Addendum to the Technical Report:

Rio Grande Salinity Management Program: Preliminary Economic Impact Assessment

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In the review process of the Preliminary Economic Impact Assessment Report there were suggestions for the economic analysis that were beyond the charge to the team. However, to provide insight relative to these ideas and suggestions, this addendum was developed. There are assumptions and estimated benefits included herein where further analysis would provide significant refinement which is recommended by the economics team.

Technical Report Addendum

Several members of the Rio Grande Salinity Management Coalition reviewed the report on preliminary economic estimates of Rio Grande salinity control. Many of the suggestions and comments were incorporated into the main report. However, some of the suggestions are more appropriately addressed in a supplement to the main report (this addendum). The primary suggestions and associated requests by the Salinity Coalition were to: 1) assume a different crop production mix than the existing cropping pattern in El Paso County, Texas to address underestimation of agricultural benefits attributable current cropping patterns; 2) calculate the present value impacts/benefit of a 200 mg/L reduction in salinity over a 50 year time horizon with the new cropping pattern for El Paso County assuming all other water uses and impacts remain the same as existing uses and impacts; and 3) include an estimate of El Paso urban supply treatment costs associated with non-irrigation season water use. These estimates are provided below.

Modified El Paso County Crop Production

The estimates for agricultural impacts and potential benefits of salinity reduction presented in the main report are based on current cropping patterns. Based on other studies and on experience, as salinity changes, so do cropping patterns. With increases in water and soil salinity, as are present in the study area, the crop mix by necessity shifts to more salt tolerant and usually lower value crops. As an indication of the potential for crop production in the region, the crops grown in the El Paso Valley in the late 1800's included fruits, vegetables and vineyards. From the book Salt Warriors: Insurgency on the Rio Grande by Paul Cool, Texas A&M University Press, 2008.

> *In 1852, J. D. B. De Bow, a leading antebellum proponent of southern industrial and commercial development, called El Paso "one continuous orchard and vineyard." William M. Pierson, the American vice consul in Paso del Norte, agreed. The Mexicans, he observed in 1872, had cultivated a "solid mass" of land ten miles long and six to ten miles wide. In comparison, the land under cultivation on the U.S. side was quite limited, perhaps five square miles each around Ysleta, Socorro, and San Elizario, with less around Franklin. In general, said Pierson, family farms were small, from ten to fifty acres in size. Beyond these farms, lay "a barren waste for many miles, where a few jack rabbits and horned frogs struggle for existence."*
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> *In the valley, Pierson reported, "The cereals attain great perfection and most especially all varieties of wheat. . . . Vegetables of all kinds known to the temperate zones develop finely, and attain a thrift and size rarely known in other portions of the United States. The famous El Paso Onion often reaches three to four pounds in weight, and is far more mild and palatable than the common onion of the North, while its yield to the acre is enormous." The vice consul extolled the "apple, pear, peach, quince, plum, cherry, raspberry, and strawberry" as equaling the best found anywhere in the States. According to the hyperbolic De Bow, "The most important productions of the valley is [sic] the grape, from which annually is manufactured not less than two hundred thousand gallons of perhaps the richest and best wine in the*

world. ... I doubt not that they are far superior to the best wines ever produced in the valley of the Rhine, or on the sunny hills of France." At two dollars per gallon, wine provided Paso del Norte's principle source of revenue. The vineyards, producing wine of "the first rank of North American specimens," were of special interest to Pierson. In one report, he drew the image of a "stalwart Mexican" pressing grapes with his "remarkably brawny feet." Produce not eaten by local residents traveled along trade routes stretching to Santa Fe in the north and Chihuahua in the south.

Over time, the quality of water and accumulation of salt in soils drove farmers in the El Paso area to adjust to more salt tolerant crops. Production of more profitable crops and potential shifts in cropping patterns with a hypothetical reduction in water salinity concentration depends on many factors such as crop salt tolerance, soil types and changes in soil salinity concentrations, yields, climate, market prices and net revenue, capital equipment required for different crops, agricultural/cultural production practices, and infrastructure.

Economic optimization models are the most frequently used and technically accepted method to estimate potential changes in crop production patterns. Use of these models would provide an improved method for calculating benefits to irrigated agriculture due to reduced salinity. These models provide estimated returns to land (profit) for the current cropping pattern and then develop the expected cropping pattern with reduced salinity and associated estimates of returns to land. This method would indeed provide an improved measure of benefits to agriculture from a reduction in salinity. However, these models require time and resources to produce robust, defensible estimates.

