Edmund G. "Ed" Archuleta has been manager of the El Paso Water Utilities Public Service Board since January 1989. He is responsible for all aspects of water, wastewater, reclaimed water service, and storm water to the greater El Paso metropolitan area. He reports to and implements strategic policies set by the five-member Public Service Board. A registered Professional Engineer in Texas, New Mexico, and Iowa, Ed earned B.S. and M.S. degrees in civil engineering from New Mexico State University and a Master of Management degree from the University of New Mexico. He is an American Academy of Environmental Engineers Diplomat. He was appointed in June 2006 by President George W. Bush to the National Infrastructure Advisory Council. Ed is currently involved with several technical and professional organizations, including the American Water Works Association, the Water Environment Federation, Water for People, WateReuse Foundation, the National and Texas Societies of Professional Engineers, the Texas Water Conservation Association, New Mexico/Texas Water Commission, Far West Texas Planning Group, and Regional Economic Development Corporation. He is a past Chairman of the American Water Works Association Research Foundation, and current Trustee of the Association of Metropolitan Water Agencies, Water for People, and the WateReuse Foundation. He serves as chairman of the Multi-State Salinity Coalition.

El Paso's Experience in Surface Water Treatment – Lessons Learned

Ed Archuleta
El Paso Water Utilities
P.O. Box 511
El Paso, TX 79961-0001

Good morning. I appreciate the opportunity to be here. Before I talk about using surface water in El Paso, which we've been doing for a long time, I want to talk about the watershed and where the water supply comes from – the Rio Grande Project from Elephant Butte to Fort Quitman. In 1989 when I moved to El Paso, one of the things I recognized very early was that we did not have a long-term water plan for El Paso. We were relying primarily on groundwater, mostly from the Hueco Basin on the eastern side of the Franklin Mountains and to some extent the Mesilla Basin on the west side. We used some surface water from the Canal Water Treatment Plant located in Central El Paso. For our long-term plan, El Paso Water Utilities needed to diversify our portfolio significantly. One of the lessons learned as a city utility is to be diversified to deal with emergencies like climate change or drought. In order to deal with these issues, we diversified significantly and have been implementing programs concerning these types of issues over the past 19 years.

Our priorities for additional water supplies started with conservation. As most of you know, El Paso has a very aggressive water conservation program. In 1991, El Paso used 201 gallons per person per day. Last year consumption was reduced to 134 gallons per person per day, and this year it is estimated that consumption will be reduced even further. Conservation has been very important, but it was also very difficult to explain to customers in 1991 why they needed to comply with

an outside watering schedule. But we have been very successful. Our peak demand has fallen from about 195 million gallons per day in 1990 to about 155 or so on a hot summer day in El Paso. That is because of our conservation program, as well as with our next priority, which is reclaimed water.

We have significantly expanded our reclaimed water program. We want to thank the Bureau of Reclamation's (BOR) Eluid Martinez who has helped us, as well as others within the BOR, including Mike Gabaldon and members of his staff, and former Commissioner Keys. We developed a master plan for reclaimed water, and now all four of our wastewater treatment plants reclaim water. Our Fred Hervey Wastewater Treatment Plant treats water to drinking water standards, while the others are advanced secondary plants that treat water to a standard used primarily for industrial use and for turf at school grounds, parks, cemeteries, golf courses, and some apartments. Reclaimed water use has grown from about 200 million gallons per year to about 2 billion gallons per year with infrastructure of about 40 miles of pipeline, holding tanks, ground storage tanks, and pump stations. Reclaimed water has become a big part of our portfolio.

Surface water is my main discussion and I want to talk about the Mesilla Basin. The Mesilla Bolson has been stable for many years and serves our customers in the Upper Valley and West El Paso. The Hueco Bolson is the basin that is being depleted as years go by. When it was reported that El Paso was running out of water, it was the Hueco Bolson that was losing 8,000 acre-feet of water due to the growth in East El Paso. We were taking about 20,000 acre-feet out of the Hueco, but as part of our plan, have weaned ourselves from the Hueco. The groundwater table was dropping 2 to 4 feet a year, and now has actually risen and is stable. It is our intent to keep it stable and use the renewable sources that we have available to minimize the amount of groundwater use, particularly from the Hueco Bolson.

