CENTRAL ARIZONA SALINITY STUDY --- PHASE I

Technical Appendix J

ECONOMIC ASSESSMENT MODEL

Introduction

One of the most important aspects of the salinity study has got to be: Why are we concerned with salinity? The answer of course is that high salinity water is an economic burden to society. In hopes of finding out just how much of a burden, the Technical Committee decided to analyze the economic impact of importing salts into Central Arizona.

In the late 1980's, the Milleken Chapman Research Group, Inc. created a computer model to estimate the economic impacts of salinity in the Colorado River. The model development was funded by the Bureau of Reclamation in hopes of quantifying the efforts of the Colorado River Basin Salinity Control Advisory Council (Council). The Council's function is to "…advise the Secretaries of the Departments of the Interior and Agriculture…on all matters relating to efficient and timely planning and execution of salinity control measures…specified in the Colorado River Basin Salinity Control Act." Most of the salinity control measures implemented have been improvements in agricultural water efficiency. These salinity control measures include such things as installing concrete linings in canals and the retrofitting flood irrigation systems to drip or sprinkler irrigation systems. These projects were reducing the salt load into the Colorado River, but the economic impact of reducing salinity into the Colorado River was unknown. Thus the impetus for creating the original computer model was to make an economic analysis of the work by the Council

The original model estimates the economic impact due to salinity through the entire Lower Colorado River Basin. It does this by looking at five specific areas where high salinity Colorado River water is impacting society. These areas are residential, commercial, industrial, agriculture and water utilities. The original model did a fairly good job of looking at the big picture, but what was lacking in the model was detailed knowledge at the local level.

The Metropolitan Water District of Southern California (MWD) as part of their Salinity Management Study, upgraded the original computer model to better calculate the economic impacts of changes in salinity in the MWD service area. MWD, using their intimate knowledge of salinity problems and water systems in their service area, made modifications to the original model. Their modified model did a much better job at analyzing the salinity impacts in southern California. Some changes incorporated included accounting for salinity impacts by both State Water Project and Colorado River water, local water treatment policies, water recycling policies and improvements of the data about southern California water use. MWD also re-evaluated the formulas and functions used in the model. The basic formulas were considered sound and were not altered. The cost functions were revised to reflect costs in California. MWD also did extensive surveys of consumers, commercial establishments and industrial manufacturers to get a better picture of water consumption. The work done by MWD to improve the model was extensive and thorough. But they were only concerned about their water service sector. The rest of the Lower Colorado River Basin continued to use the original model's design and programming.

The Technical Committee decided to use the MWD model as a starting point for the economic study for CASS and then modify it to reflect Central Arizona's water and salinity issues. The basic formulas were not changed in the model. These had been reviewed by MWD and found to be adequate. The major changes implemented for the CASS economic model had to do with improving the data and better simulating the water use in Arizona. Such thing as including the salinity contribution of the Salt, Verde and Gila Rivers, including the poor quality ground water in certain parts of the study area, the cost to replace salinity damaged evaporative coolers, and the cost of leaching salt from the root zone of crops were added to the model. Some of the MWD model was discarded because it did not fit in with the water and salinity issues in Arizona. Such things as disposal costs of cooling tower blow down water (there is no additional cost to the industry based on salinity level of water disposed into the sewer), costs of replacing galvanized pipe (there is not enough galvanized pipe in Central Arizona to make this an issue), and desalinization of effluent before recharging (this is not required in Arizona) were eliminated from the model. The biggest improvement to the model was the gathering of good solid data to include into the model. This economic analysis had the best data on Central Arizona ever used in the model.

How the model works

The model gages the economic impact of salinity by analyzing five specific areas where salinity has impacted society. These areas are residential, commercial, industrial, agriculture and water utilities. In each of these sectors different methods are used to come up with a value of the economic impact based on the salinity level of the water used by that sector. For example, the irrigation districts use poorer quality water then residential consumers because the irrigation districts use effluent and also use poor quality groundwater.

The model does not calculate an absolute value of the economic impacts due to salinity. The model starts from a base line then calculates an increase in economic impacts when salinity rises or calculates a decrease in economic impacts when salinity declines in the waters used in the study area. The base line for this study was the creation of a typical year. The typical year uses typical or average salinity levels of Central Arizona's water sources and water supply. The typical year will be described in better detail later in this chapter.

Population and Water Usage

The 2000 census data was used to estimate the population in each of the sub-areas of the entire study area. Refer to the map of the study area in other portions of this report for the boundaries of each sub-area. The number of households was calculated by dividing population by 2.7.

CENSUS 2000 POPULATION DATA		
Sub-area	Population	# of Households
1) Harquahala	500	185
2) Phoenix Metro Area	3,095,577	1,143,245
3) Gila Bend	1,980	733
4) Pinal	135,383	50,142
5) Tucson Metro	843,737	312,495
6) GRIC	11,257	4,169

Population and Households for the Study Area
Table E-1

The water use data that was used for the modeling was gathered from many sources. Most of the water use data came from the Arizona Department of Water Resources (ADWR) and the associated Active Management Areas (AMA). But other sources of information were the Salt River Project (SRP), the Central Arizona Water Conservation District (CAWCD), the United States Geological Service (USGS), the City of Phoenix and other local sources. Initially, all the water use data was for the year 2000. When this was presented to the Technical Committee it was rejected for use in the analysis because the year 2000 was a drought year. Some of the problems pointed out were that the SRP river system was very under utilized that year and ground water use was higher than normal. Also, the salinity level in the Salt River was very high (763 mg/l) because of the low flows. The Technical Committee recommended a "typical year" be created. A typical year was created by holding the year 2000 water demands constant and using an average or median value for water supply and salinity levels.

A median value was used for water delivered by SRP from the Salt and Verde Rivers. SRP supplied this value. This was an acceptable choice because a median value discounts flood years and drought years. Other data, such as the surface water from the Gila River used by the Gila River Indian Community was an average value, since that was the data available. Several compromises had to be made to make the water supply match the year 2000 demands. The water supply data and water use data are reasonably accurate for a "typical year" and work well enough for the accuracy level delivered from the economic model. Table E-2 shows the water used in different sectors of society for the typical year.

WATER USE BY SECTOR "typical year"				
	All values in acre-feet			
Sub-area	Residential	Commercial	Industrial	Agricultural
1) Harquahala	70	22	0	131,908
2) Phoenix Metro Area	678,657	212,966	142,877	923,000
3) Gila Bend	251	79	0	284,670
4) Pinal	18,335	5,730	8,735	765,000
5) Tucson Metro	137,434	42,924	55,142	130,000
6) GRIC	990	340	0	116,670
Total	835,737	262,061	206,754	2,351,248

Table E-2

Table E-3 shows the water use by "source" for a typical year. Surface water is all river water except for the CAP. Surface water includes the Salt River, the Verde River, the Agua Fria River and the Gila River. CAP water is from the Colorado River delivered via the Central Arizona Project canals. These numbers include losses due to evaporation and seepage. The GRIC irrigation system is notorious for losses, losing up to 40% of the water before it is delivered to the fields. The Tucson Metro numbers reflect the current CAP usage including recharged water but CAP usage will increase as the City of Tucson's Clearwater Recharge facility expands operation.

WATER USE BY SOURCE (typical year)				
	All values in acre-feet			
Sub-area	Ground	Surface	CAP	effluent
1) Harquahala	27,000	0	105,000	0
2) Phoenix Metro Area	410,000	752,000	752,000	130,000
3) Gila Bend Agricultural Area	200,000	85,000	0	0
4) Pinal	310,000	130,000	363,000	5,800
5) Tucson Metro	325,000	0	74,000	12,500
6) GRIC	41,000	54,000	54,000	6,900
Total	1,313,000	1,021,000	1,348,000	155,200

Table E-3

Surface water salinity levels for the typical year were averages for the rivers for the last 25 years. The data was supplied by reports issued by USGS, SRP and the Salinity Control Board. The ground water salinity level was the average water quality in wells located in each sub-area from measurements taken between 1992 and 2000. The Phoenix metro area had two separate ground water qualities calculated: municipal and agricultural. This was done because of the very high TDS in the southwest part of the study area was skewing the groundwater quality. This water is not used for drinking but only for agriculture irrigation. Therefore, the wells located in the agricultural districts in the southwest and southeast of the Phoenix metro area were averaged for irrigation water quality only. The wells located in the rest of the Phoenix metro study area were averaged for the ground water quality delivered for municipal purposes. Note in Table E-4, the very good quality ground water located in the Tucson Metro area.

Typical Salinity in Source Water (mg/L) "Typical Year"				
Sub-area	Groundwater	CAP Water	Surface H2O	Effluent
1) Harquahala	733	649	0	0
2) Phoenix Metro Area	738	649	475	951
3) Gila Bend	1,823	0	2,368	0
4) Pinal	919	649	554	950
5) Tucson Metro	278	649	0	550
6) GRIC	2,334	649	554	1,286
7) Phoenix Agriculture	2,105	649	475	951

Table E-4

The salinity level used for the analysis was a weighted average of the volumes and salinity level of the ground water, the CAP, the surface water and the effluent in any given sub-area. Table E-5 shows the typical year salinity level used in the model.

Sub-Area	Weighted TDS (mg/l)
1) Harquahala	666
2) Phoenix Metro Area	621
3) Gila Bend	1986
4) Pinal	741
5) Tucson Metro	316
6) GRIC	994
7) Phoenix Agriculture	907

Weighted TDS for Sub-Areas
Table E-5

Residential

The economic impact on residential users of water with high salinity levels has been classified into two categories:

1. Reduced life of water-using appliances.
2. Avoidance of salinity impacts by purchase of dispensed water or home water softening systems.

The economic impacts of a reduced life for water using appliances are calculated by determining the life span of the appliance at different salinity levels. At higher salinity levels the life of the appliance is reduced therefore the annualized cost of purchasing the appliance is increased. For example, a $500 appliance lasting 5 years has a $100 annual cost. If that same appliance last only 3 years due to using water with a higher salinity level the annual cost is $166.67. Therefore, the result of increased salinity in the water would be an annual economic impact to the resident of $66.67. Since we are considering a large population and appliances are purchased at a relative constant rate the concept works well. Table E-6 is a summary of the appliances and the formulas that were used to determine the economic impacts to residents in Central Arizona.

