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# Economic and Financial Costs of Saving Water and Energy:

## Preliminary Analysis for Hidalgo County Irrigation District No. 2 (San Juan) – Replacement of Pipeline Units I-7A, I-18, and I-22

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## Preface

Texas Agricultural Experiment Station and Texas Cooperative Extension economists and engineers have been collaborating, since calendar year 2002, with Rio Grande Basin irrigation district (ID) managers, their consulting engineers, and the U.S. Bureau of Reclamation to perform tasks associated with proposed capital improvement projects to water-delivery infrastructure. Such tasks include water-loss assessments and economic analyses associated with Public Laws 106-576 and 107-351.[1] In those Acts, the U.S. Congress authorized rehabilitation projects for IDs diverting Rio Grande water for agricultural, municipal, and industrial interests.

The U. S. Bureau of Reclamation (USBR) was/is the agency tasked with administering the Act(s) and has a set of guidelines for preparing and reviewing such projects.[2] Inclusive in these guidelines are three required economic measures:

- No. of acre-feet of water saved per dollar of construction costs;
- No. of British Thermal Units (BTU) of energy saved per dollar of construction costs; and
- Dollars of annual economic savings per dollar of initial construction costs.

The inverses of these measures have been incorporated into a spreadsheet model based upon Capital Budgeting; i.e., Rio Grande Irrigation District Economics (RGIDECON©) which has been used to estimate projects' economic and financial costs of saving water and energy. Results allow comparison of projects with different expected useful lives and provide apple-to-apple values which can be compared (a) to priority-rank projects based on their economic performance and (b) with economic values of water (and energy) to conduct full cost-benefit analyses.

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1 "The Lower Rio Grande Valley Water Resources Conservation and Improvement Act(s)" of 2000 and 2002. See United States Public Law 106-576 and United States Public Law 107-371 in the References section of this report.

2 "Guidelines for Preparing and Reviewing Proposals for Water Conservation and Improvement Projects." (U.S. Bureau of Reclamation).

## Acknowledgments

This report is made possible in large part by the assistance and contributions from many of our colleagues, associates, and assistants. Special thanks are extended to Allan Jones, B.L. Harris, Ellen Weichert, Danielle Supercinski, and Rosemary Payton of the Texas Water Resources Institute, as well as to Michele Zinn and Angela Catlin in the Department of Agricultural Economics, and Martha Bloom with Texas Cooperative Extension for all they do which improves our work.

This report relies heavily upon primary data developed by (1) Alfonso Gonzalez of Sigler, Winston, Greenwood, and Associates of Weslaco, TX, (2) Eric Leigh and Guy Fipps of the Department of Biological and Agricultural Engineering at Texas A&M University and with Texas Cooperative Extension in College Station, TX, (3) Thomas Michalewicz with the U.S. Bureau of Reclamation in Austin, TX, and (4) Sonny Hinojosa with Hidalgo County Irrigation District No. 2 in San Juan, TX. We thank these collaborators, for without their assistance, this work would not have been possible.

Further, since this report is one of a series of similar capital-rehabilitation reports, we would like to again reiterate our appreciation to all the individuals noted in Rister et al. 2002 for their assistance. Thanks to every individual noted. We, the authors, accept responsibility for any errors or omissions.



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**Table of Contents**

**Table of Contents, continued**

# List of Tables

**Table** **Page**

# List of Exhibits

Economic and Financial Costs of Saving Water and Energy:
Preliminary Analysis for Hidalgo County Irrigation District No. 2 (San Juan) –
Replacement of Pipeline Units I-7A, I-18, and I-22


## Abstract

*Initial construction costs and net annual changes in operating and maintenance expenses are identified for a three-component capital renovation project proposed by Hidalgo County Irrigation District No. 2. The proposed project primarily consists of replacing aged mortar-joint pipe in pipeline units I-7A, I-18, and I-22 with new rubber-gasketed, reinforced concrete pipe. Both nominal and real estimates of water and energy savings and expected economic and financial costs of those savings are identified throughout the anticipated useful life for the proposed project. Sensitivity results for the cost of saving water are presented for several important parameters.*

*Annual water and energy savings forthcoming from the total project are estimated, using amortization procedures, to be* ***485 ac-ft of water*** *per year and* ***179,486,553 BTUs {52,604 kwh} of energy*** *per year. The calculated economic and financial cost-of-saving water is estimated to be* ***$385.46 per ac-ft****. The calculated economic and financial cost-of-saving energy is estimated to be* ***$0.0010735 per BTU {$3.663 per kwh}****.*

*In addition, expected real (vs. nominal) values are provided for the U.S. Bureau of Reclamation's three principal evaluation measures specified in U.S. Public Law 106-576. The aggregate initial construction cost per ac-ft of water saved measure is* ***$510.92****. The aggregate initial construction cost per unit of energy saved measure is* ***$0.0013798 per BTU {$4.708 per kwh}****. The aggregate ratio of initial construction costs per dollar of total annual economic savings is estimated to be* ***-2.53****.*

# Economic and Financial Costs of Saving Water and Energy:
## Preliminary Analysis for Hidalgo County Irrigation District No. 2 (San Juan) – Replacement of Pipeline Units I-7A, I-18, and I-22

## Introduction

This report documents the analysis conducted for a project anticipated to be proposed to the Border Environmental Cooperative Commission (BECC) for certification and to the North American Development Bank (NADB) for partial cost-share financing.[1] Further, the Hidalgo County Irrigation District No. 2 (HCID2) is hopeful future legislation authorizing additional projects (similar to those found in PL 106-576 and PL 107-351)[2] will also provide partial cost-share funding. Although this project is currently non-authorized, it is reasonable to assume the consistency in methodology provided by RGIDECON© would continue to satisfy any future related legislative-authorized project(s) overseen by the USBR.[3]

## Project Purpose

The purpose of this rehabilitation project is to save water and energy. This study provides the economic and financial costs of such. Note that in this study (and others), estimates of water savings are applied to agricultural water use only; i.e., no savings related to municipal and industrial (M&I) water use are considered.[4] Further, water savings are estimated to occur at the project site and do not include any conveyance losses during water transit from the Rio Grande pumping plant diversion site to the in-district project site. Thus, all noted water savings are based on a "delivered" basis, which is the same as the "diverted" basis for this project analysis.[5] Existing estimates of water losses via seepage are applicable to pipelines, canals, and laterals in their present state. It is highly likely that additional deterioration and increased water loss and associated O&M expenses should be expected as pipelines, canals, and laterals age (Carpenter;

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1 This analysis is based on the best information available at the time and is subject to resource limitations. At times, District management's best educated estimates (or that of the consulting engineer) are used to base cost and/or savings' values well into the future. Obviously this is imperfect, but given resource limitations, it is believed ample inquiry and review of that information were used to limit the degree of uncertainty.

2 Note PL refers to Public Law. See *United States Public Law 106-576* and *United States Public Law 107-371* in the References section of this report.

3 Though currently non-authorized, this project's analysis (and the methodology behind it) is consistent with and comparable to other publications (on similar projects) as found on the website http://twri.tamu.edu/ (e.g., Rister et al. 2006).

4 A major assumption made embedded in this and other analyses of irrigation districts' (IDs) proposed projects is that only the local IDs perspectives are considered, i.e., activities external to the ID are ignored. Also, all marginal water and energy savings are recognized, notwithstanding that in actuality, the "savings" may continue to be utilized within (or outside) the District.

5 The District's system-wide conveyance loss is estimated to be 23% (Fipps and Pope), as determined by considering total diversions and total sales (Hinojosa). Additional savings, beyond the local project-area, are not claimed. That is, even though water will be saved at a component/project site, the District's delivery-system infrastructure will remain fully charged throughout the year as usual and will therefore not produce additional water savings beyond those realized at the in-district project site(s) (Michalewicz).

Halbert). While estimates of ever-increasing seepage losses over time could be developed, the analysis conservatively maintains a constant water savings (Michalewicz), consistent with assumptions embedded in previous analyses (e.g., Rister et al. 2005).

In a general sense, energy savings <u>may</u> occur as a result of less water being pumped at the Rio Grande diversion site and also because of lower relift pumping requirements at one or more points throughout the canal delivery system. The amount of such energy savings and the associated monetary savings are detailed. Energy savings associated with reduced diversions and reduced relift pumping are expected with this project. That is, water delivered with the I-7A, I18, and I-22 pipelines is diverted from the Rio Grande and is also relifted within the water-delivery system.

## Summary of Economic and Financial Methodology [6]

Rehabilitation of water-delivery infrastructure typically requires an initial investment to fund initial construction, requires dollars to fund ongoing maintenance and operations of the infrastructure, and can provide benefits in the form of saved water (e.g., reduced seepage and evaporation) and/or reduced energy consumption (e.g., thru reduced pumping from water savings or from replacement of pumps and motors) for some number of years into the future. With an expected life lasting into future years and financial realities such as inflation, the time-value of money, etc., the *life-cycle cost* of saving an acre-foot of water or units of energy are appropriate cost measures to be determined. Net Present Value (NPV) analysis, in combination with the calculation of annuity equivalents, is the methodology of choice because of the capability of integrating expected life with related annual costs and outputs, as well as other financial realities into a comprehensive $/ac-ft/year {or $/kwh/year} *life-cycle* cost. Assumed in the calculations and methodology are zero net salvage values (for the infrastructure) and a continual replacement of such capital items into perpetuity.

To facilitate a NPV-Capital Budgeting analysis (with annuity-equivalent calculations) of water-delivery capital-rehabilitation projects, agricultural economists from Texas Agricultural Experiment Station and Texas Cooperative Extension developed the Microsoft® Excel® spreadsheet model RGIDECON© (Rio Grande Irrigation District Economics). This model analyzes and provides life-cycle costs (e.g., $/ac-ft/year) for <u>up to</u> five individual project segments, as well as for the entire project. RGIDECON© is custom built and useful for analyzing and reporting on rehabilitation of water-delivery infrastructure, regardless of size, location, etc.

Results derived using RGIDECON© allow an "apples to apples" comparison to be made across projects of different useful lives, thereby facilitating the prioritization of projects based on their economic performance. The results can be compared with an externally-specified economic value of water to easily provide for implications of a complete cost-benefit analysis. Methodology similar to that presented for water savings is also included for determining the

6 The publication, "Economic Methodology for South Texas Irrigation Projects – RGIDECON©," Texas Water Resources Institute TR-203 (Rister et al. 2002), provides extensive documentation of the methodology used. Several of the authors of this report are co-authors of TR-203. The documented methodology was endorsed in July, 2002, by the USBR, as expressed by Larry Walkoviak, Area Manager of the Oklahoma-Texas Office.

economic and financial costs of saving energy (i.e., on a BTU and kwh basis). That is, in general, there are anticipated energy savings from pumping less water caused by reducing leakage and seepage, and from improving the efficiency of pumping plants.