Desalination is another priority and our new Kay Bailey Hutchison Desalination Plant has been running very well. We have ramped up its production all the way to its designed capacity of 27.5 million gallons per day. We have a plentiful surface water supply which is our intent to use first, then reclaimed water for non-potable uses, and to augment surface water with groundwater. As a result, we have only been using one skid out of five at the desalination plant, so approximately 4 million gallons of desalinated water per day is actually being processed currently from the plant. The plant was built to meet future needs with the Fort Bliss expansion and is predicted to triple in size. Many military families will be relocating to El Paso, so we expect significant population growth in that part of El Paso to be serviced by the desalination plant.

In 1943, El Paso built its first surface water treatment plant, the Robertson Plant, and in 1967, the Umbenhauer Plant was built right next to the Robertson Plant. This second plant doubled the size of the capacity to 40 million gallons per day. Back in 1989, we had only one water plant in Downtown El Paso and our other plants could no longer expand. As part of our long-term plan, we decided to work with the El Paso County Water Improvement District #1 (EPCWID #1) to try to buy more property and lease more water rights in order to build a second water treatment plant. We have had a very cooperative relationship with EPCWID #1, and in fact, the long-term plan I talked about was developed in cooperation with the Irrigation District. I want to thank the Irrigation District and their General Manager Chuy Reyes, who is also a speaker at this conference, along with Filiberto Cortez from the Bureau of Reclamation, and Gary Esslinger, manager of the Elephant Butte Irrigation District. They played a significant part in the Lower Rio Grande Project Operating Agreement Settlement that has been reached.

We wanted to double the surface water treatment capacity from 40 to 80 million gallons per day by building the Jonathan W. Rogers Water Treatment Plant in 1993, and then we expanded that plant in 2002 and added another 20 million gallons per day. Between the two plants, we now have 100 million gallons per day, with a demand similar to that of Albuquerque. We have about 100 million gallons per day or about 100,000 acre-ft per year, and we have had this capacity for almost 20 years. The amount has not changed much because of our water conservation efforts that allow us to use about the same amount of water annually as we did 20 years ago, despite the fact that we have grown by about 180,000 people. That is the proof in the pudding that water conservation does work. We also feel we have avoided about $300 million in capital costs because of what we have done. Otherwise, our per capita consumption would have stayed the same or even increased. Those are the basic reasons why we are at where we are today - because we diversified and implemented a program.

Most of the surface water that is available to us is only available between March and October. I think most of you know that Elephant Butte and Caballo are Bureau of Reclamation (BOR) dams, so they are operated, maintained, and regulated by the BOR. Our supply

depends on how much water is in the Rio Grande in a given year, and the BOR works with the irrigation districts to allocate flows for the irrigation year. The BOR is about to close the gates for this season, and after that return flows are received. At that time, we shut down our two major water plants and convert entirely to groundwater. Some customers transition from groundwater to surface water daily, but have not had any significant issues with these customers. Depending on the location of the customer, some customers remain on groundwater year round, but a good part of our customer base switches from surface to groundwater. The surface water quality does deteriorate significantly, and from the headwaters to El Paso, the salt content is a significant concern. Our agencies in El Paso are working with others in New Mexico to begin to better quantify and identify salt loadings and salt contents. We deal with salinity, total dissolved salts (TDS), and sulfate, particularly in late releases, and, of course, from time to time depending on thunderstorms, we do have taste and odor changes.

As mentioned, the operational issues include the seasonal surface water instability as we transition customers from source to source, and in blending different water types in the distribution system, which calls for careful planning and attention to detail. Over the years, we have learned how to operate the system in order to provide the best water quality possible for our customers. Besides salts, TDS, and sulfates, we also now have to be concerned about disinfection byproducts, total organic carbon (TOC), and bromide, which all must adhere to EPA and state standards.

With regard to salts in the El Paso area, we receive a significant amount of salt, TDS loading, and sulfates (Figure 1). We have our own wastewater treatment plants in the region and have upstream wastewater treatment plants, but because of the discharge, we have poorer water quality in our area.