ECONOMIC IMPACTS OF REDUCED LIFE OF WATER USING APPLIANCES AND PLUMBING (2000 Price Level)			
Appliance/Plumbing Item	**Percent of Residences with Appliance**	**Cost**	**Life Span in Years (y) as a Function of TDS in mg/L**
Galvanized steel water supply pipes	0	NA	y = 12 + exp(3.4 - 0.0018 * TDS)
Water Heater	100	$302.45	$y = 14.63 - 0.013 * TDS + 0.689(10^{-5}) * TDS^2 – 0.11(10^{-8}) * TDS^3$
Faucet	100	$408.59	y = 11.55 - 0.00305 * TDS
Garbage Disposal	43%	$109.61	$y = 9.23 - 0.00387 * TDS + 1.13(10^{-6}) * TDS^2$
Clothes Washer	95%	$629.20	$Y = 14.42 - 0.011 * TDS + 0.46(10^{-5}) * TDS^2$
Dish Washer	60%	$431.98	$Y = 14.42 - 0.011 * TDS + 0.46(10^{-5}) * TDS^2$
Evaporative Coolers	43%	$1159.00	y = 20 / exp(0.0001761 * TDS)

Table E-6

Galvanized steel water supply pipes were dropped as an impact after research indicated that galvanized pipes for individual homes are no longer installed and the last of the public water supply pipelines will be replaced with in the next 5 years. It was felt this impact was no longer valid or would be no longer valid with in a few years.

Water heaters were considered to be in every single residential unit. The cost of water heaters is an average value of many different brands including both gas and electric water heaters. Data was collected from several major retail stores. The research was web based.

Faucet prices were calculated as an average of many different brands for the bathroom, kitchen and shower. The total number of faucets in a typical house was estimated to be 5: 2 bathroom faucets, 1 kitchen faucet, 1 shower faucet and 1 bathtub faucet.

Garbage Disposals were considered to be in 43% of the residential households, this percentage came from a national survey from the Association of Home Appliance Manufacturers. The price came from an average of many different models.

Clothes Washers were considered to be in 95% of the households, this percentage also came from a national survey from the Association of Home Appliance Manufacturers.

This value seems reasonable for Arizona. The price was calculated as an average from many different models.

Dish Washers were considered to be in 60% of the households, this percentage came from a national survey from the Association of Home Appliance Manufactures. The price was calculated as an average from many different models.

Evaporative Coolers were considered to be on 43% of the homes in Central Arizona either alone or in conjunction with refrigerated air conditioning. This percentage came from an article in the *Journal AWWA*, Vol. 90, No. 4 (April 1998). The price was an average of many different models.

The functions that calculate the life span of the appliances with respect to salinity came from the report, *Estimating Economic Impact of Salinity of the Colorado River* prepared by the Milliken Chapman Research Group, Inc. (February 1988). The CASS Technical Committee decided there was no need to revise the functions because they were reviewed by MWD during the course of their salinity study and found to be adequate.

The second category of residential economic impacts is the avoidance costs. Water softening systems and purchasing bottled water are two methods considered in the model. Table E-7 shows the functions and annual costs for these two avoidance costs.

ECONOMIC IMPACTS OF AVOIDANCE OF SALINITY IMPACTS BY PURCHASE OF DISPENSED WATER, HOME FILTRATION SYSTEMS, AND WATER SOFTENERS (2000 Price Level)

Avoidance Method		Annual Cost	Unit or Cost (y) as a Function of TDS in mg/L
Bottled Water	-	$135.93	y = 61.1 + 0.00323 * TDS {y = % of households using bottled water}
Water Softener	-	$319.30	$y = 6.758 + 0.007 * TDS + 3.01(10^{-6}) * TDS^2 + 2.2(10^{-10}) * TDS^3$ {y = % of households using water softening devices}

Table E-7

Bottled Water annual cost was calculated from individual daily consumption of water multiplied by 365 days multiplied by an average cost of bottled water. According to a survey conducted by *Bottled Water Web Consumer Focus*, the national average individual daily consumption of water is 6.1 eight ounce servings of water daily. This is 48.8 ounces or 0.38 gallons daily. In a survey of 45 people in Reclamation's Phoenix Area Office, they indicated that they on average consumed 0.48 gallons of water daily. The survey gave a "reality check" for the *Bottled Water Web Consumer Focus* value. The cost of bottled water was averaged from numerous sources including surveying supermarkets and web based research.

Many water resource planners including members of the CASS Technical Committee are uncomfortable with the idea that there is a direct correlation between purchase of bottled water and salinity. But W. H. Bruvold performed both laboratory taste tests and field surveys confirming that the higher the TDS level the poorer the taste of water. Bottled water is purchased in part because of poor tasting water. Other CASS team members were concerned with using bottled water consumption as an economic impact because the bottled water industry that promotes drinking bottled water in a highly effective advertising campaign and is not a detriment to society. The function shows that 61.1% of the population drinks bottled water no matter what the TDS value of the local tap water, these people are not included in the economic impacts. It is the increase of people drinking bottled water because of high salinity tap water that is used to calculate a value for the economic impact.

Water Softeners are used to treat hardness by replacing calcium with sodium in the water, which exacerbates salinity problems by adding more salinity to the system. The cost for a water softening system was calculated by annualizing the initial cost and yearly maintenance cost for a typical system.

Commercial

Commercial water users are schools, department stores, hospitals, banks, restaurants, nursing homes and other similar businesses and institutions. Data was not plentiful on the amount of water consumed by the commercial sector. But the City of Tucson Water Department (Tucson Water) provided data that indicated that commercial water use in Tucson is 23.8% of non-industrial municipal water use. This ratio of 23.8% commercial and 76.2 % residential non-industrial water use was used for the entire study area. The MWD report used a value of 26% commercial water use, so the data supplied by Tucson Water seems reasonable. The economic impact calculations for the commercial sector are the same as the earlier model. The only adjustments made were to reflect current pricing and unique attributes to Arizona. Table E-8 shows the estimated water used by the commercial sector in each sub-area.

Commercial water use by Sub-Area (acre-feet/ year)	
Sub-area	**Estimated Water Use Year 2000**
1) Harquahala	22
2) Phoenix Metro Area	212,966
3) Gila Bend	79
4) Pinal	5,730
5) Tucson	42,924
6) GRIC	340

Table E-8

Water use by commercial entities can be broken into the following categories; sanitary, cooling, irrigation, kitchen, laundry and other. The effect that salinity and its associated hardness have on the commercial sector of society is measured by looking at its effect in each of these categories. The Technical Committee agreed that the data on commercial water use, MWD collected concerning Southern California would be very similar to Central Arizona. The breakdown of commercial water use is reflected in Table E-9.

PERCENT WATER USE FOR EACH USE CATEGORY							
Sub-area	**Sanitary**	**Cooling**	**Irrigation**	**Kitchen**	**Laundry**	**Others**	**Total**
1) Harquahala	29%	12%	32%	7%	8%	12%	100%
2) Phoenix Metro Area	29%	12%	32%	7%	8%	12%	100%
3) Gila Bend	29%	12%	32%	7%	8%	12%	100%
4) Pinal	29%	12%	32%	7%	8%	12%	100%
5) Tucson	29%	12%	32%	7%	8%	12%	100%
6) GRIC	29%	12%	32%	7%	8%	12%	100%

Table E-9

Sanitary costs are similar to residential costs especially if you consider schools, hotels, motels and hospitals but also other commercial establishments. Using the equation for faucet replacement a value can be calculated. Assuming 0.5 acre-feet per household per year and one-half of household use affecting interior faucet, the cost impact is 6.8 cents per acre-foot per mg/l of salinity.

Additional costs are associated with water softening. Softening water costs vary depending upon size, peak flow rate, hardness of the water, and desired hardness. A median value is about $131 per acre-foot. Assuming that one is reducing hardness in water with a salinity of 600 mg/l to the equivalent hardness of water with a salinity of 400 mg/l, the cost of a reduction would be equivalent to $0.65 per acre-foot per mg/l. Hotels, hospitals and various other entities soften water to some degree. Estimating that 20% of the commercial sanitary water is softened, then it can be calculated that the costs are approximately $0.13 per acre-foot per mg/l. These calculations make the total impact for sanitary costs to be $0.20 per acre-foot per mg/l

Cooling water is approximately 12% of total commercial water use. The use of water for cooling is directly affected by salinity. Cooling towers operate by evaporation, which in turn results in a concentration of salt in the water. Make-up water is supplied to replace evaporated water. The concentration of water in the tower is maintained at a desired salinity level by adding water in addition to that evaporated and allowing a like amount of water (blow down water) to be discharged.

A major factor of the effect of increased salinity is the cost of additional water and added chemicals. Currently, Arizona does not have a disposal cost for highly saline water. According to the MWD study an increase in salinity requires a 7% increase in water based on a tower operating salinity of 2,500 mg/l. Water purchased at retail prices is approximately $600 acre-foot and $157 acre-foot for chemicals. Therefore a cost function would be: Cost = acre-feet * .07/100 * 757 * increase in TDS per mg/l. Or Cost = acre-feet * .53 * increase in TDS per mg/l.

Irrigation water is approximately 32% of the water used by the commercial sector. This is water used to keep the common green areas watered. The wide spread use of plastic pipe for irrigation systems have reduced the impact of salinity. Also, landscape architects and nurseries tend to supply plants that are tolerant of the environment in which they will be planted, and this environment would include the water supply. Salinity impacts for growing grass and irrigating common green areas is not noticeable. The salinity function is zero.

Kitchens account for about 7% of the water used by commercial entities. Restaurants, hotels, hospitals, schools and nursing homes would be the primary users in this sub-category. Surveys indicate that approximately 2/3rds of the water used by commercial kitchens would be softened. Prime water softening uses are in dishwashers and steam tables where softened water reduces scaling and spotting. As calculated above, softened water costs approximately $0.65 per acre-foot per mg/l. Estimating, that only ½ of the water is softened used in commercial kitchens, the cost factor is then $0.33 per acre-foot per mg/l.

