating the quality of life and economic opportunities in our communities, do we have the level of scientific understanding needed to assess accurately the sustainability of the surface and groundwater resources upon which we depend? Do we have an adequate scientific understanding to address potential water use conflicts? What initiatives should be undertaken to improve our scientific understanding in these areas?

While states are gathering the necessary data to inform decision-making, no state has met its data collection goals. In fact, only two of 28 states responding to an NGWA survey are very confident they know the potential yield from all of the state's major aquifers. We lack the fundamental data necessary to adequately understand the nation's ground water resources and make informed decisions regarding its use and management (NGWA 2003a; 2003b).

The federal government is currently playing and must continue to play a vital role as well. Although actual ground water management decision making is most effective when taking into account site-specific considerations, federal funding of cooperative water quality and quantity data collection and aquifer mapping leverages the expertise and resources of the federal government with partners around the country.

NGWA members identified increased federal funding for cooperative ground water quantity and quality data collection and aquifer mapping as the most useful actions the federal government could take. Additionally, NGWA identified increased research related to ground water availability and the development of a national clearinghouse for ground water quality and quantity information as a top priority requiring federal government leadership. The most important types of water data to expand identified by NGWA members include: accurate water use, water quality for all aquifers, ground water level monitoring networks, on-line aquifer data and ground water recharge rates. Within each area, examples of possible specific activities are provided for consideration and further discussion.

Data Gaps

- Establish a collaborative framework among federal, state, local and non-governmental entities to address data gaps on ground water resources. Collecting ground water data is costly, given its location and variability. While specific data gaps and priorities may vary around the country, collaboration will help maximize everyone's data-gathering efforts.

- Increase federal funding for cooperative ground water quantity data collection. Ground water professionals identified the need for additional federal funding for cooperative ground water quantity data collection as the most useful federal action. The data would be used to fill information gaps and will assist states in developing and implementing overall ground water management goals. The federal government should develop a cooperative program with the states and other interested parties so goals meet not only the national but also state and local

needs as well. First steps include assessing available data and identifying the appropriate role of federal agencies. A potential model to follow is the National Cooperative Geologic Mapping Program, which includes a federal, state and educational component.

- Provide federal support for aquifer mapping. Funding for geologic mapping is provided to state geological surveys through the USGS STATEMAP program, the state component of the National Cooperative Geologic Mapping Program. The STATEMAP program utilizes state staff knowledgeable in the local geology that maintains the data upon which much of the mapping is based. The states, not the federal government, also select the areas of the state that are in most need of mapping data. The program provides a comprehensive understanding of the geology at/near land surface, in which ground water is commonly a major consideration. Limitations of the program are that it requires 1:1 matching of state funds; the mapping is required to be completed within one year; derivative maps such as fracture trends are not considered for funding; and maps do not necessarily focus on delineating subsurface aquifers.

- Another federal-state cooperative program involves the USGS and the state surveys from Illinois, Indiana, Michigan and Ohio. This partnership, known as the Central Great Lakes Geologic Mapping Coalition, is conducting three-dimensional geologic mapping mainly at 1:24,000 – scale, specifically targeting the delineation of glacial aquifers. Limited funding has allowed only pilot study areas to be mapped during the last three years. However, the states and USGS have contributed considerable federal and state funds toward the effort. If additional funds are not forthcoming, it will take about 170 years to complete this. mapping in high-priority areas of the four states. Although under funded, the Coalition serves as an excellent example of how a federal-state partnership can address the specific needs of a region that is united by common ground water issues

- Establish a national clearinghouse to identify sources of ground water data and links to those sources. These data should be disseminated widely to the public – or at least to authorized public and private water professionals - using several formats. These formats should include maps and reports showing interpreted data as well as Internet-based access to archived data and real time data collection. These data should be available from links on already existing National Spatial Data Infrastructure (NSDI) sites to make the information easier to find and assure that the proper documentation of these data is maintained.