Also, if the same methodology and factors are used, comparisons can be made with other capital projects which 'add' to the region's available water supply (e.g., on-farm and municipal water-conservation measures, seawater desalination, rainwater harvesting, ponding and retainment, rehabilitation of water-conveyance systems, etc.).[7] Ultimately, having comparable costs for all alternatives which add water to a region's supply will provide information useful for prioritizing projects in the event of limited funding, and other varied circumstances.

Public Law 106-576 legislation requires a variation of economic analyses in which the initial construction costs and annual economic savings are used independently in assessing the potential of capital renovations proposed by irrigation districts (USBR). In addition, all calculations are performed on a nominal rather than real basis (Hamilton). Detailed results for this study, following the methodology presented in Rister et al. 2002, appear in subsequent sections of this report.

## Assumed Values for Discount Rates and Compound Factor

Much primary data are used in this analysis. Two important discount rates and a compound rate are assumed, however. The discount rate used for calculating net present values of cost streams represents a firm's required rate of return on capital (i.e., interest). The discount rate is generally considered to contain three components: a risk-free component for time preference, a risk premium, and an inflation premium (Rister et al. 1999) (Klinefelter).

Discounting Dollars: Having different annual operating costs and expected lives across projects (and possibly project segments) encourages 'normalizing' such flows by calculating the net present value of costs, which requires a discount factor. Since successive-years' costs are increased by an inflationary factor, there is an inflationary influence to consider in the discounting of costs (Klinefelter), i.e., the *inflation premium (I)* and *time (t)* portions of the discount factor should be used.[8] The discount rate used in this analysis is 6.125%, which is consistent with other prior analyses and documented in Rister et al. 2002.

Discounting Water: Having different annual water savings (e.g., reduced seepage and/or evaporation) and expected useful lives across projects encourages 'normalizing' such flows by calculating the net present value of water savings, which requires a discount factor. Since

[7] Note, the cost-of-saving water via rehabilitation of water-conveyance systems needs to be adjusted for municipal treatment costs to par the quality of Rio Grande surface water with that of potable water. Also, ongoing efforts by the authors are focused on analyzing the listed capital project alternatives.

[8] One estimate of a discount rate from an owner's perspective is the cost at which it can borrow money (Hamilton). Griffin notes, however, that because of the potential government/public funding component of this project, it could be appropriate to ignore the risk component of the standard discount rate as that is the usual approach for federal projects. After considering those views and interacting with Penson and Klinefelter, both Texas A&M University agricultural economists specializing in finance, a discount rate of 6.125%, consistent with and documented in Rister et al. 2002, was adopted for use in discounting all financial streams.

it is inappropriate to inflate successive-years' water savings, there is no inflationary influence to consider in the discounting of water (Klinefelter), i.e., only the *time (t)* portion of the discount factor should be used. Consultations with Griffin and Klinefelter contributed to adoption of the 4% rate used by Griffin and Chowdhury for the social time value in this analysis.

Compounding Costs: Inflation is a financial reality with future years' ongoing operational costs. As presented in Rister et al. 2002, use of an overall discount rate of 6.125%, with a 4.000% social time value and a 0% risk premium, infers a 2.043269% annual inflation rate.[9] Thus, nominal dollar cost estimates for years beyond 2007 are inflated at 2.043269% annually.

## Data Input – Common Across Project Components

Water savings (i.e., ac-ft) and their associated energy savings are specific to individual project components. In determining energy savings (i.e., dollars), however, certain data are used across all components. Specifically, the average number of units of energy (Btu and kwh) used to divert water from the Rio Grande and relift water at relift stations, as well as the per unit value (i.e., costs) of energy at each location, are used in calculating energy savings for individual project components.

Energy Usage per Acre-Foot of Water: This analysis includes calculating the cost of energy savings and applying the value of such savings as a credit to the project's construction cost when evaluating the cost of saving water. The historic average *diversion-energy* usage level of 201,384 BTU {59.02 kwh} per ac-ft of water diverted (by the District) for calendar years 2002-2006 is used to estimate energy savings when less water is diverted from the Rio Grande due to the proposed project (**Table 1**). Also, the historic average *relift-energy* usage level of 168,893 BTU {49.50 kwh} per ac-ft relifted for calendar years 2002-2006 is used to estimate energy savings when less water is relifted within the Districts' water-delivery infrastructure system (**Table 2**).[10]

Value of Energy Savings per BTU/kwh: Corresponding to the amount of energy saved, historic average pumping costs (diversion and relift) are used to determine the dollar value of the expected energy savings. Records for calendar years 2002-2006 indicate the average *diversion-energy* cost has averaged \$0.0000230 per BTU {\$0.078 per kwh}. Related calculations indicate the average diversion-energy cost has ranged from \$4.07 to \$5.58 per ac-ft, with the 5-year average of \$4.63 per ac-ft used in this analysis (**Table 1**). Similarly, the average *relift-energy* unit costs have averaged \$0.0000240 per BTU {\$0.082 per kwh}, with the relift-energy costs ranging from \$3.35 to \$4.97 per ac-ft, with the 5-year average of \$4.06 per ac-ft used in this analysis (**Table 2**) to determine dollars of energy savings.

9 Represented mathematically: $\frac{1+6125\%}{1+4000\%} - 1 = 2.043269$.

10 Units of energy are also discussed/provided in terms of kwh. For such, it is assumed there are 3,412 BTU per kwh (Infoplease.com).

## Data Input – Engineering Related Parameters

The capital improvement project anticipated to be proposed by the District to BECC and NADB (and possibly the USBR) consists of three different pipeline components. They are referred to as units I-7A, I-18, and I-22 (**Exhibit 1**). A brief overview and discussion of key engineering parameters about each are discussed below, with summary data for each presented in **Tables 3**, **4**, and **5**.

Description/Overview:

**Pipeline unit I-7A** consists of replacing aged mortar-joint pipe. The total 1.88 mile project length consists of 1.00 mile of 36", 0.50 mile of 24", 0.25 mile of 18", and 0.13 mile of 15". All segments will be replaced with rubber-gasket, reinforced-concrete pipe. This pipeline unit services approximately 1,098 acres within the District (Gonzalez).

**Pipeline unit I-18** consists of replacing the 2.00 mile-long segment of aged mortar-joint pipe with 48" rubber-gasket, reinforced-concrete pipe. This pipeline services approximately 2,844 acres within the District (Gonzalez).

**Pipeline unit I-22** consists of replacing a 1.25 mile-long segment of aged mortar-joint pipe with 48" rubber-gasket, reinforced-concrete pipe, and replacing a 0.75 mile-long segment of aged mortar-joint pipe with 36" rubber-gasket, reinforced-concrete pipe. This pipeline services approximately 1,896 acres within the District (Gonzalez).

Installation Periods: It is anticipated that it will take one year after purchase and project initiation for each of the three new pipeline segments to be installed and fully implemented (**Table 4**). No loss of operations or otherwise adverse impacts are anticipated during the installation period since it will occur in the off-season.

Expected Useful Life: Once installed, a useful life of 49 years[11] for each of the new pipeline segments is expected and assumed in the baseline analysis (**Table 4**). A shorter or longer period is possible, but 49 years is considered reasonable and consistent with engineering expectations (Michalewicz). Sensitivity analyses are utilized to examine the effects of this assumption.

Initial Construction Costs: Total initial construction costs for all three pipeline segments amounting to $4,968,081 (2007 dollars) (Gonzalez) are indicated in **Table 4**, and are shown in more detail in **Table 5** for both the aggregate total and individual segment sub-totals. Sensitivity analyses on the individual segment sub-totals are performed. All expenditures are assumed to occur on day one, thereby avoiding the need to account for inflation.

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[11] Actually, the estimated useful life is 50 years instead of 49 years. RGIDECON© was developed to consider up to a maximum 50-year planning horizon, with the view that projections beyond 50 years are largely discounted and highly speculative. Allowing for the one-year installation period on the front end reduces to 49 years the time remaining for productive use of the asset during the 50-year planning period allowed within RGIDECON©.

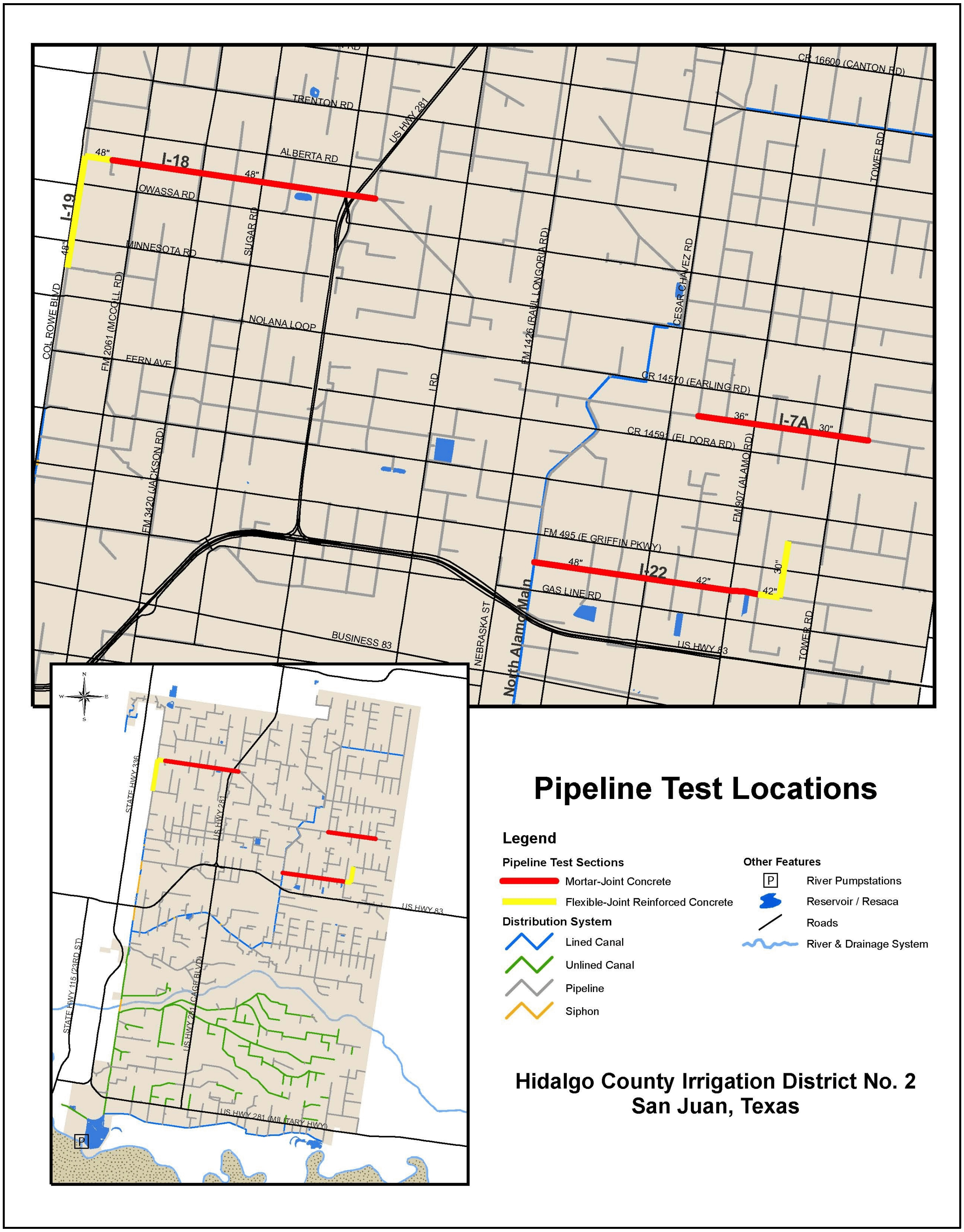


Exhibit 1. Project Component and Pipeline Test Locations for Units I-7A, I-18, and I-22, HCID No. 2, 2007 (Leigh).

