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Validating the Estimated Cost of Saving Water Through Infrastructure Rehabilitation in the Texas Lower Rio Grande Valley

A Case Study Using Actual Construction Costs for the Interconnect and Pumping Plant Project, Cameron County Irrigation District No. 2 (San Benito)

by:

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Background

The original economic analysis reporting on the Interconnect (between Canals 39 and 13-A1) and Pumping Plant project for Cameron County Irrigation District No. 2 (CCID2) was reported in March 2003 in Texas Water Resources Institute TR-212, entitled "*Economic and Conservation Evaluation of Capital Renovation Projects: Cameron County Irrigation District No. 2 (San Benito) – Interconnect Between Canals 39 and 13-A1 and Replacement of Rio Grande Diversion Pumping Plant* (Rister et al. 2003)." Subsequent to that report's release, the project was installed and implemented within the District's water-delivery infrastructure system, with actual construction costs thereby becoming known. Further, the U.S. Bureau of Reclamation (USBR) was/is the agency tasked with oversight of federal legislation providing construction funding for up to a potential maximum 50% of this project's cost (U.S. Public Law 107-351). Additional funding was provided by the North American Development Bank for construction, as well as from the Texas Water Development Board (TWDB) for this district's use toward engineering planning and design costs.

To gauge this project's merit (with other, similar projects proposed by other irrigation districts (IDs)), three federally-required evaluation-criterion values and a 'comprehensive' estimate of the *cost-of-saving-water* were calculated and reported in TR-212. In a review of the project's plan, the USBR and TWDB considered and relied upon these data in their evaluation processes.

As a follow-up and as part of due diligence to the oversight mandate, the USBR wishes to validate the original federally-required criteria and the comprehensive *cost-of-saving-water* estimate, to the extent possible, by using the actual construction costs (as opposed to the estimate used in TR-212). The request by USBR for a follow-up analysis and a brief report on revised 'final' key results, using the actual construction expense, was the impetus to this special report.

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Component #1: Interconnect between Canals 39 and 13-A1

Review of Project Data

The capital improvement project proposed (in March 2003) by the District to the USBR involved the enlarging of 6,600 feet of existing Canal 39 and connecting it to a new 6,000-foot segment of canal to be dug which resulted in an 'interconnect' between Canals 39 and 13-A1. Once readied, the combined 12,600 ft segment was lined with a geomembrane liner and a concrete cover. Expected water-saving benefits included net reduced seepage and evaporation with the lining's installation. Below are key data-input information on the project; for a detailed review, refer to the original report (Rister et al. 2003):

Table 1. Summary of Key Project Data Incorporated Into the Comprehensive Analysis for the Interconnect Project Component, CCID2, 2003 and 2006.

Item	Value in Original Analysis (i.e., in TR-212)	Value in this Final Analysis
Initial Construction Costs	$ 3,585,300	$ 3,278,276
Installation Time Period	1 year	. . . . . same
Expected Useful Life	49 years	. . . . . same
Net Change in Annual O&M ($)	$ 1,704	. . . . . same
Annual Water Savings (ac-ft) - net		
off-farm (seepage)	3,199.0	. . . . . same
off-farm (evaporation)	586.1	. . . . . same
on-farm (percolation)	5,771.4	. . . . . same
total	9,556.5	. . . . . same
Cumulative Water Savings (ac-ft)		
nominal	468,267	. . . . . same
real (i.e., time adjusted)	196,105	. . . . . same
Annual Energy Savings - net		
BTU	1,081,164,224	. . . . . same
kwh	316,871	. . . . . same
$'s	$ 20,071	. . . . . same

As shown in **Table 1**, the original estimated initial capital construction costs totaled $3,585,300 with the revised, actual value equaling $3,278,276 (Balcombe). The installation period was projected to take one year, with an ensuing expected useful life of 49 years. No losses of operations or other adverse impacts were anticipated (nor did they occur) as installation occurred in the 'off-season' for irrigating. These values are unchanged in the revised analysis reported here.