Research Priority Areas

The following research areas have been identified by our ground water professionals as top priorities in the area of developing long-term ground water sustainability plans:

- Research on water reuse and conservation
- Research on alternative treatment systems
- Research on development of brackish ground water supplies

- Development of models and data standards that can bring together scientific data and inform local policy decision makers.
- Research on aquifer storage and recovery or artificial recharge.
- Research on emerging contaminants and the development of remediation technologies that can be used to address new and current pollutants.

Education and Collaboration among Federal, State, and Local Decision Makers

It is important for collaborative efforts among federal, state, local, and non-governmental entities and water professionals to educate decision makers, professionals, and the general public on topics including:

- What ground water data are being collected and what data are needed.
- How to utilize ground water data to make sound decisions.
- What current research projects and technologies are being developed, and how to incorporate these developments into ground water management decision making.
- What long-term effects does water supply infrastructure design have on the sustainability of the natural ground water system, and how do we design systems that take those impacts into consideration.
- What constitutes effective ground water conservation measures and how to incorporate these initiatives on a state and local level.

Senate Energy and Natural Resources Committee
Water Conference

City of Albuquerque

Conservation and Technological Developments – Executive Summary

Water conservation is critical to the future of this country. As population grows over time, demand increases, and supplies remain essentially the same, conservation must play a significant role in helping water providers meet demand. Water conservation is the easiest, quickest, and least expensive way to extend supplies dramatically.

Urban areas have led the way in demonstrating that conservation can achieve dramatic results. In the West, major urban areas like Seattle, Washington, El Paso, Texas, Denver, Colorado, and Albuquerque, New Mexico have achieved reduction rates of 30% or more – extending adequate supply many decades into the future. These programs and others have proven that conservation can be successful, can significantly reduce usage, and will benefit both suppliers and users with little or no change in their quality of life.

Technological advances in plumbing fixtures, appliances, irrigation equipment, and landscaping techniques have led the way in this effort. Replacing older equipment and appliances can immediately reduce user's water use dramatically. Focusing on management of water use, which requires education and understanding, is equally important. A xeriscape can use as much or more water than turf if it is not managed properly. Low flow plumbing appliances, if installed properly, can save one-third of a customer's usage almost "overnight." But these fixtures and appliances must be properly maintained to continue to operate effectively.

Many improvements in water delivery and use have not received the attention needed. Water systems typically have water losses or non-revenue producing water of 7% to 40% of production. Smaller systems, in particular, may not have the resources to install even basic tools like meters in order to determine how much water is being lost between the source and the customer. Water pressure, though specified in the nationally-adopted Uniform Plumbing Code, is often ignored. Meters, which are essential to understanding usage, are often not replaced when malfunctioning or broken.

The federal government, through the Bureau of Reclamation, the Environmental Protection Agency, and other agencies, has supported conservation through grants and promotion of advanced technology. These programs have suffered more recently, however, as some emphasis has shifted back to large supply and "hard" solutions. Competition for limited funds will become even more intense as the nation is forced to address its aging water and sewer infrastructure and the need for replacement. Federal support of water conservation, including "soft" components like education, must continue in order to maintain the success that has been achieved to-date and to more fully realize the benefits yet to be achieved through conservation.

Conservation and Technological Developments

Introduction

The nature of water conservation in the United States has changed dramatically over the last decade. In the 1970's and '80's, conservation was used largely as a tool to carry utilities over periods of drought or infrastructure inadequacies. Conservation was utilized as a short term solution to a short term problem. In the last decade, it has become increasingly clear that conservation must be a component of many, if not most, long term water resource strategies for communities and states. In the West and in some areas east of the Mississippi, supply cannot meet the existing and/or growing demand if usage levels remain at the high per capita rates common in the '70's and '80's. Without reduction of usage and further development of new technology that increases supply at reasonable cost, many areas of this country cannot meet future demand. And as most areas become more conscious of this situation, the willingness to share and/or allow limited commitment of currently unused supply decreases.

This presentation will focus on urban or community water use and conservation. While urban or domestic use is a small percentage of overall use in most western states, urban areas have led the way in demonstrating that conservation can achieve dramatic results. Many major urban areas, including Seattle, El Paso, Denver, and Albuquerque have achieved 30% or better reductions in per capita use. This has occurred concurrent with natural drought that has dramatically decreased precipitation for many of the last ten years. Areas historically dependent on ground water are now preparing to use surface water while, overall, use of ground water has increased as precipitation becomes less dependable. And, as flows in rivers decrease, demands for water for environmental purposes, e.g., endangered species and riparian habitat, increase.