Recurring Annual Costs: Total net annual operating and maintenance (O&M) expenditures for all three pipeline segments are expected to be $53,672 less than those presently occurring for the leaky mortar-joint pipe (Hinojosa) (**Table 4**). In addition, installation of the new pipeline is anticipated to reduce annual emergency repair expenses by a total of $42,972 (Hinojosa) (**Table 4**) for the three segments. Thus, a total net annual savings of $96,644 is anticipated across the combined segments. Similar values for individual segment sub-totals are also provided in **Table 4**.

Expected Annual Water Savings: Total annual water savings for all three pipeline segments are estimated to be 507.5 ac-ft per year (**Table 3**), with the area and category amount of water savings differing by pipeline segment. Anticipated water savings originate from reduced seepage and reduced recharging. Both are categorized into an *off-farm* general category.[12]

The reduced seepage estimated is based on recent ponding tests by Leigh and Fipps and amounts to 465.0 ac-ft per year. Their work documented varying water-loss rates for the three pipelines, with unit I-7A having water losses of 62.49 ac-ft/mile/year, unit I-18 having water losses of 64.85 ac-ft/mile/year, and unit I-22 having water losses of 45.43 ac-ft/mile/year (Hinojosa). Incorporating this information with the respective lengths of the individual project components results in the anticipated 465.0 ac-ft per year of *off-farm* water savings by reducing seepage (**Table 3**).

Reduced recharge occurs with the elimination of emergency repairs to the old (i.e., current) pipeline segments. That is, the current pipelines must be completely drained to facilitate emergency repairs with the drained water effectively lost. Avoiding the emergency repairs with the new pipe will reduce/eliminate the need to pump out and 'recharge' the pipelines. Reduced recharge is based on calculations by Michalewicz and amounts to 42.5 ac-ft per year (**Table 3**). The 42.5 ac-ft of reduced recharge, when added to the 465.0 ac-ft of reduced seepage, results in the project's total anticipated 507.5 ac-ft of water savings.

Expected Annual Energy Savings: Since the above 'saved water' will not need to be pumped (i.e., at either the Rio Grande diversion station or the relift facility), there are associated energy savings at two locations. For each area of water savings, the specific average amount of energy (Btu and kwh units) required per ac-ft is multiplied by the 5-year average cost of energy ($/Btu and $/kwh) to determine total annual energy savings ($/yr).

Multiplying the average number of units of diversion energy and relift energy by the 507.5 ac-ft of total annual water savings results in anticipated total annual energy savings of 140,786,506 BTU {41,263 kwh} (**Table 3**). Assuming the historical 5-year average costs (i.e., 2002-2006) of $0.078 per kwh for diversion energy (**Table 1**) and $0.082 per kwh for relift energy (**Table 2**), the estimated annual energy cost savings amount to $3,304 in 2007 dollars (**Table 3**). Details on the expected annual energy savings for individual segments are provided in **Table 3**. For this project, all energy savings are off-farm in nature.

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[12] *Off-farm* water savings include those occurring in the District's water-delivery infrastructure system, while those classified as *on-farm* occur at the field turn-out gate or in the field as a direct result of the project. The counterpart to off-farm savings is on-farm savings, of which there are none associated with this project.

## Results

Results for the proposed project are separated into three different categories: (1) comprehensive economic and financial life-cycle costs, which constitute the 'baseline' results generated by the RGIDECON© analysis, (2) legislative-criteria values as specified by the USBR (incorporated into RGIDECON©), and (3) sensitivity analyses of key data-input parameters (upon the cost-of-saving water only). Note that summary **Table A** is on the next page, with more detailed tables found at the back of the report.[13]

According to USBR management, a comprehensive, aggregated measure is required to assess the overall potential performance of a proposed project consisting of multiple components (Shaddix). That is, projects are to be evaluated in the form submitted by Districts and when two or more components comprise a project, one general measure should be determined to represent the total project. Thus, the following discussion focuses on the comprehensive aggregate measures, with less discussion on individual project components following.

### Comprehensive Economic and Financial Life-Cycle Costs

Determining these values constitute the key reason for developing and using RGIDECON© toward analysis of rehabilitation projects of water-delivery infrastructure. Life-cycle costs are just that. They represent the specified cost, in 2007-based dollars, in a common unit of measure, over the life of the project.[14] Necessarily, they incorporate initial costs, continued costs, and the other key parameters discussed earlier.[15]

Cost-of-Saving Water: The aggregate annual economic and financial cost to save water across all project components is estimated to be **$385.46 per ac-ft** (**Table A**). Such costs for individual project components are $413.84 for component #1, $348.63 for component #2, and $427.27 for component #3 (**Tables 6**, **7**, **8**, and **9**). These final cost values, seemingly simple, are in fact derived from several intermediate values:

**NPV of Water Saved**:[16] The total quantity of water anticipated being saved over the expected lifetime for the three pipeline segments amounts to 24,864 ac-ft on a nominal (i.e., non-discounted) basis (**Tables 6**, **7**, and **8**). Using the 4% annual discount rate previously discussed, this nominal savings amount translates into 10,413 ac-ft of real basis savings (**Table 9**). Such quantities (real) for individual components #1, #2, and #3 are: 2,465 ac-ft, 5,116 ac-ft, 2,833 ac-ft, respectively (**Table 9**).

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13 Note, Table A reports on data just as Table ES1 did in earlier reports (e.g., Rister et al. 2006). That is, a new, revised report format (i.e., this report) does not include an Executive Summary.

14 Other, similar terms are 'levelised', or 'annualized' costs.

15 Following the methodology in Rister et al. 2002, the cost measures calculated for individual components are expressed in 'annuity equivalents' which facilitate comparison and aggregation of capital projects with unequal useful lives, effectively serving as a common denominator. The finance aspect of the 'annuity equivalent' calculation in RGIDECON© represents an annual cost of saving one unit of water (or energy) each year extended indefinitely into the future. Zero salvage values and continual replacement of the capital items are assumed.

16 NPV = abbreviation for Net Present Value.

Table A. Summary of Key Data and Results for Replacement of Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007. [a]

| | Project Component | | | |
|---|---|---|---|---|
| | Pipeline Unit I-7A | Pipeline Unit I-18 | Pipeline Unit I-22 | Aggregate |
| Initial Investment Cost ($) | $ 1,184,751 | $ 1,881,500 | $ 1,901,830 | $ 4,968,081 |
| Expected Useful Life (years) | 49 | 49 | 49 | n/a |
| Total Net Change in Annual O&M and Emergency Repair Expenses ($) | ($ 20,847) | ($ 26,851) | ($ 48,945) | ($ 96,644) |
| Annuity Equivalent of Total Costs – for Water Saved ($/yr) | $ 47,481 | $ 83,019 | $ 56,345 | $186,845 |
| Nominal Annual Water Savings (ac-ft) | 120.1 | 249.3 | 138.1 | 507.5 |
| Annuity Equivalent of Water Saved (ac-ft) | 115 | 238 | 132 | 485 |
| Cost of Saving Water ($/ac-ft) | **$ 413.84** | **$ 348.63** | **$ 427.27** | **$ 385.46** |
| Annuity Equivalent of Total Costs – for Energy Saved ($/yr) | $ 48,864 | $ 85,889 | $ 57,934 | $ 192,687 |
| Annuity Equivalent of Energy Saved (BTU) | 42,483,259 | 88,174,604 | 48,828,690 | 179,486,552 |
| Annuity Equivalent of Energy Saved (kwh) | 12,451 | 25,842 | 14,311 | 52,604 |
| Cost of Saving Energy ($/BTU) | **$ 0.0011502** | **$ 0.0009741** | **$ 0.0011865** | **$ 0.0010735** |
| Cost of Saving Energy ($/kwh) | **$ 3.924** | **$ 3.324** | **$ 4.048** | **$ 3.663** |

[a] Note, this Table A reports on data just as Table ES1 did in earlier reports (e.g., Rister et al. 2006). That is, a new, revised report format (i.e., this report) does not include an Executive Summary.

**NPV of Total Cost - for water**: This value is the total amount of money which will be invested in and spent (towards saving water) on the project over the entire useful life, adjusted and placed into 2007 dollars. As such, it includes initial construction costs, net changes in O&M expenditures, and credits for energy savings all rolled into one dollar value. The nominal total NPV of Total Costs for the entire project amounts to a negative $3,756,889 (**Table 6**, **7**, and **8**). Using the previously-identified discount rate of 6.125%, these nominal cost dollars translate into present-day, real costs of $2,894,405 (**Table 9**). Such values (real) for individual components are: $735,531, $1,286,041, and $872,833, respectively (**Table 9**).[17]

**Annuity Equivalents of Net Costs and Water Savings**: Converting the above 2007 NPV values for water savings and net costs into annuity equivalents (or 'annualized' amount) (per the methodology presented in Rister et al. 2002) results in an annual cost estimate of $186,845 to achieve 485 ac-ft of annual water savings for the entire project (**Table 9**). Such values for individual components are $47,481 to achieve 115 ac-ft of annual water savings for component #1, $83,019 to achieve 238 ac-ft of annual water

[17] For the project total, note the positive real-value amount of costs is greater than the negative nominal-value amount. This occurs because in the nominal-value amount, the savings accruing from reduced O&M, emergency repairs, and energy use in the long planning period offset an amount of dollars which greatly exceeds the initial investment cost, while the real (i.e., "discounted) dollars of energy savings offset only a portion of the initial investment cost. In the case of the real-value amount, the savings occurring during the latter years of the planning period are discounted significantly and thus do not offset as much of the initial investment costs.

savings for component #2, and $56,345 to achieve 132 ac-ft of annual water savings for component #3, respectively (**Tables 6**, **7**, **8**, and **9**).