Further, the net annual increase in operation and maintenance (O&M) expenses of $1,704 is assumed to remain applicable. As the Interconnect project expands the water-delivery infrastructure, a slight increase in O&M is expected (**Table 1**). Both *off-* and *on-farm* water savings are/were anticipated for the lining and interconnect, with the nominal total equaling 468,267 ac-ft over the 49-year productive life of this component and the real total (i.e., adjusted for time preference) equaling 196,105 ac-ft. Annual *off-farm* water savings estimates are based on reduced seepage of 3,199.0 ac-ft and reduced evaporation of 586.1 ac-ft. Annual *on-farm* water savings of 5,771.4 ac-ft are predicted from increased head pressure at farm-diversion points that reduce field percolation losses, assuming increased head from 0.5 to 1.2-1.5 head on the effected 6,146.3 acres of crop land.

Associated estimates of annual energy savings (which serve as a 'credit' against the initial construction costs) are 1,081,164,224 BTU (316,871 kwh). Multiplying these savings with historical per-unit energy costs (incurred by the District) results in an annual energy savings of $20,071 (**Table 1**). Energy savings are/were based on reduced Rio Grande diversions and reduced relifting for this project component.

Updated (Abridged) Results: *Cost-of-Saving-Water* and Three Legislative Values

As depicted in **Table 2**, the revised comprehensive cost of saving water ($/ac-ft) with the new interconnect is estimated to be $20.51 per ac-ft, in contrast to the original estimate of $22.68. This value is determined by dividing the annuity equivalent of net costs for water savings of $187,197 per year by the annuity equivalent of water savings of 9,129 annual ac-ft (**Table 2**).

In addition, expected real values are shown for the USBRs three principal evaluation measures specified in U.S. Public Law 106-576 (U.S. Public Law 106-576). The initial construction cost per ac-ft of water savings measure is $16.72 per ac-ft of water savings versus the original estimate of $18.28. The initial construction cost per BTU (kwh) of energy savings measure is $0.0001478 per BTU ($0.504 per kwh), versus the original estimate of $0.0001616 ($0.551 per kwh). The ratio of initial construction costs per dollar of total annual economic savings is estimated to be -8.66, rather than the initial -9.47 (**Table 2**).

Table 2. Summary of Intermediate Data and Abridged Results for the Interconnect Component for the Original 2003 Estimate and the Revised 2006 Calculations, CCID2.

	Interconnect Project [1, 2] (enlarging/extending/lining Canals 39 & 13-A1)	
	Original 2003 Analysis (i.e., in TR-212)	This Final 2006 Analysis
~ Intermediate Calculations ~		
Annuity Equivalent of Net Cost Stream (for Water Savings) – $/yr	$ 207,017	$ 187,197
Annuity Equivalent of Water Savings (ac-ft/yr)	9,129	. . . . . same
~ Abridged Results ~ [3]		
Comprehensive Cost-of-Saving-Water ($/ac-ft)	**$ 22.68**	**$ 20.51**
Legislative Evaluation Criteria [4]		
$ of ICC per ac-ft saved	$ 18.28	$16.72
$ of ICC per BTU saved	$ 0.0001616	$ 0.0001478
$ of ICC per kwh saved	$ 0.551	$ 0.504
$ of ICC per $ of annual savings	-9.474	-8.663

1 Note this table reports similar summary information as that provided in Table ES1 and Table A2 in the original report (Rister et al. 2003).

2 For sake of comparison, the 2006 abridged results were calculated as if the revised analysis was done in 2003 to provide a 'side-by-side' comparison, rather than imposing the effects of a different discount period (i.e., 2003-2052 vs 2006-2055).

3 Real values (vs nominal), calculated using a 6.125% discount factor for dollars, a 4.000% discount factor for water, and a 2.04% inflation rate.

4 Note ICC is abbreviation for 'Initial Construction Costs', which makes for a more reader-friendly table.

Sensitivity Analyses

The certainty of the construction costs for this analysis reduces the total uncertainty about the exactness of the original results. Nonetheless, some uncertainty of the preciseness of this revised estimate persists, as other data-input uncertainties remain (e.g., water savings level, energy costs/savings, etc.).