To provide a quick estimate of agricultural impacts in El Paso County with crops that could possibly be grown with improved salinity conditions, the Salinity Coalition asked that the cropping pattern for Doña Ana County, New Mexico (higher quality water and associated higher value crops that are more sensitive to salinity) be projected to El Paso County under the assumption of a reduced level of salinity. For this Doña Ana cropping pattern, the returns to land are estimated and compared to those for the current cropping pattern. This difference is the estimated annual benefits to irrigated agriculture where the cropping pattern adjusts with level of salinity.

The analysis employed in the main report estimated benefits from reduced salinity as a reduction in level of damages. The methodology employed here also measures the benefit as an increase in returns to land; that is the difference between the returns to land under current salinity levels and existing cropping pattern, with the associated yield losses and using a Doña Ana County cropping pattern that has higher returns to land (facilitated by the higher quality irrigation water) applied to existing EL Paso County acreage. We do not claim that a reduction in salinity would result in an immediate change in cropping pattern or even that Doña Ana cropping pattern would reflect a new cropping pattern. This would require extensive soil remediation and adoption of production and marketing practices used in Doña Ana. The per acre returns in this analysis also differ from the main report in that irrigation costs are accounted for separately.

The current cropping pattern in El Paso has a majority of acreage in cotton (55%) followed by pecan (26%). All other crops types are less than 10%. High value vegetable production is a very small percent of total acreage. In Doña Ana County, the dominant crop is pecans (26%) followed by cotton (21%), alfalfa (19%) then extensive vegetable production (onions, lettuce and chile). Alfalfa production which has a ready market with dairies located in Doña Ana County has the second highest return to land (note alfalfa production in southwestern irrigated areas is very different from Midwest or Eastern production – the volume and feed quality of the crop make it a high valued crop as opposed to more generic hay production). Additional alfalfa production would also need development of markets such as dairy to sustain the increased supply. Market outlets and infrastructure such as vegetable sheds and processing facilities would need to be developed for increased production of other crops such as vegetables. The source of water is another major difference between Doña Ana and El Paso Counties. Surface water in Doña Ana County is routinely supplemented with groundwater. In El Paso County groundwater is only used during drought conditions because of the elevated salinity levels in the groundwater.

As requested by the Coalition, Hudspeth County Conservation and Reclamation District #1 was not included in this revised analysis. The water district has both water quality and water quantity limitations. A Doña Ana type cropping pattern could not be sustained with the high variability of water supply; in particular it would too risky to grow pecans and other such crops.

Increase in Net Returns to Land in El Paso County

Table Addendum-1, indicates the estimate of current net returns to land (net income) for El Paso County with the existing cropping pattern. Table Addendum-2 indicates the returns to land based on the adoption of a Doña Ana cropping pattern and a 200 mg/L TDS reduction in water salinity to 635 mg/L.

The increase in returns to land (net income) to El Paso County agriculture with a 200 mg/L lower salinity concentration and assuming a Doña Ana County alternative cropping pattern is estimated to be $6,085,550 ($15,611,991 - $9,526,441).

Table Addendum-1: Returns to Land in Agricultural Production El Paso County with Damages from Current Salinity Levels of 835 mg/L TDS

	alfalfa	chile	pecans	onions	lettuce	small grains	corn	cotton	Pasture Other hay
Net returns per acre	$ 588.00	$ 1,036.57	$ 582.00	$ 167.00	$ 443.00	$ 24.00	$ 387.00	$ 97.10	$ 9.00
Yield loss ($)	$ 5.24	$ 86.20	$ -	$ 24.91	$ 47.45	$ -	$ 9.52	$ -	$ -
Net of yield losses	$ 582.76	$ 950.37	$ 582.00	$ 142.09	$ 395.55	$ 24.00	$ 377.48	$ 97.10	$ 9.00
Irrigation Costs									
AET (inches)	60.00	39.00	45.60	37.44	22.44	18.00	30.00	31.20	31.20
Leach Water (inches)	9.77	6.35	7.42	6.09	3.65	2.93	4.88	5.08	5.08
Per Acre water use (acre-feet)	5.81	3.78	4.42	3.63	2.17	1.74	2.91	3.02	3.02
Water Costs	37.44	31.34	33.26	30.88	26.52	25.23	28.72	29.07	29.07
Net Returns after water costs	545.32	919.03	548.74	111.21	369.03	(1.23)	348.76	68.03	(20.07)
Crop acreage	3,346	248	10,534	909	207	2,602	-	22,595	867
Total Returns to Land (net income)	$ 9,526,441								

