Lake Powell Pipeline Economic Feasibility Analysis for Washington County, UT

October 2015
Lake Powell Pipeline Feasibility for Washington County Water District

The following summarizes concerns about the ability of the Washington County Water Conservancy District (WCWCD) to repay debt issued by the State of Utah for the WCWCD’s financial obligation for participating in the proposed Lake Powell Pipeline (LPP).

1. Washington County Water District’s Questionable Water Needs. Based on declining population growth, potential to convert additional agricultural water, potential water conservation savings, and previously unconsidered water sources, Washington County has ample water to serve future populations without participation in the Lake Powell Pipeline.

1a. Outdated Population Forecasts. The Governor’s Office of Planning and Budget (GOPB) 2012 Baseline Population Projections estimates Washington County will grow to 581,731 residents by the year 2060, 32.4 percent lower than population projections made by the GOPB in 2005. Since the District’s water needs projections rely on these population projections, the more updated data pushes the supposed need for the LPP back over 12 years. The labeled 2006 Population and 2012 Projection with No Conservation lines in Figure 2 on page 3 illustrates the difference between these two different population forecasts on water use.

1b. Potential Agricultural Water Transfers. In the most recent Kanab Creek/Virgin River Basin Plan by the Division of Water Resources (DWR) from 1993 (1993 KCVRBP) it was estimated the basin had 25,600 acres of irrigated cropland, diverting over 123,000 acre-feet of water (pg. 10–14), with 87,800 acre-feet of the agricultural diversions in the basin occurring in Washington County. Much of the water diverted for agriculture in Washington County uses inefficient conveyance systems and it is estimated “If the overall irrigation efficiency could be increased one percent, it would save 2,500 acre-feet of water in the basin.” (pg. 2–8 1993 KCVRBP).

As future development replaces former agricultural lands in the county, the new development creates a surplus of water formerly used to irrigate crops. Table ES-11 in the 2011 DWRe Water Needs Assessment claims that Washington County can only expect to convert 10,080 acre-feet of agricultural water for M&I needs. However Table 10-6 of the 1993 KCVRBP implies, using linear interpolation, that there will be a reduction of 27,100 acre-feet of irrigated cropland water diversions from 2011 to 2040. According to the 2012 USDA Census of Agriculture, Washington County had 14,781 acres of irrigated lands in 2012, a reduction of over 10,000 acres since 1993.

The 2015 Legislative Audit of the Division of Water Resources found that “the state engineer typically approves the conversion of 100 percent of agricultural water to municipal use” and thus Washington County can expect much more than 10,000 acre-feet of water to be available from agricultural conversions.

2 Utah State Water Plan, Kanab Creek/Virgin River Basin, Utah Division of Water Resources, August 1993.
1.c Potential Water Conservation Savings. According to the 2011 DWRe Water Needs Assessment, WCWCD uses 295 gallons per capita per day ("GPCD"; p. ES-7) and had 13 percent water conservation savings from 2000–2009 (p. ES-10). If WCWCD encouraged residents to get closer to neighboring cities or the state conservation goal of 220 GPCD, the district could extend its water supply even further into the future.

WCWCD claims only 10,080 ac-ft of water will be available for municipal use from the conversion of agricultural lands as a function urban growth, yet the 1993 KCVRBP projects there will be 27,100 acre-feet made available by 2040.

The recent legislative audit noted:

"The Southern Nevada Water Authority, which serves the Las Vegas region, has a goal to reduce water use to 199 by 2035. In contrast, the communities in Southwestern Utah, which have a climate similar to that of Southern Nevada, have a goal to reduce water use to 292 GPCD by the year 2060."5

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Figure 2: Population projections from the Governor’s Office of Planning & Budget demonstrate reduced water demand for Washington County. The recent Legislative Audit of water needs projections questioned the conservation efforts of Utah and criticized the DWRe for not including local sources of water available outside of WCWCD supplies in planning documents. The dotted red line shows water demand if per capita water use was reduced each year after 2025 by 1 percent of the 2025 level.