The following sensitivity results (**Tables 3** and **4**) for the cost-of-saving-water are presented whereby two parameters are varied with all others remaining constant. This permits testing of the stability (or instability) of key input values and illustrates how sensitive results can be to variances in data input levels.

Table 3 reveals a range in the cost-of-saving-water from $12.68 to $46.02 (per ac-ft) around the baseline estimate of $20.51. These calculated values were derived by varying the water savings from the new interconnect from as low as 4,778 ac-ft up to 14,335 ac-ft (i.e., from as low as 50%, and as high as 150% of the expected 9,556.5 ac-ft) and by investigating a range of net changes in annual O&M costs (+/- 10%, 20%, 30%) about the anticipated $1,704. As expected, lower water savings and/or higher increases in O&M costs (than the anticipated) result in higher cost estimates. Conversely, lower increases in O&M costs and/or higher water savings provide for a lower cost estimate.

Table 4 reveals a range in the cost-of-saving-water estimates from $12.73 to $97.28 (per ac-ft) around the baseline estimate of $20.51. These calculated values were derived by varying the water savings from the new Interconnect from as low as 4,778 ac-ft up to 14,335 ac-ft (i.e., from as low as 50%, and as high as 150% of the expected 9,556.5 ac-ft) and by investigating a range of expected useful lives of the Interconnect from the expected 49-year life, down to as low as only 10 years. As expected, shorter-useful lives and/or lower water savings (than the estimated baseline) result in higher cost estimates. Conversely, longer useful lives and/or higher water savings provide lower cost-of-saving-water estimates.

Table 3. Sensitivity Results of the *Cost-of-Saving-Water* for the Interconnect (Between Canals 39 and 13-A1) Project Component – Varying the Amount of Annual Water Saved and Annual O&M Costs, CCID2, 2006.

		variation in water saved									
		50%	60%	70%	80%	90%	**100%**	110%	120%	130%	150%
		Annual estimated water savings (ac-ft) for the Interconnect Project									
		4,778	5,734	6,690	7,645	8,601	**9,556.5**	10,512	11,468	12,423	14,335
Net Changes to Annual O&M Costs ($) [1]	-30%	$45.71	$34.94	$31.18	$25.52	$23.35	$20.43	$18.46	$16.10	$15.11	$12.68
	-20%	$45.76	$34.98	$31.21	$25.55	$23.38	$20.46	$18.48	$16.12	$15.13	$12.69
	-10%	$45.81	$35.02	$31.25	$25.58	$23.40	$20.48	$18.50	$16.14	$15.15	$12.71
	$1,704	$45.87	$35.06	$31.28	$25.61	$23.43	**$20.51**	$18.53	$16.16	$15.17	$12.73
	+10%	$45.92	$35.10	$31.32	$25.64	$23.46	$20.53	$18.55	$16.18	$15.19	$12.74
	+20%	$45.97	$35.15	$31.36	$25.67	$23.49	$20.56	$18.57	$16.20	$15.21	$12.76
	+30%	$46.02	$35.19	$31.39	$25.70	$23.52	$20.58	$18.59	$16.22	$15.22	$12.77

[1] Anticipated baseline net changes to O&M costs are positive $1,704 (i.e., an increase is expected); thus, a sensitivity-test reduction (e.g., -30%) makes for a lower annual increase (than the baseline) in O&M costs, and vice versa.

Table 4. Sensitivity Results of the *Cost-of-Saving-Water* for the Interconnect (Between Canals 39 and 13-A1) Project Component – Varying the Amount of Annual Water Saved and Expected Useful Life, CCID2, 2006.