Laundries account for 8% of the water used. This includes commercial laundries, coin operated laundries and laundries for hospitals, nursing homes, etc. Commercial laundries and hospitals will soften their water but most coin operated laundries the water is not softened. The economic impact that MWD chose to use in their study was the full $0.65 per acre-foot per mg/l because it was felt that although all laundries did not soften water there were other economic impacts such as increased soap use which were felt by users.

The "Other" category accounts for 12% of the water use. This includes water use such as car washing, ice machines, pools in hotels and things not fitting into the neat categories previously discussed. The cost function used for other is a weighted average of the previous categories.

Table E-10 shows all the cost functions used for commercial water use in the model.

TDS IMPACT FUNCTION FOR EACH CATEGORY						
Use Category	**Sanitary**	**Cooling**	**Irrigation**	**Kitchen**	**Laundry**	**Others**
TDS Function ($/AF per mg/L)	$0.20	$0.53	$0.00	$0.33	$0.65	$0.22

Table E-10

Industrial

High salinity water has a significant economic impact on industry in Central Arizona. Some industries require water which is better quality than the quality of water delivered to them. Food and beverage manufacturing require water which has undergone reverse osmosis to remove the TDS but other industries only need to soften the water by removing the calcium and magnesium components. The high tech industries, such as microchip manufacturing, need ultra-pure water for its manufacturing process. Each of these processes are expensive and costs rise with the increased removal rates.

The imported water coming into Central Arizona is not only high in dissolved solids it also can change drastically in dissolved solid content over a few days time. For example, this can happen when the Salt River Project switches water supplies from the Verde River (average TDS 269 mg/l) used in winter to the Salt River (average TDS 576 mg/l) used during the summer.

The Arizona Department of Water Resources (ADWR) supplied some industrial water use numbers, but the model needed additional information to cover the entire industrial spectrum. ADWR had industrial water use numbers for dairy farms, cattle feedlots, mining and sand & gravel companies, which for the most part supplied their own water through wells. The model calculates economic impacts for high tech industries, manufacturing industries, food manufacturing, etc. These industries for the most part are buying retail water from private water suppliers or city supplies and were not included in data received from ADWR. Economic census data was used to calculate the industrial water use in Arizona.

The water use by the industrial sector was calculated by first estimating the number of industrial establishments in each sub-area and their size. Information on Central Arizona's industry and the number of employees was gathered from the 1997 Economic Census Data assembled by the U.S. Census Bureau. Water use per employee in gallons per day was also available. With those numbers it was simple arithmetic to come up with annual use in acre-feet per year. The dairy farms, cattle feedlots, mining companies and sand & gravel companies water consumption supplied by ADWR was added to the calculated industrial use to come up with a total for each sub-area. The total use was partitioned into the following use categories; process water, boiler water, cooling water, sanitation and irrigation water for each industry. Each of the use categories have a cost function associated with it.

Tables E-11, E-12 and E-13 for Pinal, Pima and Maricopa Counties respectively, give the industries, the number of establishments of that industry, the total number of employees, the water use per day per employee and then annual water use. The second part of each table has industry data supplied by ADWR.

Pinal County Industry	Establish.	Employees	Water use per employee gallons/day/employee	Annual use gallons/yr	Annual use Ac-ft/yr
Food mfg	8	825	714	147,262,500	452
Paper mfg	1	825	2,174	448,387,500	1,376
Primary Metal mfg	5	2,318	909	526,765,500	1,616
Fabricated metal prod.	10	626	246	38,499,000	118
sub-total	24	4,594			3,562
Dairies					2,088
Power Plants					0
Sand & Gravel					277
Feedlot					2,647
Mining					161
sub-total					5,173
Total					**8,735**

Table E-11

Pima County Industry	Establish.	Employees	Water use per employee gallons/day/employee	Annual use gallons/yr	Annual use Ac-ft/yr
Food mfg	44	654	714	116,739,000	358
Beverage mfg	9	575	1,282	184,287,500	565
Plastics & rubber prod	39	1,100	625	171,875,000	527
Non-metallic mineral	59	1,796	375	168,375,000	517
Fabricated metal prod	123	3,768	246	231,732,000	711
Machinery mfg	52	1,988	357	177,429,000	544
Comp & electronic	56	3,904	227	221,552,000	680
Transportation equip	19	7,499	300	562,425,000	1,726
sub-total	250	17,159			5,629
Dairies					115
Power Plants					5,214
Sand & Gravel					5,455
Feedlot					0
Mining					38,729
sub-total					49,513
Total					**55,142**

Table E-12

Maricopa County Industry	Establish.	Employees	Water use per employee gallons/day/employee	Annual use gallons/yr	Annual use Ac-ft/yr
Food mfg	154	7,499	714	1,338,571,500	4,107
Beverage mfg	17	1,749	1,282	560,554,500	1,720
Textile product mills	75	749	315	58,983,750	181
Apparel mfg	52	1,749	24	10,494,000	32
Wood product mfg	122	6,169	794	1,224,546,500	3,757
Paper mfg	31	1,749	2,174	950,581,500	2,917
Chemical mfg	124	5,798	1,818	2,635,191,000	8,086
Plastics & rubber prod	167	6,391	625	998,593,750	3,064
Nonmetallic mineral	133	3,749	375	351,468,750	1,078
Primary metal mfg	32	3,749	909	851,960,250	2,614
Fabricated metal prod	605	14,329	246	881,233,500	2,704
Machinery mfg	232	7,500	357	669,375,000	2,054
Comp & electronic	270	37,500	227	2,128,125,000	6,530
Electrical equip.	66	3,750	227	212,812,500	653
Transportation equip	172	17,500	300	1,312,500,000	4,027
Furniture prod. Mfg	246	6,526	151	246,356,500	756
sub-total	2,498	126,456			44,282
Dairies	98				9,992
Power Plants	4				78,800
Sand & Gravel	43				9,681
Feedlot	17				122
Mining	0				0
sub-total					98,595
Total					**142,877**

Table E-13

Table E-14 is a breakdown of water uses for each industry into the categories of process water, boiler water, cooling and sanitation & irrigation. Process water can be treated by desalinization, such as reverse osmosis, softening or no treatment depending on what industry is using the water. The high tech industries, such as chip manufacturing, require ultra-pure water. Other industries may require only softening, filtering or no treatment. Boiler feed water for electrical generation requires ultra-pure water but these plants condense virtually all their steam so there is little need for makeup water. In contrast most other industrial boiler feed water represents a relatively large use. Typically, this water will be softened or maybe even desalinated. Cooling water in cooling towers is used for a number of cycles then discarded. The cycles of use depends on what the TDS was to start and to what level of concentration will be allowed and also by law in Arizona. The irrigation and sanitation water uses are minor compared to the other uses.

	Profile of water Use				
	Process	Boiler	Cooling	Sanitation & Irrigation	total
Food mfg	59.00%	5.00%	34.00%	2.00%	100.00%
Beverage mfg	79.40%	11.30%	7.20%	2.10%	100.00%
Textile product mills	81.00%	16.00%	0.00%	3.00%	100.00%
Apparel mfg	81.00%	16.00%	0.00%	3.00%	100.00%
Wood product mfg	81.00%	16.00%	0.00%	3.00%	100.00%
Paper mfg	62.00%	21.00%	9.00%	8.00%	100.00%
Chemical mfg	19.00%	15.00%	62.00%	4.00%	100.00%
Plastics & rubber prod	20.00%	15.00%	61.00%	4.00%	100.00%
Non-metallic mineral	93.00%	0.00%	3.00%	4.00%	100.00%
Primary metal mfg	13.00%	5.00%	24.00%	58.00%	100.00%
Fabricated metal prod	13.00%	5.00%	24.00%	58.00%	100.00%
Machinery mfg	68.00%	4.00%	16.00%	12.00%	100.00%
Comp & electronic	50.00%	2.00%	18.00%	30.00%	100.00%
Electrical equipment	50.00%	2.00%	18.00%	30.00%	100.00%
Transportation equip	68.00%	4.00%	16.00%	12.00%	100.00%
Furniture mfg	81.00%	16.00%	0.00%	3.00%	100.00%
Dairies	10.00%	1.00%	20.00%	69.00%	100.00%
Power plants	19.00%	15.00%	62.00%	4.00%	100.00%
Sand & Gravel	90.00%	0.00%	5.00%	5.00%	100.00%
Feedlot	10.00%	1.00%	20.00%	69.00%	100.00%
Mining	91.00%	3.00%	3.00%	3.00%	100.00%

Table E-14

Tables E-15, E-16 and E-17 for Pinal, Pima and Maricopa Counties respectively, gives the total water use for each county for each process based on Table E-14.