Lower precipitation levels are expected to become the norm in portions of the Southwest. Rivers such as the Colorado and Rio Grande, which were appropriated in the early, historically very wet twentieth century may very well not supply as much water as has already been appropriated, further increasing supply shortfalls. Population growth, while it has slowed in many portions of the Sun Belt, is still occurring at 3% to 10%, a trend which is not likely to change, particularly given the expected higher growth rates of Hispanic Americans (through both natural increase and immigration). Water conservation is vital to the future economic and environmental health of the country.

Technology and the Federal Role

Technological advances affect water conservation in many ways. At the household level, the development of well-functioning, low water use toilets, showerheads, and other plumbing fixtures has provided the easiest, quickest, and least expensive "fix" to reduce water usage. For less than $200, any household can reduce its indoor per capita water use by one-third by simply replacing higher use fixtures. With minimal maintenance, these inexpensive fixtures will continue to keep usage down indefinitely. However, people must be educated to watch for and repair leaks, replace flappers with correct

models, and manage their water use habits to reduce even further. Plumbing models which will further reduce the waste taken for granted with every flush are under development. Research is not adequate, however, to understand the limits of conventional sewage collection systems, i.e., whether sewer flows become inadequate if toilet flush volumes go too low.

The federal government, through adoption of plumbing fixture standards in 1992, led the country into the needed, new conservation-oriented mentality. Passing these laws at the federal level avoided much of the confusion and backlash that would have occurred if each state had to adopt its own laws. This same leadership is needed relative to new products which circumvent the intent of these laws, such as gang showers (multiple low flow shower heads used simultaneously in one stall) and continuous bleed-off evaporative coolers. Egregious water waste should not be acceptable just because a homeowner can afford expensive fixtures and high water bills.

The federally-supported Energy Star program has been very successful in promoting the development, sale, and use of high water efficiency appliances. While the primary focus has been on energy, most low energy use appliances also use less water. At some point in the future, manufacture of high water use appliances should be prohibited, just as federal law now prohibits manufacture of high water use plumbing fixtures. Effort is now underway to develop a program for water use labeling requirements. This effort will help educate and inform the public in making wise water use purchasing decisions, in ways not possible now. Federally-supported financing programs, such as Fannie Mae mortgages, could also be utilized to increase the market penetration of high efficiency appliances and hot water on demand systems in new construction.

In the dry West, landscaping can consume 30% to 50% of total urban use. This usage creates the high seasonal peak which drives and then underutilizes water system capacity. And, unlike indoor usage which can be treated and reused, this outdoor water use generally evaporates. Led by the landscaping community in Denver, xeriscaping (low water use landscaping) techniques and plants have been developed and individualized for the climate conditions in different parts of the West. The endless possibilities of this low use alternative to turf are being explored and promoted. And irrigation technology has changed dramatically as newer landscapes require less water and customers demand higher efficiency systems. Sprinkler system efficiency, particularly for large turf areas that are professionally managed and maintained, has gone from 50% to 70%+. Drip irrigation hardware continues to become both more sophisticated and easier for do-it-yourselfers to understand.

Additional research, promotion, and education is necessary before the potential reductions in landscaping use are approached even in the urban setting, however. The Bureau of Reclamation's Conservation Field Services Program, among other federal programs, has helped to fund local research and education projects. More recently, in some regions, these funds have been substantially reduced and restricted to exclude education efforts. At the customer level, research and development can provide products and information, but proper management and maintenance of the products depends on

education and public information. Excluding this important component is diluting the effectiveness of more efficient products and plants. Uneducated homeowners are also more likely to overuse pesticides and herbicides, often leading to additional water use as well as contamination of storm and ground water.

