



GROWING THE U.S. WATER SUPPLY THROUGH PURIFICATION TECHNOLOGIES WORKSHOP

Summary Report of a Workshop
April 10, 2000
Golden, Colorado

Desalination and Water Purification
Research and Development Program
Report No. 56

Sponsored by
Bureau of Reclamation
Dr. Stanley L. Ponce
Director, Office of Research

U.S. Department of the Interior
Bureau of Reclamation
Denver Office
Technical Service Center
Environmental Resources Team
Water Treatment Engineering and Research Group



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Mission Statement*

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

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Mission Statement*

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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CONTENTS

	<i>Page</i>
EXECUTIVE SUMMARY	1
INTRODUCTION	2
Overview of Workshop Format	3
Overview of Workshop Report	5
WORKSHOP PRESENTATIONS	5
National and International Water Needs and Solutions	
Senator Paul Simon	6
Current Costs and Technological Opportunities	
Lisa Henthorne, Partner, Aqua Resources International	14
Introduction to Current Legislation –	
Title XVI, Water Reuse Program	
Rick Martin, Reclamation Program Manager	20
Introduction to Current Legislation –	
Desalination and Water Purification Research and Development	
Kevin Price, Reclamation Program Manager	23
WORKSHOP BREAKOUT SESSIONS	27
Breakout Session Structure	27
Breakout Session Group Members	27
Group Top Priorities	28
Breakout Session I	29
Breakout Session II	31
Breakout Session III	32
WORKSHOP CLOSING FACILITATION	34
Where Do We Go From Here?	
Stan Ponce, Reclamation Research Director	34
Research	34
Communication	34
Political	34
Technical	35
Economics	35
Policy	35
Public Relations	36
Coalition	36
Involvement	36
CONCLUSIONS	37
APPENDIX A WORKSHOP AGENDA	A-1
APPENDIX B WORKSHOP ATTENDEES	B-1
APPENDIX C WORKSHOP VOLUNTEER COALITION MEMBERS	C-1
APPENDIX D BREAKOUT SESSIONS SUMMARIES	D-1

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EXECUTIVE SUMMARY

A workshop, entitled *Growing the U.S. Water Supply Through Purification Technologies*, was held in Golden, Colorado, on April 10, 2000. The workshop was sponsored by the U.S. Bureau of Reclamation's (Reclamation) Office of Research, Dr. Stanley L. Ponce, Director. A core group of leaders in the water resources community was invited to participate, including representatives from national organizations, various state/local water organizations, and industry, as well as several congressional representatives.

The major purpose of the workshop was to begin a conversation and to develop a consensus on ways to more actively promote new water purification technologies among representatives of water users. The workshop consisted of presentations by water experts on current water supply and purification topics, breakout sessions at which participants developed and discussed critical water supply and purification issues, and a closing facilitation aimed at identifying solutions to address the water supply concerns of the participants and the water users they represent.

During the workshop closing facilitation, the major water supply concerns and solutions identified by the participants generated considerable discussion and served as the catalyst for creation of a volunteer coalition group who agreed to prepare a summary of the workshop and serve as contacts for further work related to the workshop and the critical water supply issues identified.

This report includes a discussion of the workshop format, a review of the presentations, and outcomes from the breakout sessions and the closing facilitation. Specifically, it delineates the critical water supply issues and major water supply concerns and solutions raised during the breakout sessions and closing facilitation, respectively. Common issues and concerns among all breakout session groups include:

- ◆ The need for a coalition group to encourage development of a national water policy related to purification technologies;
- ◆ The need for education concerning current and future water supply issues;

- ◆ The need for education about purification technologies, including desalination, reuse, and recycling; and
- ◆ The need for funding of purification technologies research and demonstration to ensure that cost-effective, reliable, adequate, and healthy water supplies are available now and in the future.

INTRODUCTION

Thirty water experts and key representatives of water users from across the U.S. attended the Reclamation-sponsored workshop entitled *Growing the U.S. Water Supply Through Purification Technologies* in Golden, Colorado, on April 10, 2000.

The purpose of the workshop was to discuss critical water supply issues facing the U.S. in the near future and the role of water purification technologies to increase the U.S. water supply. The workshop provided a platform for the participants to brainstorm about barriers to the implementation of water purification technologies for increasing U.S. water supplies through purification technologies. The workshop agenda is provided in Appendix A. The workshop participants are listed under Workshop Breakout Sessions below and in Appendix B.



The following goals and objectives of the workshop were provided to participants prior to attendance:

- ◆ Develop a clearer understanding of how desalting and water purification and reuse research can benefit the workshop participants, the water research community, and the Nation.

- ◆ Clarify the roles and goals within the water research community to meet user needs.
- ◆ Create a forum for developing a general research agenda and defining research needs between users who need additional water supplies and organizations funding purification research.
- ◆ Define the Federal role in facilitating the development of new technologies for desalting and water purification and reuse through cooperative research and demonstration.

OVERVIEW OF WORKSHOP FORMAT

The workshop included presentations by water experts on current water supply and purification topics, including national and international water needs and solutions; current advanced water treatment costs; and current Federal legislation related to water purification. The objective of the presentations was to provide participants with the latest information related to key water supply topics and provide a common background of information.

The workshop also included three breakout sessions of four groups where participants were posed questions relative to growing the U.S. water supply through purification technologies; were given time to brainstorm, discuss, and prioritize their answers; and brought their top priorities back to the general workshop in a plenary session. Each breakout group was aided by a facilitator who posed the question for each session, provided Post-It® pads for group members to list their answers, collected answers, and, based on group discussion, categorized all group answers on “flip-chart” sheets of paper. Once the group answers were categorized, each group member was given 20 points to distribute among the categories. The categories were prioritized based on the number of points distributed.



Once the plenary session reconvened, the facilitator presented the top priorities from their group in a general session.

The workshop concluded with a facilitation and identification of the most pressing issue of each participant. As a result of the significant concerns identified during the closing facilitation, a volunteer coalition group was identified, and its members agreed to prepare

a summary of the workshop and serve as contacts for further work related to the critical water supply issues identified. The workshop volunteer coalition group members are listed in Appendix C.

In order to provide all participants the opportunity to assist with coalition group activities, comments were solicited that the coalition group could use in preparation of a vision statement. A vision statement could help direct the coalition group's future activities, as well as assist with preparation of the workshop summary. The following vision statement comments were written on Post-It® pad paper and collected on a "flip chart" sheet. These are not listed in any order of priority.

- ◆ The Federal role is to gather and publish technical knowledge in order to reduce cost and inefficiency.
- ◆ To be successful, technology development needs to be integrated into the long-term management of our water resources. Equally important to the technology is the decision methodology regarding its application.
- ◆ Centralized treatment versus point-of-use/point-of-entry: Are big systems the most effective way to treat all water problems?
- ◆ What is the value of the product of purification technology?
- ◆ Meet customer expectations. Exceed current regulations and anticipate future hurdles. Reclamation should create a forum for dialog.
- ◆ The Federal Government should, through incentives, research funding, and pilot project cost sharing, encourage localities to stretch their water supply and reach water quality requirements through advanced treatment technology.
- ◆ Provide a sustainable future for the citizens of the U.S. that ensures the quality of life and freedoms by providing safe and sufficient amounts of water where it is needed to provide jobs, recreation, and food and fiber through innovation, conservation, and education.
- ◆ Take note in the water planning and research Federal programs of the past. Learn from good and bad and make future plans on subjects of the Federal role in water policy, water planning, and water research. Proposals could include: Water Planning Act, Water Research Act, and Desalting Act.
- ◆ Utilize standards as the driver for water quality, treatment techniques, and costs/funding issues.
- ◆ Recognize the makeup of the Nation's water and wastewater utilities: 94 percent serve less than 10,000 in population, and 60 percent serve an average of 150 connections.

OVERVIEW OF WORKSHOP REPORT

This report provides overviews of the presentations given during the workshop, the top priorities identified by each breakout group for each breakout session, and lists of the critical water supply issues and major water supply concerns and solutions identified by participants. Appendix D includes a summary of the notes derived from the Post-It® pads and “flip charts” responses from each breakout session group as recorded by the group facilitator.



In addition to this report, a separate three page summary, entitled the *Golden Paper*, was prepared by the workshop volunteer coalition group. It is a call for action and is intended to act as a catalyst for legislators and public officials to take steps now to prepare for future national needs in this critical water supply area. To receive a copy of the *Golden Paper*, send a request to <WaTER@do.usbr.gov>

WORKSHOP PRESENTATIONS

NATIONAL AND INTERNATIONAL WATER NEEDS AND SOLUTIONS Senator Paul Simon

Senator Paul Simon's presentation was recorded on video tape.

Introduction

I thank Kevin [Price] for your leadership and Georgeann [Price], your wife, for picking me up from the airport. I'm mentioning her because I want to get a ride back, too. The good news is that I have to catch a plane, so I'm not going to speak at length.

Last week in the Netherlands, Mikhail Gorbachev gave a talk. He had just come from meeting with Prime Minister Barak of Israel, King Abdullah of Jordan, and Chairman Yasser Arafat of the Palestinian Liberation Organization, and his message in the Netherlands—which someone caught on Reuters News Service; I didn't see it in any newspaper—was that if we don't come up with solid answers on water in 10 or 15 years, the Middle East is going to explode. It is very interesting in the Middle East right now, the key to almost every peace agreement is water. How many refugees can go to various places? How much water can you sustain?

I have been invited twice by former Prime Minister Shimon Perez to come over to meetings in the Middle East, but because of my wife's illness, I was not able to accept. Clearly, water is very, very key there.

That is just part of the overall picture. And some of these things you know and you've heard of, and, Jack [Jorgensen], you've heard me talk about so many times. And I am not a technical expert by any stretch of the imagination, but you don't need to be a technical expert to understand their problem. I wrote a couple of books about the world hunger situation—that is how I got into this—and I started getting reports, I was on the Senate foreign relations committee, reports from the World Bank and others, that we were heading for disaster. And so I started getting involved in the water situation.

The United States is fortunate—we have only 4 percent of the world's population and we have 8 percent of the world's fresh water. Yet, here in the U.S., we face some problems, not huge compared to other part of the world, but some serious water problems. Metropolitan Water District, who did I meet from the Metropolitan Water District, Andy, your projection from present sources is that by the year 2010 we will only be able to meet 43 percent of our water demands. Well, 2010 isn't that far off, so we're facing some problems very soon.

Owens Lake which became a source of water for Los Angeles is now called Owens Dry Lake, and they are talking about putting some water back in there (I don't know if that has happened). But what was a lake purchased by Los Angeles to get water became

known as Owens Dry Lake, and the residue blown up by the wind has caused that to be the area of highest air pollution in the United States with Gary, Indiana, being second to that area.

Getting agreements between states, and we are going to have to do some of that, will be very difficult. We have not had any real agreements except for the one river agreement between California and Nevada. Otherwise, you go back to the Colorado River Compact of 1922. That was the last time we've had a serious kind of agreement.

Texas, and we have two Texans here, Texas has been warned in a report that in 15 years they must reduce per capita water consumption by 25 percent. That's not an easy thing to do.

Florida, I was pleased to meet Gene Schiller and Dave Brown from Florida. Gene is honchoing the Tampa desalination plant, and the good news I just learned today for the first time, is that there is going to be a second desalination plant. Things are moving in a constructive direction.