Water in each process Pinal County (acre-feet)					
	Process	Boiler	Cooling	Sanitation & Irrigation	Total
Food mfg	267	23	154	9	452
Paper mfg	853	289	124	110	1,376
Primary Metal mfg	210	81	388	937	1,616
Fabricated metal prod.	15	6	28	69	118
Dairies	209	21	418	1,441	2,088
Power Plants	0	0	0	0	0
Sand & Gravel	249	0	14	14	277
Feedlot	265	26	529	1,826	2,647
Mining	147	5	5	5	161
Total	**2,214**	**450**	**1,659**	**4,411**	**8,735**

Table E-15

Water in each Process Pima County (acre-feet)					
	Process	Boiler	Cooling	Sanitation & Irrigation	Total
Food mfg	211	18	122	7	358
Beverage mfg	449	64	41	12	565
Plastics & rubber prod	105	79	322	21	527
Non-metallic mineral	480	0	15	21	517
Fabricated metal prod	92	36	171	412	711
Machinery mfg	370	22	87	65	544
Comp & electronic	340	14	122	204	680
Transportation equip	1,174	69	276	207	1,726
Dairies	12	1	23	79	115
Power Plants	991	782	3,233	209	5,214
Sand & Gravel	4,910	0	273	273	5,455
Feedlot	0	0	0	0	0
Mining	35,243	1,162	1,162	1,162	38,729
Total	**44,377**	**2,246**	**5,846**	**2,672**	**55,142**

Table E-16

Water in each Process Maricopa County (acre-feet)					
	Process	Boiler	Cooling	Sanitation & Irrigation	total
Food mfg	2,423	205	1,396	82	4,107
Beverage mfg	1,366	194	124	36	1,720
Textile product mills	147	29	0	5	181
Apparel mfg	26	5	0	1	32
Wood product mfg	3,044	601	0	113	3,757
Paper mfg	1,808	613	263	233	2,917
Chemical mfg	1,536	1,213	5,013	323	8,086
Plastics & rubber prod	613	460	1,869	123	3,064
Non-metallic mineral	1,003	0	32	43	1,078
Primary metal mfg	340	131	627	1,516	2,614
Fabricated metal prod	352	135	649	1,568	2,704
Machinery mfg	1,397	82	329	246	2,054
Comp & electronic	3,265	131	1,175	1,959	6,530
Electrical equip.	326	13	118	196	653
Transportation equip	2,739	161	644	483	4,027
Furniture mfg	612	121	0	23	756
Dairies	999	100	1,998	6,894	9,992
Power plants	14,972	11,820	48,856	3,152	78,800
Sand & Gravel	8,713	0	484	484	9,681
Feedlot	12	1	24	84	122
Mining	0	0	0	0	0
Total	**45,692**	**16,015**	**63,603**	**17,566**	**142,877**

Table E-17

The model calculates economic impact for industry in four industrial categories of water use, process water, cooling water, boiler water and sanitary & irrigation water. Process water is further broken down into demineralization, softened and not further treated.

Demineralization costs include reverse osmosis, distillation and electro-dialysis. The cost of reverse osmosis is dropping but still is expensive and varies from about $700 to $1000 per acre-foot for water at about 650 mg/l. Being conservative and using $700 per acre-foot to reduce the water to about 16 mg/l the cost is $1.10 per mg/l. But some de-mineralized process water needed for high tech industry must be ultra-pure and is further treated with distillation or some other process. The costs for additional treatment may increase the costs by another 150%. Estimating that 25% of the de-mineralized water is ultra-pure water this would make the total demineralization costs per mg/l at about $1.53 mg/l per acre-foot.

Water softening costs have previously been calculated in this chapter to be $0.65 per mg/l.

Of course process water that is not treated any further by industry, which is the majority of water used by industry, has no additional costs associated with salinity.

Table E-18 is an estimate of the industrial Process Water that is de-mineralized, softened and not treated by industry.

Industrial Process Water	
Treatment needs	Percent
Demineralization	24%
Softening	24%
No treatment	52%

Table E-18

Cooling towers for industry are usually larger than the ones used for commercial buildings. The use of water for cooling is directly affected by salinity. Cooling towers operate by evaporation, which in turn results in a concentration of salt in the water. Make-up water is supplied to replace evaporated water. The concentration of water in the tower is maintained at a desired salinity level by adding water in addition to that evaporated and allowing a like amount of water (blow down water) to be discharged.

A major factor of the effect of increased salinity is the cost of additional water and added chemicals. Water used for cooling towers for industry can operate at a higher salinity than the smaller towers associated with commercial cooling. According to the MWD study an increase in salinity requires a 4% increase in water based on a tower operating salinity of 3,500 mg/l.

Water purchased at retail prices is approximately $600 acre-foot and $157 acre-foot for chemicals. Therefore a cost function would be: Cost = acre-feet * .04/100 * 757 * increase in TDS per mg/l. Or Cost = acre-feet * .30 * increase in TDS per mg/l.

Boiler feed water can be broken into three groups: electrical generation, space heating and industrial purposes. Electrical generation plants use ultra-pure water to run through the generators. These are closed systems and very little water is lost. For general space heating in buildings, boilers operate at relatively low temperatures and recycle the steam, once again very little water is needed as make up water. On the other hand, industrial use of boiler feed water can be very high. Make up water can be up to 50% of boiler feed water. Industrial steam is lost by injection into products, cleaning and losses from deterioration of steam condensing equipment. Typically, this water is either softened or de-mineralized by reverse osmosis or electro-dialysis. Allowing for 50% to be softened and 50% to be de-mineralized the costs would be approximately $1.09 per acre-foot per mg/l.

<u>Sanitation & irrigation</u> costs are negligible for industry. Irrigation costs have not been considered because of the same reasoning given for the commercial sector. The same factors that apply to the residential sector are assumed to apply for industrial sanitation uses. The majority of costs come from bottled water consumption and home softening systems. Home softening systems do not apply for industry. Bottled water does apply. The bottled water calculations consider the daily consumption of water, but not broken down between consumed at work or at home. It would be double counting to put that function into the industry also sector.

Table E-19 shows the cost functions used for the industrial sector in the model.

Industrial Water Use Impact Functions						
	Process Water Demineralization	Process Water Softening	Process Water Minor	Cooling Towers	Boiler Feed	Sanitation & Irrigation
Total Industrial Water Impact Functions ($/af per mg/l)	$1.53	$0.65	$0.00	$0.30	$1.09	$0.00

Table E-19

Agricultural

Two factors were taken into consideration to determine the economic impacts on agriculture in Central Arizona because of salinity. The first factor was reduced crop yield. It has been established that as the salinity level increases in the irrigation water the crop yield per acre declines. It is the salt build up in the soil at the root zone that causes the reduction in crop yield. Of course different crops have different tolerances to salinity. Cotton, barley and alfalfa are quite tolerant to salinity and are major crops in Central Arizona. This reduces the impacts that salinity has on agriculture to some degree. The U.S. Salinity Laboratory in Riverside, California developed crop yield curves over the last 25 years. These curves were used in the model to determine the reduction in crop yield. Because growing conditions can vary dramatically, the crop reduction curves can only approximate the actual change in crop yield. But the curves are sufficient to get a reasonable value for the economic impact on agriculture. The model calculates the economic impact by using the year 2000 as a base year. When the salinity level in the model is increased new crop yield is calculated for each crop type. A dollar amount can then be calculated based on the difference of the yields. Of course there are many, many factors that affect the price of crops on the market. This model only gages the economic impact of changing salinity levels assuming all other factors remained the same. Table E-15 lists the primary crops and approximate acres of those crops grown in the study area for the year 2000. These crop acreages were used for the model.

Crop Type	Harquahala	Phoenix Agriculture	Gila Bend	Pinal	Tucson	GRIC
Cotton	15,920	69,900	14,400	104,357	12,300	3,443
Barley	235	11,200	8,280	16,594	1,000	406
Alfalfa (Hay)	4,041	55,280	17,320	26,325	1,900	2,975
Wheat	600	8,420		18,697	3,900	1,703
Corn	750	600		500		
Broccoli	440	4,000				
Cantaloupe	2,360	9,600				
Watermelon	486	3,900		492		408
Potatoes	130	6,500		2,500		
Head Lettuce					600	
Grapefruit		2,400				250
Oranges		4,600				700
Lemons		1,400				
Tangerines		3,200				
Onions		900				233
Olives						600
Cauliflower		300				
Carrots		1,800				
Honeydews		2,700				
Grapes		2,000		675		
Totals (acres)	24,962	188,700	40,000	170,140	19,700	10,718

Crop Acreage for the Study Area
Table E-20

Table E-21 shows crop value for the study area in the year 2000. These values were used as the base line for the economic analysis.

Crop Type	Harquahala	Phoenix Metro Area	Gila Bend	Pinal	Tucson	GRIC
Cotton	$880.00	$1,019.00	$931.00	$878.00	$932.00	$1,107.00
Barley	$173.00	$274.00		$272.00	$276.00	$370.00
Alfalfa (Hay)	$743.00	$756.00	$752.00	$791.00	$698.00	$733.00
Wheat	$345.00	$325.00	$325.00	$295.00	$283.00	$362.00
Corn	$313.00	$468.00		$477.00		
Broccoli	$3,044.00	$4,853.00				
Cantaloupe	$4,116.00	$2,913.00				
Watermelon	$3,876.00	$2,551.00		$2,786.00		$2,040.00
Potatoes	$3,286.00	$2,947.00		$3,023.00		
Head Lettuce					$5,191.00	
Grapefruit		$380.00				$33.00
Oranges		$1,009.00				$387.00
Lemons		$4,369.00				
Tangerines		$1,299.00				
Onions		$2,067.00				$560.00
Olives						
Cauliflower		$7,678.00				
Carrots		$2,187.00				
Honeydews		$3,725.00				
Grapes		$3,504.00		$3,504.00		

Crop Value per Acre for the year 2000
Table E-21

The second factor considered in the model is the cost of leaching salts from the root zone. The cost calculated was the value of the additional water used for leaching above the water needed for consumptive use by the crops. A weighted average value for the cost of water was calculated from the different sources used by agriculture in the Phoenix metro area. Table E-22 shows the cost of and acre-foot of water for agriculture in the Phoenix metro area.

Cost to pump GW	Cost of SRP ag water	Cost of CAP ag water	Cost of effluent
$33.00	$10.00	$33.00	$8.66

Value of Agricultural Water for Phoenix Metro (Acre-Feet)
Table E-22

Table E-23 and E-24 were used to calculate the weighted average for an acre-foot of water used for agriculture. The cost of SRP water used in the Phoenix metro area was used for the cost of surface water for Pinal, GRIC and Gila Bend. Table E-19 is the weighted average cost used for the model.

	GW	Surface	CAP	effluent
Harquahala	26,908	0	105,000	0
Gila Bend	199,670	85,000	0	0
Pinal	277,200	130,000	352,000	5,800
Tucson	102,000	0	28,000	0
GRIC	23,270	54,000	32,500	6,900
Phoenix Ag	286,600	286,600	286,600	63,200

Agricultural Water use for a Typical Year (Acre-Feet)
Table E-23

Harquahala	**$33.00**
Gila Bend	**$26.13**
Pinal	**$28.91**
Tucson	**$33.00**
GRIC	**$20.92**
Phoenix Ag	**$24.19**

Weighted Average cost of Agricultural Water for a Typical Year (Acre-Feet)
Table E-24

The leaching costs per acre are calculated using Table E-25. The formula used to calculate column "leaching requirement by formula" comes from the Food and Agriculture Organization of the United Nations, FAO Handbook #29. This is the most commonly used formula and was used by ADWR in calculation of leaching requirements in the AMA's. It calculates the leaching requirement needed for the crop based on it's salinity tolerance and the salinity of the water. Table E-20 shows a water quality salinity of 833 uS/cm which is equivalent to 500 mg/l TDS and with a cost associated with agricultural water in the Phoenix metro area. The model calculates a cost for leaching water usage for the base case. It then calculates the cost of additional leaching water usage for a new level of salinity. The difference between those values is the economic impact to the farmer for increases in salinity in the irrigation water.