For the remaining non-residential urban water uses, research and development into lower use equipment, education to ensure efficient water management and maintenance, and financial assistance for major improvements is even more important. Commercial, industrial, and institutional users often ignore water costs and efficiencies while focusing on high cost, energy usage. Longer-term paybacks are often less acceptable, even if the changes will benefit the company, and saving water is often not within the accepted corporate mandate. Hospitals, for instance, often run high use wash equipment twenty-four hours a day even if that flow is not needed much of the day. Water bills are often paid by financial people who have no direct connection to either management or operational staff. And management may not communicate a commitment to efficient water use to staff, diffusing the ability of the organization to minimize usage.

The federal government, through FEMA, educates facility managers about water conservation, as well as working more directly on some federal facilities to reduce usage. Performance contracting for federal facilities to reduce usage of energy is common, but is often not feasible for water because water costs are so low. And funds to implement water conservation improvements are often not available for federal facilities, similar to non-federal facilities. Since 9/11, security issues and the financial demands to meet these concerns have reduced the federal resources focused on water conservation in many areas. While the need to counteract terrorism is unquestionable, the need to ensure that federal facilities and the communities in which they are located will be able to meet future water demand is also critical. Excessive turf landscaping, leaking and inadequate infrastructure, and no metering of individual water uses are examples of inefficient use of water under federal control which need attention in many areas. In Albuquerque, development of innovative approaches to individual building water reuse was severely reduced or lost as a result of the focus on security issues.

At the water provider or system level, many potential methods to reduce conservation have been inadequately addressed. Unaccounted-for-water (UAW) or non-revenue water ranges from 7% to 50%, tending to the higher end for small utilities, which typically have volunteer boards, minimal staff, and very low water rates. While these losses cannot be eliminated, UAW rates of 7% to 12% are entirely feasible. The new standards for calculating these losses, while maybe improving understanding in the long term, have confused the issue and made data from different systems incomparable. Federal assistance in funding efforts to audit UAW, reduce loss from leaks, replace malfunctioning meters, and meter unmetered uses would help address this area.

Federal water and wastewater funding should be available for these improvements, as well as rehab and replacement of older or worn lines. The need for rehab and replacement will become greater as the majority of the nation's water and sewer systems reach forty plus years; but other system needs, including UAW, cannot be ignored.

Even self-supporting UAW efforts, like testing, maintenance, and replacement of large meters, are often cut first when budgets get tight. And more low volume uses, like drip irrigation and continuous bleed-off evaporative coolers, may not be registered by meters, increasing the non-revenue water. Pressure issues have been addressed by a few utilities, but too many systems are not meeting the national Uniform Plumbing Code requirement for 80 psi. Pressure reduction valves are often not installed where needed, even though much of the conservation-related equipment, particularly drip irrigation, needs to operate on lower pressure.

The Environmental Protection Agency assists utilities through Clean Water Act and Safe Drinking Water Act funds. Provision of these funds should be linked to development, adoption, and effective implementation of a water conservation plan, including measures aimed at customers, and education. The amount charged for water, i.e., rates, is a crucial component of these plans since low and/or decreasing block rates falsify the value of water, provide inadequate resources for utility improvements and conservation incentives, and may lead to utility failure.

The EPA itself could also launch a more aggressive education campaign related to conservation, both by promoting conservation issues and solutions itself and through making materials available to communities and utilities. This federal role was more evident in the '80's when the need for "permanent" conservation was just beginning to be recognized. EPA grants should also be available for state conservation efforts, where issues and target population are much more diverse, the logical link between revenue and program doesn't exist, and the conservation effort may not be "owned" and/or financed by one agency.

"Larger" ways to extend supply such as reuse and desalination are necessary, also. While reuse is not a solution in some cases, since it may reduce river flows, reusing gray or treated water for irrigation and other purposes help preserve potable water for drinking water purposes. In an urban setting, large scale reuse is most practical and safe while, in a rural setting, individual reuse is most practical. The Bureau of Reclamation has helped fund and will hopefully continue to help fund many large scale reuse efforts. The Bureau is also helping to fund some desalination projects. In inland areas, these may involve recovery of brine water which was formerly considered nonpotable. In the coastal areas, if costs can be brought down over time, desalination may provide a source for drinking water supply that would allow inland states to use more of the country's surface water supply. Additional research and expanding technology to bring the costs of treating ocean water down are needed.