But places you would not expect to have water problems; Puerto Rico, believe it or not, has water problems. I get letters from people who live on some of the islands in Puget Sound. With all the water they have up there, you would think that the last thing they would have would be water problems. So it is in many areas. Governor Tom Ridge of Pennsylvania and Governor Jim Edgar of Illinois asked me to speak to a luncheon meeting of Great Lakes Governors about what's going to happen to the Great Lakes. Well, what's going to happen to the Great Lakes is: first of all, we are already under court orders to reduce our consumption of water, at least for Lake Michigan (I'm not sure about any of the others). Inevitably, if we don't find answers, we are going to have to be piping water from the Great Lakes to the Southwest portion of the United States; and when people of Illinois say that they would never tolerate that, well, senators from Illinois who want to get projects approved had better go along with high priorities for senators from Southwest States or they won't get projects approved for Illinois. It's not that complicated when it gets into the United States Senate.

The international situation is compounded by the population problem. The population problems affect southern California and affect other areas, too. But very briefly, for most of the history of civilization, we have had about 10 million people on the face of the earth. In 1830, we hit 1 billion and in 1930, 2 billion. This past October, we hit 6 billion. I was born in 1928. That is pretty close to the 1930 date. If the actuaries are correct about my likely life span, I will see the world's population quadruple in my lifetime. And if I had a blackboard—I'm getting used to a blackboard now that I'm teaching at Southern Illinois University—if I had a blackboard here, you would see that our population would be going up like this and our water supply would be constant. Projections are that we will double or come close to doubling the world's population in the next 50 to 90 years. The Population Institute projects 50 years, and others put it out a little further.

You look at that, and you don't have to be a rocket scientist to figure out that we are headed for huge problems. A lot of these problems we can pinpoint very specifically. Egypt gets 98 percent of its water from the Nile, and 85 percent of the Nile comes from Ethiopia. Ethiopia has one of the highest birthrates in the world. It is going to double its population in the next 20 years. Those two nations are on a collision course, unless Egypt can use the Mediterranean. So, we know where the needs are going to be.

Even areas that are not considered crisis areas, a very significant one being China, could have water problems. China is not listed on probable emergency lists, but China has 21 percent of the world's population and 7 percent of the world's fresh water. China now has some 300 large cities with serious water problems. Nations go to war over oil, but there are substitutes for oil. There are no substitutes for water, so we are going to have to deal with some very serious problems.

I remember being in Mauritania, on the northern coast of Africa; and they were growing 8 percent of their own food—right there at the Atlantic Ocean, with the desert creeping in.

The World Bank estimates that today about 300 million people worldwide live in a serious to severe water shortage; scattered among 6 billion, that is not all that volatile. But 20-25 years from now, it will be 3 billion, and that is volatile, and that is why we need your help.

Talking to Georgeann [Price] on the way in, and I learned she is, among other things, a counselor at Columbine High School. We were all stunned by what happened at Columbine High School, and yet each day 630 times the number of children that were killed at Columbine die from poor quality water, and we pay no attention—9,500 children die every day according to the United Nations. Somehow, we have to lift ourselves on this.

Two-thirds of the people of the world have to haul water to their homes. And even for the other one-third, much of the water is unsafe. Probably every one here has been to a country where they tell you not to drink the water. And this is at hotels where you are paying a good price, a fancy price, for a room. And I would add for the women who are here, who are in a slight minority, that this water issue is a woman's issue. The people who haul the water in developing nations are overwhelmingly women, helped by their children, but it's the women who do that tough work.

And the quality of water changes a great deal in so many ways. Israel has the highest quality water in the Middle East. But it is not up to our standards, and not up to Western European standards. And because it is not of the best quality, Israelis just don't drink as much water as we do. Kidney stones—you have nine times as many problems with kidney stones per capita in Israel as you do in the United States. It's not a major world issue; but in these little ways, our lives are affected.

Probably, the most dramatic thing I could take you to see, if I wanted to illustrate the water situation, is to go to the Aral Sea in the Soviet Union. Kai [Anderson] is here from

Senator Harry Reid's office, and we are happy to have you here. Harry Reid and I went to the Aral Sea. As you know, the Aral Sea was the world's fourth largest body of fresh water in the world. We went to the port city and looked down 50-70 feet. And what had been the port was now dry land. Nikita Krushov had been convinced by some engineers that you could divert water for cotton irrigation, an old dream of Lenin's, and then the water would come back to the Aral Sea. Some ship captains, under the old Soviet Union, were concerned about lowering the water. Soviet leaders told them not to worry about it. Just leave the ships there and shortly the water will be rising again. Well, here we were at the water's edge with these rotting hulks of great ships on dry land. We couldn't see water 50 miles away. And again, like Owens Dry Lake, the wind was blowing up the residue, causing thoracic problems for the people of that area and a high infant mortality rate. A volunteer team from North Carolina was there to help with some medical problems. Water problems are tied to health problems.

What Can We Do About Water Issues in the U.S.?

- ◆ Price water adequately. A lot of farmers don't pay anywhere near the real cost for their water. We had a very interesting thing in East Germany and West Germany when there were two Germany's. East Germany under the Communist system had a flat rate. And, incidently, we still have water districts in nearly every state still charging a flat rate. There is no rationality at all. You look at how people are charged in various places. Peoria, Illinois, which is water rich should be charging more for water than Tucson, Arizona. It just doesn't make much sense. East Germany had a flat rate. In general, water consumption goes up as the standard of living goes up. East Germany's standard of living was far below that of West Germany, but they were using four times the water per capita. When they had to pay for the water they were using, the consumption of water in East Germany dropped dramatically. Pricing is one way we can reduce the use of water.
- ◆ Get the private sector involved in the supply of water. Floyd, of American States Water, has got to make a profit for the shareholders, so he has to charge adequately. He doesn't need to worry about politics. If you have a government-owned entity, *sometimes* you have to worry about the politics, and you cannot charge adequately. In many areas, it is working out well, and you have people with enough courage to charge adequately. Adequate charging is clearly important.
- ◆ Modernize irrigation systems to reduce waste and lose. If you don't have anything else, use plastic sheets so the water doesn't just go into the ground. Nearly 85 percent of water used in the world is not for household use but for agriculture and industry. Drip irrigation developed in Israel is extremely effective where it is being used, but it is extremely costly. There is an investment factor in a lot of places.
- ◆ Reuse water. We are going to have to do much more there, and we are going to have to educate the public to the benefits and safety through technology of water reuse, a public is not that eager for esthetic reasons to reuse water. We are going to have to sell it.

- ◆ Replace aging water systems in older cities. Older cities, like Chicago, are going to have to replace their water and sewer pipes, and that means Federal assistance.
- ◆ Conserve water. In some of your areas, we are going to have to stop building golf courses, which are huge consumers. And home construction. You know, the shower in my bedroom at my home which we built in 1981, not that long ago, the shower is at one end of the house and hot water heater is at the opposite end of the house. I didn't think about it, and obviously the architect didn't think about it. Well, I have to turn that water on for so long before I get hot water and just waste that water. We can do little things to make a difference. Conservation is part of the short-term answer. Pollution control is part of the short-term answer.
- ◆ Reduce the depletion of aquifers. Our aquifers around the world are gradually being depleted. I heard about one in Texas that is not being depleted yet, but generally aquifers are being depleted. If I could use this glass to illustrate. I have this glass full of water, and I pour a teaspoonful of toxic substance in that water; you have a certain level of toxicity within that glass. However, if I have half a glass and pour in the same teaspoonful, you have double the toxicity. And when our aquifers are being depleted, when farmers are saying we are not using any more fertilizer (I'm from a rural area, and farmers are great abusers of this), and industry saying we are not dumping anymore industrial waste, they are probably right. But the aquifers are being depleted, so we are having increased problems there.
- ◆ Long-term family planning has to be encouraged. The United States is not doing what it should be doing in this area. We have made clear in our statutes that you cannot use family planning money to aid developing nations for abortion purposes. So, there really shouldn't be a political problem, but there is. And in virtually every country, Afghanistan is the only one I can think of right now that is an exception, they recognize the need for family planning. As you reduce the population, you reduce the demand for water.
- ◆ Desalination and water purification are going to have to be a much bigger part of the solution. The sooner we can get going on that, the better. Here again, the U.S. is the military, economic, and research giant of the world, and we ought to be putting money into research. We should easily be spending 100 times the current amount of money being applied to water research as you have right now. Kevin [Price], I know you will go along with that idea. One of the things I also favor is that a small amount of money, \$2-3 million per year, should be available to analyze ideas and patents people have, to find the good ones. Most of them are probably not any good, but some of them are, and we ought to be seizing the opportunity and be looking at those. Two presidents urged that we get research in this area. One was Dwight Eisenhower who, in his final message to Congress, urged that we move in this area; and the other was John F. Kennedy who, in a press conference in 1961, was asked what scientific breakthrough he would like to see, and he said—you have heard me talking about getting a man to the moon, but if we really want to do something for humanity, we could get less expensive conversion of salt water to fresh water. We would really be helping humanity. Ninety-seven percent of the water on earth is salt

water, only 3 percent is fresh water, and two-thirds of the fresh water is locked up in ice and snow. That leaves approximately 1 percent for human use and consumption.

Let me add one final point. You are going to have to become missionaries. You know what the facts are. Hardly any of the public does. So you are going to have to reach out beyond your comfortable circle. And that means talking to a Rotary Club, talking to a woman's club. Those of you who don't work for the Federal Government, write letters to members of Congress. I remember a member from Florida, who later got into legal problems. I made a speech on behalf of foreign aid on the floor of the House. He came up after and said, "You are absolutely right; it is essential that we have aid to poorer nations. I wish I could vote with you." I asked, "Why can't you?" He said, "The people in my district are opposed." I asked how he knew they are opposed. "From the letters I get." "How many letters did you get in the last 2 months opposed to foreign aid?" He said he received half a dozen. Half a dozen people frightened him into voting against foreign aid. That same member was later involved in the Ab Scam thing with pictures showing him filling his pockets with money. Some of you probably saw that on the news. And I have often thought that one was legal and one illegal, but morally which was worse—taking that money as a bribe or taking those half dozen letters and not voting in the national interest because he was afraid that maybe he would lose an election?

But you are going to have to spread the word. Write letters to the editor. Every survey shows that letters to the editor are read more than editorials are. Speak to people of influence. Do what you can to spread the word. We need to address this national problem before we have to face a serious national and international crisis. And if we don't, your sons and your daughters are going to be in jeopardy. That is reality.

Question and Answer Session

Q. Do you see opportunities for success in this? Is investing money in new technology showing an economic return in other countries? Does investing money in these new technologies show up in other countries?

A. I think it will show up. When we were investing significant money at the Federal level, we were the world leader in this technology. We have slipped relative to Japan and Germany since then. There is indeed a payoff. If American States Water installs a desalination plant in California, we learn a little bit. There is an incremental assist there. I have to believe (and this is not a good metaphor) that it starts a snow ball rolling in the right direction. And then there will be demand in other countries. Mauritania, for example, is a developing nation with very limited skills in its population. It will have to go to some other country. It might as well go to American States Water, or Bechtel, or some place here to have their plant built.

Q. Is there any consideration given to putting a small charge to electric bills, water bills, and wastewater bills for research?

A. I am not aware of any legislation to pass these research costs along as increased taxes, although, it makes a great deal of sense. As you know, the small 1-cent gasoline tax brings in a great deal of money. We could do a huge service to the world. We could do so much good. And for gasoline, the Saudis are the only nation that charges less for gasoline than we do. Recently, those prices have been going up.