<u>**Cost per Acre-Foot of Water Saved**</u>: This key result is arrived at by dividing the first annuity equivalent (i.e., cost) estimate by the second (i.e., water savings) estimate. Performing the math for the entire project results in dividing $186,845 by 485, which results in an annualized cost to save water <u>for the entire project</u> of $385.46 per ac-ft (**Table 9**). With like calculations, such result values for individual components #1, #2, and #3 are $413.84, $348.63, and $427.27, respectively (**Tables 6**, **7**, **8** and **9**).

The cost-of-saving water value(s) can be interpreted as the cost of leasing one ac-ft of water in year 2007. That is, it is not the cost of purchasing the water right of one ac-ft. Following through with the economic and capital budgeting methodology presented in Rister et al. 2002, this value represents the <u>costs per year</u> in present-day dollars of <u>saving one ac-ft of water each year</u> into perpetuity through a continual replacement series of the new pipelines with all of the attributes previously indicated.

<u>Cost-of-Saving Energy</u>: The aggregate annual economic and financial cost to save energy across all project components is estimated to be **$0.0010735 per BTU {$3.663 per kwh}** (**Tables A** and **9**). Such costs for individual project components are $0.0011502 per BTU {$3.924 per kwh} for component #1, $0.0009741 per BTU {$3.324 per kwh} for component #2, and $0.0011865 per BTU {$4.048 per kwh} for component #3 (**Tables 6**, **7**, **8**, and **9**). These final cost values, seemingly simple, are in fact derived from several intermediate values:

<u>**NPV of Energy Saved**</u>: The total quantity of energy anticipated being saved over the expected lifetime for the three pipeline segments amounts to 9,206,942,034 BTU {2,698,400 kwh} on a nominal (i.e., non-discounted) basis (**Tables 6**, **7**, and **8**). Using the 4% annual discount rate previously discussed, this nominal savings amount translates into 1,130,059 BTU {i.e., 52,604 kwh} on a real basis (**Table 9**). Such quantities (real) for individual components #1, #2, and #3 are: 267,477 BTU {i.e., 12,451 kwh}, 555,153 BTU {i.e., 25,842 kwh}, and 307,429 BTU {i.e., 14,311 kwh}, respectively (**Table 9**).

<u>**NPV of Total Cost - for energy**</u>: This value is the total amount of money which will be invested in and spent (towards saving energy) on the project over the entire useful life, adjusted and placed into 2007 dollars. As such, it includes initial construction costs and net changes in O&M expenditures all rolled into one dollar value.[18] The nominal total NPV of Net Cost Stream for the entire project amounts to a negative $3,376,160 (**Tables 6**, **7**, and **8**). Using the previously-identified discount rate of 6.125%, these nominal cost dollars translate into present-day, real costs of $2,984,894

[18] Note, the *NPV of Net Cost - for energy* is very similar to that discussed above for water. The difference being, however, that the *NPV of Net Cost - for energy* does not include 'credits' for energy savings. That is, the NPV of Net Cost for energy ignores changes in energy costs. Also, any monetary value established for 'credits' for the water savings is ignored in both NPV costs.

(**Table 9**). Such values (real) for individual components #1, #2, and #3 are: $756,949, $1,330,494, and $897,450, respectively (**Table 9**).

**Annuity Equivalents of Net Costs and Energy Savings**: Converting the above 2007 NPV values for energy savings and net costs into annuity equivalents (or 'annualized' amount) (per the methodology presented in Rister et al. 2002) results in an annual cost estimate of $192,687 to achieve 179,486,553 BTU {52,604 kwh} of annual energy savings for the entire project (**Table 9**). Such values for individual components are $48,864 to achieve 42,483,259 BTU {12,451 kwh} of annual energy savings for component #1, $85,889 to achieve 88,174,604 BTU {25,842 kwh} of annual energy savings for component #2, and $57,934 to achieve 48,828,690 BTU {14,311 kwh} of annual energy savings for component #3, respectively (**Tables 6**, **7**, **8**, and **9**).

**Cost per BTU {and kwh} of Energy Saved**: This key result is arrived at by dividing the first annuity equivalent (i.e., cost) estimate by the second (i.e., energy savings) estimate. Performing the math for the entire project results in dividing $192,687 by 179,486,553 BTU {and 52,604 kwh}, which results in annualized costs to save energy for the entire project of **$0.0010735 per BTU {$3.633 per kwh}** (**Table 9**). With like calculations, such result values for individual components #1, #2, and #3 are $0.0011502 per BTU {$3.924 per kwh}, $0.0009741 per BTU {$3.324 per kwh}, and $0.0011865 per BTU {$4.048 per kwh}, respectively (**Tables 6**, **7**, **8**, and **9**).

The cost-of-saving energy value(s) can be interpreted as the cost of saving one BTU {kwh} of energy in year 2007. Following through with the economic and capital budgeting methodology presented in Rister et al. 2002, this value represents the costs per year in present-day dollars of saving one BTU {kwh} of energy each year into perpetuity through a continual replacement series of the project with all of the attributes previously indicated.

## Legislative Criteria Values

United States Public Law 106-576 (and the amending legislation U. S. Public Law 107-351) requires three economic measures be calculated and included as part of the information prepared for the USBRs (USBR 2001) evaluation of proposed projects. According to the USBR, these measures are more often stated in their inverse mode:[19]

- Dollars of construction cost per ac-ft of water saved;
- Dollars of construction cost per BTU (and kwh) of energy saved; and
- Dollars of construction cost per dollar of annual economic savings.

The legislative values involve a series of calculations similar to, but different from, those used to calculate the comprehensive economic and financial life-cycle costs in the prior section. Principally, the legislative values do not require aggregation of the initial construction costs with the annual changes in O&M expenses, but rather entailing separate sets of calculations for each

[19] Per discussions with Bob Hamilton of the Denver USBR office on April 9, 2002. Hamilton's suggested convention is adopted and used in the RGIDECON©.

type of cost relative to the anticipated water and energy savings. Since the legislated criteria do not specify the need for discounting the nominal values into real terms, both nominal and real values are presented (**Table 10**). Since the USBR advises one measure should be used, however, to evaluate a project with multiple components (Shaddix), only real values are presented in the *Aggregate* column in **Table 10** and discussed below.[20]

Intermediate Calculation Values: The project as a whole requires an initial capital investment of $4,968,081 for construction costs (**Table 10**). In total, 10,413 ac-ft of real water savings (i.e., adjusted for social preference) are estimated. Real energy savings are anticipated to be 3,855,763,258 BTU {1,130,060 kwh}. The net change in real total annual O&M and emergency repair expenditures is a decrease of $2,073,675 (**Table 10**).

Construction Cost per ac-ft of Water Saved: The aggregate initial construction costs are **$510.92 per ac-ft** of water savings (**Table 10**) which is much higher than the comprehensive economic and financial value of $385.46 per ac-ft identified and discussed in the prior section (**Table 9**). The differences in these values are attributable to the incorporation of both initial capital costs and changes in operating expenses in the latter value, and its treatment of the differences in the useful lives of the respective project components.

Construction Cost per Unit of Energy Saved: The aggregate initial construction cost per BTU {kwh} of energy savings is $0.0013798 per BTU {$4.708 per kwh} (**Table 10**). These cost estimates are much higher than the $0.0010735 per BTU {$3.663 per kwh} comprehensive cost identified (**Table 9**) for reasons similar to those noted above for construction cost per ac-ft of water saved.

Construction Cost per Dollar of Annual Economic Savings: This third legislative value is a ratio of dollars which can be either negative or positive. The estimate for the total project is -2.53, indicating that (a) the net change in annual O&M expenditures is negative, i.e., a reduction in O&M expenditures is anticipated; and (b) $2.53 of initial construction costs are expended for each such dollar reduction in O&M expenditures, with the latter represented in total real 2007 dollars accrued across the three project components' respective planning periods (**Table 10**).

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20 Readers are directed to Rister et al. 2002 for more information regarding the issues associated with comparing capital investments having differences in length of planning periods. Further, the approach used in aggregating the legislate-criteria results into one set of uniform measures uses the present value methods followed in the calculation of the comprehensive economic and financial life-cycle cost results, but does not include the development of annuity equivalent measures. These compromises in approaches are intended to maintain the spirit of the legislated criteria's intentions. Only real, present value measures are presented and discussed for the legislated criteria aggregate results, thereby designating all such values in terms of 2007 equivalents. Differences in useful lives across project components are not fully represented, however, in these calculated values.

## Caveat to Interpretation of Legislative-Value Results

The proper interpretation of the third legislated ratio (i.e., dollars of initial construction cost divided by dollars of economic savings) for any component can be somewhat difficult and involves recognition that the most desired value is negative and close to zero (**Exhibit 2**). That is, a negative ratio signifies a net real reduction in future expenses (i.e., O&M and energy), while a positive ratio signifies a net real increase in future expenses. Also, whether the value of the ratio is *less than* or *greater than* negative 1 makes a difference. That is, if less than negative one (e.g., -3.45), it infers that construction costs are *greater than* the sum of real expected annual economic savings (which are on a "current dollar basis"). Likewise, if the value is greater than negative one and less than zero (e.g., -.74), it infers construction costs are *less than* the sum of real expected annual economic savings. Of course, if the value is positive (i.e., greater than zero), it infers that in addition to initial construction costs, the project component will incur net increases in real future operating and maintenance costs (i.e., not realize net real economic savings over the life of the project). Finally, a negative value close to zero indicates a relatively low required investment to achieve a dollar of savings in O&M expenses.

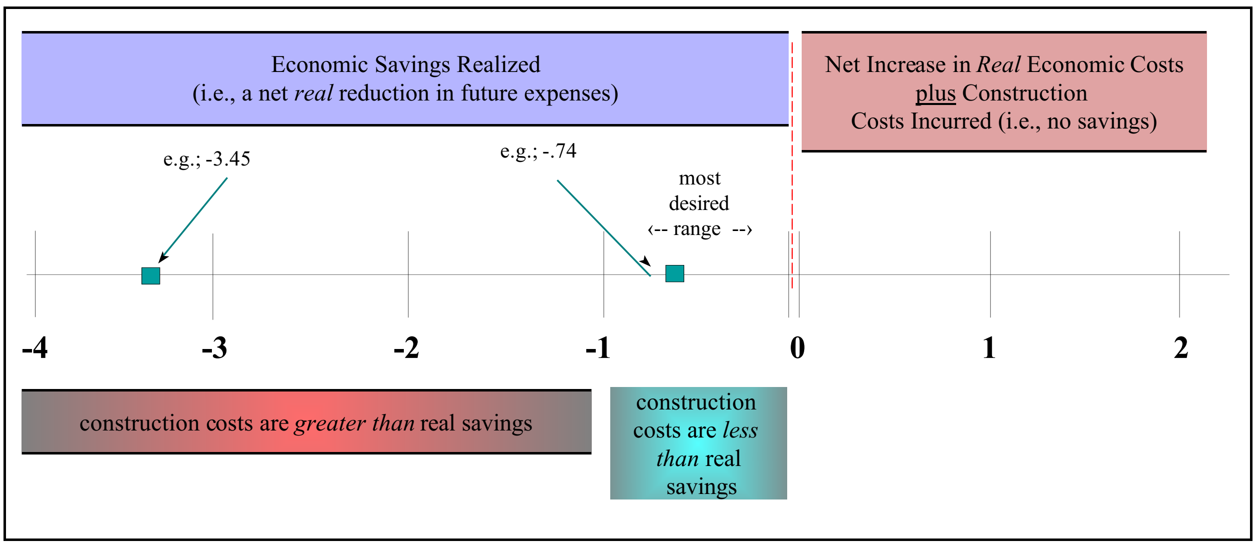


Exhibit 2. Graphical Interpretation of the Ratio "Dollars of Initial Construction Cost" Divided by "Dollars of Economic Savings" as Required by Federal Legislation for Water Conservation and Improvement Projects.