Table Addendum-2: Returns to Land in Agricultural Production for El Paso County with Damages from Reduced Salinity Levels of 635 mg/L (200 mg/L TDS Reduction in Salinity)

	alfalfa	chile	pecans	onions	lettuce	small grains	corn	cotton	Pasture Other hay
Net returns per acre	$ 588	$ 1,037	$ 582	$ 167	$ 443	$ 24	$ 387	$ 97	$ 9
Yield loss ($)	$ -	$ -	$ -	$ 8.66	$ 12.74	$ -	$ -	$ -	$ -
Net of yield losses	$ 588.00	$ 1,036.57	$ 582.00	$ 158.34	$ 430.26	$ 24.00	$ 387.00	$ 97.10	$ 9.00
Irrigation Costs									
AET (inches)	60.00	39.00	45.60	37.44	22.44	18.00	30.00	31.20	31.20
Leach Water (inches)	10.59	6.88	8.05	6.61	3.96	3.18	5.29	5.51	5.51
Per Acre water use (acre-feet)	5.88	3.82	4.47	3.67	2.20	1.76	2.94	3.06	3.06
Water Costs	$ 43.53	$ 35.29	$ 37.88	$ 34.68	$ 28.80	$ 27.06	$ 31.76	$ 32.24	$ 32.24
Net Returns after water costs	$ 544.47	$ 1,001.28	$ 544.12	$ 123.66	$ 401.46	$ (3.06)	$ 355.24	$ 64.86	$ (23.24)
Crop acreage	7,857	1,702	12,556	2,837	804	1,351	4,434	8,847	912
Total Returns to Land (net income)	$ 15,611,991								
Net Gain in income	$ 6,085,550								

Benefits of a 200 mg/L Reduction in Salinity Beginning at San Acacia

With a reduction in salinity concentration there are two types of agricultural production benefits, (1) reduced damages from original salinity levels and (2) increased benefits from re-optimization of the cropping pattern for El Paso County. Table Addendum-3 indicates the level of damages with the 200 mg/L TDS reduction in salinity.

Table Addendum-3: Estimate of Salinity Damages with a 200 mg/L TDS Reduction in Salinity

Type of Use		
Agricultural[1]	$	1,575,999
Residential El Paso County	$	1,935,710
Landscape	$	305,900
Commercial/Other	$	711,073
Industrial/Large Users	$	138,833
Treatment Plants	$	53,186
	$	4,720,700

1. Estimate of agricultural damages does not include El Paso County because of the method necessary to calculate the benefit change attributable to the cropping pattern adjustment.

It is important to note that because of the methods necessary to impose a new cropping pattern in El Paso County the damages at current salinity levels and the decreased damages do not correspond with the estimates in the main report. With the cropping patterns adjustment, the relevant measure for El Paso agriculture benefits is not reduced damages but rather an increase in the returns to land.

The total estimated benefits from salinity reduction including the revised agricultural cropping pattern in El Paso County are shown in Table Addendum-4. This estimate of the benefit of a 200 mg/L salinity reduction is more than double the damage estimate in the main report. Most of these increased benefits ($6.1 million) results from the assumption of Doña Ana agriculture production (cropping pattern) in El Paso County. With this assumption, total annual estimated benefits of a 200 mg/L reduction in Rio Grande salinity concentration throughout the entire study area is estimated to be $10.851 million.

Table Addendum-4: Benefits of a 200 mg/L TDS Decrease in Salinity from San Acacia, NM to Fort Quitman, TX and Using Doña Ana Cropping Pattern for El Paso County

Reduced Damages	All Users
Damage at Current Salinity Levels[1]	$9,486,790
Damages with a 200 mg/L TDS decrease[1]	$4,720,700
Reduced damage benefit	$4,766,090
El Paso County Benefits with salinity reduction and Change in El Paso County Crop Pattern	$6,085,550
Total estimated benefits from 200 mg/L TDS reduction	$10,851,640

1. Estimate of damages does not include El Paso County agriculture because of the method necessary to calculate the benefit change attributable to the cropping pattern adjustment.