1d. Previously Unconsidered Water Sources. According to a May 2015 bond rating update for WCWCD from Fitch Ratings:

“The district has ample water supply, is expanding its water reserves through a groundwater recharge program, enjoys surplus system capacity, operates predominantly new infrastructure, and faces no known regulatory issues.”

The District noted it operates a groundwater recharge program that currently provides 100,000 acre-feet of water and will provide access to up to 300,000 af in the future.6 This amount of water more than twice the District’s supply, yet is not accounted for in the LPP planning documents.

The 2015 Legislative Audit of the state sponsor of the Lake Powell Pipeline, the Utah Division of Water Resources, showed that water planners are ignoring the fact that local water providers have the ability to expand their own sources of water supply. The auditors noted St. George has the ability to expand its water supply without the assistance of WCWCD through new well drilling and other sources.7 These future water sources were also not included in the LPP planning documents.

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2. Estimate of Existing Revenues vs. Debt Service for WCWCD.

One important question is whether or not local taxpayers can support Washington County’s repayment obligation for the LPP as is required by Utah Law. The Lake Powell Pipeline (LPP) Development Act (Utah Code 73-28-402) mandates the entire project cost be repaid to the State of Utah with interest.

Repayment of the LPP construction costs requires the District’s total revenues to cover their existing operation and maintenance costs, preexisting debt obligations, debt from LPP construction, and the operation and maintenance costs associated with the LPP.

A review of the WCWCD’s revenue streams is warranted, based on the 2013 Audited Financial Statement Prepared for WCWCD, the “2013 WCWCDAFS”.

2a. Current Revenues

Operating Revenues. WCWCD received $7,013,377 in water sales revenue, $926,134 in power sales revenues and $1,379,171 in Water Development and Connection Fees (page 22 of the 2013 WCWCDAFS). These last two categories are represented as “Power Sales & Surcharges” in the above pie chart.

Property Tax Revenues. In 2013 WCWCD collected $9,938,660 from property taxes (see the source in the next paragraph). Its levy rate was 0.000970544 times the taxable value of the county (p. 19 of the 2013 WCWCDAFS).

Impact Fee Revenues. WCWCD collected $5,919,316 in impact fees for new development in 2013 (page 19 of the 2013 WCWCDAFS):

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“Washington County Water Conservancy District Financial Statement With Other Government Reports For the year ending June 30, 2013.”
Revenues from Sale of WCWCD’s Surplus Real Property. According to page 7 of the 2013 WCWCDAFS, the District has between 1000–1200 acres in real property that can be sold at market value for additional funds. The District claims this property is valued between $50,000–$125,000 per acre. For this analysis it was assumed the District would sell 1200 acres at the highest market value to help pay for the LPP, giving the district a one-time revenue source of $150,000,000.

The District owns real property which is shown on the books at cost. Approximately 1000 - 1200 acres may eventually be declared surplus property and sold at market value. The current fair market value for this property is $50,000 to $125,000 per acre. It is anticipated that the value will continue to increase over time. These values are not reflected in the statement of net position.

2b. Existing Debt Service by WCWCD (not including LPP). The WCWCD has $7,026,322 in annual debt service for previous obligations for FYE 2013, not including debt from the Lake Powell Pipeline, as shown on the 2014 row of the District’s debt service schedule (p. 39 of the 2013 WCWCDAFS). This non-LPP debt service increases annually through 2037 before being extinguished in 2050, totaling $94.3 million. The District’s debt schedule is included below.
2c. Existing Operation and Maintenance Expenses. In addition to its debt obligations, WCWCD has operating and maintenance expenses, totaling $13,231,636 according to the 2013 WCWCDAFS. These expenses are assumed to grow proportionally to the number of new households in the county, shown in the attached spreadsheet’s Column J9. Operating and maintenance costs have been included as part of LPP participation in Column L. Our estimates of WCWCD Total Expenses are shown in Column N10.

