__John E. Balliew__ is the Water Systems Division Manager for El Paso Water Utilities. He has worked for EPWU for 21 years in a variety of positions including Plant Engineer, Planning and Development Manager, and Environmental Compliance Manager before obtaining his present position. John is a graduate of Texas A&M University with a degree in chemical engineering. He has authored or coauthored many papers related to water reuse, arsenic, membrane treatment, surface, and groundwater treatment.

EL PASO'S WELL-HEAD DESALTING PROGRAM

John E. Balliew
El Paso Water Utilities
P.O. Box 511
El Paso, TX 79961-0001

As you may know, El Paso gets a substantial amount of its water, about fifty percent, from the Rio Grande. We are subject to the same drought conditions that the rest of New Mexico faces in terms of water supply. In order to do something about the situation, we needed to obtain additional water. At the same time, we have an arsenic issue with which to deal. Like many cities in New Mexico, we are faced with a new arsenic standard. I am sure many of you are familiar with this issue. Of the 152 groundwater wells we had at the time the new standard was imposed, our average arsenic concentration was about 12 parts per billion (ppb) in a range of up to about 30 ppb. The problem is that even though the average is 12 ppb, there are some areas of the city that are served by particular wellfields that might have levels as high as 16 ppb. Arsenic is a concern for us.

Figure 1 shows the concentration of arsenic with dots representing the wells in El Paso. In the northwest portion, we have a wellfield that is substantially impacted by arsenic. On the east side, the arsenic issue is more scattered. There are some wells that have arsenic and some wells that do not though some are adjacent to each other and coming out of the same aquifer. We have a wellfield in the Lower Valley area but most of the wells have not been used in about twenty years due to brackish water intrusion. Of the Lower Valley fresh-water wells that are in use, three wells have an arsenic problem and were selected for treatment for arsenic removal. The rest of the wells require some sort of treatment for salt content. Twenty-six wells are located in that wellfield and the TDS ranges from freshwater, 524 ppm (parts per million) – that is as good as we get – to 1,974 ppm. The arsenic in those wells ranges from 6.5 to 19.5 ppb, while the total capacity of those wells is 38 million gallons per day (mgd). From the time these wells were drilled, which was as late as the 1960s to the 1980s, we have lost 38 mgd primarily due to the intrusion of brackish water.

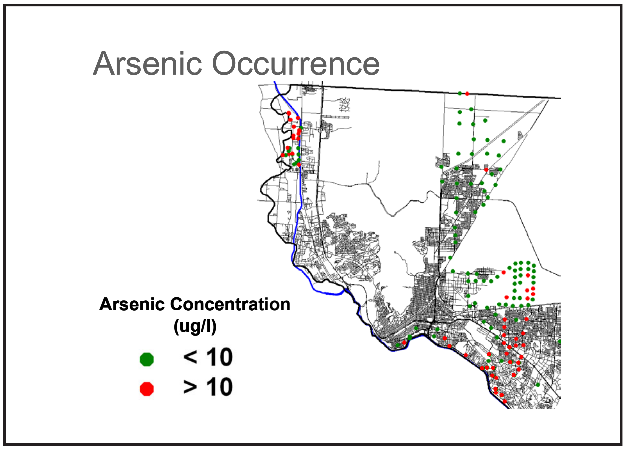

Figure 1.

Figure 2 depicts most of the wells in the Lower Valley and is color coded. Two wells in service meet the standards for both arsenic and total dissolved solids (TDS) and are shown with black diamonds. The light blue diamonds indicate the two wells that do not meet the TDS standard but do meet the arsenic standard. Fifteen wells do not meet either standard, and seven meet the TDS standard but not the new arsenic standard.