		variation in water saved									
		50%	60%	70%	80%	90%	**100%**	110%	120%	130%	150%
		Annual estimated water savings (ac-ft) for the Interconnect Project									
		4,778	5,734	6,690	7,645	8,601	**9,556.5**	10,512	11,468	12,423	14,335
Expected Useful Life (years)	10	$97.28	$74.37	$66.35	$54.33	$49.70	$43.49	$39.29	$34.28	$32.17	$26.99
	20	$62.59	$47.85	$42.69	$34.95	$31.98	$27.98	$25.28	$22.06	$20.70	$17.37
	25	$56.21	$42.98	$38.34	$31.39	$28.72	$25.13	$22.70	$19.81	$18.59	$15.60
	30	$52.25	$39.94	$35.64	$29.18	$26.69	$23.36	$21.10	$18.41	$17.28	$14.50
	40	$47.85	$36.58	$32.64	$26.72	$24.45	$21.39	$19.33	$16.86	$15.82	$13.28
	49	$45.86	$35.06	$31.28	$25.61	$23.43	**$20.51**	$18.52	$16.16	$15.17	$12.73

Component #2: Pumping Plant Replacement

Review of Project Data

The capital improvement project proposed (in March 2003) by the District to the USBR involved the construction of a new Rio Grande diversion pumping plant to replace the original one located near Los Indios, Texas. Expected water-saving benefits included the District's continued and insured diversion and delivery capabilities for years to come and improvements in operational efficiencies and capacities. Below are key data-input information on the project; for a detailed review, refer to the original report (Rister et al. 2003):

Table 5. Summary of Key Project Data Incorporated Into the Comprehensive Analysis for the Pumping Plant Replacement Component, CCID2, 2003 and 2006.

Item	Value in Original Analysis (i.e., in TR-212)	Value in this Final Analysis
Initial Construction Costs	$ 9,715,000	$ 7,273,360
Installation Time Period	2 year	. . . . . same
Expected Useful Life	48 years	. . . . . same
Net Change in Annual O&M ($)	($ 431,195)	. . . . . same
Annual Water Savings (ac-ft)		
off-farm (diversion of no-charge)	2,380.2	. . . . . same
on-farm	0.0	. . . . . same
total	2,380.2	. . . . . same
Cumulative Water Savings (ac-ft)		
nominal	114,250	. . . . . same
real (i.e., time adjusted)	46,643	. . . . . same
Annual Energy Savings		
BTU	2,700,210,150	. . . . . same
kwh	791,386	. . . . . same
$'s	$ 48,554	. . . . . same

As shown in **Table 5**, the original estimated initial capital construction costs totaled $9,715,000 with the revised, actual value being $7,273,360 (Balcombe). The installation period was projected to take two years, with an ensuing expected useful life of 48 years. No losses of operations or other adverse impacts were anticipated (nor did they occur) as installation occurred while the original pumping plant was still in operation. These values remained unchanged in the revised analysis reported here.

Further, the net annual decrease in operation and maintenance (O&M) expenses of $431,195 is assumed to remain applicable. As the new pumping plant project replaces an aged and dilapidated one, the base, annual O&M expenses are significantly improved (**Table 5**). Only *off-farm* water savings are/were anticipated for the new pumping plant, with the nominal total equaling 114,250 ac-ft over the 48-year productive life of this component and the real total (i.e., adjusted for time preference) equaling 46,643 ac-ft. Annual *off-farm* water savings estimates are based on the annual capture of 2,380.2 ac-ft of additional no-charge water, which is provided for by new pumps capable of lifting 50 cfs of water, twice a month.

Associated estimates of net annual energy savings (which serve as a 'credit' against the initial construction costs) are 2,700,210,150 BTU (791,386 kwh). Multiplying these savings with historical per-unit energy costs (incurred by the District) results in a net annual energy savings of $48,554 (**Table 5**). Energy savings are/were based on an estimated 28.2% improvement in energy consumption associated with the new facility's pumps and motors, and eliminated recirculating of water from the older pumping plant back to the Rio Grande (i.e., the walls leaked and required water to be pumped out).

Updated (Abridged) Results: *Cost-of-Saving-Water* and Three Legislative Values

As depicted in **Table 6**, the revised comprehensive cost of saving water ($/ac-ft) with the new pumping plant is estimated to be $46.82 per ac-ft, in contrast to the original estimate of $119.41. This value is determined by dividing the annuity equivalent of net costs for water savings of $101,649 per year by the annuity equivalent of water savings of 2,171 annual ac-ft (**Table 6**).