Although an interpretation of the third legislative criteria is provided above, ranking and/or comparing this ratio measure across project components (either within or across irrigation districts' projects) solely by this ratio should be approached with caution due to criticisms of the ratio's very nature. That is, it is difficult to determine the rank order of components since either a low initial construction cost and/or a high increase in O&M expenses result in a low ratio of the calculated values. Similarly, a high construction cost requirement and/or a low increase in O&M expenditures result in a high ratio of the calculated values. The resulting paradox is apparent. Furthermore, the reader is reminded that the legislative criteria do not reflect differences in useful lives of the respective project components.

## Comparing the Ranked Order of Comprehensive Life-Cycle Cost Values and Legislative Criteria Values

Notably, the legislated criteria numerical results differ from the comprehensive economic and financial life-cycle cost results. The numbers are dissimilar due to the difference in mathematical approaches, i.e., construction costs and O&M expenditures are not comprehensively evaluated per ac-ft of water savings and per BTU {kwh} of energy savings in the legislative criteria values.

The comprehensive assessment indicates component #2 (piping of Unit I-18) is a more economical source of *water savings* than component #1 (piping of Unit I-7A) and component #3 (piping of Unit I-22) (**Tables 6**, **7**, **8**, **9**, and **11**). The comprehensive costs of *energy savings* yielded the same rankings (**Tables 6**, **7**, **8**, **9**, and **11**). Although very expensive (i.e., compared to the District's 5-year average diversion-energy cost of $0.078 per kwh (**Table 1**)), Unit I-18s energy savings are cheaper to attain than those associated with Units I-7A and I-22.

The legislative-value results indicate Unit I-18 is the most economical in terms of dollars of initial construction costs per ac-ft of *water savings*, with Unit I-7A ranked second (**Tables 10** and **11**). With respect to cost of *energy savings*, Unit I-18 again is the most economical, out-performing Unit I-7A and Unit I-22 in terms of dollars of initial construction costs per BTU of energy saved (**Tables 10** and **11**).

Finally, for the construction costs per dollar of economic savings in annual O&M criterion, the anticipated net savings in O&M for Units I-7A and I-18 pipeline components appear to be less than that for Unit I-22 when evaluated in real (i.e., discounted) terms (**Tables 10** and **11**). It is difficult to determine the absolute rank order of these three components, however, since either a low construction cost requirement and/or a high increase in O&M expenditures result in a low ratio of the two designated calculated values. Similarly, a high construction cost requirement and/or a low increase in O&M expenditures result in a high ratio of the two designated calculated values. The resulting paradox is apparent.[21]

## Sensitivity Analyses (of Baseline Comprehensive Life-Cycle Results)

Sensitivity analyses permit testing of the stability (or instability) of key input values and show how sensitive results are to variances in specified input factors. Although sensitivity results for both the costs of saving water and energy are possible, only such analyses for the cost-of-saving-water are presented herein. To perform these analyses, the two-way Data Table feature of Excel (Walkenbach), whereby two parameters are varied with all others remaining constant, is used.

The most critical assumption made in the baseline analysis is considered to be the amount of water savings that will result from the project's installation. As such, the amount of water saved is varied +/- 50% with three other key variables (i.e., individually). The other variables pared with water savings in the sensitivity analyses include: expected useful life, initial construction costs, and the value of energy savings. Results for these three sets of sensitivity analyses, for all three project components, are presented in **Tables 12, 13,** and **14**, respectively.

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[21] See the previous sub-section entitled *Caveat to Interpretation of Legislated Criteria Results* for more discussion.

Variations in Water Savings & Expected Useful Life: Variations in these two data input are made for each of the three project components. For each, the useful life dimension is varied from the expected 49 years to as short as only 10 years. The variation in the water-savings dimension is done so on an individual project-component basis. For each component, a range from 50% to 150% of the expected water savings is calculated.

*Component #1 (Pipeline Unit I-7A)* has its water savings varied from 60 to 180 ac-ft (including the baseline of 120.1 ac-ft). The calculated values in **Table 12** reveal a range in the annual cost of saving an ac-ft of water from $271.88 to $1,781.10 around the baseline estimate of $413.84.

*Component #2 (Pipeline Unit I-18)* has its water savings varied from 125 to 374 ac-ft (including the baseline of 249.3 ac-ft). The calculated values in **Table 12** reveal a range in the annual cost of saving an ac-ft of water from $228.40 to $1,504.46, around the baseline estimate of $348.63.

*Component #3 (Pipeline Unit I-22)* has its water savings varied from 69 to 207 ac-ft (including the baseline of 138.1 ac-ft). The calculated values in **Table 12** reveal a range in the annual cost of saving an ac-ft of water from $280.83 to $1,838.09, around the baseline estimate of $427.27.

As expected, shorter-useful lives and lower water savings contribute to higher cost-of-saving water estimates, and vice versa.

Variations in Water Savings & Initial Construction Costs: Variations in these two data input are made for each of the three project components. For each, the initial construction cost dimension is varied from the expected amount by +/- $100,000, $250,000, and $500,000. The variation in the water-savings dimension is done so on an individual project-component basis. For each component, a range from 50% to 150% of the expected water savings is calculated.

*Component #1 (Pipeline Unit I-7A)* has its water savings varied from 60 to 180 ac-ft (including the baseline of 120.1 ac-ft). The calculated values in **Table 13** reveal a range in the annual cost of saving an ac-ft of water from $84.33 to $1,402.37, around the baseline estimate of $413.84.

*Component #2 (Pipeline Unit I-18)* has its water savings varied from 125 to 374 ac-ft (including the baseline of 249.3 ac-ft). The calculated values in **Table 13** reveal a range in the annual cost of saving an ac-ft of water from $138.04 to $980.39, around the baseline estimate of $348.63.

*Component #3 (Pipeline Unit I-22)* has its water savings varied from 69 to 207 ac-ft (including the baseline of 138.1 ac-ft). The calculated values in **Table 13** reveal a range in the annual cost of saving an ac-ft of water from $117.66 to $1,356.12, around the baseline estimate of $427.27.

As expected, higher construction costs and lower water savings contribute to higher cost-of-saving water estimates, and vice versa.

Variations in Water Savings & Value of Energy Savings: Variations in these two data input are made for each of the three project components. For each, the value of energy savings dimension is varied from the expected amount by +/- 10%, 30%, and 50%. The variation in the water-savings dimension is done so on an individual project-component basis. For each component, a range from 50% to 150% of the expected water savings is calculated.

*Component #1 (Pipeline Unit I-7A)* has its water savings varied from 60 to 180 ac-ft (including the baseline of 120.1 ac-ft). The calculated values in **Table 14** reveal a range in the annual cost of saving an ac-ft of water from $265.85 to $845.76, around the baseline estimate of $413.84.

*Component #2 (Pipeline Unit I-18)* has its water savings varied from 125 to 374 ac-ft (including the baseline of 249.3 ac-ft). The calculated values in **Table 14** reveal a range in the annual cost of saving an ac-ft of water from $222.38 to $715.33, around the baseline estimate of $348.63.

*Component #3 (Pipeline Unit I-22)* has its water savings varied from 69 to 207 ac-ft (including the baseline of 138.1 ac-ft). The calculated values in **Table 14** reveal a range in the annual cost of saving an ac-ft of water from $274.81 to $872.63, around the baseline estimate of $427.27.

As expected, lower energy-savings values and lower water savings contribute to higher cost-of-saving water estimates, and vice versa.

## Study Limitations

The analysis methodology and results are robust, providing useful information on the potential performance of the proposed project. There are limitations, however, to what the results are and are not and how they should and should not be used.

- The analysis is conducted from a District perspective and ignores any impact on water users that may occur by the District saving water. Any indirect economic impact effects to the local economy or other entity are ignored.
- The analysis is *pro forma* in nature, based on forecasts into the future. Obviously, the imperfect information contributes to a degree of uncertainty in the exact input values and final results.
- Limited time and funds necessitated the use of best estimates without the use of extensive field experiments to document all engineering- and water-related parameters.

- Though the analysis framework is deterministic, sensitivity analyses are included for several of the dominant parameters (in recognition of the prior two limitations). Beyond the sensitivity analyses, however, there is no accounting for risk in this analysis.

- This report provides an economic appraisal of the proposed projects life-cycle cost to save water and energy. Estimates of the value of water and energy are ignored.

- Only the project analyzed herein is discussed. Other projects, within or external to the District, which could be more economical are not evaluated here. Results of this project are comparable, however, to other projects analyzed and reported on by the authors.

While such caveats indicate limitations, they should not be interpreted as negating the results. These results are bonafide and conducive for use in the appraisal of the proposed project.

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## Tables

Table 1. Summary of Water Diversions, and Energy Use and Expenses (2002-2006) for HCID No. 2s Rio Grande Diversion Pumping Plant.

| Item | Calendar Year 2002 | 2003 | 2004 | 2005 | 2006 | 5-year Average |
|---|---|---|---|---|---|---|
| Electricity - Diverted: | | | | | | |
| - kwh used | 5,001,600 | 4,514,400 | 4,032,000 | 5,379,208 | 5,251,691 | 4,835,780 |
| - Btu equivalent | 17,065,459,200 | 15,403,132,800 | 13,757,184,000 | 18,353,859,197 | 17,918,769,828 | 16,499,681,005 |
| - total electric expense | $367,859 | $328,052 | $291,639 | $453,387 | $456,464 | $379,480 |
| Natural Gas - Diverted: | | | | | | |
| - kwh used | 0 | 0 | 0 | 0 | 0 | 0 |
| - Btu equivalent | 0 | 0 | 0 | 0 | 0 | 0 |
| - total natural gas expense | $0 | $0 | $0 | $0 | $0 | $0 |
| Total Energy - Diverted: | | | | | | |
| - kwh used | 5,001,600 | 4,514,400 | 4,032,000 | 5,379,208 | 5,251,691 | 4,835,780 |
| - Btu equivalent | 17,065,459,200 | 15,403,132,800 | 13,757,184,000 | 18,353,859,197 | 17,918,769,828 | 16,499,681,005 |
| - total energy expense | $367,859 | $328,052 | $291,639 | $453,387 | $456,464 | $379,480 |
| Water - Diverted: | | | | | | |
| - CFS pumped | 44,293 | 39,058 | 36,122 | 45,772 | 41,276 | 41,304 |
| - ac-ft equivalent | 87,860 | 77,476 | 71,652 | 90,793 | 81,876 | **81,932** |
| Calculations (diverted water): | | | | | | |
| - kwh / ac-ft | 56.93 | 58.27 | 56.27 | 59.25 | 64.14 | 59.02 |
| - Btu / ac-ft | 194,234 | 198,812 | 191,999 | 202,151 | 218,853 | **201,384** |
| - avg. cost per kwh ($/kwh) | $0.074 | $0.073 | $0.072 | $0.084 | $0.087 | $0.078 |
| - avg. cost per Btu ($/Btu) | $0.0000216 | $0.0000213 | $0.0000212 | $0.0000247 | $0.0000255 | $0.0000230 |
| - avg. energy cost of water pumped ($/ac-ft) | $4.19 | $4.23 | $4.07 | $4.99 | $5.58 | **$4.63** |

Source: Per district records (Hinojosa).