Present Value of Salinity Reduction Benefits

Remediation of salinity concentrations in the Rio Grande would be expected to produce benefits over an extended period of time. Coalition members asked for a present value estimate of such benefits over a 50 year time horizon, the length of the Texas State Water Planning period. Future annual estimated benefits are discounted to a present value by applying the federally published discount rate set by the Office of Management and Budget. The current social real discount rate (without inflation) for capital projects with a life cycle of 30 years or more is 2.7% (http://www.whitehouse.gov/omb/circulars_a094_a94_appx-c/). Using this federal discount rate, a 50 year salinity control project horizon, and annual net benefits of $10,852,000 from a 200 mg/L TDS reduction in Rio Grande salinity concentration for the study region, the present value of benefits over 50 years is estimated to be $296 million.

It is important to note this estimate assumes Doña Ana County cropping patterns in El Paso County, no other changes in agricultural or urban Rio Grande supplied water use, base salinity concentrations, cropping patterns, residential, commercial or industrial equipment and appliance technology and prices, or changes in agricultural and urban water prices over the 50 year period.

Non-Irrigation Season Water Use for El Paso Urban Supply

The Coalition also suggested possible consideration of non-irrigation season salinity impacts related to operation of the El Paso Water Utility surface treatment plant. El Paso Water Utilities provided two sets of costs figures to assist with this additional analysis. One set of figures were estimates of capital and operating costs of a possible future membrane treatment facility to reduce the salinity of non-irrigation season return flows (from all sources) to levels suitable for urban water supply. The EPWU information received on possible membrane treatment is provided below followed by calculation of total treatment cost using these figures. This is followed by estimated costs and benefits of a potential 'new' source of water.

Salinity Reduction Treatment Cost Information Provided by El Paso Water Utilities

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The costs to produce water at the Canal Plant during the non-irrigation season are shown below. The salinity of the water was assumed to be 1,400 mg/L as the base case, and then costs were developed for higher TDS conditions:

Case	TDS	Capital Cost	O&M Cost	Total Cost
Base	1400	$0.76	$0.11	$0.87
20%	1680	$0.78	$0.34	$1.12
50%	2100	$0.81	$0.72	$1.53

You can see the capital cost does not increase significantly in this range. So, if we were to build a plant, we would probably chose to build a plant that could handle a 50% increase in TDS over the base case, but knowing most operating would be done at the $0.11 cost. Costs are per thousand gallons.

These estimated capital and operating costs at the Canal Plant are to treat 10 mgd during the non-irrigation season assuming that we could do that for four months using a membrane addition to the plant. This will represent the cost of having poor drinking water quality during that period that necessitates a shutdown.

Using these EPWU figures and the assumptions of treating 10 mgd of non-irrigation season surface water with a salinity concentration of 1,400 mg/L to urban water use standards for four months would result in a cost of $1,044,000. This represents estimated salinity reduction treatment costs during the non-irrigation season at approximately the long-term non-irrigation season river flow salinity concentration for a possible future plant using a source of water not currently being used because of both water quality and quantity limitations. This is a potential

future additional cost of urban water supply for El Paso attributable to elevated Rio Grande salinity concentrations. This cost can and should be compared to other potential salinity reduction management alternatives as part of the decision support process to determine which management method(s) are most cost effective.

Dilution of Brackish Groundwater with Surface Water to Create Additional Supply

El Paso Water Utilities also provided potential future additional water supply cost estimates (Addendum Table-5). The potential future water supply assumes a "new water source", inexpensive brackish (3,000 mg/L) groundwater that could possibly be blended with up to 20,000 acre-feet of Rio Grande water. Several hypothetical Rio Grande salinity concentration reduction levels were calculated by EPWU to estimate the quantity of brackish water that could be blended through dilution to a combined water source concentration of 750 mg/L TDS. The cost comparison and potential benefits are based on the relative supply costs of brackish water ($35 per acre-foot) and surface water ($300 per acre-foot). According to EPWU, at the current irrigation season surface water salinity concentration of 835 mg/L TDS no brackish water would be blended and the supply would consist of all surface water at a cost of $6,000,000 for 20,000 acre-feet of urban supply. With an assumed reduction of 235 mg/L TDS the surface water concentration would be 600 mg/L allowing 1,250 acre-feet of inexpensive brackish groundwater to be blended to a combined concentration of 750 mg/L for a total 'new' blended supply of 20,000 acre-feet. The estimated benefit or savings with blending with a 235 mg/L TDS improvement in surface water salinity is $331,250. This savings is because of the cost difference between surface water and brackish water. Reducing surface water salinity concentrations could enable brackish water to be used for blending which could extend surface water supplies.