Q. Are other senators aware of the water issue?

A. I would say that it is very much the exception. Senators from states with water problems are very aware of the problem. Harry Reed of Nevada has a member of his staff here; Nevada faces water problems very, very soon. California senators are sensitive. New Mexico senators are sensitive. Florida senators are sensitive. It is where you have problems that have surfaced already. In Texas, it is not so much of a problem, and I haven't seen as much interest; but as problems surface, there will be more interest. But a greater problem is indifference. People aren't hostile to this. As a senator, you are hit with a thousand and one problems. There just are not many people paying attention to it. As long as you can turn the faucet on and water comes out, people will continue to be indifferent. We need one or two champions for funding in the House and the Senate. And we have the possibility of both candidates for president being a little more sensitive to this issue. I've learned this morning some of the things that George Bush has done in Texas, and I've talked to Al Gore two or three times about this issue. That would help too, having a president who was willing to lead.

Q. How politically viable is it to set up water costs by region? Everyone now wants to live in the Southwest.

A. The cost factor is going to be part of the politics of the thing. One of the things that is happening in your Tampa Bay projections is that the cost of desalination is coming down and the cost of fresh water is going up. But there is still a gap there, and that gap is one of the problems. And when we get to the point where we are going to have to pipe water, you are talking about substantial costs and substantial complications. For example, Canada has 1 percent of the world's population and 9 percent of the world's fresh water. They are the second richest country in the world in terms of water, but Canada has already announced the policy that they will not transfer water to the U.S. I think that policy will have to change. Is it going to be a little complicated? Yes. And are there going to be senators from Illinois, Indiana, and Michigan and Pennsylvania who won't want to see this happen? Yes. These politics will get tough if we don't come up with constructive answers.

Conclusions

My thanks to all of you, and my thanks to Kevin [Price] for inviting me. And again, you are going to have to be the message carriers. You know and understand this issue. The average citizen just has no comprehension of these water issues. This will have to rest on your shoulders.

If I could close by telling you a little story about a country that faces a problem, in fact I am meeting with their embassy people tomorrow, and that is Tunisia. Back before the Oslo talks in the Middle East, you might remember when the Palestinians left Lebanon and went to Tunis. Yasser Arafat was making positive sounds, and Senator Russ Feingold of Wisconsin, Senator Harry Reid from Nevada, and I flew to Tunis to talk with Yasser Arafat about the situation. While we were there, we paid a courtesy call on the President of Tunisia, and I said to the President of Tunisia, "I am curious; you are playing a moderate role in terms of Israel, and your neighbors are so extremely anti-Israel and even within your country you face some problems. I am curious how and why you are taking this posture." And he told about his family's problems during World War II, and then he said, "a Jewish family took me in." A Jewish family took in a little Arab boy and changed history. All of us change history, either by what we do or by our indifference. And I want you to change history positively. Thank you again.

CURRENT COSTS AND TECHNOLOGICAL OPPORTUNITIES

Lisa Henthorne, Partner, Aqua Resources International

Overview of Discussion Topics

Global and national fresh water needs will become critical in the next 20 years with increased population, population shifts, and increased environmental needs. A study by the Hudson Institute found that by the year 2025, 45 percent of the U.S. population growth will occur in California, Texas, and Florida, states already faced with severe water shortages in some areas. California, alone, is expected to increase in population by as much as 15.4 million people by 2020. Options for growing the water supply will need to increase.

In addition to growing demands from the shift in population to arid areas of the country, the U.S. faces increased water demands from the environment. Environmental regulations will provide for the ecological needs of wetlands, streams, rivers, and lakes, increasing the already heavy demands on this water.

On an international perspective, traditional methods can increase the water supply by 10 percent, but the population will grow four times over. We need more efficient and appropriate water conservation and water reuse. New technologies can increase water supply using low pressure membranes, reverse osmosis or nanofiltration membranes, water reuse, water recycling, new desalination approaches, and improvements to existing technology.

This presentation of current costs and technological opportunities includes global and national water needs, current technologies and the market, current costs, changes in the marketplace, and new technologies and what new technologies can offer for the future. This presentation focuses on water reuse as well as desalination.

Presentation Materials

Fresh Water Needs Will Grow Critical

Global and national fresh water needs will grow critical in the next 20 years with increased needs. Projections to the year 2020 show a significant increase in areas of water stress (1,700 cubic meters per year per person [$\text{m}^3/\text{yr}/\text{person}$]) and water scarcity (1,000 $\text{m}^3/\text{yr}/\text{person}$). In the U.S., the arid Southwest will show an increase in areas of water scarcity. By 2015, globally there will be a huge jump in the number of people moving from a sufficiency of water to water stressed, and 1.7 billion people in the world will be faced with a water scarcity.

The U.S. water needs will be affected by population movement to the arid Southwest and increasing environmental water needs (instream flow requirements).

On the national level, a recent demographic study looked principally at our workforce and how that workforce would be impacted by the movement of people within the U.S. What the study found was that between now and 2025, 45 percent of the population growth will occur in just three states—California, Texas, and Florida. Those three states currently have limited water resources. California, alone, is expected to increase in population by 15.4 million people by 2020; and by that date, it is anticipated the state would experience a water shortage of 2.4 million acre-feet in an average rainfall year if no further water resource development was made. The anticipated growth in California's population by the year 2020 is approximately equivalent to the combined population of its eight neighboring states: Arizona, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Wyoming. Options for growing the water supply will need to increase.

What Options Do We Have for Growing the U.S. Water Supply?

The options we have to meet increasing water demands include traditional large water projects, water conservation, water reuse, water transfers, and desalination.

- ◆ Traditional – large water projects
 - ◇ Estimated new global dam construction may increase the available supply of water by about 10 percent over the next 30 years, but the population is expected to grow at four times that rate.
- ◆ More efficient and appropriate uses and water conservation
- ◆ Water reuse from all sources
 - ◇ What we are seeing in water reuse:
 - ✦ Multiple barriers.
 - ✦ Reverse osmosis (RO) membrane technologies as a functional component.
 - ✦ Low pressure filtration membranes are replacing conventional RO pretreatment.
 - ✦ Ultraviolet (UV) playing increasing role.
 - ✦ California has provided U.S. leadership.
 - ✦ Industrial factor is very important.
 - ✦ International interest growing – Sulaibya, Kuwait, as an example.
 - ✦ Water recycling rate – estimated recycling average is 17 recycles in industrial application.
 - ✦ West Basin Recycling Plant – both conventional and microfiltration (MF) trains for pretreatment.
- ◆ Desalination
 - ◇ Predominantly utilize membrane technology in the U.S. (50-percent membrane/50-percent thermal worldwide).

- ✧ RO or nanofiltration (NF) membranes used depending on feed water quality and product needs; NF is fastest growing market in U.S.
- ✧ Market growth rate in U.S. is 19.4 percent per year.
- ✧ Over 3 million cubic meters per day (m^3/day) (0.8 billion per gallon per day [billion/gal/day]) has been installed in the U.S.
- ✧ Over 1,200 plants in the U.S. with unit capacities over $100 m^3/day$ (26,000 gallons per day [gal/day]), 53 percent of desalination is in the Middle East but 17 percent in North America..
- ✧ Upcoming Tampa Bay Plant.
 - ✦ First large-scale seawater desalination plant in the U.S. under contract.
 - ✦ 25 million gal/day product capacity.
 - ✦ Using seawater cooling water from nearby power plant as feed water.
 - ✦ Lower salinity (25,000-29,000 milligrams per liter [mg/L]) compared to normal seawater concentration.
 - ✦ Yearly water selling price of \$0.55 per cubic meter (m^3), \$2.08 per 1,000 gallons.
 - ✦ Privatized over 30-year period.

Cost

Tracking the decreasing membrane cost and increasing productivity since the 1980s shows the cost dropped 86 percent and the productivity doubled.

Examples of specific cost, beginning with water reuse:

- ◆ Water Factory 21 is most well known reuse facility in the world
 - ✧ \$1.44 per 1,000 gallons (/1,000 gal.) (blended granular activated carbon [GAC] and RO product).
 - ✧ \$0.99/1,000 gal. after blending with well water for re-injection.
 - ✧ Drop by another \$0.40/1,000 gal. after Groundwater Replenishment System is installed.
- ◆ West Basin Recycling Plant
 - ✧ \$0.86/1,000 gal. for train using MF as pretreatment to RO.
 - ✧ \$1.64/1,000 gal. for trains using conventional pretreatment to RO.

Desalination Costs

- ◆ Brackish water – \$1-2/1,000 gal.
- ◆ Seawater – \$2-4/1,000 gal.
- ◆ Recent seawater reverse osmosis (SWRO) projects
 - ◇ Tampa selling price is \$2.08/1,000 gal.
 - ◇ Trinidad selling price is \$2.76/1,000 gal.
 - ◇ Larnaca selling price is \$3.10/1,000 gal.

Changes in the Market Place

Another topic of importance are changes in the marketplace and some of the things that are impacting that marketplace.

- ◆ Decreasing cost of membrane technologies
 - ◇ Decreasing cost of membrane elements.
 - ◇ Improved membrane properties.
 - ◇ Improved energy recovery for seawater reverse osmosis (SWRO).
- ◆ Privatization of supplies
 - ◇ Take or pay.
 - ◇ Long-term arrangements and amortization.
 - ◇ Distribute risk away from municipality.
- ◆ Regulation in the U.S. to remove contaminants to lower levels (may not include desalting)

What Will Be the Technology and Opportunities of the Future?

The last topic is looking at the technology for the future. What sorts of things do we see coming down the road? These can be divided into three general topics: big picture technology changes, new desalination approaches, and improving existing technologies.

- ◆ Big picture technology changes
 - ◇ Integrated membrane systems.
 - ✦ Challenging surface waters.
 - ✦ Water reuse.

- ✦ SWRO.
- ✦ Many industrial applications.
- ◇ Membrane bio-reactors.
 - ✦ Potable reuse.
- ◇ Associating membrane desalination with power plants (Tampa Project).
- ◇ Utilizing membrane softening prior to distillation (global).
- ◆ New desalination approaches
 - ◇ Spectrum Arabieh PIMA Process uses laser to desalinate water (little data available).
 - ◇ Far West Group/Lawrence Livermore – capacitive deionization.
 - ◇ Defense Advance Research Projects Agency’s (DARPA) High Tech Innovations.
- ◆ Improving existing technologies – a lot of small steps made in last few years
 - ◇ Mineral Water Development.
 - ✦ Flow distributor – A flow distributor is placed directly in front of the membrane elements which increases turbulence within the membrane element.
 - ◇ Bureau of Reclamation – developing membranes, small systems.
 - ✦ Chlorine resistant thin film composite membrane with salt rejection and flux properties exceeding FT-30 standards.
 - ✦ Improved CA membrane with reduced crystalline pattern which limited salt rejection properties.
 - ✦ Small systems–University of Arizona dew-vaporation (low temperature evaporative process).
 - ◇ Commercial membrane manufacturers.
 - ✦ Higher flux membranes.
 - ✦ Less fouling tendencies.
 - ✦ Operating at lower feed pressures.
 - ✦ Range of salt rejections and contaminant specific.
 - ✦ Surface modifications to customize.
 - ✦ Increased automation of the production process.
 - ✦ Larger diameter and longer length elements.
 - ◇ Energy recovery devices – gaining in use and innovation, energy cost larger share of total water cost as membrane costs are going down and increasing competition in build it, own it, operate it (BOO) agreements.

*Growing the U.S. Water Supply
Through Purification Technologies*

- ✧ Technical advances with reduced capital cost, improved reliability, and reduced maintenance costs.
- ✧ Research sponsored by the Middle East Desalination Research Center in Muscat, Oman.
- ✧ Research and development by the Saline Water Conversion Corporation in Saudi Arabia.
- ✧ Support of universities and research institutes.