Conclusion

Water conservation can have a dramatic impact. In Seattle, Washington, which most people are surprised to find even needs conservation, water use has been cut dramatically over the last twenty-five years. Over that period, the motivation for conserving has varied from avoiding the cost of new facilities to ensuring that water remains in the rivers for salmon, and the reductions have been significant. The city expects that, by finding

additional ways to reduce usage, they will be able to keep production level for another ten to twenty years. To-date, Seattle has saved over 267 billion gallons of water or about 820,500 acre feet.

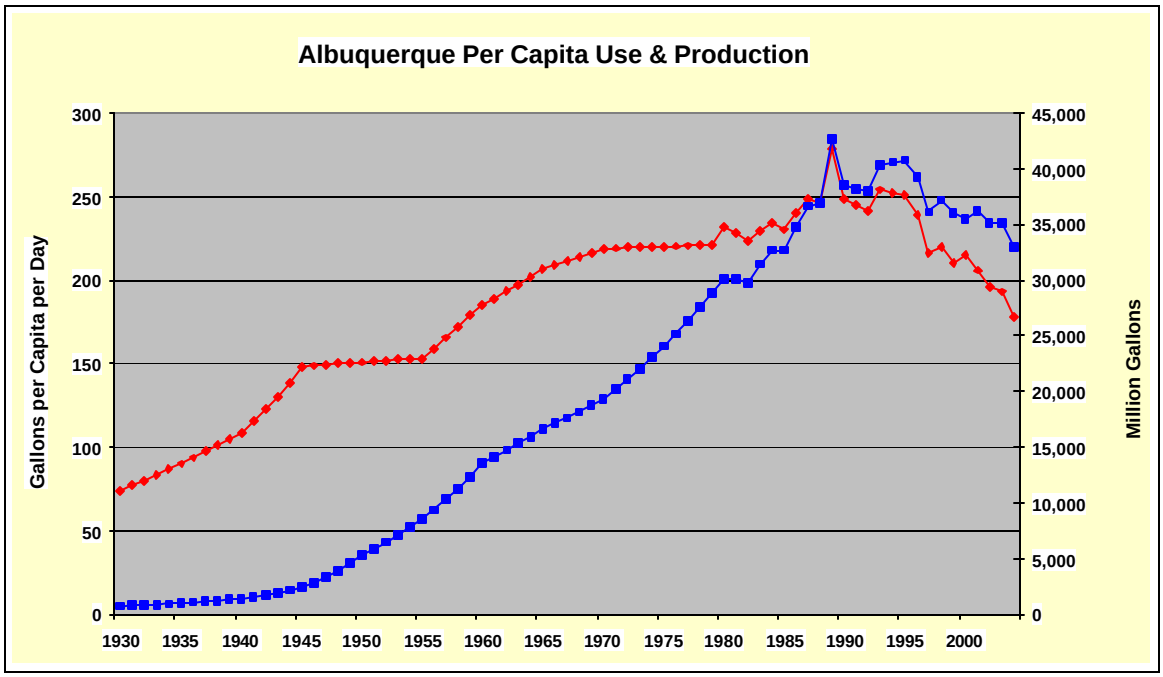
El Paso, Texas has reduced usage from 230 in 1978 to 140 gallons per capita per day in 2004. Water utility officials estimate they've saved $300 million in infrastructure costs through this reduction in usage.

Albuquerque, New Mexico's sole source of water supply to-date has been ground water. Usage has been reduced from 250 to 177 gallons per capita per day. The program, which was adopted only ten years ago, has already saved over 54 billion gallons of water (167,250 acre feet) the equivalent of a year and a half's production. Despite a population growth rate around 3%, production is at mid-'80's levels; per capita usage is at an amazing late-'50's level (see Chart). Albuquerque recently adopted a 40% goal which should continue to reduce production through 2010. Albuquerque also intends to begin using surface water by 2007, providing a "window" of significantly reduced ground water pumping to allow the aquifer water levels to partially recharge.