In addition, expected real values are shown for the USBRs three principal evaluation measures specified in U.S. Public Law 106-576 (U.S. Public Law 106-576). The initial construction cost per ac-ft of water savings measure is $155.94 per ac-ft of water savings versus the original estimate of $208.29. The initial construction cost per BTU (kwh) of energy savings measure is $0.0001375 per BTU ($0.469 per kwh), versus the original estimate of $0.0001836 ($0.626 per kwh). The ratio of initial construction costs per dollar of total annual economic savings is estimated to be -1.28, rather than the initial -1.70 (**Table 6**).

Table 6. Summary of Intermediate Data and Abridged Results for the Pumping Plant Replacement Component for the Original 2003 Estimate and the Revised 2006 Calculations, CCID2.

	Pumping Plant Replacement Project [1, 2]	
	Original 2003 Analysis (i.e., in TR-212)	This Final 2006 Analysis
~ Intermediate Calculations ~		
Annuity Equivalent of Net Cost Stream (for Water Savings) – $/yr	$ 259,266	$ 101,649
Annuity Equivalent of Water Savings (ac-ft/yr)	2,171	. . . . . same
~ Abridged Results ~ [3]		
Comprehensive Cost-of-Saving-Water ($/ac-ft)	**$ 119.41**	**$ 46.82**
Legislative Evaluation Criteria [4]		
$ of ICC per ac-ft saved	$208.29	$ 155.94
$ of ICC per BTU saved	$ 0.0001836	$ 0.0001375
$ of ICC per kwh saved	$ 0.626	$ 0.469
$ of ICC per $ of annual savings	-1.705	-1.276

1 Note this table reports similar summary information as that provided in Table ES1 and Table A4 in the original report (Rister et al. 2003).

2 For sake of comparison, the 2006 abridged results were calculated as if the revised analysis was done in 2003 to provide a 'side-by-side' comparison, rather than imposing the effects of a different discount period (i.e., 2003-2052 vs 2006-2055).

3 Real values (vs nominal) calculated using a 6.125% discount factor for dollars, a 4.000% discount factor for water, and a 2.04% inflation rate.

4 Note ICC is abbreviation for 'Initial Construction Costs', which makes for a more reader-friendly table.

Sensitivity Analyses

The certainty of the construction costs for this analysis reduces the total uncertainty about the exactness of the original results. Nonetheless, some uncertainty of the preciseness of this revised estimate persists, as other data-input uncertainties remain (e.g., water savings level, energy costs/savings, etc.).

The following sensitivity results (**Tables 7** and **8**) for the cost-of-saving-water are presented whereby two parameters are varied with all others remaining constant. This permits testing of the stability (or instability) of key input values and illustrates how sensitive results can be to variances in data input levels.

Table 7 reveals a range in the cost-of-saving-water from $3.64 to $176.37 (per ac-ft) around the baseline estimate of $46.82. These calculated values were derived by varying the water savings from the new pumping plant from as low as 1,190 ac-ft up to 3,570 ac-ft (i.e., from as low as 50%, and as high as 150% of the expected 2,380.2 ac-ft) and by investigating a range of net changes in annual O&M costs (+/- 10%, 20%, 30%) about the anticipated -$429,490. As expected, lower water savings and/or lower reductions in O&M costs (than the anticipated) result in higher cost estimates. Conversely, higher reductions in O&M costs and/or higher water savings provide for a lower cost estimate.

Table 8 reveals a range in the cost-of-saving-water estimates from $31.87 to $194.70 (per ac-ft) around the baseline estimate of $46.82. These calculated values were derived by varying the water savings from the new pumping plant from as low as 1,190 ac-ft up to 3,570 ac-ft (i.e., from as low as 50%, and as high as 150% of the expected 2,380.2 ac-ft) and by investigating a range of expected useful lives of the pumping plant from the expected 48-year life, down to as low as only 10 years. As expected, shorter-useful lives and/or lower water savings (than the estimated baseline) result in higher cost estimates. Conversely, longer useful-lives and/or higher water savings provide lower cost-of-saving-water estimates.