The two sets of cost estimates provided by El Paso Water Utilities represent future potential conditions. The first would require construction of new membrane treatment facilities at the Canal Plant to reduce surface water salinity concentrations and also initiate the use of non-irrigation return flows. The second set of cost estimates is the future possibility of using improved quality surface water to enable the blending of brackish water and has the potential to provide cost savings and extend surface water supplies. The estimated cost savings of both of these potential future strategies will provide a good comparison when analyzing the cost effectiveness and efficiency of salinity reduction management alternatives. However, both of these cost estimates are not compatible or consistent with the salinity damages calculated in the **Preliminary Economic Impact Assessment Report** and they cannot simply be added to the economic impact assessment report's damage or benefit estimates.

The Preliminary Economic Impact Assessment Report calculations are for economic damages in agricultural production and urban water uses based on damages to equipment, appliances and landscape irrigation costs under current conditions and specified salinity concentrations. As requested by the Coalition, the Preliminary Economic Impact Assessment also analyzed the potential benefits (reduction in damages) of a 200 mg/L TDS reduction in salinity. Fundamental differences in the Assessment Report and water treatment/new water supply estimates include the fact that damages are not the same as treatment costs or potential future water supply savings. In the cases of water treatment costs and future water supply savings, the costs and savings need

to be compared to the lowest cost/highest savings alternatives to determine the impacts and potential benefits. In addition, the treatment costs and new water supply savings assume different salinity concentration levels than those calculated in the Preliminary Economic Impact Assessment and are not comparable (1,400 mg/L TDS to some drinking water standard level and from a surface water supply of 835 mg/L to 600 mg/L TDS, a 235 mg/L change). Even if blending cost savings were comparable to the Assessment Report calculations, the assumed blended finished water quality of 750 mg/L is not consistent or comparable with damage estimates based on 835 mg/L TDS or reduced salinity concentrations impacts of 635 mg/L TDS.

Again, while these supplemental cost and savings estimates are not compatible or consistent with the salinity damages calculated in the Preliminary Economic Impact Assessment Report and cannot be added to the economic impact assessment report's damage or benefit estimates, the estimated cost savings of both of these potential future strategies will provide a good comparison when analyzing the cost effectiveness and efficiency of salinity reduction management alternatives to be conducted in Phase II of the Rio Grande Salinity Management Program.

Addendum Table-5:

Potential Future Additional Water Supply Cost and Benefit Estimate Spreadsheet Provided by El Paso Water Utilities

Dilution of Brackish Groundwater and Surface Water to create additional supply

Cost Comparison

Concentration of Surface Water (mg/l)	835	600	500	400	300
Concentration of Brackish Water (mg/l)	NA	3,000	3,000	3,000	3,000
Concentration of "New Source Water" (mg/l)	750	750	750	750	750
Volume of Brackish Water (acre-feet)	NA	1,250	2,000	2,700	3,330
Volume of Surface Water (acre-feet)	20,000	18,750	18,000	17,300	16,670
Volume of "New Water Source" (acre-feet)	20,000	20,000	20,000	20,000	20,000
Cost of Brackish Water	NA	43,750	70,000	94,500	116,500
Cost of Surface Water	6,000,000	5,625,000	5,400,000	5,190,000	5,001,000
Cost of "New Water Source"	6,000,000	5,668,750	5,470,000	5,284,500	5,117,500
Savings from "New Water Source"	0	331,250	530,000	715,500	882,500

The baseline concentration of 835 mg/l is the average TDS concentration of surface water that is currently processed by the EPWU surface water treatment plants during the irrigation season.

Comparison showing the costs of "New Water Sources" made by dilution of brackish groundwater with surface water
For this analysis, TDS of the surface water varies from 835 mg/l to 300 mg/l.

The volume of the "New Water Source" is 20,000 acre-feet.
The TDS of the "New Water Source" is 750 mg/l.

Cost of brackish water in the analysis is $35 per acre-foot. Surface water cost is $300 per acre foot.