Reference material is available for particular questions regarding data or statistics given in the presentation.

INTRODUCTION TO CURRENT LEGISLATION – TITLE XVI, WATER REUSE PROGRAM Rick Martin, Reclamation Program Manager

Overview of Discussion Topics

The Reclamation Wastewater and Groundwater Study and Facilities Act of 1992, referred to as Title XVI of Public Law 102-575, directs the Secretary of the Interior to undertake a program to investigate and identify opportunities for water reclamation and reuse. The act authorizes Reclamation to participate in the construction of five recycling projects, four of which have been receiving Federal construction funding.

In 1996, Congress enacted the Reclamation Recycling and Water Conservation Act (Public Law 104-266) which amended Title XVI and authorized Reclamation to participate in an additional 18 projects, including 2 research and development projects. In addition, Congress specified prerequisites that must be met before construction funds can be appropriated for a project. These prerequisites are:

- ◆ Reclamation or the non-Federal project sponsor has completed a feasibility study that complies with the provisions of the act;
- ◆ The Secretary has determined that the non-Federal sponsor is financially capable of funding the non-Federal share of the project costs; and
- ◆ The Secretary has approved a cost-sharing agreement with the project sponsor.

In addition, Reclamation must ensure completion of appropriate environmental compliance under the National Environmental Policy Act (NEPA) during the feasibility stage before construction funding can be disbursed.

Title XVI was amended again in 1998 by the Oregon Public Lands Transfer and Protection Act (Public Law 105-321) to include construction authorization for an additional water recycling project in Oregon.

Guidelines for Project Proposals

Packets for those attending the workshop contain the complete text of the legislation and the *Guidelines for Preparing, Reviewing, and Processing Water Reclamation and Reuse Project Proposals Under Title XVI of Public Law 102-575, as Amended*.

This guideline document provides information describing the Bureau of Reclamation's water reclamation and reuse program as authorized by the Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 (Title XVI of Public Law 102-575, as

amended). It also provides information on how to comply with statutory requirements of Title XVI and Reclamation policy that applies during the preconstruction phase of project development.

These guidelines also address common questions that project sponsors and others may have in several areas: the Title XVI program, funding, the feasibility study and report, environmental requirements, reclamation priorities, and cost sharing. The guidelines address applicable contents of a complete feasibility study, economic analysis, NEPA, and other environmental requirements, cost-sharing procedures, determining financial capability, and demonstration projects.

What Authorities Does This Program Provide?

Title XVI directs the Secretary through the Bureau of Reclamation to undertake a program to:

- ◆ Investigate and identify opportunities to reclaim and reuse municipal, industrial, domestic, agricultural wastewater, groundwater, and surface water in the 17 Western States;
- ◆ Design and construct demonstration and permanent facilities to reclaim and reuse water; and
- ◆ Conduct research, including desalting, for the reclamation of wastewater and naturally occurring ground and surface water.

The program allows us to conduct appraisal level investigations with 0-percent cost share—we pay the full cost. It also allows us to look at feasibility level studies for potential projects, funding up to 50 percent of the cost; and in the research and development program, it allows us to fund 25- to 50-percent cost share with the sponsor paying the rest.

- ◆ Appraisal (0-percent cost share)
- ◆ Feasibility (50-percent cost share)
- ◆ Research and development (25- to 50-percent cost share)
- ◆ Design and construction (25-percent cost share up to \$20 million)

This program allows us specific authority to plan, design, and construct actual projects. The 1992 act authorized five specific construction projects: three in California (Los Angeles, San Gabriel, and San Diego), one in northern California (San Jose), and one project in Phoenix, Arizona.

The act was amended in 1996 to give us authority for 16 more construction projects and 2 research and development projects, and modified again in 1998 to add a project in Medford, Oregon. Projects are now in California, Utah, Nevada, Texas, Oregon, and Arizona.

We need specific authority to spend money on construction projects. We do not need specific authority to do appraisal and feasibility studies, which is within the purview of the Secretary's charge to identify opportunities and investigate potential projects.

Over \$196 million has been provided to the local, non-Federal sponsors of these programs. Currently, we have 16 projects that have received funding since 1994. The President's request for 2001 is \$22 million, which is low. The request is usually in the \$30-35 million range. The highest amount ever received was nearly \$50 million, which funded congressional write-ins.

Funding After the 1996 Amendment

There are 23-24 projects which have been authorized with a total cost in the \$2-billion range if we were to build all of them, with the Federal commitment in the \$400- to \$500-million range. We are aware that many organizations would like to get recycling projects authorized for construction throughout the West. For fiscal year (FY) 2000, we requested \$2.2 million for research and feasibility studies. We got the \$2.2 million, but Congress earmarked the funds for specific feasibility studies they wanted conducted. Research was left unfunded. Eventually, we would like to develop a research and development program which targets:

- ◆ Lower cost water treatment processes for on-site,
- ◆ Tools to ensure water quality, public safety, and public awareness,
- ◆ Methods to increase economic efficiency and specific application,
- ◆ Testing of laboratory and pilot systems, and
- ◆ Technology transfer.

We have asked for \$1.4 million for FY 2001 with \$500,000 available for research. We asked only for \$500,000 for research because we have such a great need for funds for construction projects. There are many existing, authorized projects that have not received funds. We are hopeful we can begin funding research and development in FY 2002.

**INTRODUCTION TO CURRENT LEGISLATION –
DESALINATION AND WATER PURIFICATION RESEARCH AND
DEVELOPMENT**
Kevin Price, Reclamation Program Manager

Overview of Discussion Topics

The purpose of the Desalination and Water Purification Research and Development (DWPR) Program is to determine the most cost-effective and technologically efficient means by which usable water can be produced from saline water or water otherwise impaired or contaminated; to provide additional, reliable supplies of healthy water for water-short communities; to improve current technologies; and to develop new technologies.

A number of generalized objectives are inherent in this purpose, including:

- ◆ Increasing the ability of communities of varying sizes and financial resources to economically treat saline water to potable standards;
- ◆ Increasing the ability of the United States desalting industry to compete throughout the world, by fostering partnerships to develop new and innovative technologies;
- ◆ Developing methods to make desalting more efficient through promotion of dual-use facilities in which waste energy could be applied to desalting water;
- ◆ Developing methods to ensure desalting technologies are environmentally friendly;
- ◆ Ensuring regulations are appropriate for the application by working with regulators to fully evaluate effects of concentrate streams; and
- ◆ Maximizing technology transfer to ensure full transfer of knowledge and commercialization of technology.

The Water Desalination Act of 1996, Public Law 104-298, is national in scope and not limited to the 17 Western States. The Secretary of the Interior was authorized by the act to carry out its provisions; and Reclamation, as the steward of the act, manages the program. Funding for the program is provided through Reclamation's Office of Research, Dr. Stanley L. Ponce, Director. Administration of the program is assigned to the Technical Service Center's Water Treatment Engineering and Research Group in Denver, Colorado. This law requires cost sharing and authorizes the Government to cost share research to serve as a catalyst in reducing the costs of desalting technologies. The authorization includes not only desalination but technologies that remove anything that is suspended or dissolved in water.

Program Authorization

There are two parts to Public Law 104-298. The first is research and studies which began in 1997 with a maximum funding of \$5 million per year. The second part of the program, demonstration projects, was authorized to begin in FY 1999 but has not been funded.

Research and Studies

The research and studies are accomplished through:

- ◆ Awarding grants, contracts, and cooperative agreements with non-Federal entities;
- ◆ Using a competitive, merit-reviewed process for awards;
- ◆ Using a recommended cost sharing of 25- to 50-percent Federal contribution (a Federal contribution in excess of 25 percent may not be made unless it is determined that the project is not feasible without such increased Federal contribution). Up to \$1 million per year may be awarded to institutions of higher education, including United States–Mexico binational research foundation and interuniversity research programs established by the two countries without mandatory cost sharing.
- ◆ Having authorization of up to \$5 million per year Federal contribution for 6 years.

Development Projects

The development projects will be:

- ◆ Based on the research findings (and a recommendation of projects in a report to Congress),
- ◆ Awarded through cooperative agreements and contracts with non-Federal entities,
- ◆ Accomplished using a cost sharing of 25- to 50-percent Federal contribution, (a Federal contribution in excess of 25 percent may not be made unless it is determined that the project is not feasible without such increased Federal contribution), and
- ◆ Accomplished with authorization of up to \$25 million total Federal contribution, over a 6-year period.

All information from studies sponsored or funded under authority of the act is considered public information.

Program Priorities

What are we going to need in desalination technology? Priorities in the research and testing include:

- ◆ Membranes
- ◆ Water reuse
- ◆ Concentrate disposal
- ◆ Nontraditional (innovative)
- ◆ Ancillary and economic improvements

We want to do the research and testing in the laboratory, then move to the pilot plant, and then to demonstration plants. After that, it is up to the private sector to commercialize the technology, if it is cost effective.

The program has funded projects in Illinois, California, Texas, Florida, Nevada, Utah, Colorado, New Mexico, Arizona, Delaware, New Jersey, Hawaii, Montana, New York, and Connecticut.

Cost of Research and Development Components

It takes money upfront to have the management in place. As the money in the program increases, more and more of the money goes into research projects. It takes a certain number of small-scale research projects to get the pilot plants, and not everything is successful. Once you get the pilot plants, not every one of those is successful. The Government's share of the cost includes:

- ◆ Laboratory studies – \$150,000 each, \$1,500,000 total
- ◆ Pilot plants – \$250,000 each, \$1,250,000 total
- ◆ Demonstration plants – \$1 to \$2 million each

In FY 1998, 83 preproposals were submitted, 41 full proposals were reviewed, and 20 cooperative agreements were signed. In FY 1999, because of a reduced budget, 64 preproposals were submitted, 25 full proposals were reviewed, and 15 cooperative agreements were signed.

Materials Available on the Internet

Everything we do is now available on the Internet, and we keep it up to date. We produce a newsletter three or four times a year. Specifically, the *Water from Water* newsletter discusses current projects and priorities and announces when we are going to advertise a call for proposals, the technical areas that are being solicited, and some information of what funding is available. We also have an extensive reports collection that is growing rapidly. We have 50 reports available either printed, on CD ROM, or by the fall of 2000, directly downloadable from the website.

- ◆ Program home page <www.usbr.gov/water/desal.html>
- ◆ Reports <www.usbr.gov/water/reports.html>
- ◆ *Water from Water* newsletter <www.usbr.gov/water/wfw.html>

If you have any questions, you can send an e-mail to kprice@do.usbr.gov or WaTER@do.usbr.gov.

WORKSHOP BREAKOUT SESSIONS

BREAKOUT SESSION STRUCTURE

During the three workshop breakout sessions participants were organized into four working groups (group 1-red, group 2-blue, group 3-green, and group 4-yellow) each led by a facilitator. The color coding was used for easy recognition by facilitators and group members. The objective of the breakout sessions was to obtain a better perspective of the critical water supply issues and key barriers in developing purification technologies to meet the Nation's current and future water supply needs. The workshop participants are listed under Breakout Session Group Members below and in Appendix B.

The process used was previously described in "Overview of Workshop Format." Group 2 collectively decided not to prioritize items because they felt the time would be better spent in discussion. This group's two to three top priorities were determined based on the number of Post-It® pad responses listed under each category. Appendix D includes a summary of the notes derived from the Post-It® pads and "flip charts" responses from each breakout session group as recorded by the group facilitator.