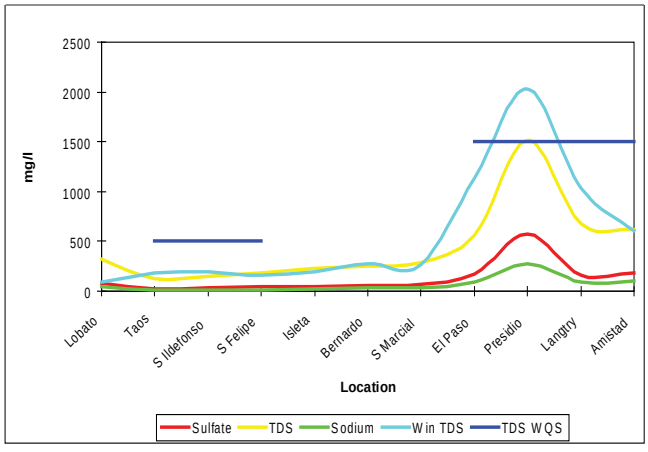

Figure 1. Rio Grande Quality

The TDS from drain inflows and water treatment plant effluents by miles from Elephant Butte is depicted in Figure 2. The first red bar represents the Las Cruces wastewater treatment plant followed by our plants; there are also various drains that come into play. This information was taken from a study that the Coalition is going to be working on in order to better quantify locations, amounts, and what can be done in the future. Comparing data, total organic carbon (TOC) in Albuquerque is about 3 while in El Paso, the TOC is 8; bromide is .02 in Albuquerque and is about .20 in El Paso. These substances are precursors to disinfection byproducts. A portion of the TOC becomes trihalomethanes (THMs) upon disinfection. A portion of the bromide becomes bromate as we go through ozonation.

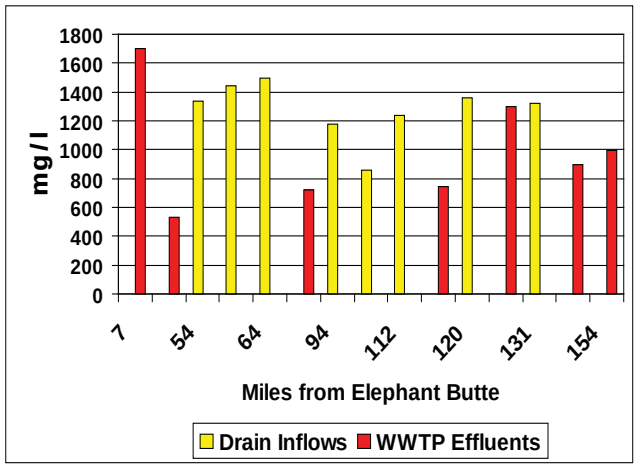

Figure 2. Inflow Streams TDS

So what's the good news? My staff provided me with Figure 3, and I thought it was interesting enough to share. We have a lot of fish despite all of our issues, and in looking at the fish species, you'll see that we don't have the silvery minnow. I remember Rumsfeld saying you don't go to war with the army you wish you had, you go to war with the one you have. And that's what we are dealing with – what we have. We have water quality that is not necessarily pristine, but it is the water we have, and we have been able to work with it for a long time.

There was a question this morning about water delivery costs, as opposed to the cost of treated surface water. Groundwater costs us about 50 cents per 1,000 gallons to process while surface water costs about $1.00 per 1,000 gallons. Desalination costs about $1.65 per 1,000 gallons, and reclaimed water is over $2.00 per 1,000 gallons. We expect reclaimed water costs to come down once we finish building our distribution system and add more customers. We subsidize the cost in delivering reclaimed water and price it lower in order to

get people to use it. The overall cost to us is probably in the range of $2.20 per 1,000 gallons.