Denver, Colorado initiated a conservation program around twenty years ago. The effort, which focused primarily on voluntary and education measures, was forced to change dramatically in 2001 due to the extreme drought. With the addition of mandatory measures, higher cost measures like rebates, and drought rates, usage dropped dramatically (see Chart).

Each of these cities and their conservation efforts is unique. Annual rainfall ranges from 9 inches in Albuquerque to 37 inches in Seattle. Initial usage rates ranged from 253 gallons per capita per day in Denver to 154 in Seattle. One city uses exclusively ground water to-date while three use a varying mix of ground and surface supply sources. What unites these cities is a community-supported commitment to reduce usage significantly through conservation programs supported almost entirely through utility revenues. Logically, as water becomes more limited, rates rise, though three of these cities' commodity rates do not exceed $3.50 per 1,000 gallons, a bargain compared to other potable liquids and compared to most other urban areas. While further reductions and price increases may be required, these cities have been able to greatly extend the water supply currently available to them for decades. *(Please note - results from 2004 may be unusually low due to the wet fall and winter.)*

The federal government has played a part in the success of each of these conservation programs, through adoption of the federal plumbing standards, Energy Star promotions, Bureau of Reclamation grants, federal facility use reductions, and other programs. Support for communities and utilities that do not have the level of resources available to these cities of half of million or more population is needed even more. Conservation is, in fact, the easiest, quickest, and least expensive way to extend water supply. Reduction of per capita usage must be a component of this country's water resource strategy. Federal assistance, whether through funding or other methods, is essential to helping make this happen.


Albuquerque Per Capita Use & Production
Gallons per Capita per Day
Million Gallons
300
250
200
150
100
50
0
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1930
1935
1940
1945
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1955
1960
1965
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1975
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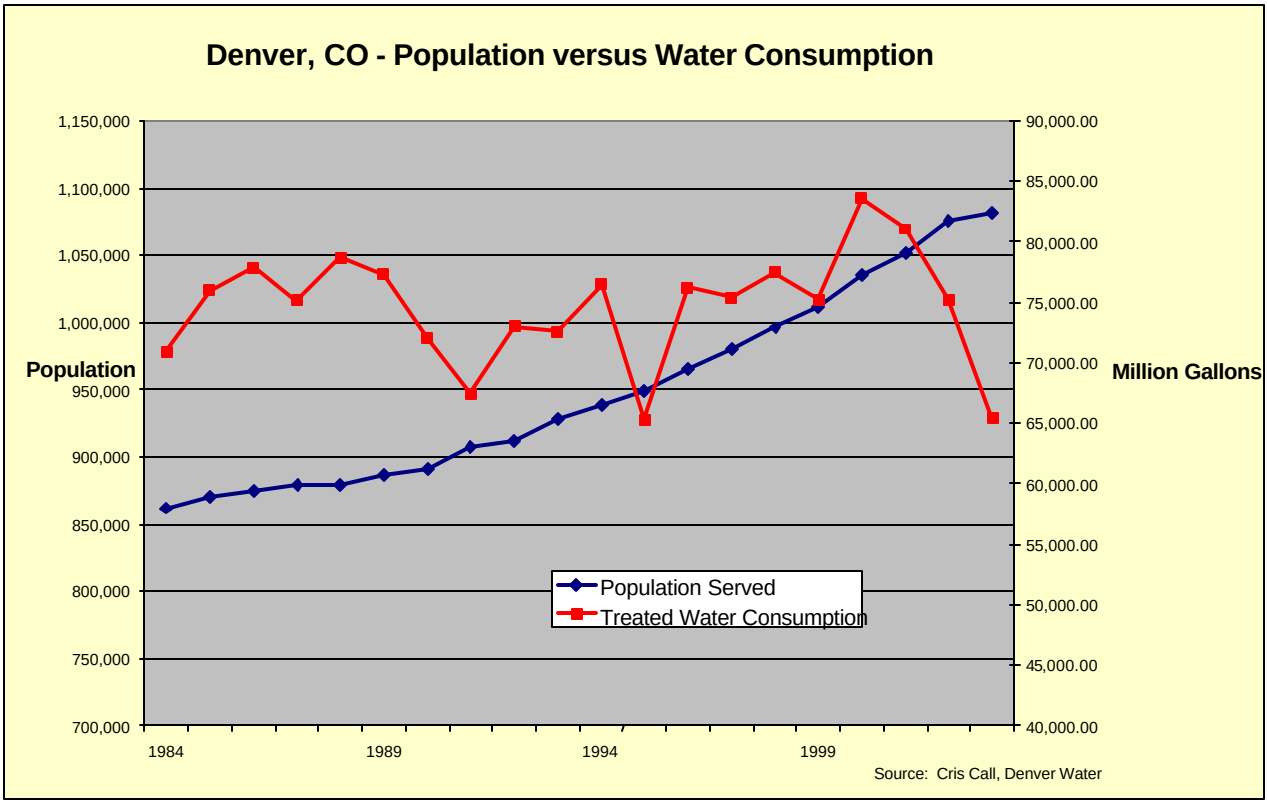
Denver, CO - Population versus Water Consumption
Population
Million Gallons
1,150,000
1,100,000
1,050,000
1,000,000
950,000
900,000
850,000
800,000
750,000
700,000
90,000.00
85,000.00
80,000.00
75,000.00
70,000.00
65,000.00
60,000.00
55,000.00
50,000.00
45,000.00
40,000.00
1984
1989
1994
1999
Population Served
Treated Water Consumption
Source: Cris Call, Denver Water