Breakout Session Group Members

Group 1 (red):

Facilitator: Kevin Price

Members: Ron Linsky, Executive Director, National Water Research Institute; Keith Carns, Director, EPRI Community Environmental Center; Dan Beckett, Director, Research Division, Texas Water Development Board; Paul Gagliardo, Manager, Water Research and Development, City of San Diego; Andy Shea, Vice President of

Development, Poseidon Resources Corporation; Bob Dobek, Legislative Director for Representative Karen Thurman; Stan Ponce Director, Reclamation's Office of Research Office

Group 2 (blue):

Facilitator: Susan Martella

Members: Sam Wade, Deputy Chief Executive Officer, National Rural Water Association; Rick Karlin, Deputy Executive Director, American Water Works Association Research Foundation; Dave Furukawa, Past President, International Desalination Association; Andy Sienkiewich, Section Manager, Resource Procurement Section, Metropolitan Water District of Southern California; Dave Paulson, Director of Corporate Development, Osmonics; Kai Anderson, Legislative Assistant for Senator Harry Reid; Huali Chai, Esq., Attorney

Group 3 (green):

Facilitator: Mark Lichtwardt

Members: Rob Renner, Deputy Executive Director, American Water Works Association; Chuck Noss, Director of Research, Water Environment Research Foundation; Eugene Schiller, Deputy Executive Director, Southwest Florida Water Management District; Bob Yamada, Senior Civil Engineer, San Diego County Water Authority; Jack Jorgensen, Water Resources Consultant; Lisa Henthorne, Partner, Aqua Resources International; Steve Kasower, Planning Officer, Reclamation's Southern California Area Office

Group 4 (yellow):

Facilitator: Chuck Hennig

Members: Peter MacLaggan, Executive Director, WateReuse Association and WateReuse Foundation; Cloice Whitley, Manager, Harlingen Water Works, Harlingen, Texas; David Brown, Director, Water and Utilities, City of Jupiter, Florida; Floyd Wicks, President and Chief Executive Officer, American States Water Company; Rick Martin, Area Manager, Reclamation's Southern California Area Office and Manager, Title XVI Program

Group Top Priorities

Following is a summary of the top priority categories from each group for each breakout session, as presented by the group facilitators. The responses are listed in order of priority based on the number of points each category received during the session's prioritization exercise. Group 2 priorities are based on the number of Post-It® pad responses listed under the identified categories. Group 1 collectively decided not to separate the breakout session I questions into two responses.

Breakout Session I

Session I Questions: *Parts of the U.S. water supply will be under stress between now and 2025. What major nontechnical issues will need to be addressed for the next generation? What should the Federal role be?*

A discussion of the question by the four breakout groups produced these major nontechnical issues to be addressed for the next generation:

- ◆ The first major issue to be addressed is education—education of the public, the professionals, and the law makers. Public education on water conservation, pollution prevention, water reuse acceptance, and water development issues must be increased in order to evaluate and develop realistic solutions.
- ◆ A second issue to be addressed is the need for an integrated national plan for water management and water policy without waiting for a crisis. The national plan should include educational goals to make the plan happen.
- ◆ A final issue to be addressed is how to pay, and who should pay, the costs of the needed education, research, and development of solutions.

The Federal role should include:

- ◆ Leadership, funding, and communication.
- ◆ Take the lead in the resolution of conflicts arising between states and between the U.S. and other nations.
- ◆ Look at what has been done in the past to establish an integrated national policy to help shape the future national policy.
- ◆ Develop a funding policy.
- ◆ Research technologies that show promise to create “new” or previously unusable water.
- ◆ Provide cost assistance in research and pilot programs and leadership in establishing microbial standards.
- ◆ Provide information on the relative importance of conflicting water uses.

Below are the prioritized categories from each group. Detailed responses within each category can be found in Appendix D.

Group 1:

1. The Federal role in developing public policy
2. Advocacy of technology through coalitions
3. Funding/financing to encourage technology
4. Public perception of technology
5. Education for acceptance
6. Economics of technology

Group 2:

Nontechnical issues

1. Education about purification technologies
2. Demographic issues related to water supply
3. Salt loading/concentrate disposal effects

Federal role

1. Funding issues
2. Standards development
3. Education for acceptance

Group 3:

Nontechnical issues

1. Policy and planning
2. Public acceptance of technology
3. Economics of technology

Federal role

1. Leadership in all areas (education, policy, funding, etc.)
2. Funding of research of technology
3. Communication to encourage cooperation and use of technology

Group 4:

Nontechnical issues

1. Planning/resource management within industry
2. Public education/involvement about technology
3. Funding sources/costs in all areas

Federal role

1. Leadership and guidance of education, planning, and regulations
2. Financial and nonfinancial incentives to invoke action

Breakout Session II

Session II Question: *What are the challenges/hurdles to growing the U.S. water supply through purification technology?*

The discussions of the question by the breakout groups produced four challenges/hurdles to growing the U.S. water supply through purification technology:

- ◆ The first challenge is to ensure safety through reliable technology all the way to the tap and demonstrate process reliability.
- ◆ The second challenge is the need for public education and awareness, especially on the benefits to the economy and the environment through the use of purification technologies. There is a lack of public awareness of the need for purification technologies and a lack of confidence that water is safe, especially water reuse.
- ◆ The third challenge is the need for an economic analysis of the cost of purification technologies as compared to the economic benefits provided—the price of water versus the true value of water. A related challenge is keeping the costs affordable and controlling costs due to regulatory hurdles.
- ◆ The fourth and final challenge is to establish an integrated national water policy.

Below are the prioritized categories from each group. Detailed responses within each category can be found in Appendix D.

Group 1:

1. Public acceptance of technology (reuse, recycling)
2. Economics of technology
3. Concentrate disposal

Group 2:

1. Cost in all areas
2. Education/public acceptance of technology
3. Technology demonstration

Group 3:

1. Risk versus funding issues
2. Funding/allocation in all areas
3. Regulatory policy issues

Group 4:

1. Ensuring safety through reliable technology
2. Public education/awareness of technology
3. Cost of implementing/operating the technology

Breakout Session III

Session III Question: *What could be done now to meet the future needs of water users and water managers?*

From the discussion of the question by the breakout groups, three major actions were developed.

- ◆ First, develop a comprehensive strategic plan that all water and wastewater agencies and organizations could use to articulate a position to decisionmakers in order to secure appropriations and help facilitate a nationwide water resources policy that includes purification technologies as a major component. Then build coalitions among the stakeholders, build bridges with other regions and other agencies, and form a coalition with non-Reclamation entities. This coalition could act as a steering committee for Reclamation's Desalination and Water Purification Research and Development Program.
- ◆ Second, vigorously provide education and information. Educate the public, the policymakers, and those entering the professional field. Provide sample educational materials for local providers to use with their public information programs. Provide funds for public and school education contests for students on why we need water reuse and desalination now. Demonstrate to public officials what can be achieved by current technologies. To provide technical education, provide dollars for a web site to serve as a clearinghouse of up-to-date information on technical and relevant information, and advertise through all affected association newsletters; and provide workshops on new technologies for water entity users, for consulting engineers, and for engineering students and their professors, demonstrating what could happen without new sources of water.
- ◆ Third, develop strategic and tactical planning. Develop a long-term national vision through a process driven by stakeholders. Establish permanent national and regional committees of Federal, state regulators and educators, and regional and local utilities to share possibilities on a permanent basis. Provide funds for interstate planning and to support long-range water source planning studies.

Define and begin documenting legislation, rules, and regulations to pave the way for the adoption of new technologies.

Below are the prioritized categories from each group. Detailed responses within each category can be found in Appendix D.

Group 1:

1. Coalition movement to promote technology
2. Information delivery about technology
3. Budget planning

Group 2:

1. Organize a constituency
2. Technology transfer
3. Education about technology

Group 3:

1. Leadership/organize coalitions
2. Public education about technology
3. Strategic and tactical planning

Group 4:

1. Planning for development of technology
2. Policy development by Congress
3. Education about technology

WORKSHOP CLOSING FACILITATION

WHERE DO WE GO FROM HERE?

Stan Ponce, Reclamation Research Director

Prior to conclusion of the workshop, each participant was given the opportunity to openly identify a single solution to address a water supply concern which they felt was most critical for their organization and the water users they represent. These solutions, categorized and listed below, were the basis for organization of the workshop volunteer coalition group and development of the *Golden Paper*. These are not listed in any order of priority.

Research

- ◆ Integrate seawater desalination membrane research (pretreatment/reverse osmosis).
- ◆ Update non-potable recycling criteria.
- ◆ Research on concentrate disposal.

Communication

- ◆ Determine value of water (current and future).
- ◆ Encourage public awareness.
- ◆ Provide education in public schools.
- ◆ Develop a national public education program to promote water reuse.
- ◆ Educate regulators.
- ◆ Compile existing technology database for public use (i.e., Reclamation's DESALNET database in cooperation with American Water Works Association).
- ◆ Reclamation should provide sponsorship of Senator Simon's public education program on Public Broadcasting System.
- ◆ Expose academia to new technologies.
- ◆ Educate public to the magnitude and proximity of the future national water shortage and the relative likelihood of solving it by methods generally used today.
- ◆ Distribute message that there is no more cheap potable water.

Political

- ◆ Identify opportunities to use desalination/purification technologies beyond water supply.

- ◆ Create specialized coalition support for a national program (Reclamation program).
- ◆ Build political and geopolitical constituencies.
- ◆ Build constituencies that represent the scope of water purification and reuse needs.

Technical

- ◆ Develop process sustainability for small communities (renewables).
- ◆ Improve technologies to correct salt imbalance plaguing many watersheds (salinity control from a basin-wide perspective).
- ◆ Determine how to meet drinking water standards for small communities.

Economics

- ◆ Develop ways to evaluate payoff of purification technologies (regional, national, global, etc.).
- ◆ Develop protocols and data for comparing effectiveness of processes (define best practices).
- ◆ Determine innovative ways to use existing systems.
- ◆ Understand that there is no single solution (diversify solution space).
- ◆ Develop economic assessment of all alternatives.
- ◆ Clearly identify ways to reduce and distribute financial and technical risk.

Policy

- ◆ Develop a national water resources policy document.
- ◆ The President, Congress, and Office of Management and Budget should consider including a requirement that every program which requests substantial Federal funds to improve water supply or quality (i.e., CalFed Bay-Delta Program) contain a component to implement advanced treatment technology, including membranes and ultraviolet irradiation.
- ◆ Ensure national security while providing technology transfer.
- ◆ Develop a leadership vision.
- ◆ Update infrastructure (water distribution systems, wastewater conveyance systems, etc.).

Public Relations

- ◆ Actively promote change (funding of pilot plants, dissemination of information, etc.) and create culture for change in Reclamation.

Coalition

- ◆ Develop national forum to coordinate Federal investment in research and development.

Involvement

- ◆ Clearly identify ways to reduce and distribute financial and technical risk.

CONCLUSIONS

The Reclamation-sponsored workshop, *Growing the U.S. Water Supplies Through Purification Technologies*, was attended by 30 water experts and key representatives of water users from across the U.S., including representatives from national organizations, various state/local water organizations, and industry, as well as several congressional representatives.

The major purpose of the workshop, to begin a conversation and develop of a consensus on ways to more actively promote new water purification technologies among representatives of water users, was successfully accomplished through presentations by water experts on current water supply and purification topics, breakout sessions at which participants discussed critical water supply issues, and a closing facilitation aimed at identifying solutions to address the water supply concerns of the participants and the water users they represent. The issues and concerns that were common among all breakout session groups include:

- ◆ The need for a coalition group to encourage development of a national water policy related to purification technologies;
- ◆ The need for education concerning current and future water supply issues;
- ◆ The need for education about purification technologies, including desalination, reuse, and recycling; and
- ◆ The need for funding of purification technologies research and demonstration to ensure a cost-effective, reliable, adequate, and healthy current and future water supply.