Table 7. Sensitivity Results of the *Cost-of-Saving-Water* for the Pumping Plant Replacement Project Component – Varying the Amount of Annual Water Saved and Annual O&M Costs, CCID2, 2006.

		variation in water saved									
		50%	60%	70%	80%	90%	**100%**	110%	120%	130%	150%
		Annual estimated water savings (ac-ft) for the Pumping Plant Replacement Project									
		1,190	1,428	1,666	1,904	2,142	**2,380.2**	2,618	2,856	3,094	3,570
Net Changes to Annual O&M Costs ($) [1]	-30%	$176.37	$147.30	$126.54	$110.97	$98.86	$89.15	$81.24	$74.63	$69.04	$60.10
	-20%	$148.14	$123.77	$106.37	$93.32	$83.17	$75.04	$68.41	$62.87	$58.19	$50.69
	-10%	$119.90	$100.25	$86.21	$75.68	$67.49	$60.93	$55.57	$51.11	$47.33	$41.28
	($429,490)	$91.67	$76.72	$66.04	$58.03	$51.80	**$46.82**	$42.74	$39.34	$36.47	$31.87
	+10%	$63.44	$53.20	$45.88	$40.39	$36.12	$32.70	$29.91	$27.58	$25.61	$22.46
	+20%	$35.21	$29.67	$25.71	$22.74	$20.44	$18.59	$17.08	$15.82	$14.75	$13.05
	+30%	$6.98	$6.14	$5.55	$5.10	$4.75	$4.47	$4.25	$4.06	$3.90	$3.64

[1] Anticipated baseline net changes to O&M costs are negative $429,490 (i.e., a savings is expected); thus, a sensitivity-test reduction (e.g., -30%) makes for a lower annual savings (than the baseline) in O&M costs, and vice versa.

Table 8. Sensitivity Results of the *Cost-of-Saving-Water* for the Pumping Plant Replacement Project Component – Varying the Amount of Annual Water Saved and Expected Useful Life, CCID2, 2006.

		variation in water saved									
		50%	60%	70%	80%	90%	**100%**	110%	120%	130%	150%
		Annual estimated water savings (ac-ft) for the Pumping Plant Replacement Project									
		1,190	1,428	1,666	1,904	2,142	**2,380.2**	2,618	2,856	3,094	3,570
Expected Useful Life (years)	10	$194.70	$162.95	$140.27	$123.26	$110.03	$99.43	$90.78	$83.56	$77.46	$67.69
	20	$125.08	$104.68	$90.11	$79.18	$70.68	$63.87	$58.32	$53.68	$49.76	$43.48
	25	$112.25	$93.95	$80.87	$71.06	$63.43	$57.32	$52.34	$48.18	$44.66	$39.02
	30	$104.26	$87.26	$75.11	$66.00	$58.92	$53.24	$48.61	$44.75	$41.48	$36.25
	40	$95.38	$79.82	$68.71	$60.38	$53.90	$48.71	$44.47	$40.93	$37.94	$33.16
	48	$91.67	$76.72	$66.04	$58.03	$51.80	**$46.82**	$42.74	$39.34	$36.47	$31.87

Aggregate of Components #1 and #2

Updated (Abridged) Results: *Cost-of-Saving-Water* and Three Legislative Values

As discussed in Rister et al. 2003, projects can include separate, unrelated components, but in the end are to be considered in their entirety (Shaddix). Here, the abridged results presented above separately for components #1 and #2 are merged into comprehensive, abridged results for the entire project.

As depicted in **Table 9**, the revised comprehensive cost of saving water ($/ac-ft) with the total aggregate project is estimated to be $25.56 per ac-ft, in contrast to the original estimate of $41.26. This value is determined by dividing the annuity equivalent of net costs for water savings of $288,846 per year by the annuity equivalent of water savings of 11,300 annual ac-ft (**Table 9**).