Fish Common Name	Rio Grande near Del Norte, CO	Rio Grande at El Paso, TX
Gizzard Shad		X
Red Shiner		X
Common Carp		X
Fathead Minnow	X	X
Bullhead Minnow		X
Longnose Dace	X	
River Carpsucker		X
White Sucker	X	
Rainbow Trout	X	
Brown Trout	X	
Channel Catfish		X
Flathead Catfish		X
Brook Stickleback	X	
White Bass		X
Bluegill		X
Longear Sunfish		X
Sunfish		X
Largemouth Bass		X
TOTALS	**6**	**13**

Figure 3. Fish Collected

The cost of treated surface water has increased very sharply (Figure 4). We have different contracts with the BOR including one negotiated in 2001 that is scheduled to be re-negotiated in 2011. There is an annual increase in that cost, which is pretty significant and is driving the increase in water purchase costs. When talking about treating surface water, you have to be wary of the escalating costs of chemicals. We have had double or triple digit increases in chemical costs, as well as high power costs. El Paso Electric has partial ownership in the Palo Verde Nuclear Plant and some ownership in the Four Corners Power Plant. Most of their energy is natural gas driven, so as fuel adjustments in price occur, the cost of treatment goes up.

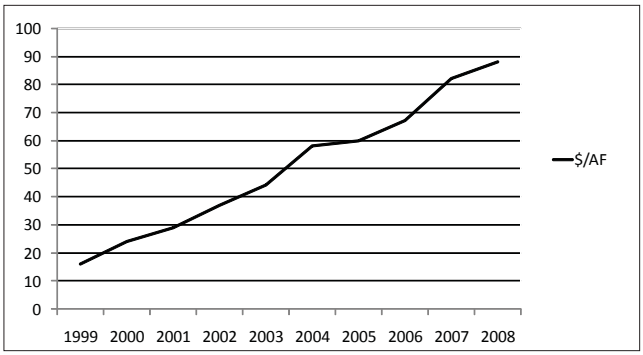

Figure 4. Cost of Treated Surface Water (O&M cost only)

The Jonathan W. Rogers Water Treatment Plant is our newest plant, and our water quality goals include less than .15 NTU, pathogens 2-Log *giardia* inactivation and 1-Log *cryptosporidium* inactivation; no detectable taste and odor; low corrosivity for lead and copper; and the free chlorine distribution system disinfectant. We detect from time to time spores of *cryptosporidium* in the source water, but of course, not in the finished water because we remove it. I believe that part of the problem comes from upstream dairies in New Mexico between El Paso and Las Cruces. I also believe that better source water protection would help a great deal. EPA, EBID, and TCEQ are trying to do a better job of source water protection.

We have highly variable turbid water, particularly during the summer months, going down to .15 NTU from 90 NTU. The dissolved organic carbon or disinfection byproduct precursor removal ranges from 8 to 1.5 mg/L. We also remove and inactivate pathogens. We must deal with taste and odor issues and, of course, stabilize the finished water.

We use a process very similar to what Albuquerque uses starting with presettling, then pre-ozonation, rapid mix, flocculation, coagulation, sedimentation, more ozonation, and then finally, the biological granular activated carbon (GAC) filtration with activated carbon and chlorination. We did extensive pilot plant testing because our source water has a fair amount of wastewater treatment plant effluents, which in El Paso, comes through the American Canal.

Figure 5 shows some of our ponds. We have 45 acres of presettling ponds that provide 146 million gallons of raw water storage and remove 75% of the raw water turbidity. In the last couple years, with all the rain and flooding El Paso has received, we have taken out tons of material from these ponds. The good news is between the months of October and March, preventive maintenance is being done including removal of silt from ponds. On the one hand, it would be nice to have year-round flow and year-round operation, but on the other hand, we do a lot of maintenance to make sure that during the seven or eight months of production, we don't have disruptions or loss of service due to mechanical or electrical failures.

Figure 5. Presettling: 45 acres of presettleing ponds provide 146 million gallons of raw water storage and remove 75% of the raw water turbidity.

Pre-ozonation works very well for us. It provides microflocculation benefits that reduce coagulant usage, precipitates soluble iron and manganese, and aids in taste and odor removal. Chlorine dioxide is added to minimize bromate.

Figure 6 is part of the pilot plant work. The rapid mix, flocculation, and settling again, work very well. Ferric chloride coagulation destabilizes turbidity and disinfection byproduct precursors, providing 95% turbidity removal and up to 50% disinfection byproduct precursor removal.

Figure 6. Rapid Mix Flocculation, Settling: Ferric chloride coagulation destabilizes turbidity and disinfection byproduct precursors, providing 95% turbidity removal and up to 50% disinfection byproduct precursor removal.