Crop Type	Crop tolerance uS/cm	Crop water usage (af)	Water quality uS/cm	Leaching requirement by formula (af)	Max leaching (af)	Leaching requirement (af)	Cost of water per (af)	Additional cost per acre
Cotton	7,700	3.43	833	0.08	1.72	0.08	$24.19	$1.88
Barley	8,000	2.08	833	0.05	1.04	0.05	$24.19	$1.09
Alfalfa (Hay)	2,000	6.19	833	0.62	3.10	0.62	$24.19	$14.97
Wheat	6,000	2.15	833	0.06	1.08	0.06	$24.19	$1.53
Corn	1,700	2.12	833	0.26	1.06	0.26	$24.19	$6.25
Broccoli	2,800	1.64	833	0.11	0.82	0.11	$24.19	$2.68
Cantaloupe	1,000	1.56	833	0.39	0.78	0.39	$24.19	$9.43
Watermelon	1,000	1.75	833	0.44	0.88	0.44	$24.19	$10.58
Potatoes	1,700	2.03	833	0.25	1.02	0.25	$24.19	$5.99
Head Lettuce	1,300	0.71	833	0.12	0.36	0.12	$24.19	$2.96
Grapefruit	1,800	3.99	833	0.45	2.00	0.45	$24.19	$10.97
Oranges	1,700	3.26	833	0.40	1.63	0.40	$24.19	$9.62
Lemons	1,700	3.99	833	0.49	2.00	0.49	$24.19	$11.77
Tangerines	1,700	3.26	833	0.40	1.63	0.40	$24.19	$9.62
Onions	850	1.70	833	0.55	0.85	0.55	$24.19	$13.27
Olives	2,500	2.58	833	0.20	1.29	0.20	$24.19	$4.80
Cauliflower	2,800	1.55	833	0.10	0.78	0.10	$24.19	$2.53
Carrots	1,000	1.38	833	0.35	0.69	0.35	$24.19	$8.35
Honeydews	1,000	2.00	833	0.50	1.00	0.50	$24.19	$12.10
Grapes	1,500	3.00	833	0.43	1.50	0.43	$24.19	$10.37

Calculation of Leaching Water Cost per Acre
For Phoenix Metro Area with a water quality of 500 mg/l
Table E-25

Water Utilities, wastewater utilities and distribution pipelines

Salinity impacts to water treatment facilities, waste water facilities and water distribution pipelines are of concern.

Corrosion to waste water facilities is a serious matter.   However, this corrosion is associated with sulfides rather than TDS. Because of the problems associated with sulfides, corrosion resistant materials are used in wastewater treatment facilities such as stainless steel. A conclusion can be drawn that wastewater facilities are not noticeably affected by increases in salinity. Wastewater treatment facilities were not included into the model. Although, it can be argued that the physical facility is not affected by salinity, the effluent that is discharged by a wastewater facility has less value if the salinity is too high.

An article in the AWWA Research Foundation, 1985, titled "*Internal Corrosion of Water Distribution Systems*", has a couple of pertinent comments on salinity.

This report states:

> "*Iron pipe corrosion is largely affected by the oxygen content of the water which is unrelated to the salinity*."

Further it states:

> "*Waters of low alkalinity show increased rates of internal corrosion. That is because these waters do not form a protective film of calcium carbonate on the interior surface*."

Since most of the water in Central Arizona is high in calcium carbonate and the previous statement about oxygen being the cause of the corrosion, it was decided not to include the affects of salinity on the water distribution system.

Water treatment facilities were included in the model. For the economic life of water production facilities was developed by Dennis P. Tihansky. The expected life of a water facility can be expressed by the following formula:

$$\text{Expected life in years} = 30.83 - (0.0033 * \text{TDS})$$

A list of all the water treatment facilities in the Phoenix metro area was compiled along with an estimated replacement cost. These were the only water treatment facilities used in the study as most of the sub-areas do not have water treatment facilities because they use groundwater for drinking water purposes. Tucson has a large water treatment facility, the Hayden-Udall water treatment facility, but it is not currently in operation.

The capital costs to replace a facility were calculated using a simple formula of $2.00 per million gallons per day. For example; a water treatment plant that can process 50 million gallons a day would cost $100 million dollars to replace. The model averages the capital cost over the life of the water treatment plant to give a yearly cost. The model then calculates the change of life for each water treatment plant when there is a change in the TDS of the water that that plant processes. It then averages the capital cost over the new calculated life to give a new yearly cost. The difference between the two yearly costs is the economic impact.

City – Water Facility	Size (mgd)	Replacement Cost (millions of dollars)
Phoenix – Deer Valley	160	$ 320
Phoenix – Val Vista	220	$ 440
Phoenix – Squaw Peak	140	$ 280
Phoenix – Verde	60	$ 120
Phoenix – Union Hills	160	$ 320
Phoenix – Lake Pleasant*	80	$ 160
Gilbert - Gilbert	30	$ 60
Glendale – Cholla	30	$ 60
Glendale – Pyramid Peak	40	$ 80
Scottsdale – CAP	55	$ 110
Tempe – Papago	50	$ 100
Tempe – South Tempe	50	$ 100
Chaparral City Water Co. 1	5	$ 10
Chaparral City Water Co. 2	5	$ 10
Peoria – Peoria	16	$ 32
Paradise Valley Water Co.	9	$ 18
Chandler – Chandler	45	$ 90
Total	**1155**	**$2,310**

Water Treatment Facilities in Phoenix Metro Area
Table E-26

Model Analysis

What are we trying to find out in the economic model analysis? The model is too broad or imprecise to give meaningful economic impacts to any one company or even city. It is a regional model that can tell us only the "big picture." The economic analysis can tell us the magnitude of the impacts that society faces if the salinity level of imported waters were to increase. Or on the other hand the analysis can tell us the magnitude of the benefits to society if the importation of salinity can be decreased.

The model does not calculate the absolute value of the economic impact of salinity, rather the model calculates the change of the economic impact to society starting from a base level as salinity levels increase or decrease. That base level for our purposes is the typical year described earlier in this chapter. In the typical year the weighted average salinity of the Salt and Verde Rivers is 475 mg/l, the average salinity for the CAP is 649 mg/l and the average salinity for groundwater is 738 mg/l. The salinity for effluent is a calculated value depending on the salinities of the other waters and societies salt input. The salinity level in the water in the Phoenix Metro area according to the model is a weighted average salinity of the groundwater, the Salt and Verde Rivers, the CAP and the effluent.

Three separate model analyses were done. The first analysis the salinity level in the Salt and Verde Rivers was adjusted by increments of 100 mg/l from a range of 275 mg/l to

1475 mg/l. When the Salt and Verde rivers salinity is adjusted by 100 mg/l the weighted average of the Phoenix Metro and Phoenix agriculture TDS levels adjust to the new input.

The second model analysis was to adjust the salinity level in the CAP. The base year or typical year salinity level for the CAP was 649 mg/l.   The salinity level was adjusted by increments of 100 mg/l from 249 mg/l to 1549 mg/l.   This is much greater than is ever anticipated the level of salinity would change in the CAP but we were looking for a curve.   The model calculates a new weighted average salinity for each step in each sub-area except for Gila Bend. Gila Bend does not receive CAP so is not directly effected by changes in CAP only indirectly.   Examine Table E-27. It can be seen that for a salinity change of 100 mg/l of CAP water, the weighted average salinity of the Phoenix Metro area changes by only 34 mg/l.

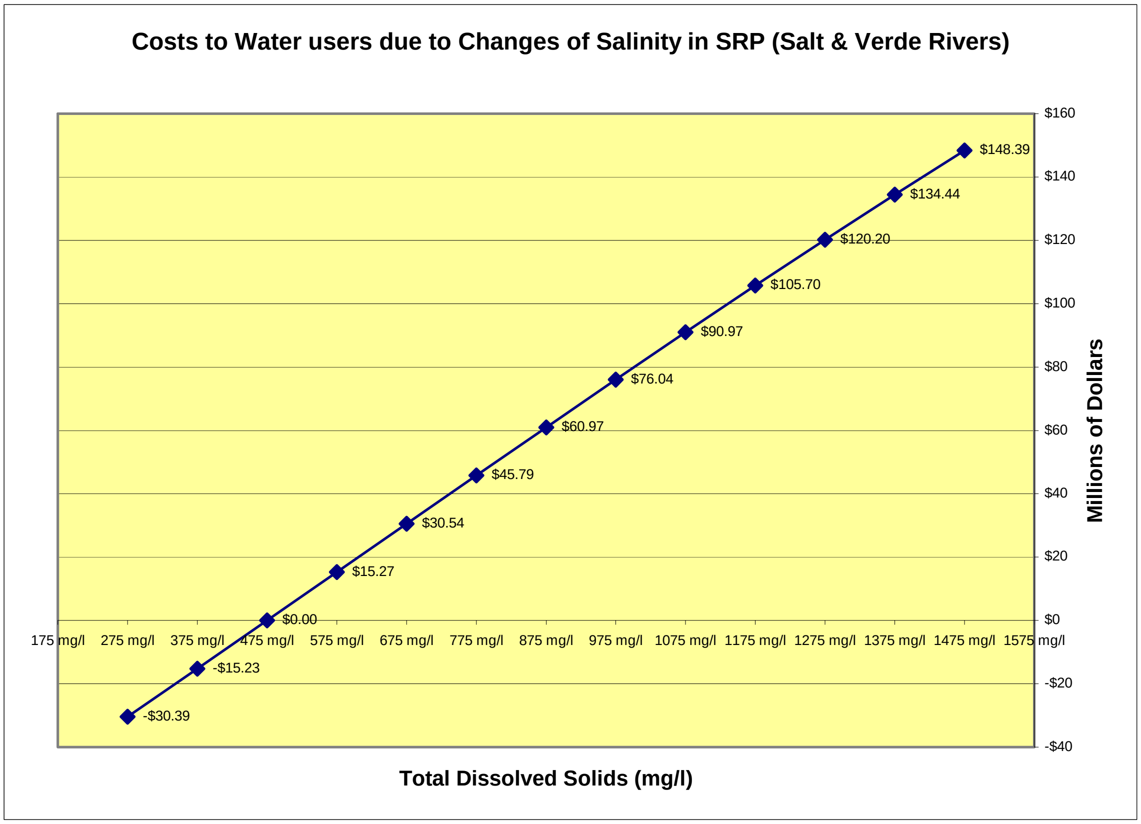
CAP salinity increase versus Weighted average TDS increase					
TDS	**Groundwater**	**Surface water**	**CAP**	**Effluent**	**Weighted Average**
Phoenix Metro	738	475	**649**	951	**621**
Phoenix Metro	738	475	**749**	951	**655**
Phoenix Metro	738	475	**849**	951	**689**
Water Use	**Groundwater**	**Surface water**	**CAP**	**Effluent**	
Phoenix Metro	410,000	750,500	667,000	130,000	