3. Estimate of Additional Debt Service from the Lake Powell Pipeline on WCWCD

3a. 50-Year Repayment Obligation for Lake Powell Pipeline by Washington County Taxpayers. The following is the calculation of total annual debt service the WCWCD would incur to participate in the LPP. The WCWCD has announced they intend to receive 94.5 percent of the project water11, meaning they will be required to repay 94.5 percent of the roughly $1.4–$1.8 billion cost.12 The WCWCD can therefore expect to repay $1.33 billion – $1.75 billion in capital costs to repay. Assuming a 50-year repayment period, the annual debt service varies with the interest rate as follows:

<table>
<thead>
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<th>Annual Debt Service Payments for LPP by the Washington County Water Conservancy District</th>
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<tr>
<td>Repayment Cost</td>
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<td>$1.33 Billion</td>
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<tr>
<td>$1.75 Billion</td>
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</table>

In other words, the repayment obligation from the LPP will add between $51.6 and $258 million in additional annual debt burden onto WCWCD’s existing debt service, depending on final project cost and interest rate. A reasonable assumption for a 50-year interest rate is 4 percent, meaning an additional $61.8–131 million in new annual debt payments due to the LPP, shown in the attached spreadsheet’s Column K.

3b. LPP Power Generation Revenues and Operation and Maintenance Costs. The different cost estimates put forward in the 2012 Lake Powell Pipeline Modified Draft Study Report 10 are due to different levels of pump-storage power generation capacities presented in the planning documents. The $1.8 billion cost estimate generates more power sales revenues than the $1.4 billion project cost projection, but also requires much more operation and maintenance costs. The expected revenues and expenses can be seen here:

<table>
<thead>
<tr>
<th>Construction Cost</th>
<th>2026 Power Sales Revenue</th>
<th>2026 Operation and Maintenance Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.4 Billion</td>
<td>$9,947,747</td>
<td>$23,493,231</td>
</tr>
<tr>
<td>$1.8 Billion</td>
<td>$72,005,740</td>
<td>$62,867,794</td>
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9 The First and Second Scenarios in the spreadsheet represent the low and high cost estimates of the LPP project assumed in our analysis. Existing revenues and expenses of the District were assumed to stay the same in both scenarios (Columns B-F). Differences in the two project cost scenarios resulted in changes to the debt associated with the project (Columns G-P) and the repayment options (Columns Q-V).

10 Note: Columns K and L differ between the two project cost scenarios.

11 69,000 af / 73,000 af, Page ES-5, 2011 LPP Water Needs Assessment. (For the CICWCD see “Iron County pulls out of Lake Powell pipeline project,” Salt Lake Tribune, March 22, 2012.)

12 Lake Powell Pipeline Modified Draft Study Report 10, Socioeconomic and Water Resource Economics, February 2012
Based on the expected growth of existing revenue streams due to population increase in the county, WCWCD’s revenues can be projected over the next 50 years, as shown in Column H. The deficit schedule for the repayment period can be seen in Columns O and P. These columns show that the District’s revenues fall significantly short of the District’s expenses for every year of the 50-year repayment schedule (except for any initial payment-free years). Unless the District has an increase in revenues, WCWCD’s cumulative debt would grow to between $5.84–6.76 billion (cell P73) by the end of the project repayment period. Clearly, participation by the WCWCD in the LPP will require significant increases in impact fees and/or water rates.

4. Water Rate and Impact Fee Increases Required to Repay Debt

The fundamental question is whether the WCWCD can make these debt payments via an increase in revenue13, and if so how they will raise this revenue.

**Increasing Property Taxes.** According to Utah law, water conservancy districts in the Lower Colorado River Basin may not tax higher than 0.001 per dollar of taxable value of taxable property in the district.14 WCWCD currently collects property taxes at the rate of 0.00097. However, even if WCWCD increased their levy to the maximum collection rate, this only increases revenues $301,642 and revenues would still fall short of their expenses by tens of millions of dollars each year, accumulating to a deficit of billions dollars at the end of the 50-year repayment period. Therefore increasing water rates and/or impact fees must also be implemented by WCWCD.