During the workshop closing facilitation, the major water supply concerns and solutions identified by participants generated considerable discussion and served as the catalyst for creation of the volunteer coalition group. This coalition group agreed to prepare a summary of the workshop and serve as contacts for further work related to the workshop and the critical water supply issues identified. The first action item of this coalition was development of the *Golden Paper*, available upon request to <WaTER@do.usbr.gov>.

APPENDIX A

GROWING THE U.S. WATER SUPPLY THROUGH PURIFICATION TECHNOLOGIES WORKSHOP AGENDA

Sunday, April 9, 2000 - Table Mountain Inn, Arapaho Room

Reception and Cash Bar	6:00-7:00
Dinner	7:00-8:00

Monday, April 10, 2000 - Golden Hotel, Clear Creek Ballroom

Breakfast	7:30-8:00
Welcome - Stan Ponce, Research Director	8:00-8:10
Workshop Introduction - Kevin Price, Program Manager	8:10-8:30
Breakout Session I - Parts of the U.S. water supply will be under stress between now and 2025. What major non-technical issues will need to be addressed for the next generation? What should the Federal role be?	8:30-9:45
Break	9:45-10:00
Summary Reports from Session I - Group Facilitators	10:00-10:20
Open Discussion	10:20-10:45
Presentation - <i>Current Costs and Technological Opportunities</i> - Lisa Henthorne	10:45-11:15
Breakout Session II - What are the challenges/hurdles to growing the U.S. water supply through purification technology?	11:15-11:45
Lunch	11:45-1:00
Presentation - <i>National and International Water Needs and Solutions</i> - Senator Paul Simon	
Summary Reports from Session II - Group Facilitators	1:00-1:20
Open Discussion	1:20-1:45
Presentation - <i>Introduction to Current Legislation</i> - Rick Martin and Kevin Price, Program Managers	1:45-2:15
Breakout Session III - What could be done now to meet the future needs of water users and water managers?	2:15-2:45
Break	2:45-3:00
Summary Reports from Session III - Group Facilitators	3:00-3:20
Open Discussion	3:20-3:45
Closing Facilitation - <i>Where Do We Go from Here?</i> - Stan Ponce	3:45-5:00

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APPENDIX D

BREAKOUT SESSIONS SUMMARIES

Following is a summary of the notes derived from the Post-It® pads and “flip charts” responses from each breakout session and group as recorded by the group facilitator. The responses are listed under each category. Each category is in order of priority based on the number of points received during the session’s prioritization exercise. Group 2 priorities are based on the number of Post-It® pad responses listed under the identified categories. Group 1 collectively decided not to separate the breakout session I questions into two responses.

BREAKOUT SESSION I RESPONSES

Session I Questions: *Parts of the U.S. water supply will be under stress between now and 2025. What major nontechnical issues will need to be addressed for the next generation? What should the Federal role be?*

Group 1 Responses:

- ◆ Public Policy (Federal Role)
 - ◇ Develop guidelines for brine.
 - ◇ Develop a comprehensive strategic plan that all water and wastewater agencies and organizations can use to articulate a position to decision makers in order to secure financial aid.
 - ◇ Develop nationwide strategic plan for water resources development.
 - ◇ Communicate that quantity issues are not confined to the West—bridge the gap between the Western Reclamation States and the remainder of the U.S.
 - ◇ Communicate that parts of the U.S. water supply will become unusable due to water quality or other environmental issues.
 - ◇ Increase public education on water conservation, pollution prevention, and water development issues in order that realistic solutions can be evaluated and developed.
 - ◇ The Federal role should be to take the lead in the resolution of conflicts arising between states and between the U.S. and other nations, to research technologies that show promise to create “new” or previously unusable water, and to provide information of relative importance of conflicting water users—and, of course, fund it all.
 - ◇ What is the overall Federal policy for water resources management that integrates water quantity and water quality? Do we need to re-institute the National Water Research Council or some derivative of that infrastructure?

- ✧ Request legislation in Congress in 2001-2002 that would create framework—look for bills outside of existing Resources Committee (Clean Water Act, Safe Drinking Water Act).
- ✧ Create legislation to provide funding for identified initiatives.
- ✧ Interconnect the desires of industry, the need for water, and environmental protection.
- ✧ Address water rights in the West—what changes need to be made in existing administration of water quantity to promote more effective management of a limited resource?
- ✧ Global (national) water purification policy that integrates Federal agencies (DOI, Agriculture, EPA, and Public Health).
- ✧ Identify strategies to use water appropriately treated for specific uses (e.g., do not need drinking water quality for irrigation purposes).
- ✧ Integrate water purification to sustained economics development and environmental quality.
- ✧ Acknowledge that all water does not have to be potable—reuse can save money otherwise used to clean water to drinking standards.
- ✧ Develop watershed-based water resources management practices and plans.
- ✧ Federal Government should develop and communicate policy—and enact legislation in support of policy.
- ◆ Advocacy
 - ✧ Demonstrate the value of purification to both supply and the environment.
 - ✧ Develop a vision that focuses on the issue before it becomes a crisis—limited water supplies and marginal source streams will make this an issue outside of California.
 - ✧ Create educational program to inform the general public and decisionmakers regarding water resources needs.
 - ✧ Develop a constituency—who and where are the people who need to know the desalination story.
 - ✧ Develop a communications strategy to deliver the “story” in nontechnical terms.
 - ✧ Create an agenda that looks beyond the traditional sources and programs.
- ◆ Funding/Financing
 - ✧ Federal Government should appropriate funding for projects with Title XVI authorization.
 - ✧ Develop good government initiatives—Proposition 218 in California limits new funding commitments without voter approval (“a nonstarter”).
 - ✧ Federal Government should authorize increased research funding of appropriate agencies (Reclamation, EPA).
 - ✧ Federal roles should include revolving funds, grants, tax credits.
 - ✧ Federal role should be to remove bond caps on tax-exempt financing for public-private partnerships.

- ✧ Address how small communities are going to address meet future water quality regulations.
- ◆ Public Perception
 - ✧ Initiate consumer confidence research and perspective analysis.
 - ✧ Deal with public awareness issue—nobody really cares unless there is a crisis—without a coherent policy, proper planning and communication or advocacy becomes ineffective.
- ◆ Education
 - ✧ Promote education and training of scientists and engineers in the new water resources/purification technology fields.
- ◆ Economics
 - ✧ Apply product marketing principles to various waters and determine valuation.
 - ✧ Determine who really is going to pay the full avoided cost of incremental supply.
- ◆ Regulatory Guidelines
 - ✧ Need for regulatory guidelines on decentralized water/wastewater systems.
- ◆ Institutional
 - ✧ Determine if reclaimed wastewater (municipal and industrial) should be used for potable consumption.
 - ✧ Address political in-fighting over who gets to build the next facility.
 - ✧ Get Federal agencies (Reclamation, Army, EPA, Corps, etc.) to work together on integrated resources plans.
- ◆ Incentives
 - ✧ Develop incentives for nonpotable reuse, current trend is to stick with potable supplies.
- ◆ Research Agenda
 - ✧ Federal Government should develop research agenda for water supply and reuse.
 - ✧ U.S. should test technology in use abroad (we don't have monopoly on invention).
- ◆ Demographics
 - ✧ Accept that the demand for water in the U.S. will not decline and that conservation only works for a year or two.
 - ✧ Address water quality in “wet areas” as a result of El Niño and other climatic changes.

- ◆ Public Health
 - ◇ Develop trust in reuse in terms of public health.
- ◆ Best Available Technology
 - ◇ Federal Government should update the best available technologies for potable water.

Group 2 Responses to Part a - Nontechnical Issues:

- ◆ Education About Purification Technologies
 - ◇ Address lack of acceptance that there is a critical issue.
 - ◇ Need to develop constituencies for purified water.
 - ◇ Showcase purification successes.
 - ◇ Help public and legislators understand means by which incremental supply can be developed.
 - ◇ Address public acceptance issues.
 - ◇ Address public acceptance/perception issues.
 - ◇ Understand the urgency of the issue.
 - ◇ Educate policy makers.
 - ◇ Educate the public on real water issues—vis-a-vis demand/supply.
 - ◇ Educate about water reuse—public education/public acceptance.
 - ◇ How can we convince local government to control/regulate growth based on their ability to stretch their local supply through recycling?
 - ◇ How can we convince politicians, agencies, local government, and populace that water treatment is the only way to provide high quality water for all beneficial uses in areas where the supply is limited?
 - ◇ How can we convince water agencies and industry of the wisdom of utilizing advanced water treatment rather than stream and river diversions to achieve high quality tap water?
 - ◇ How can we convince public to accept treated wastewater for groundwater recharge and tap water supplies?
- ◆ Demographics
 - ◇ Address that political jurisdictions don't match hydrological boundaries.
 - ◇ Address and define the critical regions in the U.S. that will become water stressed—establish an estimate of when the water scarcity will occur.
 - ◇ Understand the trend of current and future demographics.
 - ◇ Address geographic diversification of purification demand.
 - ◇ Control growth.

- ✧ Identify critical growth areas.
- ✧ Demonstrate rural applications.
- ◆ Salt Loading/Concentrate Disposal
 - ✧ Address impact of desalting on natural systems—maintenance—stream flow through alternative source.
 - ✧ Address salt loading/degradation of water supplies.
 - ✧ Address that irreplaceable resources are being lost and new resource opportunities are unrealized due to salt loading.
 - ✧ Understand cost of salinity in system maintenance.
 - ✧ Address waste disposal issues (reject, sludge, etc.).
 - ✧ Solve concentrate disposal problems, particularly inland.
 - ✧ Initiate reliable research on environmental effect of purification technologies (e.g., brines on ocean environment).
- ◆ Competing Resources/Needs
 - ✧ Energy versus water—higher energy cost and environmental impact of generation (e.g., Four Corners air issues).
 - ✧ Where does this issue rank compared to other needs—transportation, education, etc.?
 - ✧ Address that competition of limited water resources between urban, agriculture, and environment is a major constraint.
- ◆ Cost
 - ✧ Determine desalting costs—all aspects.
 - ✧ What is the relative societal cost of desalting? Reuse? Status quo?
 - ✧ How to prioritize desalting against other technologies?
 - ✧ Delineate linkage between water purification and expanded opportunities for economic development.
- ◆ Alternative Treatment
 - ✧ Determine where best to remove specific contaminants—municipal versus point-of-entry/point-of-use.
 - ✧ Take a challenge to incorporate more natural purification means in systems.
 - ✧ Address the attitude to treat the polluted water instead of the polluted source (example: end of pipe water reclamation versus water course management).
 - ✧ Address the attitude to treat all water the same way—big system is the only approach.
- ◆ Funding
 - ✧ Identify funding (cost share) for demonstration projects.
 - ✧ Obtain Federal support, political and financial, for research, implementation, and incentives (such as cost sharing).

- ◆ Federal Structure
 - ◇ Identify institutional arrangements for multi-agency projects.
- ◆ Technology Transfer
 - ◇ How to tap private industries' technical knowledge that is no longer proprietary?