Table E-27

The final model analysis was to adjust the salinity level in the SRP rivers and also the CAP over a range of –200 mg/l to +800 mg/l from the base salinity level of the typical year.   Of course, when both the SRP and the CAP salinity levels were changed there was a larger increase in the salinity level of the weighted average then there was when only one of them was increased.

Results of economic analysis

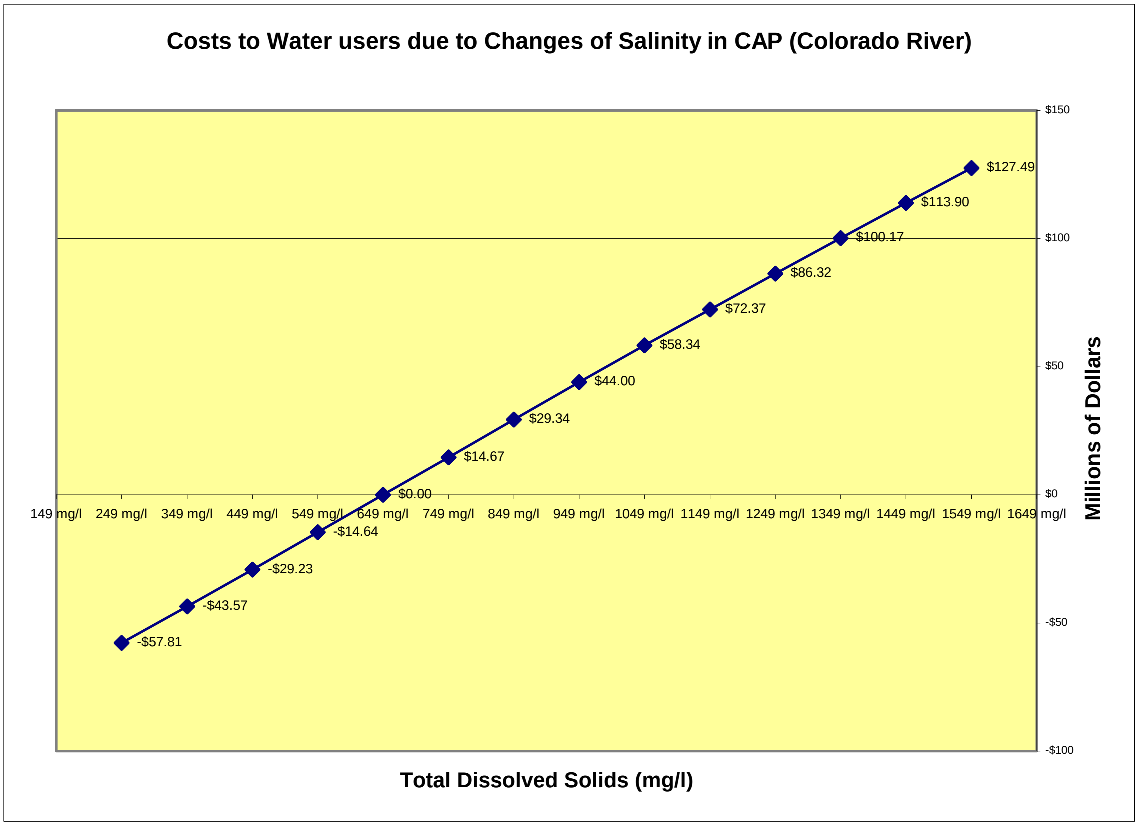
Graph E-1 shows the estimated economic impacts from incremental changes of 100 mg/l TDS in the Salt River and Verde River delivered by the Salt River Project (SRP) from a baseline of 475 mg/l TDS. The graph indicates that the economic impact is slightly above $15 million for each increase or decrease of 100 mg/l TDS. The economic impact is nearly linear with the change of salinity concentration in the Salt and Verde Rivers. These impacts show up only in the Phoenix Metropolitan area because that is the only place where the Salt and Verde River water is used.



Graph E-1

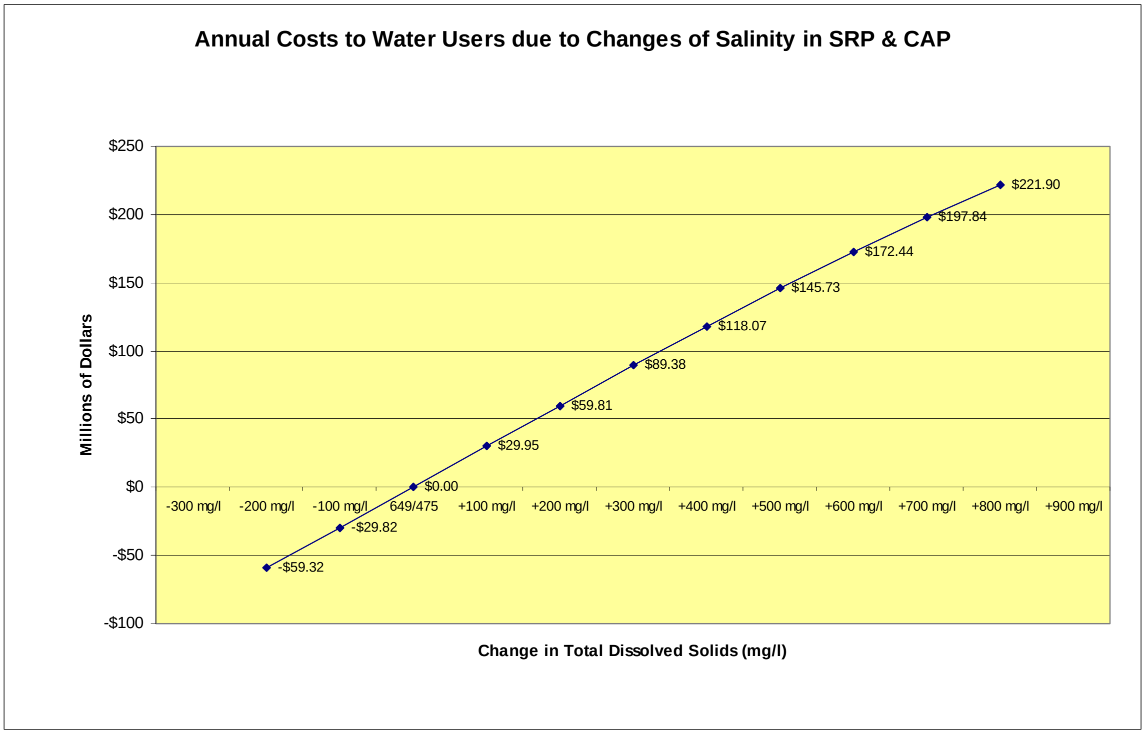
Next the salinity level in the CAP was changed by 100 mg/l TDS increments from a starting point of 649 mg/l TDS. Graph E-2 shows the results of that analysis. The costs are slightly less than $15 million annually for each increase or decrease of 100 mg/l TDS. The graph also indicates that the economic impacts are nearly linear with increasing salinity. The economic impacts due to changes in the salinity level of the CAP effects all the sub-areas except for Gila Bend.

While the economic impacts for CAP and SRP are both near $15 million per incremental change of salinity levels by 100 mg/l, it is just by chance that they are close to each other. In a typical year 1.35 million acre-feet of CAP water is used in the study area and 0.81 million acre-feet of SRP water is used in the study area. Although less SRP water is used, it is used for residential, industrial, commercial and agriculture, all of it in the Phoenix Metropolitan area. CAP water on the other hand is used through out Central Arizona and a greater portion of it is used for agriculture. Agriculture in Arizona is resistant to economic impacts from salinity because so many saline tolerant crops are grown, such as cotton, wheat, and barley. In addition, currently a good portion of CAP water is directly recharged into the ground. Recharged water does not have an economic impact in the model. (In actuality the degrading of the groundwater has an economic impact but it is not considered in the model.) There are many differences in how the CAP and SRP water is used in Central Arizona it just so happens that the economic impacts due to high salinity are nearly equal.



Graph E-2

Graph E-3 shows changes of salinity by 100 mg/l TDS in both the SRP and the CAP waters. As could be expected the impacts are a mathematical combination of the two previous runs, approximately $30 million of annual economic impacts per increase of salinity by 100 mg/l. The impacts are again nearly linear with increasing salinity levels.



Graph E-3

The data used to create the graphs is located in the final section of this chapter. Tables E-28, E-29 and E-30 show the costs incurred by different sectors of society in different areas of Central Arizona. The data shows that the majority of the economic impacts are in the Phoenix Metro area. There are a couple of apparent reasons for this; the Phoenix Metropolitan area uses the most water, has the most residents and the area has the most industry (industrial water processing costs are high). Conversely, Tucson has very minimal impacts because they are not directly using their CAP water at this time except for a small amount of crop irrigation. Tucson has no other surface water and depends on ground water for most of there needs. In the future Tucson will be using CAP water for commercial and residential uses through a recharge and recovery process and the impacts from salinity will increase.