**Increasing Water Rates.** Columns Q and R examine whether increasing water rates alone, without any impact fee increases, could repay Washington County Water District’s total future debt. Although one might think the WCWCD could simply increase water rates to raise revenues, raising water rates will result in a decrease in total water demand. Because the debt is relatively large, in order for water sales to cover the debt obligations of the project, water sales revenues would need to increase by 320–358 percent, depending upon the total cost of the LPP (spreadsheet cell B10). This would still require the WCWCD to shoulder significant deficits over time, but would result in a balance of essentially zero in 2063 (Columns Q and R; cell R73).

Due to the fact that the price elasticity of demand for water is estimated to be -0.5, repayment through water sales alone would require rate increases of 1665–1995 percent (cell B12). This enormous increase in water rates would lead Washington County water users to need less water in 2060 than they used in 2010 (cells 012 and AA12 of the “Water Demand” worksheet), meaning that there would be no need for the water supplied by the LPP. In other words, if the LPP is financed only by increasing water rates, water would become so expensive that future water demand would drop below the current water demand of WCWCD,15 even if one ignores other water sources identified above.

Increases in water rates may slow the rate of population growth in Washington County, which would make the LPP both harder to pay back and less necessary. To avoid this and maintain the desirability of homes and building lots in Washington County in the face of increases in water rates, the price of that real estate would have to fall. The lower property values would decrease the

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13 In the low-cost scenario, we assumed repayments start immediately, which keeps costs as low as possible. In the high-cost scenario, we assumed repayments begin after a delay of 10 years, which is more realistic and raises costs.


15 This is because cell B11 is larger than cell B8 in both scenarios.
property taxes collected by the District, forcing water rates to go up more than anticipated and forcing real estate values to go down more than anticipated.

**Increasing Impact Fees.** Columns S and T examine whether increasing impact fees alone, without any additional revenue increases, could repay Washington County Water District’s total future debt. Impact fees are the fees new development pays to hook up to the water system, and there has been some discussion about making debt payments through an increase in impact fees. Currently WCWCD has an average impact fee of $6,102\(^{16}\) and if the District chose to repay debt just using impact fees, revenues from impact fees would need to increase by 247–276 percent (cell B15), requiring an average impact fee of between $21,158–$22,927 (cell B17).

The large impact fees required in Washington County would be among the highest in the nation,\(^{17}\) likely deterring new growth in the county or significantly lowering property values (or both). Both effects would add even more problems for WCWCD’s repayment obligations: the first would lower the amount of impact fees collected, and the second would lower property values and lower the total property taxes collected by the district. Our analysis did not compensate for these factors.

**Combination of Increased Water Rates and Impact Fees.** The significant debt to participate in the LPP will require WCWCD to raise revenues by tens of millions of dollars every year. The District’s only real flexibility in raising revenues for its debt payments comes from deciding the proportion of increased revenues, which will come from increased water rates versus from increased impact fees.

Participating in the $1.4 billion low-cost alternative of the Lake Powell Pipeline from 2012 Socioeconomics and Water Resource Economics Report could require the WCWCD to raise its revenues by:

- raising impact fees 123 percent (spreadsheet cell B21), to an average of $13,630 per connection (spreadsheet cell B22); together with
- raising water rates by 576 percent (spreadsheet cell B20); together with
- selling 1200 acres of land owned by the District; and with
- continuing to collect property taxes near the maximum levy rate allowed by state law.

Participating in the $1.8 billion high-cost alternative of the Lake Powell Pipeline from 2012 Socioeconomics and Water Resource Economics Report could require the WCWCD to raise its revenues by:

- raising impact fees 138 percent (cell B21), to an average of $14,514 per connection (cell B22); together with
- raising water rates by 678 percent (cell B20); together with
- selling 1200 acres of land owned by the District; and with
- continuing to collect property taxes near the maximum levy rate allowed by state law.

In addition, the 576–678 percent increase in water rates means that Washington County water users would demand more than their current water demand\(^{18}\) but only 84–90 percent of their current water supply in 2060 (worksheet "Water Demand" cells U11 and AG11), so there would be no need for LPP water.