Senate Energy and Natural Resources Committee
Water Conference

Texas Water Development Board

Question 5. Knowledge of Water Resources

"It is a capital mistake to theorize before one has data."
– Sir Arthur Conan Doyle

Our knowledge of water resources is the foundation upon which we build our solutions to water needs. If this foundation is faulty and inadequate, our solutions are doomed to collapse, costing taxpayers billions of dollars and, in times of drought, adversely affecting millions of lives. Unfortunately, our knowledge of our water resources, our foundation, is not as strong as it needs to be, especially as our water demands grow relative to a fixed resource. Federal support for collecting and interpreting basic water resource information has been cut and continues to shrink. This is unfortunate because the data we need to make important policy and financial decisions concerning our water resources is shrinking at a time when problems with meeting our water demands are growing.

During the drought of the 1990s, Texas instituted regional water planning, a process infused with local guidance of water planning in sixteen regions across the state. This process required a significantly more refined understanding of water resources in Texas, including the development of water availability models (WAMs) for water rights permitting of the major rivers and numerical groundwater availability models (GAMs) of the major and minor aquifers. As water becomes scarcer and scarcer and as people look closer and closer at water issues, the need grows for more water data and more thorough analysis of that water data.

Do we have the level of scientific understanding needed to accurately assess the sustainability of groundwater and surface water resources?

We do not have the scientific understanding to assess the sustainability of our water resources at the level currently required by our policymakers and citizens. For groundwater, we need a better understanding of the outcrop processes that affect recharge, the primary parameter for estimating sustainability. These processes include evapotranspiration and surface water and groundwater interaction. Many of our aquifers have no field-measured estimates of recharge. Our aquifers in the western part of the state are often lacking basic hydrologic information related to hydraulic properties, flow paths, and quality.

Do we have an adequate scientific understanding to address potential water use conflicts?

We need more scientific studies to address potential interstate and international water conflicts. Streamgaging is less than adequate (less than 70 percent of needed gages are reporting data), and groundwater information is less than adequate (many aquifers with little information). Many water issues requiring more data are interstate and international in scope. Texas shares surface and groundwater resources with four states and Mexico. We have had surface water conflicts with New Mexico and Mexico (Rio Grande, Rio Concho, and Pecos River) and concerns about water conflicts with Oklahoma (potential

export of surface and groundwater from reservations in Oklahoma to Texas and a potential reservoir in the Panhandle that would have affected Okalahoma). Other states face border issues as well. As demand for water grows, new issues and conflicts will appear. Good science is needed to understand the facts behind the issues so that fair and defensible solutions can be reached. More federal support in transboundary studies would help create a common database for resolving transboundary water issues.