Post-ozonation is the process ahead of the filters and, of course, the filtration. It provides primary disinfection for pathogen inactivation, taste and odor removal, and conditions water for enhanced biological removal of disinfection byproduct precursors across the GAC filters.

GAC filtration provides the final barrier to turbidity, taste and odor removal, an additional 25% biological removal of disinfection byproduct precursors, nitrification of trace ammonia, ozone byproducts removal, and synthetic organic chemicals removal. Carbon also is very expensive. We have eight filter galleries at a particular plant; we rotate on a three to four year cycle. At first our operation was more conservative and we rotated every other year. Carbon is very expensive in today's market, but is the heart of water treatment. Ozonation obviously also plays a big role in water treatment. At one plant rather than chlorine, we use chlorine and oxide and it does fine with disinfection and control. The challenge is to meet the new disinfection byproduct standard. Hopefully at some point when we will get rules from the EPA, we'll also receive funding to meet their standards. In Albuquerque, John Stomp talked about moving water from the east side to the west side, which is a very expensive process. We have spent $76 million in capital expenses and $4 million in operation and maintenance on our arsenic removal effort, even though we had no real evidence that we had an arsenic problem. As you know, no epidemiological study has shown that we needed to go to that extreme. Some have argued that our arsenic levels are at 20 parts per billion, not 50. At 20 ppb, we would probably not have spent any money; at 10 ppb, we spent $76 million.

As a utility manager, it's hard to explain to the public, to the ratepayers, why their water bill just keeps going up. I'm not against safe drinking water, but I've been in business for a long enough time that I know people aren't dying because of drinking tap water. We have some of the safest, if not the safest, water in the country. And even today, everybody's drinking tap water, right? You're not drinking bottled water. You go to a restaurant and ask for iced tea. You don't ask for bottled water iced tea. You get tap water iced tea. It's a huge marketing effort to get everybody to consume bottled water. But if we are going to treat our tap water, we must recognize the value of water and convince our customers of its value.

Now let's talk about disinfection byproducts and why we have to meet the strictest standards. Just like in Texas, we have to meet every standard. In my case, I live on the west side of El Paso, but I drink water on the east side where I work. And I'm here and I'm there, in Albuquerque today and yesterday I was in Chicago. What's my exposure? While in Chicago, I was at a meeting where during the opening session, a professor, who is a member of the Stockholm Project, talked about the "water footprint." Now we are talking about virtual water, embedded water. When I arrived in El Paso years ago, we had garment industries that used a lot of water. I wondered, why did they bring garment finishers to El Paso to take groundwater to wash jeans? It was based on jobs though, in fact, based on low-paying jobs. A lot of people, including me, were glad when those jobs went to Asia because now they are using the water over there. So that's the embedded water. Whether you are in agriculture or manufacturing, whether you are importing or exporting, whether you are growing pecans or lettuce, there is a net exchange. I think states are becoming more cognizant of their water footprint and the value they get for a particular commodity. It was an intriguing discussion and don't be surprised if, before too long, somebody asks you what your water footprint is. How much water a year are you as a community, you as an individual, you as a company, you as a farmer, you as an irrigator ... how much water are you using and is that water being used for the benefit of the area or is it just being exported?

We face a challenge with the Stage 2 DBP Rule. Our historical average treatment process removal of TOC ranges from 30-40%, which is not enough of itself to guarantee compliance with the rule. We are working on this and have done a lot of pilot plant and modeling work throughout the system. We may have to go to some type of air stripping, and a distribution system might be the most economical way to do it. My staff is working on this, along with CH2M Hill consultants. We have done a lot of bench-scale testing, as well as small testing in columns. It's a very complex process to make sure to meet the standards without causing harm to some other part of the process.

In summary, El Paso is glad to have a surface water treatment program. Whether we have a full supply or less than full supply, we are in good shape. We are going to use surface water first, and if we find ourselves in a drought in the future, will implement a new agreement between the districts and the BOR. We will then turn to desalination and groundwater. As our population continues to grow, we will expand to additional surface water use. For now, we are in very good shape, and I would say our biggest success has been that we diversified our portfolio.