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\(^{16}\) 2013 WCWCD Audited Financial Statement


\(^{18}\) This is because cell B19 is smaller than cell B8 in both scenarios.
Figure 4: The WCWCD would be required to increase revenues substantially to cover annual LPP debt payments. Since WCWCD cannot raise taxes further, this increase in revenues would have to come from water rates and/or impact fees.

The right side of this graphic shows the increases required by WCWCD if they chose to only increase revenues from one source to repay the debt (cells B12 & B17). The left side of this graphic shows the increases required if WCWCD shifted the increases proportionally on the revenue sources (cells B20 & B22) The upper and lower parts of the graphic show the water price increases and impact fee increases required respectively.
Figure 5. Since WCWCD’s property tax collections are already near their maximum authorized levy amount, the future growth in property tax revenues will come from population growth (column B). Yet even with this increase in revenues the District must increase water rates and impact fees considerably to repay the annual debt from the Lake Powell Pipeline.

Figure 6. A). 2012 water demand projection for Washington County, which does not include the effect increased water rates would have on reducing water use. This projection assumes no additional water conservation after 2025, keeping water use at 241 GPCD until 2060. This is also the projection if the LPP is only paid for with impact fees.

B). Under the $1.4 billion LPP cost projection, WCWCD’s water demand would decrease by 62% due to increased water rates to repay LPP debt (cell J21). This calculation assumes half the LPP debt would be paid through increased water rates and the other half through increased impact fees.

C). Under the $1.8 billion LPP cost projection, WCWCD’s water demand would decrease by 64% due to increased water rates to repay LPP debt (cell J21). This calculation assumes half the LPP debt would be paid through increased water rates and the other half through increased impact fees.
5. Washington County Water District does not have a current repayment plan.

The most recent repayment plan for the LPP project was in the Regional Water Capital Facilities Plan and Impact Fee Analysis from 2006\textsuperscript{19}. The 2006 CFP has many problems as it relies on data that is nearly a decade old, including growth projections made before the 2008 economic downturn. The 2006 CFP completely relied on impact fees for repayment of the project, increasing the fees by 5 percent per year to increase revenues. This impact fee increase is not sufficient to repay the WCWCD debt, as shown in Section 4 above.

The plan also relied on an outdated cost estimate for the LPP project of $562 million. Newer documentation shows the project will cost between $1.4 billion and $1.8 billion.

Despite these many problems, the WCWCD continues to rely on this plan to set their impact fee schedule. Due to the decrease in expected new growth in the area and the higher LPP construction costs, the fund is far behind where it should be to repay the project. The 2006 CFP projected the Impact Fee Fund balance to be $113,770,522 but in reality the 2013 WCWCDAFS showed the district had only $44,839,323, 61 percent lower than planned in the 2006 CFP.

6. ‘Pay-As-You-Go’ Repayment Concept Creates Large Subsidy Funded by State Taxpayers

In public discussions related to the repayment problems of the proposed Lake Powell Pipeline, water officials from the Division of Water Resources and the WCWCD coined a repayment concept called “Pay-As-You-Go.” In a 2008 correspondence between WCWCD and the Division of Water Resources, the District’s General Manager outlined this pay-as-you-go concept, asking for confirmation from the Division about the proposal. The concept would allow the WCWCD to defer paying for the entire project by instead buying smaller portions of the Lake Powell Pipeline’s water, which they refer to as “blocks.” According to these officials, the District would only pay the costs and interest associated with one small block of water at a time. This would leave the rest of the unused water and its costs to collect interest without any repayment for decades. This letter from WCWCD’s general manager explicitly stated that he believed,

“No interest would be charged until such time as the actual contract to take the water occurs.”\textsuperscript{20}

This was echoed and confirmed in correspondence from the Division of Water Resources.\textsuperscript{21} The letters stated that WCWCD would not be required to pay interest on the entire project and would only have to pay interest on small blocks of the project which could be purchased at any point during the first 50 years after the project’s completion. This would defer paying interest on the entire project, leaving the State of Utah holding billions of dollars of debt for an indeterminate amount of time.