Group 2 Responses to Part b - Federal Role:

- ◆ Funding
 - ◇ Establish local drive for Federal support (if necessary).
 - ◇ Who pays? Whole Nation or just affected states?
 - ◇ Establish incentives.
 - ◇ Fund new projects.
 - ◇ Fund long-term research and development.
 - ◇ Federal Government needs to invest in the future because companies typically invest in the short term.
 - ◇ Provide financing because short-term financial constraints limit long-term water management.
 - ◇ Fund study of water treatment at the source versus water purification later.
 - ◇ Congress should appropriate funds under Reclamation's Desalination and Water Purification Research and Development Program to fund research, pilot-projects, and demonstration projects.
 - ◇ Congress should fund an entity to investigate and analyze new inventions and ideas for water purification for the purpose of ascertaining and ultimately funding implementation of the most promising new technology.
 - ◇ How can we give financial support necessary for extensive use of desalination technology?
 - ◇ How can we give the financial support necessary to developing ultraviolet irradiation technology for primary disinfection purposes?
- ◆ Standards
 - ◇ Publication/organization of technical data.
 - ◇ Sanctioning or verifying removal/deactivation of microbes/virus.
 - ◇ Proof of and/or certifying technologies for removal for microbial removal/deactivation.
 - ◇ Develop purified water standards.
 - ◇ Define Federal role in helping to resolve conflicts in existing water laws.
 - ◇ Improved efficiency in water use and reuse.
 - ◇ Managing pollution to match purification technologies.

- ◆ Education
 - ◇ Identify critical areas and focus on conservation and public awareness.
 - ◇ Educate kids about water conservation.
 - ◇ Advocate new approaches to water quality programs.
 - ◇ Provide estimates of value of water, i.e., how much does it cost for a community not to have water for key purposes.
 - ◇ Develop education programs for water users and water managers.
 - ◇ How can we convince politicians of the necessity of pilot projects to demonstrate the value of advanced technology to stretch the water supply?
- ◆ Technical
 - ◇ Support basic research and stay out of policy.
 - ◇ Provide technical assistance.
 - ◇ Assist localities who face new requirements from Federal water quality regulations by advising and otherwise assisting them to meet new water quality goals through technology.
 - ◇ Develop new efficient technologies.
 - ◇ Develop a standardized cost models for key technologies.
 - ◇ Provide research and pilot testing assistance.
- ◆ Coalition
 - ◇ Why any Federal role?
 - ◇ Consolidate various agency interests into one national group to address U.S. water needs.
 - ◇ Find a more effective method to address authorization of funds after legislation is achieved.
 - ◇ Identify political champion—preferably an appropriator.
- ◆ Salt Loading/Concentrate Disposal
 - ◇ Develop processes to quantify/address salt loading/degradation of water supplies.
 - ◇ Develop methodology to define and quantify that irreplaceable resources are being lost and new resource opportunities are unrealized due to salt loading.
- ◆ Management
 - ◇ Facilitate cohesive watershed management.

Group 3 Responses to Part a - Nontechnical Issues:

- ◆ Policies
 - ◇ Determine policies and strategies to meet these future demands.
 - ◇ Balance agricultural, municipal, and ecological resource utilization.
 - ◇ Plan cooperations between water, wastewater, and storm water agencies.

- ✧ Plan interagency cooperation at local and state level.
- ✧ Funding of water issues and opportunities, not staffers and administration.
- ✧ Develop watershed management authorities.
- ✧ Cross watershed boundary/water transport issues.
- ✧ Address public awareness of problems (demographics critical).
- ✧ Identify institutions capable of carrying out program of public awareness.
- ✧ Develop programs or new legislation needed to finance or otherwise assist in carrying out proposal.
- ✧ Determine how the water supply infrastructure needs will be funded.
- ◆ **Public Acceptance**
 - ✧ Enhance public education/understanding of resource utilization/conservation.
 - ✧ Address psychological barriers regarding potable reuse.
 - ✧ Address public acceptance issues.
 - ✧ Create an understanding by consumers of water supply issues.
 - ✧ Address consumer acceptance of water conservation measures.
 - ✧ Address public awareness and use of different water qualities for different uses.
 - ✧ Address public acceptance of nonpotable reuse.
- ◆ **Economics**
 - ✧ Address agricultural use of water and the price of their water versus the competing needs of municipalities, industry, and the environment.
 - ✧ Determine the real cost of water (subsidies create a nonrealistic environment).
 - ✧ Incorporate the value of water to future generations in decisionmaking processes.
 - ✧ Determine costs of advanced treatment technologies.
 - ✧ Determine customers that need this source on a cost/benefit basis where economics make sense.
 - ✧ Understand water supply limitations and the cost required to develop supplies or to treat poor water quality supplies.
 - ✧ Need to integrate water, wastewater, storm water issues into unified (cost-saving) solutions.
 - ✧ Consider emergence and maturation of water marketing.
 - ✧ Identify broad funding opportunities.
- ◆ **Conservation**
 - ✧ Encourage water conservation—little is practiced outside the purification industry.

Group 3 Responses to Part b - Federal Role:

- ◆ Leadership
 - ◇ Provide impetus for establishing watershed authorities.
 - ◇ Provide coordinated research and funding of advanced water treatment technologies between agencies.
 - ◇ Research the feasibility of different qualities for different uses.
 - ◇ Prioritize issues and geographic areas of geographic need.
 - ◇ Facilitate integrated regional planning.
 - ◇ Support interagency cooperation.
 - ◇ Provide training (step “0”) to understand what is working nationally (information clearing house).
 - ◇ Promote research to lower costs of using advanced treatment technology.
 - ◇ Fund advanced treatment projects.
 - ◇ Develop policy and funding nationally (not just Reclamation’s 17 Western States—Florida needs dollars just as much as California).
 - ◇ Establish nationwide communication and action system to provide leadership.
 - ◇ Coordinate efforts to secure funding needed from all potential identified sources.
 - ◇ Provide ongoing monitoring of successes/problems of early projects (like desalting projects in Tampa Bay)—provide national newsletter.
- ◆ Funding
 - ◇ Appropriate research funding.
 - ◇ Ensure project funding reflects broader public values, environmental, intergovernmental, etc.
 - ◇ Mark dollars for research and development (cooperative funding to leverage limited dollars with private/public options).
 - ◇ Develop a national water policy.
 - ◇ Develop a national policy to effectively deal with the changing and competing water demands in the U.S.
 - ◇ Assist communities in implementing innovative, nontraditional water supply options.
 - ◇ Identify planning models that can be used cost effectively.
- ◆ Communication
 - ◇ Facilitate institutional cooperation.
 - ◇ Fund university study programs at graduate level in desalting and other alternative supply development, as well as study grants.
 - ◇ Establish model funding agreements and contracts reflecting best practices for public/public and public/private capital and operation and maintenance.
 - ◇ Sponsor national/regional meetings (like this one) to use as incubators for new ideas.

- ✧ Develop and understanding of regions and watershed issues.
- ✧ Create an internet site for ongoing dialog.
- ✧ Limiting the use of RO purification technology in the existing 17 Western States covered by Reclamation's existing enabling laws is not sufficient. With Florida and other non-included states needing a coordinated national approach, we suggest that Reclamation's charter of responsibilities be expanded along with more adequate nationwide funding.
- ✧ The Tampa project is a funding model for private/public partnerships in the public interest. The 25 percent of world pricing costs shows the dramatic possibilities. A second seawater desalination plant in Tampa is now under consideration, along with several other potential future sites. Israel, using the same approach, recently announced a 37-million gallons per day plant at \$2.66 per 1,000 gallons.

Group 4 Responses to Part a - Nontechnical Issues:

- ◆ **Planning/Resource Management**
 - ✧ Sitting back and waiting for crisis—no long-term picture.
 - ✧ Need leadership for an integrated national plan.
 - ✧ Improve water supply planning at state/Federal levels.
 - ✧ Develop improved linkages between Safe Drinking Water Act and Clean Water Act (e.g., improved source water control for drinking water supplies through Clean Water Act regulation of drinking water [parameters of concern are cryptosporidium and giardia]).
 - ✧ Encourage regulatory agency acceptance of membrane technologies.
 - ✧ Encourage partnering—need to form regional coalitions to take advantage of economics of scale.
 - ✧ Transfer water supply from basins with ample supply to basins with limited supply.
 - ✧ Determine whose water it is?—where does water come from?
- ◆ **Public Education/Involvement**
 - ✧ Need to increase public acceptance of recycling and reuse.
 - ✧ Need public education of the financial feasibility of desalination and other membrane technologies.
 - ✧ Reduced water usage by air towers.
- ◆ **Funding Sources/Costs**
 - ✧ Need to lower costs of recycling projects.
 - ✧ Determine where water comes from.
 - ✧ Determine who pays.
 - ✧ Determine what portion of the country is involves/affected.

- ✧ Determine where funding will come from.
- ✧ Determine what level of funding from states, Federal, etc.
- ✧ Require new growth to pay for its share of the new water supply and storage.
- ✧ Provide guidance on benefit/cost assessment of water supply development.

Group 4 Responses to Part b - Federal Role:

- ◆ Leadership and Guidance
- ◆ Financial and Nonfinancial Incentives to Invoke Action
- ◆ Incentives/Education
 - ✧ Encourage private development of regional desalination plants, designed to augment local supplies in Florida, Texas, California, Nevada, and Arizona.
 - ✧ Provide incentives to encourage private capital to invest in water supply/treatment/infrastructure (funding).
 - ✧ Remove barriers to interstate transportation of water, i.e., allow “water rights” transfer between states (e.g., Arizona and California/Nevada [stewardship]).
 - ✧ Develop a nationwide program where funding can be provided to help areas in most need (funding).
 - ✧ Encourage conservation.
- ◆ Construction Funding
 - ✧ Continue to provide funding for construction of recycling projects.
 - ✧ Provide financial support to those developing alternative water supplies.
 - ✧ Encourage increased state/Federal participation in water supply development.
- ◆ Research and Development Funding
 - ✧ Promote alternative water supply development through research and development, construction grant programs, and other incentives.
 - ✧ Conduct/fund research on wastewater treatment technologies.
- ◆ Planning
 - ✧ Take lead in establishing regional partnerships to formulate potential solutions.
 - ✧ Establish the interconnection network to transfer water from one shed to another.
 - ✧ Conduct planning studies on water transfers/change of use.
 - ✧ Assist states/local agencies with integrated water resource planning.
 - ✧ Inventory potential water supplies to apply new technologies.
- ◆ Establishing Regulations/Coordination
 - ✧ Stay with policy issues only (i.e., agricultural versus municipal and industrial water supply)—conservation should be a mandate.
 - ✧ Better coordinate regulatory oversight—develop unified or standard for regulatory acceptance.

- ✧ Integrate implementation of Safe Drinking Water Act and Clean Water Act.

BREAKOUT SESSION II

Session II Question: *What are the challenges/hurdles to growing the U.S. water supply through purification technology?*

Group 1 Responses:

- ◆ Public Acceptance
 - ✧ Address public perception and acceptance of potable reuse.
 - ✧ Address public acceptance in terms of the health effects.
 - ✧ Address public acceptance in terms of public health.
 - ✧ Address public perception of the “safety” of purified water.
 - ✧ Address public acceptance in terms of cost, water quality, taste perceptions, environmental considerations, and institutional barriers.
- ◆ Economics
 - ✧ Develop long-term valuation of next increment of supply (net present value).
 - ✧ Determine cost of purified versus new sources or transfer.
- ◆ Disposal
 - ✧ Develop brine disposal policy.
- ◆ Research and Develop and Transfer
 - ✧ Increase limited Federal support for technology development so areas/regions (such as Tampa) have a tool box of technology to make it work.
- ◆ Cost
 - ✧ Develop cheaper alternatives—high rate of filtration with ozone still beats out microfiltration, ultrafiltration, or nanofiltration at Seattle (Tolt) project and Tampa (surface design, build, and operate).
 - ✧ Determine cost competitiveness.
- ◆ Risk
 - ✧ Address investor comfort with technology.
 - ✧ Address the barrier of architects/engineers bias against advanced membrane technologies and perception that conventional filtration is less risk for municipality.