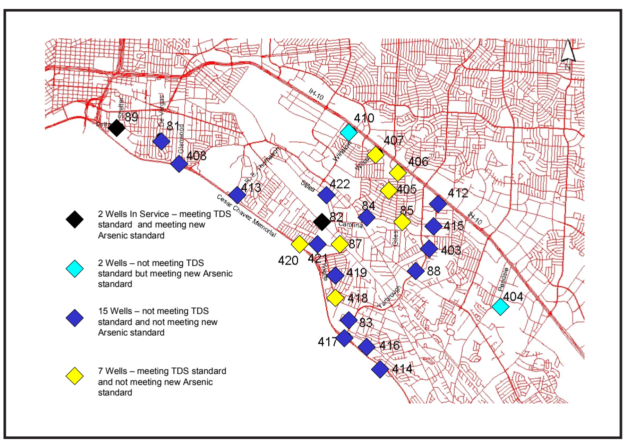

Figure 2.

While dealing with the arsenic issue, we have gained knowledge from our desalination pilot plant, the work that UTEP has been doing on concentrate management issues, and on technological advancements in membranes. We now feel it is practical to deal with both arsenic and TDS at the same time, allowing us not only to address the arsenic problem in the Lower Valley, but also to augment our water supply. We conducted a supply versus demand analysis to see how much water we would need to treat our supply and augment supplies during a drought. We focused on the critical months of May, June, and September. May is a critical month because during the course of a drought year, we are not getting water from the Rio Grande in May although municipal demand has picked up. June is typically our peak month. September also presents a situation where the ambient temperature can still be high, creating a demand for water, and yet because of the drought, we anticipate there will be no water from the Rio Grande. The Bureau of Reclamation forecasts whether we will be in a drought the following year and this year, the Elephant Butte storage is expected to be at a record low.

Figure 3 depicts water demand and supply in El Paso. The red line indicates 135 mgd well capacity. We could have some wells out of service and still be producing 135 million gallons per day, continuously. With surface water included, we could have as much as 260 mgd. But based on our drought projections, we were looking at a total capacity of 185 mgd, with 135 mgd of surface water included. You will note that in the summer months, without the surface water, there is no way that we can meet our demand.

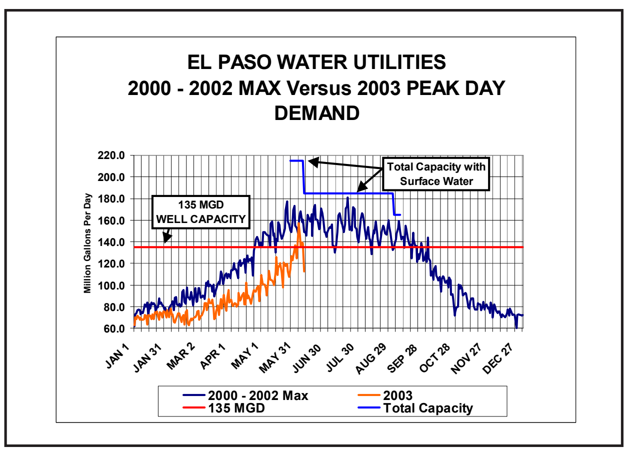

Figure 3.

The dark blue line represents the 2000-2002 average. The orange line represents 2003. In 2003, we had a drought year where we implemented Stage II drought restrictions, which were in addition to our normal day-in and day-out water restrictions on time of day and day of week to water. Stage II restrictions limit people to watering one day a week for two hours. We were able to save a considerable amount of water, yet in May, the water demand was still over 135 mgd. The question was, "How much additional water could we get to supply them?" We looked at the condition of the wells, and as I mentioned earlier, many of these wells had not been turned on in 20 to 30 years, so it took us some time to evaluate their condition. We determined that we needed up to 8 mgd to make up for demand during Stage II drought restrictions. We also determined that we could come up with 8 mgd from conjunctive treatment of arsenic and TDS from the Lower Valley wellfield. We will need the Joint (Ft. Bliss/El Paso) Water Desalination Facility by spring of 2006. Additional long-term desalination or importation should also proceed as scheduled. The 8 mgd of supply from the Lower Valley wellfield is a stop-gap drought supply that we can continue to use in the future, but we still need the desalination facility and other imported water.