In addition, expected real values are shown for the USBRs three principal evaluation measures specified in U.S. Public Law 106-576 (U.S. Public Law 106-576). The initial construction cost per ac-ft of water savings measure is $112.68 per ac-ft of water savings versus the original estimate of $157.07. The initial construction cost per BTU (kwh) of energy savings measure is $0.0001407 per BTU ($0.480 per kwh), versus the original estimate of $0.0001777 ($0.606 per kwh). The ratio of initial construction costs per dollar of total annual economic savings is estimated to be -3.57, rather than the initial -3.80 (**Table 9**).

Table 9. Summary of Intermediate Data and Abridged Results for the Total Aggregate Project for the Original 2003 Estimate and the Revised 2006 Calculations, CCID2.

	Aggregate Project [1, 2] (Interconnect and Pumping Plant Replacement)	
	Original 2003 Analysis (i.e., in TR-212)	This Final 2006 Analysis
~ Intermediate Calculations ~		
Annuity Equivalent of Net Cost Stream (for Water Savings) – $/yr	$ 466,283	$ 288,846
Annuity Equivalent of Water Savings (ac-ft/yr)	11,300	. . . . . same
~ Abridged Results ~ [3]		
Comprehensive Cost-of-Saving-Water ($/ac-ft)	**$ 41.26**	**$ 25.56**
Legislative Evaluation Criteria [4]		
$ of ICC per ac-ft saved	$157.07	$112.68
$ of ICC per BTU saved	$ 0.0001777	$ 0.0001407
$ of ICC per kwh saved	$ 0.606	$ 0.480
$ of ICC per $ of annual savings	-3.799	-3.571

[1] Note this table reports similar summary information as that provided in Table ES1 and Table B2 in the original report (Rister et al. 2003).

[2] For sake of comparison, the 2006 abridged results were calculated as if the revised analysis was done in 2003 to provide a 'side-by-side' comparison, rather than imposing the effects of a different discount period (i.e., 2003-2052 vs 2006-2055).

[3] Real values (vs nominal) calculated using a 6.125% discount factor for dollars, a 4.000% discount factor for water, and a 2.04% inflation rate.

[4] Note ICC is abbreviation for 'Initial Construction Costs', which makes for a more reader-friendly table.

Conclusion

Results are sensitive to changes in data-input values. The original report (i.e, Rister et al. 2003) demonstrated this with a variety of useful sensitivity tables which indicated energy savings, expected useful life, and the amount of *off-* and *on-farm* water savings, as well as other variables to have varying impacts upon results.

Regarding Component #1 (Interconnect): Noteworthy of mention, Table 11 (i.e., a results sensitivity table found on page 59 in the original report (Rister et al. 2003)) identified a range of costs-of-saving-water values (for the baseline water savings) from $20.91 to $19.14 (per ac-ft) by reducing the initial capital investment cost by $250,000 and $500,000, respectively. As actual investment costs were $307,024 less than originally anticipated, the revised comprehensive cost-of-saving-water (reported herein) of $20.51 per ac-ft for the new interconnect is within the range originally anticipated for the baseline water savings (and depicted in sensitivity analyses) with such changes in initial costs.

Regarding Component #2 (Pumping Plant Replacement): Noteworthy of mention, Table 21 (i.e., a results sensitivity table found on page 65 in the original report (Rister et al. 2003)) identified a range of costs-of-saving-water values (for the baseline water savings) from $89.67 to $45.08 (per ac-ft) by reducing the initial capital investment cost by $1,000,000 and $2,500,000, respectively. As actual investment costs were $2,441,640 less than originally anticipated, the revised comprehensive cost-of-saving-water (reported herein) of $46.82 per ac-ft for the new pumping plant is within the range originally anticipated for the baseline water savings (and depicted in sensitivity analyses) with such changes in initial costs.

Applying the actual construction costs for this project reduces the total uncertainty about the exactness of the revised results. Uncertainty still remains about other data-input values' exactness, however, and hence requires a reiterative point that results (original and improved/revised) are deterministic estimates. Nonetheless, the revised results herein are a refinement to the original results in Rister et al. 2003 and represent useful and comparable measures. Conjoined with data uncertainty and multiple analyses are an underlying theme and related inference that consistent and attentive methods of analysis, such as those documented in Rister et al. 2002, are warranted.

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