Table 2. Summary of Water Relifting, and Energy Use and Expenses (2002-2006) for HCID No. 2s Relift Pumping Plant.

| Item | Calendar Year 2002 | 2003 | 2004 | 2005 | 2006 | 5-year Average |
|---|---|---|---|---|---|---|
| Electricity - Relifted: | | | | | | |
| - kwh used | 2,719,691 | 2,118,360 | 2,164,800 | 2,801,062 | 2,749,735 | 2,510,730 |
| - Btu equivalent | 9,279,585,692 | 7,227,844,320 | 7,386,297,600 | 9,557,224,226 | 9,382,095,684 | 8,566,609,504 |
| - total electric expense | $190,434 | $164,972 | $159,777 | $258,390 | $255,606 | $205,836 |
| Water - Relifted: | | | | | | |
| - CFS pumped | 28,628 | 22,497 | 22,815 | 27,974 | 25,940 | 25,571 |
| - ac-ft equivalent | 56,786 | 44,626 | 45,256 | 55,489 | 51,454 | **50,722** |
| Calculations (relifted water): | | | | | | |
| - kwh / ac-ft | 47.89 | 47.47 | 47.84 | 50.48 | 53.44 | 49.50 |
| - Btu / ac-ft | 163,412 | 161,965 | 163,213 | 172,237 | 182,339 | **168,893** |
| - avg. cost per kwh ($/kwh) | $0.070 | $0.078 | $0.074 | $0.092 | $0.093 | $0.082 |
| - avg. cost per Btu ($/Btu) | $0.0000205 | $0.0000228 | $0.0000216 | $0.0000270 | $0.0000272 | $0.0000240 |
| - avg. energy cost of water pumped ($/ac-ft) | $3.35 | $3.70 | $3.53 | $4.66 | $4.97 | **$4.06** |

Source: Per district records (Hinojosa).

Table 3. Summary of Annual Water and Energy Savings Data for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.

| Component / Water Savings Category | Amount of Annual Water Savings, by Type | | | Total Water Savings (ac-ft) | Associated Annual Energy Savings [a] | | |
|---|---|---|---|---|---|---|---|
| | Reduced Seepage (ac-ft) | Reduced Recharging (ac-ft) | Reduced Other (ac-ft) | | BTU | kwh | $ |
| *Component #1 - Unit I-7A Pipeline* | | | | | | | |
| Off-farm (reduced seepage) | 115.5 | - | - | 115.5 | 42,766,928 | 12,534 | $1,004 |
| Off-farm (reduced recharging) | - | 4.6 | - | 4.6 | 1,706,974 | 500 | $40 |
| sub-total | 115.5 | 4.6 | - | 120.1 | 44,473,902 | 13,034 | $1,044 |
| *Component #2 - Unit I-18 Pipeline* | | | | | | | |
| Off-farm (reduced seepage) | 229.5 | - | - | 229.5 | 84,978,441 | 24,906 | $1,994 |
| Off-farm (reduced recharging) | - | 19.8 | - | 19.8 | 7,327,771 | 2,148 | $172 |
| sub-total | 229.5 | 19.8 | - | 249.3 | 92,306,212 | 27,054 | $2,166 |
| *Component #3 - Unit I-22 Pipeline* | | | - | | | | |
| Off-farm (reduced seepage) | 120.0 | - | - | 120.0 | 44,433,172 | 13,023 | $1,043 |
| Off-farm (reduced recharging) | - | 18.1 | - | 18.1 | 6,683,490 | 1,959 | $157 |
| sub-total | 120.0 | 18.1 | - | 138.1 | 51,116,662 | 14,982 | $1,200 |
| **Total** | **465.0** | **42.5** | **-** | **507.5** | **187,896,776** | **55,070** | **$4,410** |

Source: Hinojosa, Michalewicz.

a Inclusive of both diversion and relift energy.

Table 4. Summary of Project Cost and Expense Data for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007. [a]

| Item | Component #1 Pipeline Unit I-7A | | | Component #2 Pipeline Unit I-18 | | | Component #3 Pipeline Unit I-22 | | | Aggregate |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Expenses / Revenues | | | Expenses / Revenues | | | Expenses / Revenues | | |
| | yrs | total $ | $/mile | yrs | total $ | $/mile | yrs | total $ | $/mile | total $ |
| Installation Period | 1 | | | 1 | | | 1 | | | |
| Productive Period (i.e., useful life) | 49 | | | 49 | | | 49 | | | |
| Total Planning Period | 50 | | | 50 | | | 50 | | | |
| Initial Construction Costs | | $1,184,751 | $ 631,867 | | $ 1,881,500 | $ 940,750 | | $ 1,901,830 | $ 950,915 | $ 4,968,081 |
| Increase in Annual O&M Costs (new pipeline) | | $ 444 | $ 237 | | $ 474 | $ 237 | | $ 474 | $ 237 | $ 1,391 |
| Decrease in Annual O&M Costs (old pipeline) | | ($ 17,573) | ($ 9,372) | | ($ 18,745) | ($ 9,372) | | ($ 18,745) | ($ 9,372) | ($ 55,063) |
| Net Change in O&M Costs | | ($ 17,129) | ($ 9,136 ) | | ($ 18,271) | ($ 9,136) | | ($ 18,271) | ($ 9,136) | ($ 53,672) |
| Decrease in Annual Emergency Repairs (old) | | ($ 3,718) | ($ 1,983) | | ($ 8,580) | ($ 4,290) | | ($ 30,674) | ($ 15,337) | ($ 42,972) |
| Total Net Change in O&M & Repair Costs | | ($ 20,847) | ($ 11,118) | | ($ 26,851) | $ (13,426) | | ($ 48,945) | ($ 24,472) | ($ 96,644) |
| Value of Extra-ordinary Impacts | | $ 0 | $ 0 | | $ 0 | $ 0 | | $ 0 | $ 0 | $ 0 |

Source: Hinojosa, Gonzalez.

[a] All costs, expenses, and revenues are based on 2007 dollars.

Table 5. Details of Cost Estimates for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.[a]

| Item | -- Component #1 -- Pipeline Unit I-7A | -- Component #2 -- Pipeline Unit I-18 | -- Component #3 -- Pipeline Unit I-22 | Aggregate |
|---|---|---|---|---|
| Line Pipe | $603,119 | $1,270,210 | $1,216,682 | $3,090,011 |
| Gate Structure Pipe | 27,960 | 9,693 | 7,178 | 44,831 |
| Vent Pipe | 4,200 | 2,532 | 400 | 7,132 |
| Sluice Gates & Valves | 199,165 | 149,275 | 155,445 | 503,885 |
| Concrete for Gatewell Structures | 123,515 | 107,185 | 90,781 | 321,481 |
| Other | 29,333 | 29,023 | 114,373 | 172,729 |
| Subtotal | $987,292 | $1,567,917 | $1,584,858 | $4,140,067 |
| Contingencies (20%) | 197,458 | 313,583 | 316,972 | 828,013 |
| Total | $1,184,751 | $1,881,500 | $1,901,830 | $4,968,081 |

Source: Gonzalez.

[a] All values are basis 2007 dollars and are turn-key values (i.e., include purchase, mobilization, and installation).

Table 6. Economic and Financial Evaluation Results Across Component #1s Useful Life, HCID No. 2 – Pipeline Unit I-7A, 2007.

| Results | Units | Nominal Value | Real Value [a] |
|---|---|---|---|
| Water Savings | ac-ft (lifetime) | 5,885 | 2,465 |
| - annuity equivalent | ac-ft/year | | 115 |
| Energy Savings | BTU (lifetime) | 2,179,221,219 | 912,633,215 |
| - annuity equivalent | BTU/year | | 42,483,259 |
| Energy Savings | kwh (lifetime) | 638,693 | 267,477 |
| - annuity equivalent | kwh/year | | 12,477 |
| NPV of Total Costs - for water saved [b] | 2007 dollars | ($ 705,535) | $ 735,531 |
| - annuity equivalent | $/year | | $ 47,481 |
| *Cost-of-Saving Water* | $/ac-ft/year | | $ 413.84 |
| NPV of Total Costs - for energy saved [c] | 2007 dollars | ($ 615,219) | $ 756,949 |
| - annuity equivalent | $/year | | $ 48,864 |
| *Cost-of-Saving Energy* | $/BTU/year | | $0.0011502 |
| *Cost-of-Saving Energy* | $/kwh/year | | $3.924 |

[a] Determined using a 6.125% discount factor for dollars and a 4.000% discount factor for water and energy savings.

[b] These are the total net cost stream values (nominal and real) relevant to saving water for the life of the project component as they include initial construction costs, net changes in O&M expenses, and a credit for energy savings, and ignore any value (or sales revenue) for the saved water.

[c] These are the total net cost stream values (nominal and real) relevant to saving energy for the life of the project component as they include initial construction costs, net changes in O&M expenses, and ignore the energy-savings value, as well as any value (or sales revenue) for the saved water.

Table 7. Economic and Financial Evaluation Results Across Component #2s Useful Life, HCID No. 2 – Pipeline Unit I-18, 2007.

| Results | Units | Nominal Value | Real Value [a] |
|---|---|---|---|
| Water Savings | ac-ft (lifetime) | 12,215 | 5,116 |
| - annuity equivalent | ac-ft/year | | 238 |
| Energy Savings | BTU (lifetime) | 4,523,004,394 | 1,894,183,117 |
| - annuity equivalent | BTU/year | | 88,174,604 |
| Energy Savings | kwh (lifetime) | 1,325,617 | 555,153 |
| - annuity equivalent | kwh/year | | 25,842 |
| NPV of Total Costs - for water saved [b] | 2007 dollars | ($ 623,891) | $ 1,286,041 |
| - annuity equivalent | $/year | | $ 83,019 |
| *Cost-of-Saving Water* | $/ac-ft/year | | $ 348.63 |
| NPV of Total Costs - for energy saved [c] | 2007 dollars | ($ 436,854) | $ 1,330,494 |
| - annuity equivalent | $/year | | $ 85,889 |
| *Cost-of-Saving Energy* | $/BTU/year | | $0.0009741 |
| *Cost-of-Saving Energy* | $/kwh/year | | $ 3.324 |

[a] Determined using a 6.125% discount factor for dollars and a 4.000% discount factor for water and energy savings.