Let me describe the typical wellhead treatment system. You can purchase a typical reverse osmosis system from several different manufacturers capable of treating a well with a capacity of one- to two-million gallons per day and the system can be delivered to you very rapidly. Figure 4 shows a typical system; a GE/Osmonics system that we purchased through a competitive bid process.

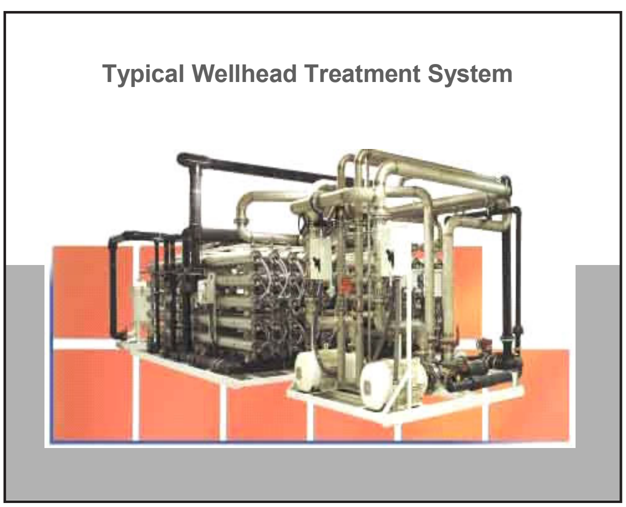

Figure 4.

The two wells highlighted by black diamonds in Figure 5 did not have any problems and will remain in service. We selected three of the arsenic wells for arsenic removal only, 11wells were selected for reverse osmosis systems, and we decided not to do anything about nine of the wells because they either had condition problems or the site was not big enough for the installation of the Reverse Osmosis unit or for some similar reason.

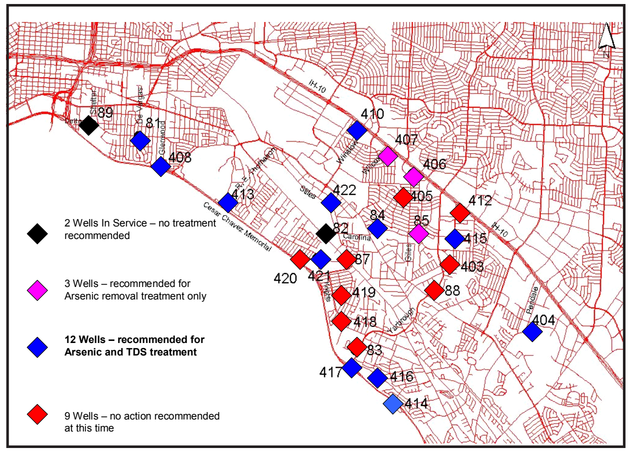

Figure 5.

We used the 11 highest capacity wells and had capital costs of $8.7 million, which included $3.5 million for membrane package units and $5.2 million for site improvements. Site improvements consisted of bringing the electrical system up to code, putting in a metal building and a slab to house the skid, fencing improvements, and the usual things needed to improve a deteriorated site. We are estimating operating costs of $1.8 million annually to produce 8 mgd of water into the distribution system, which is about 8,960 acre-feet per year capacity. We did not feel it is practical, for a variety of reasons, to treat the remaining wells at this time.

Our estimate for life cycle costs, that is, capital and operating costs, is $2.66 million per year. We compared that cost to other alternatives and one possibility is to group those 11 wells and pipe that water to a central point where the water would be treated. The treatment area could be adjacent to our Jonathan Rogers Water Treatment Plant. The advantage here is that you would have the treatment plant infrastructure in place in terms of the high-lift pump stations and distribution lines to get the water back out of the system.