What federal initiatives should be undertaken to improve our scientific understanding in these areas?

Federal agencies have a long history of working with Texas to lay a strong foundation for water policy and financial decisions. After Texas joined the United States in 1845, the U.S. military dug wells on the High Plains in search of artesian water in one of the first hydrogeologic studies in North America. The U.S. Geological Survey (USGS) arrived in the 1880s to begin seminal work to characterize the surface and groundwater resources of the central part of the state. Over the years, the U.S. Geological Survey worked closely with various state and local agencies to characterize water resources in the rest of the state and implement and maintain water monitoring networks.

Many local water-related activities are inherently federal in nature. Historical streamflow data are needed to accurately estimate the water supply yield and spillway requirements of a proposed reservoir; this data may derive from neighboring states. Two of Texas' largest reservoirs are located on state boundaries; two other major reservoirs are located on the border with Mexico.

Streamflow monitoring

In 1998, at the request of Congress, the USGS prepared a report entitled "A New Evaluation of the USGS Streamgaging Network" stating that the network's ability to meet long-standing federal goals was being compromised because of the loss of streamgages, particularly those with long periods of record, and the declining ability of the USGS to continue monitoring flow at high priority locations when local funding is discontinued.

In 1999, the USGS went to Congress to create the National Streamflow Information Program (NSIP) program. The vision of the program was to provide 100 percent funding for a base streamgage network and complement the continuous monitoring data with intense data collection during floods and droughts. There are 4,424 identified NSIP sites across the nation, and less than 70 percent are currently active and reporting data. This lack of basic data compromises our ability to conduct water resources research and assessments.

Assistance in meeting federal requirements

The permitting and construction of a dam and impoundment of a reservoir or any project that crosses a water course requires compliance with the Clean Water Act (U.S. Army Corps of Engineers) and the Endangered Species Act (U.S. Fish and Wildlife). The

supporting studies require the compilation and analysis of large amounts of data, the burden of which is generally placed on the local sponsor. More federal support in collecting the data and guiding the studies would benefit both the local sponsor and the federal interests, by ensuring that minimum standards of quality assurance on the data are met and that the ensuing studies are standardized and widely accepted.

Surface-water/groundwater interaction

The interaction between surface water and groundwater is important for understanding both resources. Groundwater discharge to rivers and streams amount to substantial amounts of water, especially in the drier parts of the state. For groundwater, understanding how much groundwater flows into rivers (what flows out of the aquifer is equal to recharge) and out of rivers into the aquifer (direct recharge) helps better understand how to manage groundwater resources and the effects of pumping on water resources. More federal support in characterizing these interactions on a basin-aquifer scale would be useful for developing better models and protecting natural resources.

Climate change

There remain significant uncertainties regarding the magnitude and impact of future climate change. What is known is that global temperatures are on the rise, as are sea levels. Most climate models also predict hotter summers and more evaporation for the United States in years to come; many predict increased hurricane activity and frequency of extreme weather events. Whatever our future climate looks like, it doesn't seem sensible to address the issue of climate change at the local level. Some kind of coordinated federal effort is needed to fully investigate the likely impacts of climate change and the recommend measures that need to be taken in order to minimize these impacts.

Research clearinghouse

Many different federal agencies conduct work associated with water. There should be one user-friendly Webpage that users can visit to find reports and data from all of the federal agencies related to water. The information could be site specific (for example, to a particular state) or of wider applications across a large area. This research clearinghouse would ensure that money invested by the federal government in research projects is available and being used by stakeholders.

Summary

We do not have the scientific understanding to assess the sustainability of our water resources at the level currently required by our policymakers and citizens. We need more scientific studies to address potential interstate and international water conflicts. The federal government can assist in these issues by:

- expanding streamflow monitoring;
- assisting states in meeting Clean Water Act and Endangered Species Act requirements;
- researching the interaction between surface water and groundwater;

- assessing the effects of climate change on the nation's water resources; and
- developing a research clearinghouse.

Together, local, state, and federal governments can build a strong foundation of basic data and scientific solutions to for our water needs.