Appendix D Breakout Sessions Summaries

- ◆ Regulatory
 - ◇ Address regulatory institutional barriers—municipalities are not complying with current regulations or anticipating future regulations.
 - ◇ Determine land use for seawater desalination plants (industrial facilities on the coast).
- ◆ Infrastructure
 - ◇ Address storage capacity—where do you put the added supply?
 - ◇ Address infrastructure age—distribution systems and storage.
- ◆ Source Water Protection
 - ◇ Develop source water protection regulations for seawater.
- ◆ Reliability
 - ◇ Address availability to satisfy demand.

Group 2 Responses:

- ◆ Cost
 - ◇ Develop cost-benefit scenario for the purification technologies.
 - ◇ Work for cost reduction.
 - ◇ Reduce cost of desalination technologies.
 - ◇ Address cost issues.
 - ◇ Address project costs and impacts on water rates.
 - ◇ Address cost of installation and financing.
 - ◇ Address risk in escalating energy costs.
 - ◇ Lower energy costs.
- ◆ Education/Public Acceptance
 - ◇ Educate public of the real value of water.
 - ◇ Address the regional, or perceived regional, nature of the need.
 - ◇ Change the mentality of the public, agencies, and legislative representatives to establish purification as a major water management tool.
 - ◇ Address public acceptance.
 - ◇ Encourage public acceptance.
 - ◇ Public and regulatory agency acceptance lags current technologies.
- ◆ Technology
 - ◇ Demonstrate that purification is the best way to grow supply (e.g., compared to demand reduction).
 - ◇ Lower energy, lower complexity technologies.
 - ◇ Develop decision processes to guide technology and project implementation.
 - ◇ Address perceptions of what technology can accomplish/do.

- ✧ Document removal efficiencies for different types of water/contaminants.
- ✧ Develop methods to remove contaminants, such as pharmaceuticals from wastewater.
- ◆ Regulatory
 - ✧ Resistance by regulatory agencies.
 - ✧ Examine risk in controlling regulations becoming more stringent.
 - ✧ Concerns about risk aversion, especially by public agencies.
 - ✧ Agency stagnation.
- ◆ Funding
 - ✧ Provide funding for research and development advances.
 - ✧ Address cost of technology development.
 - ✧ Obtain funds for researching and implementing ultraviolet irradiation technology as an alternative to current primary disinfection regimens.

Group 3 Responses:

- ◆ Risk versus Funding
 - ✧ Provide funding for technological change—reduce risk to user.
 - ✧ Develop willingness among consultants and public agencies to take risk associated with technologies perceived as “new.”
 - ✧ Address public agency aversion to implementing new methods/technologies.
 - ✧ Explain to local utilities “what is in it for them” to switch to alternatives that may cost more when no crisis exists.
 - ✧ Address fear of change by technical managers at all levels who know and have funding for existing technologies.
 - ✧ Develop a good understanding of what innovations are needed to most improve the final cost.
- ◆ Funding (Allocation)
 - ✧ Address the hurdle of costs, funding, etc. (\$).
 - ✧ Eliminate limitations of funding for research and development.
 - ✧ Address problem of aging distribution systems in delivering high quality water (\$1,000,000,000 problem).
- ◆ Regulatory Policy
 - ✧ Overcome perceptions/regulatory issues regarding concentrate disposal.
 - ✧ Modify regulatory approach to use to promote development of sustainable alternative supplies (carrot versus stick approach).
 - ✧ Address how to get EPA to support new innovative technologies.
 - ✧ Accept challenge to not just look at water supply for opportunity—integrate water, wastewater, and storm water into opportunities.

Appendix D Breakout Sessions Summaries

- ✧ Form/establish political coalition to support the appropriate use of the technology.
- ✧ Empower watershed authorities with regards to raising revenues, allocating resources, managing point and non-point contaminants, etc.
- ◆ Value of Water (Perception)
 - ✧ Address affect public officials have on driving cost of water to be low.
 - ✧ Resolve competing agendas between water supply and regulatory agencies.
 - ✧ Address perceptions about costs.
 - ✧ Communicate/address the need to spend money on water issues when there are higher profile needs in the perceptions of consumers.
- ◆ Demonstration
 - ✧ Address the need to demonstrate the process reliability (and impending process failure).
 - ✧ Determine how to move advanced technology into the mainstream.
 - ✧ Demonstrate the technology to show results and costs.
 - ✧ Devout all levels of government spending to research and development on a cooperative basis to help fund prototypes.
- ◆ Education
 - ✧ Provide the new technology ideas early to professors and teachers to help new engineering students (new rather than old students, early rather than late in curriculum).
 - ✧ Educate the engineering community to accept and apply new technology.
 - ✧ No public education process in (national) popular press to show successes and stimulate public's imagination.
- ◆ Communication
 - ✧ Address institutional myopia (water does water, wastewater does wastewater, storm water does storm water—all can solve problems cheaper together).
 - ✧ Address lack of information of what is possible at local, state, and Nation levels—there is no clearinghouse on an ongoing basis.
 - ✧ Correctly define the issue/opportunity to effect the support/funding/solutions.
 - ✧ Communicate the need for alternative sources.
- ◆ Crisis Forces
 - ✧ Need more crisis situations where desalination helps so local folks can see desalination as a possibility or as part of the solution.

Group 4 Responses:

- ◆ Ensuring Safety
 - ◇ Ensure safety to the tap through reliable technology.
 - ◇ Ensure safe drinking water.
 - ◇ Keep up with the treatment technology, for all existing and new water supplies, required to meet all current and future maximum contaminant levels as regulated by EPA.
- ◆ Public Education/Awareness
 - ◇ Provide for public awareness of alternatives.
 - ◇ Provide for public education to build confidence that water is safe.
 - ◇ Ensure education/awareness to help sustain economic development.
 - ◇ Educate on the need, benefits provided to the environment.
 - ◇ Encourage public acceptance of reuse.
 - ◇ Educate public about recycling and reuse.
 - ◇ Communicate need for increased supply through purification technology—has not been clearly established and articulated to the public.
 - ◇ Convince public that reuse through purification is reasonable/beneficial and they should pay their share.
- ◆ Cost of Implementing/Operating
 - ◇ Keep cost affordable.
 - ◇ Address public perception with respect to cost.
 - ◇ Regulate the hurdle of increasing costs.
- ◆ Economics
 - ◇ Prepare economic analysis of benefits provided.
 - ◇ Increase the supply while lowering the need to treat wastes.
 - ◇ Quantify increased benefits to the environment by implementing purification technologies.
 - ◇ Accrue benefits to the supply and wastewater sides and distribute costs accordingly.
 - ◇ Work to quantify public and health benefits (difficult to achieve).
- ◆ Planning/Management
 - ◇ Encourage individual home treatment systems.
 - ◇ Consider separate delivery systems.
 - ◇ Provide proper planning to ensure implementation is done in the most effective manner.
 - ◇ Recognize hurdle: treat to the n^{th} degree only that water which is used for potable purposes (e.g., cooking and drinking).

BREAKOUT SESSION III

Session III Question: *What could be done now to meet the future needs of water users and water managers?*

Group 1 Responses:

- ◆ Coalitions
 - ◇ Help facilitate a nationwide water resources policy that includes purification technologies as a main component.
 - ◇ Build coalitions among the stakeholders.
 - ◇ Build bridges—other regions, other agencies, etc.
 - ◇ Build an educated constituency.
 - ◇ Formalize coalition and use non-Reclamation entities to lobby.
- ◆ Information
 - ◇ Develop timely information packaging and delivery.
 - ◇ Develop “how to” primers for water managers who want to engage.
- ◆ Budget Planning
 - ◇ Prepare for Safe Drinking Water, Endangered Species, and Simon Act reauthorizations.
- ◆ Lessons Learned
 - ◇ Develop case studies of issues/problems and solutions of ongoing desalting projects as they are completed and placed into operation.
 - ◇ Complete additional research on financing options available for various types of projects.
- ◆ Funding
 - ◇ Legislate adequate funding.
 - ◇ Target appropriations.
- ◆ Advocacy
 - ◇ Communicate successes.

Group 2 Responses:

- ◆ Constituency
 - ◇ Organize political constituency.
 - ◇ Develop coalition of support.
 - ◇ Develop long-term national vision through a stakeholder driven process.

- ◆ Technology Transfer
 - ◇ Facilitate industrial information extraction (technology transfer).
 - ◇ Facilitate more compendia and technology capabilities and cost from “public literature.”
- ◆ Education
 - ◇ Expand awareness that supply quantity is a function of supply quality.
 - ◇ Develop guidelines for use of technology to solve water problems.

Group 3 Responses:

- ◆ Leadership
 - ◇ Build coalitions to increase funding and Federal support.
 - ◇ Facilitate regional coalitions to pursue funding/regulatory relief.
 - ◇ Provide congressional field trips to successful desalination sites to create possibilities (target states with problems).
- ◆ Public Education
 - ◇ Demonstrate what can be achieved by current technologies to public/elected officials.
 - ◇ Provide funding for public and in school education—contests for kids, etc. on the subject of “why desalination now.”
 - ◇ Create public education materials with broad multi-agency, diverse interests backing.
 - ◇ Provide sample educational advertisements and materials distributed to local providers to use with their public information programs.
- ◆ Planning (Strategic and Tactical)
 - ◇ Fund/support long-range water source planning studies.
 - ◇ Provide funding for interstate planning.
 - ◇ Develop permanent national and regional committees of Federal/state regulators, educators, and regional/local utilities to share possibilities on a permanent basis.
- ◆ Funding
 - ◇ Send letters to public officials to educate them to get increased funding.
 - ◇ Accelerate action on funding of demonstration projects.
- ◆ Technical Education
 - ◇ Develop and hold workshops on new technologies for water entity users, consulting engineers, engineering students and their professors, etc.
 - ◇ Provide funding for training of local utilities, providers, universities, etc., to understand possibilities of desalination.
 - ◇ Provide a clearinghouse of up-to-date information on the technology and relevant information.

- ✧ Provide funding for internet site to serve as clearinghouse—advertise through all affected associations newsletters, web sites, etc.
- ◆ Legislation (Rules/Regulations)
 - ✧ Define and begin documenting legislation (rules/regulations) to pave the way for the adaptation of new technology.
 - ✧ Facilitate cooperation between water, wastewater, and storm water (and environmentalists and regulators) to look for water supply opportunities that include solutions for regulatory problems each agency faces.
 - ✧ Stop whining about regulations and use them to leverage beneficial solutions for those who must pay.
- ◆ Innovation
 - ✧ Solicit proposals for new technology—push for innovation.
 - ✧ Fund long-term research that would not otherwise be done by private industry.
- ◆ Other
 - ✧ Reword the question to get appropriate responses—What could be done now to meet the *current and* future needs of water users and water managers?

Group 4 Responses:

- ◆ Planning
 - ✧ Provide for long-range planning at a national level through Federal leadership/support.
 - ✧ Develop regional/local/state plans and partnerships.
- ◆ Policy
 - ✧ Develop and push a plan on Congress' agenda and state agendas.
- ◆ Education
 - ✧ Publicize upcoming crisis.
 - ✧ Tell people and inform public what would happen without water.