The other alternative was the Surface Water Forbearance Contracts. We obtain water from the Rio

Grande through leases and ownership of land with water rights that we get primarily from farmers. As a city urbanizes and expands, a farmer often wants to subdivide his land and he has the capability of either selling his land outright to us and we keep the water rights and do something with the land, or he can lease the water rights to us and he can subdivide the land. Those occur typically as 75-year contracts. A forbearance contract will be for a short period of time, one or two years. For instance, if a farmer knows that next year there will be a drought, he might decide not to plant anything this year. But if he wants to retain the ability to plant once the drought is over, he could enter into a contract with us for just that one or two year period to give us the water right for a sum of money. He will then not farm for that time period and we would take that water into a treatment plant.

So basically, a farmer is at greater risk when farming during a drought because of the uncertainty of the water supply. Typically at the beginning of the year, the Bureau of Reclamation and the irrigation districts get together and try to figure out when the water is going to be available and when the farmers are going to need it. All that planning takes place before there is any run-off in the spring. So farmers are forced to plan based on water that may or may not show up – so that is an additional risk factor for the farmer. We will pay the farmer not to farm and have him sell his water rights to us and thus avoid that risk.

We need a timely execution of an implementing contract. In fact, we do have an implementing contract right now. We will need a five-month supply at 8 mgd. One problem that can arise is that you must have some carriage water, especially in the case where no other farmer is irrigating at that particular point in time. Possibly early or late in the season, we could be the only "farmer" ordering water at that time and we would have to have some carriage water to go with it. Another question is whether the water is going to meet potable standards. If we are ordering water at the beginning or at the end of the season, there is a possibility that either sulfate or TDS will be too high to be put into the potable system through our conventional treatment plant.

In terms of costs, we are talking about $216 per acre-foot paid to the landowner with some other fees that bring the total cost up to $263 per acre-foot. This puts the life-cycle cost at $5.10 million.

In order to take advantage of existing infrastructure, central desalination must occur at the J.W. Rogers site. This would require a new treatment plant, brine disposal facilities and supply wells at an estimated capital cost of $20 million and an estimated operating cost of $2.1 million. The main problem is the 36-month design and construction period. When you talk about a single plant to treat 8 mgd, it is a different matter than buying a plant that will treat 1 mgd. You can just about get those plants off the shelf. We have gone ahead and ordered and received through the bidding process the GE/Osmonics system in a matter of two to three months and that included a bonus of an early delivery payment that they did collect of $105,000. Even so, the life-cycle cost of $3.69 million per year is still more expensive than individual wellhead treatment units.

Table 1 provides a summary comparing the three options. The important thing to note is the last line of the summary: the Drought Forbearance is not a permanent supply – it is just a temporary agreement between the farmer and El Paso to take that water.

Comparison Summary

	Drought Forbearance	Central Lower Valley Desal	Wellhead Treatment
Annual Cost	$5.10 million	$3.69 million	$2.66 million
Cost per Acre Foot	$1,357	$982	$708
Cost per Thousand Gals	$4.16	$3.01	$2.17
Online by April 2004	No	No	Yes
Permanent Supply	No	Yes	Yes

Table 1.

Table 2 provides a decision matrix with other factors that we considered. In terms of the Central Project, you must get water from the wells to the treatment plant and that involves property acquisition right-of-way. You must get two TCEQ approvals, and in some cases you need Bureau of Reclamation's approval, particularly for the Drought Forbearance alternative, and from EPCWID #1, which is the El Paso County Water Improvement District #1. This is the farmers' irrigation group in El Paso that controls the supply of water to the farmer and to us as a contractee. Looking at other non-cost decision factors, the wellhead treatment is the more advantageous system. While arsenic treatment will not be required until January 2006, treating these wells now to remove total dissolved solids and remove arsenic produced the additional water supply needed to avoid Stage II drought restrictions in 2004.