[b] These are the total net cost stream values (nominal and real) relevant to saving water for the life of the project component as they include initial construction costs, net changes in O&M expenses, and a credit for energy savings, and ignore any value (or sales revenue) for the saved water.

[c] These are the total net cost stream values (nominal and real) relevant to saving energy for the life of the project component as they include initial construction costs, net changes in O&M expenses, and ignore the energy-savings value, as well as any value (or sales revenue) for the saved water.

Table 8. Economic and Financial Evaluation Results Across Component #3s Useful Life, HCID No. 2 – Pipeline Unit I-22, 2007.

| Results | Units | Nominal Value | Real Value [a] |
|---|---|---|---|
| Water Savings | ac-ft (lifetime) | 6,764 | 2,833 |
| - annuity equivalent | ac-ft/year | | 132 |
| Energy Savings | BTU (lifetime) | 2,504,716,421 | 1,048,946,926 |
| - annuity equivalent | BTU/year | | 48,828,690 |
| Energy Savings | kwh (lifetime) | 734,090 | 307,429 |
| - annuity equivalent | kwh/year | | 14,311 |
| NPV of Total Costs - for water saved [b] | 2007 dollars | ($ 2,427,663) | $ 872,833 |
| - annuity equivalent | $/year | | $ 56,345 |
| *Cost-of-Saving Water* | $/ac-ft/year | | $ 427.27 |
| NPV of Total Costs - for energy saved [c] | 2007 dollars | ($ 2,324,087) | $ 897,450 |
| - annuity equivalent | $/year | | $ 57,934 |
| *Cost-of-Saving Energy* | $/BTU/year | | $0.0011865 |
| *Cost-of-Saving Energy* | $/kwh/year | | $4.048 |

[a] Determined using a 6.125% discount factor for dollars and a 4.000% discount factor for water and energy savings.

[b] These are the total net cost stream values (nominal and real) relevant to saving water for the life of the project component as they include initial construction costs, net changes in O&M expenses, and a credit for energy savings, and ignore any value (or sales revenue) for the saved water.

[c] These are the total net cost stream values (nominal and real) relevant to saving energy for the life of the project component as they include initial construction costs, net changes in O&M expenses, and ignore the energy-savings value, as well as any value (or sales revenue) for the saved water.

Table 9. Summary of Results for the Comprehensive Economic and Financial Life-Cycle Costs-of-Saving Water and Energy, by Component and Aggregate for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.

| Item | Units | Project Component | | | Aggregate |
|---|---|---|---|---|---|
| | | #1 Unit I-7A | #2 Unit I-18 | #3 Unit I-22 | |
| NPV of Total Costs - water saved [a] | 2007 dollars | $ 735,531 | $ 1,286,041 | $ 872,833 | $ 2,894,405 |
| - annuity equivalent | $/year | $ 47,481 | $ 83,019 | $ 56,345 | $ 186,845 |
| NPV of All Water Savings | ac-ft (lifetime) | 2,465 | 5,116 | 2,833 | 10,413 |
| - annuity equivalent | ac-ft/year | 115 | 238 | 132 | 485 |
| *Cost-of-Saving-Water* [b] | $/ac-ft/year | $ 413.84 | $ 348.63 | $ 427.27 | $ 385.46 |
| NPV of Total Costs - energy saved [c] | 2007 dollars | $ 756,949 | $ 1,330,494 | $ 897,450 | $ 2,984,894 |
| - annuity equivalent | $/year | $ 48,864 | $ 85,889 | $ 57,934 | $ 192,687 |
| NPV of All Energy Savings | btu (lifetime) | 912,633,215 | 1,894,183,117 | 1,048,946,926 | 3,855,763,258 |
| - annuity equivalent | btu/year | 42,483,259 | 88,174,604 | 48,828,690 | 179,486,553 |
| NPV of All Energy Savings | kwh (lifetime) | 267,477 | 555,153 | 307,429 | 1,130,059 |
| - annuity equivalent | kwh/year | 12,451 | 25,842 | 14,311 | 52,604 |
| *Cost-of-Saving-Energy* [b] | $/btu/year | $ 0.0011502 | $ 0.0009741 | $ 0.0011865 | $ 0.0010735 |
| *Cost-of-Saving-Energy* [b] | $/kwh/year | $ 3.924 | $ 3.324 | $ 4.048 | $ 3.663 |

[a] Total net costs (real) relevant to saving water over the life of the project component as they include initial construction costs, net changes in O&M expenses, and a credit for energy savings, and ignore any value (or sales revenue) for the saved water.

[b] An annuity equivalent value (i.e., also referred to as "annualized" cost, or "levelised" cost), assuming perpetuity, net zero salvage value for capital assets, and perpetual replacement with like property.

[c] These are the total net costs (real) relevant to saving energy over the life of the project component as they include initial construction costs, net changes in O&M expenses, and ignore the energy-savings value, as well as any value (or sales revenue) for the saved water.

Table 10. Summary of Intermediate-Calculation Values and Legislative-Value Results for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.

| | Component #1 Unit I-7A | | Component #2 Unit I-18 | | Component #3 Unit I-22 | | Aggregate |
|---|---|---|---|---|---|---|---|
| | Nominal | Real [a] | Nominal | Real [a] | Nominal | Real [a] | Real [a] |
| | Intermediate-Calculation Values | | | | | | |
| Initial Construction Costs | $1,184,751 | $1,184,751 | $1,881,500 | $1,881,500 | $1,901,830 | $1,901,830 | $4,968,081 |
| Ac-Ft of Water Saved | 5,885 | 2,465 | 12,215 | 5,116 | 6,764 | 2,833 | 10,413 |
| BTU of Energy Saved | 2,179,221,219 | 912,633,215 | 4,523,004,394 | 1,894,183,117 | 2,504,716,421 | 1,048,946,926 | 3,855,763,258 |
| kwh of Energy Saved | 638,693 | 267,477 | 1,325,617 | 555,153 | 734,090 | 307,429 | 1,130,060 |
| $ of Annual Economic Savings [b] | ($1,890,086) | ($449,219) | ($2,505,391) | ($595,460) | ($4,329,492) | ($1,028,996) | ($2,073,675) |
| | Legislative-Value Results | | | | | | |
| Dollar of Initial Construction Costs per Ac-Ft of Water Saved | $201.30 | **$480.68** | $154.03 | **$367.80** | $281.15 | **$671.34** | $510.92 |
| Initial Construction Costs per BTU of Energy Saved | $0.0005437 | **$0.0012982** | $0.0004160 | **$0.0009933** | $0.0007593 | **$0.0018131** | $0.0013798 |
| Initial Construction Costs per kwh of Energy Saved | $ 1.855 | **$ 4.429** | $ 1.419 | **$ 3.389** | $2.591 | **$6.186** | $4.708 |
| $ of Initial Construction Costs per $ of Annual Economic Savings [c, d] | -0.627 | **-2.637** | -0.751 | **-3.160** | -0.439 | **-1.848** | -2.533 |

[a] Determined using a 6.125% discount factor for dollars and a 4.000% discount factor for water and energy savings.

[b] Positive (+) values indicate net added costs, while negative (-) values indicate net savings.

[c] Negative values indicate expected net reductions in O&M expenditures over the planning horizon, while positive values indicate expected net increases in O&M expenditures over the planning horizon.

[d] Interpretation and discussion of these values are provided in the sub-section entitled: *Caveat to Interpretation of Legislative-Value Results* on page 13.

Table 11. Ranked Order of Project Components I-7A, I-18, and I-22, by Comprehensive Economic and Financial Values and Legislative Values, HCID No. 2, 2007.

| | Ranking Measure / Ranked Order | | | | |
|---|---|---|---|---|---|
| | Composite Economic & Financial Values | | Legislative Values | | |
| **Project Component** | **Water Savings** | **Energy Savings** | **$ ICC per ac-ft[a] Water Saved** | **$ ICC per BTU Energy Saved** | **$ ICC per $ Annual Economic Savings** |
| #1 Pipeline Unit I-7A | 2nd | 2nd | 2nd | 2nd | 2nd |
| #2 Pipeline Unit I-18 | 1st | 1st | 1st | 1st | 3rd |
| #3 Pipeline Unit I-22 | 3rd | 3rd | 3rd | 3rd | 1st |

[a] Note that the abbreviation ICC stands for 'Initial Construction Cost'; the abbreviation allows for a more user-friendly table heading.

Table 12. Sensitivity Analyses on the Cost-of-Saving Water with Changes in Useful Life and Annual Water Savings for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.