Conclusions

Some conclusions can be reached from the modeling work. One is that if the salinity level of both the SRP and the CAP water is improved by 100 mg/l the savings to society would be about $30 million dollars a year. Residents incur about 45% of the impacts, but industry, commercial establishments and agriculture are also impacted. The economic impact is spread through out society and therefore the individual weight of the impact to any one person, community or business is easy not to great. Another conclusion drawn from the work is that there is not a particular “break point” where economic impacts rapidly improve or degrade. The results indicate that the impacts are pretty much linear. There is no "magic" range of water quality to shoot for to dramatically reduce the impacts to society. And finally it is very important to notice, as shown in Tables E-28, E-29 and E-30 that the vast majority of the economic impacts to Central Arizona are in the Phoenix Metropolitan area.

The model does not and can not grasp all the economic ramifications of importing high TDS water into Central Arizona. There are economic impacts that are not considered in the model. Such things as abandoned wells due to high TDS in the groundwater and the hidden cost of vast amounts of poor quality groundwater that is available but not able to be economically used are not considered. There are many more intangible impacts which are explored elsewhere in this report. The model is a rudimentary tool but it does give an idea of the magnitude of the annual impacts to society of the importing water high in TDS.

Economic Model Results

Table E-28

A. Sensitivity Analysis Runs. Using Typical Year Data. Baseline to measure damages -

Baseline = SRP TDS Typical Year Data

Economic Impacts to TDS Changes ($ million) 100 TDS Increments

Phoenix TDS =275	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$15,567,801	$4,751,386	$5,856,048	$3,390,076	$823,645	$30,388,956
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$15,567,801	$4,751,386	$5,856,048	$3,390,076	$823,645	$30,388,956

Phoenix TDS =375	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$7,813,738	$2,375,693	$2,928,024	$1,697,657	$414,063	$15,229,175
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$7,813,738	$2,375,693	$2,928,024	$1,697,657	$414,063	$15,229,175

Typical Year Salinity Conditions

Phoenix TDS =475	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$0	$0	$0	$0	$0	$0
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$0	$0	$0	$0	$0	$0

Phoenix TDS =575	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$7,843,470	$2,375,693	$2,928,024	$1,703,199	$418,617	$15,269,003
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$7,843,470	$2,375,693	$2,928,024	$1,703,199	$418,617	$15,269,003

Phoenix TDS =675	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$15,683,763	$4,751,386	$5,856,048	$3,411,447	$841,863	$30,544,506
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$15,683,763	$4,751,386	$5,856,048	$3,411,447	$841,863	$30,544,506

Phoenix TDS =775	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$23,485,357	$7,127,079	$8,784,073	$5,122,123	$1,269,816	$45,788,447
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$23,485,357	$7,127,079	$8,784,073	$5,122,123	$1,269,816	$45,788,447

Phoenix TDS =875	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$31,210,624	$9,502,771	$11,712,097	$6,839,113	$1,702,554	$60,967,159
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$31,210,624	$9,502,771	$11,712,097	$6,839,113	$1,702,554	$60,967,159

Phoenix TDS =975	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$38,820,495	$11,878,464	$14,640,121	$8,562,806	$2,140,159	$76,042,045
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$38,820,495	$11,878,464	$14,640,121	$8,562,806	$2,140,159	$76,042,045

Phoenix TDS =1075	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$46,275,288	$14,254,157	$17,568,145	$10,293,628	$2,582,712	$90,973,931
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$46,275,288	$14,254,157	$17,568,145	$10,293,628	$2,582,712	$90,973,931

Phoenix TDS =1175	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$53,535,688	$16,629,850	$20,496,169	$12,007,323	$3,030,299	$105,699,329
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$53,535,688	$16,629,850	$20,496,169	$12,007,323	$3,030,299	$105,699,329

Phoenix TDS =1275	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$60,563,830	$19,005,543	$23,424,193	$13,721,978	$3,483,006	$120,198,550
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$60,563,830	$19,005,543	$23,424,193	$13,721,978	$3,483,006	$120,198,550

Phoenix TDS =1375	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$67,324,468	$21,381,236	$26,352,218	$15,439,644	$3,940,921	$134,438,486
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$67,324,468	$21,381,236	$26,352,218	$15,439,644	$3,940,921	$134,438,486

Phoenix TDS =1475	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$73,786,167	$23,756,928	$29,280,242	$17,162,070	$4,404,134	$148,389,541
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$73,786,167	$23,756,928	$29,280,242	$17,162,070	$4,404,134	$148,389,541

Table E-29

A. Sensitivity Analysis Runs. Using Typical Year Data. Baseline to measure impacts -

CAP 649 TDS

Benefits from Reduced Salinity 649 TDS to 249 TDS

TDS =249	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$25,363,706	$7,792,313	$9,603,970	$6,644,618	$1,341,496	$50,746,104
2) Gila River IC	$37,843	$8,716	$0	$347,197	$0	$393,756
3) Harquahala	$8,280	$1,629	$0	$1,292,822	$0	$1,302,731
4) Tucson	$0	$0	$0	$9,384	$0	$9,384
5) Pinal	$1,262,686	$235,320	$381,905	$3,475,973	$0	$5,355,885
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$26,672,516	$8,037,979	$9,985,875	$11,769,994	$1,341,496	$57,807,860

TDS =349	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$19,107,238	$5,844,235	$7,202,977	$4,990,539	$1,010,574	$38,155,563
2) Gila River IC	$28,097	$6,537	$0	$246,795	$0	$281,429
3) Harquahala	$6,266	$1,222	$0	$1,082,689	$0	$1,090,177
4) Tucson	$0	$0	$0	$7,056	$0	$7,056
5) Pinal	$946,292	$176,490	$286,429	$2,628,069	$0	$4,037,281
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$20,087,893	$6,028,484	$7,489,406	$8,955,148	$1,010,574	$43,571,506

TDS =449	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$12,785,035	$3,896,157	$4,801,985	$3,331,912	$676,711	$25,491,799
2) Gila River IC	$18,531	$4,358	$0	$164,681	$0	$187,570
3) Harquahala	$4,202	$814	$0	$833,507	$0	$838,523
4) Tucson	$0	$0	$0	$4,730	$0	$4,730
5) Pinal	$629,580	$117,660	$190,953	$1,769,206	$0	$2,707,399
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$13,437,348	$4,018,990	$4,992,938	$6,104,035	$676,711	$29,230,020

TDS =549	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$6,410,875	$1,948,078	$2,400,992	$1,668,488	$339,866	$12,768,300
2) Gila River IC	$9,160	$2,179	$0	$82,381	$0	$93,720
3) Harquahala	$2,106	$407	$0	$421,744	$0	$424,258
4) Tucson	$0	$0	$0	$2,387	$0	$2,387
5) Pinal	$313,730	$58,830	$95,476	$886,039	$0	$1,354,076
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$6,735,871	$2,009,495	$2,496,469	$3,061,040	$339,866	$14,642,740

Typical Year Salinity Conditions

TDS =649	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$0	$0	$0	$0	$0	$0
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$0	$0	$0	$0	$0	$0

Increased Damages from 649 TDS

TDS =749	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$6,430,921	$1,948,078	$2,400,992	$1,673,841	$342,928	$12,796,761
2) Gila River IC	$8,935	$2,179	$0	$82,548	$0	$93,662
3) Harquahala	$2,091	$407	$0	$426,859	$0	$429,358
4) Tucson	$0	$0	$0	$2,402	$0	$2,402
5) Pinal	$310,298	$58,830	$95,476	$887,154	$0	$1,351,758
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$6,752,245	$2,009,495	$2,496,469	$3,072,805	$342,928	$14,673,941

TDS =849	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$12,863,877	$3,896,157	$4,801,985	$3,352,678	$688,960	$25,603,656
2) Gila River IC	$17,631	$4,358	$0	$165,220	$0	$187,210
3) Harquahala	$4,139	$814	$0	$841,916	$0	$846,869
4) Tucson	$0	$0	$0	$4,858	$0	$4,858
5) Pinal	$615,816	$117,660	$190,953	$1,777,332	$0	$2,701,761
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$13,501,463	$4,018,990	$4,992,938	$6,142,004	$688,960	$29,344,354

TDS =949	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$19,279,636	$5,844,235	$7,202,977	$5,033,657	$1,038,137	$38,398,643
2) Gila River IC	$26,078	$6,537	$0	$248,117	$0	$280,733
3) Harquahala	$6,114	$1,222	$0	$1,248,935	$0	$1,256,271
4) Tucson	$0	$0	$0	$13,426	$0	$13,426
5) Pinal	$915,197	$176,490	$286,429	$2,670,304	$0	$4,048,420
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$20,227,025	$6,028,484	$7,489,406	$9,214,439	$1,038,137	$43,997,492

TDS =1049	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$25,657,920	$7,792,313	$9,603,970	$6,720,715	$1,390,504	$51,165,422
2) Gila River IC	$34,265	$8,716	$0	$331,116	$0	$374,098
3) Harquahala	$7,989	$1,629	$0	$1,567,531	$0	$1,577,149
4) Tucson	$0	$0	$0	$35,960	$0	$35,960
5) Pinal	$1,207,102	$235,320	$381,905	$3,359,102	$0	$5,183,430
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$26,907,276	$8,037,979	$9,985,875	$12,014,424	$1,390,504	$58,336,059

TDS =1149	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$31,977,622	$9,740,392	$12,004,962	$8,414,221	$1,746,103	$63,883,301
2) Gila River IC	$42,183	$10,895	$0	$414,347	$0	$467,425
3) Harquahala	$9,738	$2,036	$0	$1,888,475	$0	$1,900,249
4) Tucson	$0	$0	$0	$58,583	$0	$58,583
5) Pinal	$1,490,247	$294,151	$477,382	$3,795,033	$0	$6,056,812
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$33,519,790	$10,047,474	$12,482,344	$14,570,659	$1,746,103	$72,366,371