Decision Matrix Other Factors

	Wellhead Treatment	Central Lower Valley Desal	Drought Forbearance
Cost	3	2	1
Online by April	3	1	1
Property Acquisition	3	2	3
Right of Way Acquisition	3	1	3
TCEQ Approval	2	2	3
EPCWID#1 / BoR Approval	3	3	1
Water Ownership	3	3	1
Implementability	3	2	1
Operational Issues	2	3	3
Total	25	19	17

Point Scoring - Most Favorable (3) - Least favorable (1)

Table 2.

In terms of financing, we have already issued $65 million in bonds to finance arsenic improvement and our total arsenic bill for El Paso is around $75 million. We were going out for $65 million in bonds and could add these projects to that bond issue. At the time of the original bonds, we were at a 42-year low in interest rates and it was a very attractive time to issue those bonds. We prepared specs during the summer of 2003 and issued bonds at the same time.

The terms of the contracts involved several different things. We had a general contractor come in and complete the site work, including the slabs and the buildings. We had an electrical contractor, mechanical contractor, and, of course, the supplier for the individual treatment units themselves. It took from August to December to do the actual site improvements. Then we installed and tested the units from December through April and had them online in April of 2004.

In summary, advancements in membrane technology have resulted in RO treatment applications for other than salt removal. Several manufacturers now offer package RO treatment plants. We sent bid packages to 11 different manufacturers and received four bids. Those four bids were from manufacturers that could produce the 11 units for El Paso in a four-month period of time. These are good sized manufacturers. After a lengthy national debate, the EPA finalized the Arsenic Rule in 2002. The Texas Commission on Environmental Quality has still not to this day finalized their regulations on arsenic. We had to proceed anyway because we had to meet the January 2006 deadline.

We have initiated pilot plant studies on treatment alternatives to meet new standards. Like Dr. Tarquin pointed out earlier today, he is taking a concentrate from another pilot plant that we are running for the Ft. Bliss/El Paso Joint Desalination Facility. Even after the facility is constructed, there will be a built-in pilot plant specifically for concentrate research. Throughout this process, whether we get the injection well permit or we have to go to the evaporation plants, we will continue to test various technologies for membrane concentrate reuse. We also have various ongoing arsenic and desalination pilot testing that indicates very favorable results at reasonable cost. We are testing various types of media such as iron-based media and aluminum media for arsenic removal. The early results indicate that both the arsenic and salt level can be dealt with very cost effectively.

With that, I'll open this up for any questions.

Question: Mr. Balliew, I'm John Hernandez from upstream in Las Cruces and I like what you guys are doing and think it is a good deal. The water that comes through that RO unit is much better quality than what you typically had in the system. Are you blending right there in the RO unit?
Answer: It's blended right there on the Reverse Osmosis unit. The skid includes a bypass pipe and an electrically operated valve. That system is designed automatically to produce a water of a given quality blended back into the system. We are talking about water being put into the system around 600 mgs per liter TDS.

Question: (John Hernandez, cont.) I wondered if you had any compatibility problems because you chose to remove some of the material out of there, calcium carbonates vs. sulfates or something like that.
Answer: We do have to add sodium hydroxide on the water that is leaving the facility just to bring the pH back up to the same pH as in the distribution system.

Question: (John Hernandez, cont.) Is that after blending?
Answer: Yes, that is after blending.

Question: (John Hernandez cont.) I think that's good. Did you tell the folks what happens to the concentrate?
Answer: That is a good question. This particular concentrate is just going into the sewer. The reason

we are doing this is because it is a relatively small volume where we can split it between two wastewater collection treatment systems. One treatment plant has 27 mgd flow and the other 39 mgd. The effect on both treatment plants is the TDS increase is absorbed within the daily fluctuations. We are talking about maybe a 100 mgs per liter increase on average, but within a given day, the TDS fluctuates more than a 100 mgs per liter per day at those treatment plants. Both are still operating well below the stream standard for the particular segment to which they discharge.

Thank you.