| | | variation in water saved | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 50% | 60% | 70% | 80% | 90% | **100%** | 110% | 120% | 130% | 150% |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-7A | | | | | | | | | |
| | | 60 | 72 | 84 | 96 | 108 | **120.1** | 132 | 144 | 156 | 180 |
| Expected Useful life (years) | 10 | $1,781.10 | $1,479.99 | $1,264.91 | $1,103.60 | $978.14 | $877.77 | $795.65 | $727.22 | $669.31 | $576.66 |
| | 20 | $1,145.93 | $952.20 | $813.83 | $710.04 | $629.32 | $564.74 | $511.91 | $467.88 | $430.62 | $371.01 |
| | 25 | $1,029.21 | $855.22 | $730.93 | $637.72 | $565.22 | $507.22 | $459.77 | $420.22 | $386.76 | $333.22 |
| | 30 | $956.59 | $794.87 | $679.36 | $592.72 | $525.34 | $471.43 | $427.33 | $390.57 | $359.47 | $309.71 |
| | 40 | $876.11 | $727.99 | $622.20 | $542.85 | $481.14 | $431.77 | $391.37 | $357.71 | $329.23 | $283.65 |
| | **49** | $839.73 | $697.77 | $596.36 | $520.31 | $461.16 | **$413.84** | $375.12 | $342.86 | $315.56 | $271.88 |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-18 | | | | | | | | | |
| | | 125 | 150 | 175 | 199 | 224 | **249.3** | 274 | 299 | 324 | 374 |
| Expected Useful life (years) | 10 | $1,504.46 | $1,249.46 | $1,067.31 | $930.70 | $824.45 | $739.45 | $669.90 | $611.95 | $562.91 | $484.45 |
| | 20 | $967.95 | $803.88 | $686.69 | $598.80 | $530.44 | $475.75 | $431.01 | $393.72 | $362.17 | $311.69 |
| | 25 | $869.35 | $722.00 | $616.75 | $537.81 | $476.41 | $427.29 | $387.10 | $353.62 | $325.28 | $279.94 |
| | 30 | $808.01 | $671.06 | $573.23 | $499.86 | $442.79 | $397.14 | $359.79 | $328.66 | $302.33 | $260.19 |
| | 40 | $740.03 | $614.60 | $525.00 | $457.80 | $405.54 | $363.73 | $329.52 | $301.01 | $276.89 | $238.29 |
| | **49** | $709.30 | $589.08 | $503.20 | $438.80 | $388.70 | **$348.63** | $315.84 | $288.51 | $265.39 | $228.40 |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-22 | | | | | | | | | |
| | | 69 | 83 | 97 | 110 | 124 | **138.1** | 152 | 166 | 179 | 207 |
| Expected Useful life (years) | 10 | $1,838.09 | $1,527.48 | $1,305.62 | $1,139.22 | $1,009.80 | $906.26 | $821.55 | $750.96 | $691.23 | $595.66 |
| | 20 | $1,182.60 | $982.76 | $840.01 | $732.96 | $649.69 | $583.08 | $528.57 | $483.16 | $444.72 | $383.24 |
| | 25 | $1,062.14 | $882.66 | $754.45 | $658.30 | $583.51 | $523.69 | $474.73 | $433.94 | $399.43 | $344.20 |
| | 30 | $987.20 | $820.37 | $701.22 | $611.85 | $542.34 | $486.73 | $441.24 | $403.32 | $371.24 | $319.91 |
| | 40 | $904.14 | $751.35 | $642.22 | $560.37 | $496.71 | $445.78 | $404.11 | $369.39 | $340.01 | $293.00 |
| | **49** | $866.60 | $720.16 | $615.55 | $537.10 | $476.09 | **$427.27** | $387.33 | $354.05 | $325.89 | $280.83 |

Table 13. Sensitivity Analyses on the Cost-of-Saving Water with Changes in Initial Construction Costs and Annual Water Savings for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.

| | | variation in water saved | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 50% | 60% | 70% | 80% | 90% | **100%** | 110% | 120% | 130% | 150% |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-7A | | | | | | | | | |
| | | 60 | 72 | 84 | 96 | 108 | **120.1** | 132 | 144 | 156 | 180 |
| Initial Construction Costs | ($500,000) | $277.09 | $228.90 | $194.48 | $168.66 | $148.58 | $132.52 | $119.38 | $108.42 | $99.16 | $84.33 |
| | ($250,000) | $558.41 | $463.33 | $395.42 | $344.49 | $304.87 | $273.18 | $247.25 | $225.64 | $207.36 | $178.10 |
| | ($100,000) | $727.20 | $603.99 | $515.99 | $449.98 | $398.65 | $357.58 | $323.97 | $295.97 | $272.28 | $234.37 |
| | **$1,184,751** | $839.73 | $697.77 | $596.36 | $520.31 | $461.16 | **$413.84** | $375.12 | $342.86 | $315.56 | $271.88 |
| | $100,000 | $952.26 | $791.54 | $676.74 | $590.64 | $523.68 | $470.10 | $426.27 | $389.75 | $358.84 | $309.39 |
| | $250,000 | $1,121.05 | $932.20 | $797.31 | $696.14 | $617.45 | $554.50 | $503.00 | $460.08 | $423.76 | $365.65 |
| | $500,000 | $1,402.37 | $1,166.63 | $998.25 | $871.96 | $773.74 | $695.16 | $630.87 | $577.29 | $531.96 | $459.42 |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-18 | | | | | | | | | |
| | | 125 | 150 | 175 | 199 | 224 | **249.3** | 274 | 299 | 324 | 374 |
| Initial Construction Costs | ($500,000) | $438.22 | $363.17 | $309.57 | $269.37 | $238.10 | $213.08 | $192.62 | $175.56 | $161.13 | $138.04 |
| | ($250,000) | $573.76 | $476.13 | $406.39 | $354.08 | $313.40 | $280.86 | $254.23 | $232.04 | $213.26 | $183.22 |
| | ($100,000) | $655.09 | $543.90 | $464.48 | $404.91 | $358.58 | $321.52 | $291.19 | $265.92 | $244.54 | $210.33 |
| | **$1,881,500** | $709.30 | $589.08 | $503.20 | $438.80 | $388.70 | **$348.63** | $315.84 | $288.51 | $265.39 | $228.40 |
| | $100,000 | $763.52 | $634.26 | $541.93 | $472.68 | $418.82 | $375.73 | $340.48 | $311.10 | $286.25 | $246.47 |
| | $250,000 | $844.85 | $702.03 | $600.02 | $523.51 | $464.00 | $416.40 | $377.45 | $344.99 | $317.52 | $273.58 |
| | $500,000 | $980.39 | $814.98 | $696.83 | $608.22 | $539.30 | $484.17 | $439.06 | $401.47 | $369.66 | $318.76 |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-22 | | | | | | | | | |
| | | 69 | 83 | 97 | 110 | 124 | **138.1** | 152 | 166 | 179 | 207 |
| Initial Construction Costs | ($500,000) | $377.07 | $312.22 | $265.89 | $231.15 | $204.13 | $182.51 | $164.82 | $150.08 | $137.61 | $117.66 |
| | ($250,000) | $621.83 | $516.19 | $440.72 | $384.13 | $340.11 | $304.89 | $276.08 | $252.07 | $231.75 | $199.24 |
| | ($100,000) | $768.69 | $638.57 | $545.62 | $475.91 | $421.70 | $378.32 | $342.83 | $313.26 | $288.23 | $248.20 |
| | **$1,901,830** | $866.60 | $720.16 | $615.55 | $537.10 | $476.09 | **$427.27** | $387.33 | $354.05 | $325.89 | $280.83 |
| | $100,000 | $964.50 | $801.74 | $685.49 | $598.29 | $530.48 | $476.23 | $431.84 | $394.85 | $363.55 | $313.47 |
| | $250,000 | $1,111.36 | $924.12 | $790.38 | $690.08 | $612.07 | $549.65 | $498.59 | $456.04 | $420.03 | $362.42 |
| | $500,000 | $1,356.12 | $1,128.09 | $965.21 | $843.06 | $748.04 | $672.03 | $609.85 | $558.02 | $514.17 | $444.01 |

Table 14. Sensitivity Analyses on the Cost-of-Saving Water with Changes in the Value of Energy Savings ($/kwh) and Annual Water Savings for Pipeline Units I-7A, I-18, and I-22, HCID No. 2, 2007.

| | | variation in water saved | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 50% | 60% | 70% | 80% | 90% | **100%** | 110% | 120% | 130% | 150% |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-7A | | | | | | | | | |
| | | 60 | 72 | 84 | 96 | 108 | **120.1** | 132 | 144 | 156 | 180 |
| Value of Energy Savings ($/kwh) | (50%) | $845.76 | $703.80 | $602.40 | $526.34 | $467.19 | $419.87 | $381.15 | $348.89 | $321.59 | $277.91 |
| | (30%) | $843.35 | $701.39 | $599.98 | $523.93 | $464.78 | $417.46 | $378.74 | $346.48 | $319.18 | $275.50 |
| | (10%) | $840.94 | $698.98 | $597.57 | $521.52 | $462.37 | $415.05 | $376.33 | $344.07 | $316.77 | $273.09 |
| | **$0.078** | $839.73 | $697.77 | $596.36 | $520.31 | $461.16 | **$413.84** | $375.12 | $342.86 | $315.56 | $271.88 |
| | 10% | $838.53 | $696.57 | $595.16 | $519.11 | $459.96 | $412.64 | $373.92 | $341.66 | $314.36 | $270.67 |
| | 30% | $836.12 | $694.15 | $592.75 | $516.70 | $457.55 | $410.23 | $371.51 | $339.25 | $311.94 | $268.26 |
| | 50% | $833.71 | $691.74 | $590.34 | $514.29 | $455.14 | $407.82 | $369.10 | $336.83 | $309.53 | $265.85 |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-18 | | | | | | | | | |
| | | 125 | 150 | 175 | 199 | 224 | **249.3** | 274 | 299 | 324 | 374 |
| Value of Energy Savings ($/kwh) | (50%) | $715.33 | $595.11 | $509.23 | $444.83 | $394.73 | $354.66 | $321.87 | $294.54 | $271.42 | $234.43 |
| | (30%) | $712.92 | $592.70 | $506.82 | $442.42 | $392.32 | $352.25 | $319.46 | $292.13 | $269.01 | $232.02 |
| | (10%) | $710.51 | $590.29 | $504.41 | $440.00 | $389.91 | $349.84 | $317.05 | $289.72 | $266.60 | $229.61 |
| | **$0.078** | $709.30 | $589.08 | $503.20 | $438.80 | $388.70 | **$348.63** | $315.84 | $288.51 | $265.39 | $228.40 |
| | 10% | $708.10 | $587.88 | $502.00 | $437.59 | $387.50 | $347.42 | $314.64 | $287.31 | $264.19 | $227.20 |
| | 30% | $705.69 | $585.46 | $499.59 | $435.18 | $385.09 | $345.01 | $312.22 | $284.90 | $261.78 | $224.79 |
| | 50% | $703.28 | $583.05 | $497.18 | $432.77 | $382.68 | $342.60 | $309.81 | $282.49 | $259.37 | $222.38 |
| | | Annual Water Savings (ac-ft) - Pipeline Unit I-22 | | | | | | | | | |
| | | 69 | 83 | 97 | 110 | 124 | **138.1** | 152 | 166 | 179 | 207 |
| Value of Energy Savings ($/kwh) | (50%) | $872.63 | $726.19 | $621.59 | $543.13 | $482.12 | $433.30 | $393.37 | $360.08 | $331.92 | $286.86 |
| | (30%) | $870.22 | $723.78 | $619.17 | $540.72 | $479.71 | $430.89 | $390.95 | $357.67 | $329.51 | $284.45 |
| | (10%) | $867.81 | $721.36 | $616.76 | $538.31 | $477.30 | $428.48 | $388.54 | $355.26 | $327.10 | $282.04 |
| | **$0.078** | $866.60 | $720.16 | $615.55 | $537.10 | $476.09 | **$427.27** | $387.33 | $354.05 | $325.89 | $280.83 |
| | 10% | $865.39 | $718.95 | $614.35 | $535.90 | $474.88 | $426.07 | $386.13 | $352.85 | $324.69 | $279.63 |
| | 30% | $862.98 | $716.54 | $611.94 | $533.49 | $472.47 | $423.66 | $383.72 | $350.44 | $322.28 | $277.22 |
| | 50% | $860.57 | $714.13 | $609.53 | $531.08 | $470.06 | $421.25 | $381.31 | $348.03 | $319.87 | $274.81 |

# — Notes —