TDS =1249	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$38,217,081	$11,688,470	$14,405,955	$10,114,575	$2,104,981	$76,531,062
2) Gila River IC	$49,826	$13,075	$0	$497,734	$0	$560,634
3) Harquahala	$11,341	$2,443	$0	$2,212,124	$0	$2,225,908
4) Tucson	$0	$0	$0	$81,195	$0	$81,195
5) Pinal	$1,763,431	$352,981	$572,858	$4,234,473	$0	$6,923,742
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$40,041,678	$12,056,969	$14,978,813	$17,140,101	$2,104,981	$86,322,541

TDS =1349	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$44,354,394	$13,636,549	$16,806,947	$11,801,214	$2,467,181	$89,066,285
2) Gila River IC	$57,189	$15,254	$0	$581,325	$0	$653,768
3) Harquahala	$12,785	$2,851	$0	$2,538,549	$0	$2,554,184
4) Tucson	$0	$0	$0	$112,812	$0	$112,812
5) Pinal	$2,025,574	$411,811	$668,334	$4,677,953	$0	$7,783,672
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$46,449,942	$14,066,464	$17,475,281	$19,711,852	$2,467,181	$100,170,720

TDS =1449	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$50,367,785	$15,584,627	$19,207,940	$13,485,531	$2,832,751	$101,478,633
2) Gila River IC	$64,268	$17,433	$0	$665,092	$0	$746,792
3) Harquahala	$14,066	$3,258	$0	$2,867,055	$0	$2,884,378
4) Tucson	$0	$0	$0	$155,646	$0	$155,646
5) Pinal	$2,275,753	$470,641	$763,811	$5,125,467	$0	$8,635,672
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$52,721,871	$16,075,958	$19,971,750	$22,298,790	$2,832,751	$113,901,121

TDS =1549	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$56,235,996	$17,532,705	$21,608,932	$15,173,508	$3,201,738	$113,752,879
2) Gila River IC	$71,063	$19,612	$0	$749,124	$0	$839,800
3) Harquahala	$15,190	$3,665	$0	$3,196,599	$0	$3,215,454
4) Tucson	$0	$0	$0	$198,540	$0	$198,540
5) Pinal	$2,513,225	$529,471	$859,287	$5,577,142	$0	$9,479,124
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$58,835,474	$18,085,453	$22,468,219	$24,894,913	$3,201,738	$127,485,797

Table E-30

A. Sensitivity Analysis Runs. Using Typical Year Data. Baseline to measure damages -
Baseline = CAP & SRP TDS Typical Year Data

Economic Impacts to TDS Changes ($ million) 100 TDS Increments

Phoenix TDS =449/275	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$28,086,394	$8,647,542	$10,658,033	$6,702,464	$1,485,856	$55,580,289
2) Gila River IC	$18,531	$4,358	$0	$164,681	$0	$187,570
3) Harquahala	$4,202	$814	$0	$833,507	$0	$838,523
4) Tucson	$0	$0	$0	$4,730	$0	$4,730
5) Pinal	$629,580	$117,660	$190,953	$1,769,206	$0	$2,707,399
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$28,738,706	$8,770,375	$10,848,986	$9,474,587	$1,485,856	$59,318,510

Phoenix TDS =549/375	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$14,177,749	$4,323,771	$5,329,017	$3,360,994	$750,250	$27,941,781
2) Gila River IC	$9,160	$2,179	$0	$82,381	$0	$93,720
3) Harquahala	$2,106	$407	$0	$421,744	$0	$424,258
4) Tucson	$0	$0	$0	$2,387	$0	$2,387
5) Pinal	$313,730	$58,830	$95,476	$886,039	$0	$1,354,076
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$14,502,745	$4,385,188	$5,424,493	$4,753,546	$750,250	$29,816,221

Typical Year Salinity Conditions

Phoenix TDS =649/475	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$0	$0	$0	$0	$0	$0
2) Gila River IC	$0	$0	$0	$0	$0	$0
3) Harquahala	$0	$0	$0	$0	$0	$0
4) Tucson	$0	$0	$0	$0	$0	$0
5) Pinal	$0	$0	$0	$0	$0	$0
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$0	$0	$0	$0	$0	$0

Phoenix TDS =749/575	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$14,274,337	$4,323,771	$5,329,017	$3,382,061	$765,335	$28,074,522
2) Gila River IC	$8,935	$2,179	$0	$82,548	$0	$93,662
3) Harquahala	$2,091	$407	$0	$426,859	$0	$429,358
4) Tucson	$0	$0	$0	$2,402	$0	$2,402
5) Pinal	$310,298	$58,830	$95,476	$887,154	$0	$1,351,758
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$14,595,661	$4,385,188	$5,424,493	$4,781,025	$765,335	$29,951,702

Phoenix TDS =849/675	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$28,440,826	$8,647,542	$10,658,033	$6,779,910	$1,546,216	$56,072,527
2) Gila River IC	$17,631	$4,358	$0	$165,220	$0	$187,210
3) Harquahala	$4,139	$814	$0	$841,916	$0	$846,869
4) Tucson	$0	$0	$0	$4,858	$0	$4,858
5) Pinal	$615,816	$117,660	$190,953	$1,777,332	$0	$2,701,761
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$29,078,412	$8,770,375	$10,848,986	$9,569,237	$1,546,216	$59,813,226

Phoenix TDS =949/775	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$42,271,454	$12,971,314	$15,987,050	$10,204,091	$2,343,119	$83,777,028
2) Gila River IC	$26,078	$6,537	$0	$248,117	$0	$280,733
3) Harquahala	$6,114	$1,222	$0	$1,248,935	$0	$1,256,271
4) Tucson	$0	$0	$0	$13,426	$0	$13,426
5) Pinal	$915,197	$176,490	$286,429	$2,670,304	$0	$4,048,420
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$43,218,843	$13,155,563	$16,273,479	$14,384,873	$2,343,119	$89,375,877

Phoenix TDS =1049/875	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$55,528,676	$17,295,085	$21,316,066	$13,603,739	$3,156,545	$110,900,111
2) Gila River IC	$34,265	$8,716	$0	$331,116	$0	$374,098
3) Harquahala	$7,989	$1,629	$0	$1,567,531	$0	$1,577,149
4) Tucson	$0	$0	$0	$35,960	$0	$35,960
5) Pinal	$1,207,102	$235,320	$381,905	$3,359,102	$0	$5,183,430
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$56,778,033	$17,540,751	$21,697,972	$18,897,448	$3,156,545	$118,070,748

Phoenix TDS =1149/975	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$67,984,712	$21,618,856	$26,645,083	$17,013,585	$3,987,012	$137,249,248
2) Gila River IC	$42,183	$10,895	$0	$414,347	$0	$467,425
3) Harquahala	$9,738	$2,036	$0	$1,888,475	$0	$1,900,249
4) Tucson	$0	$0	$0	$58,583	$0	$58,583
5) Pinal	$1,490,247	$294,151	$477,382	$3,795,033	$0	$6,056,812
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$69,526,880	$21,925,938	$27,122,465	$23,170,023	$3,987,012	$145,732,318

Phoenix TDS =1249/1075	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$79,444,196	$25,942,627	$31,974,100	$20,449,711	$4,835,062	$162,645,696
2) Gila River IC	$49,826	$13,075	$0	$497,734	$0	$560,634
3) Harquahala	$11,341	$2,443	$0	$2,212,124	$0	$2,225,908
4) Tucson	$0	$0	$0	$81,195	$0	$81,195
5) Pinal	$1,763,431	$352,981	$572,858	$4,234,473	$0	$6,923,742
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$81,268,794	$26,311,126	$32,546,958	$27,475,236	$4,835,062	$172,437,175

Phoenix TDS =1349/1175	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$89,766,843	$30,266,398	$37,303,116	$23,696,437	$5,701,258	$186,734,052
2) Gila River IC	$57,189	$15,254	$0	$581,325	$0	$653,768
3) Harquahala	$12,785	$2,851	$0	$2,538,549	$0	$2,554,184
4) Tucson	$0	$0	$0	$112,812	$0	$112,812
5) Pinal	$2,025,574	$411,811	$668,334	$4,677,953	$0	$7,783,672
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$91,862,391	$30,696,313	$37,971,451	$31,607,075	$5,701,258	$197,838,487

Phoenix TDS =1449/1275	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$98,885,903	$34,590,170	$42,632,133	$26,787,435	$6,586,189	$209,481,830
2) Gila River IC	$64,268	$17,433	$0	$665,092	$0	$746,792
3) Harquahala	$14,066	$3,258	$0	$2,867,055	$0	$2,884,378
4) Tucson	$0	$0	$0	$155,646	$0	$155,646
5) Pinal	$2,275,753	$470,641	$763,811	$5,125,467	$0	$8,635,672
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$101,239,990	$35,081,501	$43,395,944	$35,600,695	$6,586,189	$221,904,318

Phoenix TDS =1549/1375	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$106,818,509	$38,913,941	$47,961,149	$29,879,013	$7,490,470	$231,063,082
2) Gila River IC	$71,063	$19,612	$0	$749,124	$0	$839,800
3) Harquahala	$15,190	$3,665	$0	$3,196,599	$0	$3,215,454
4) Tucson	$0	$0	$0	$198,540	$0	$198,540
5) Pinal	$2,513,225	$529,471	$859,287	$5,577,142	$0	$9,479,124
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$109,417,988	$39,466,689	$48,820,437	$39,600,417	$7,490,470	$244,796,000

Phoenix TDS =1649/1475	Residential	Commercial	Industrial	Agriculture	Utilities	Total
1) Phoenix Metro Area	$113,665,558	$43,237,712	$53,290,166	$32,971,193	$8,414,743	$251,579,372
2) Gila River IC	$77,575	$21,791	$0	$833,369	$0	$932,735
3) Harquahala	$16,173	$4,072	$0	$3,530,006	$0	$3,550,251
4) Tucson	$0	$0	$0	$241,449	$0	$241,449
5) Pinal	$2,737,460	$588,301	$954,763	$6,031,298	$0	$10,311,822
6) Gila Bend	$0	$0	$0	$0	$0	$0
Total	$116,496,767	$43,851,876	$54,244,929	$43,607,314	$8,414,743	$266,615,630

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