\textsuperscript{19} WCWCD Capital Facilities Plan, 2006.
\textsuperscript{20} August 14, 2008 Letter from the General Manager of WCWCD to the Director of the Division of Water Resources.
\textsuperscript{21} October 14, 2008 Letter from the Director of the Division of Water Resources to the General Manager of WCWCD.
Yet according to the LPP Development Act,

“The board [of Water Resources] shall establish and charge a reasonable interest rate for the unpaid balance of reimbursable preconstruction and construction costs.”22

We interpret this to mean that if “Pay-As-You-Go” is allowed—and we do not know whether it is allowed under the LPP Development Act—then any due-but-unpaid interest must be added to the principal owed by WCWCD, so that the due-but-unpaid interest must be paid back later with interest (a process called “negative amortization”). Our spreadsheet is constructed using this assumption. By making the District’s repayment schedule to the State uncertain and conditional on how the District’s wishes to take water during the next few decades, this “negative amortization” interpretation of “Pay-As-You-Go” increases the uncertainty of the State’s financial condition during those decades, to the detriment of the State and, potentially, to the detriment of the State’s bond rating.

In addition, if the District discovered the LPP water was not needed after all, as seems likely, the District might never buy LPP water, leaving the State to pay all the costs of the project. In the free market, a lender would not loan money without a documented income stream, and that would be a prudent policy for the State of Utah to follow when it lends.

The alternative to the “negative amortization” interpretation of “Pay-As-You-Go” is to forgive the interest for the Lake Powell Pipeline. This scenario would be much worse for the State and its bond rating since it would constitute an interest-free loan of billions of dollars for several decades from Utah taxpayers to the District. Such a lending scenario is completely alien to free-market lenders (except in bankruptcy proceedings, when attempting to recover funds that in hindsight were imprudently lent). The only grounds upon which interest forgiveness could be justified would be as a permanent subsidy from the State to the District, which would certainly violate the intent of the LPP Development Act. Accordingly, the “permanent interest forgiveness” interpretation of “Pay-As-You-Go” is irrelevant to LPP financing.

7. Consideration of the Public Bond Market

The USA has a deep and sophisticated municipal bond market whose participants are, for the most part, better equipped than anyone else to decide whether repayment plans for a public project are sound. The best solution would be for the WCWCD to go to those markets, instead of to the State of Utah, for LPP financing. If the markets decide the WCWCD’s LPP financing scheme is sound, the markets will happily supply the needed funds. Otherwise, the market will have judged the WCWCD’s LPP financing scheme unsound, and that judgment should stand.

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22 Utah Code, Section 73-28-403.
Appendix A
Washington County, UT Population Projections

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<td>2005 Estimate</td>
<td>48,978</td>
<td>91,090</td>
<td>168,078</td>
<td>279,864</td>
<td>415,510</td>
<td>559,670</td>
<td>709,674</td>
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<td>2012 Estimate</td>
<td>48,978</td>
<td>91,090</td>
<td>138,748</td>
<td>196,762</td>
<td>280,558</td>
<td>371,743</td>
<td>472,567</td>
<td>581,731</td>
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<tr>
<td># Households (est. 2012)</td>
<td>15,481</td>
<td>30,191</td>
<td>46,545</td>
<td>70,919</td>
<td>112,378</td>
<td>151,647</td>
<td>192,884</td>
<td>237,065</td>
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</table>

To solve for geometric growth rates: 
\[ x_{2060} = x_{2010} \times \exp(r \times (2060-2010)) \] and solve for \( r \).

But that is for continuous compounding. For annual compounding:

\[ x_{2060} = x_{2010} \times (1+r)^{2060-2010} \] and solve for \( r \).

\[ \Rightarrow \exp\left( \ln\left(\frac{x_{2060}}{x_{2010}}\right) / (2060-2010) \right) - 1 = r. \]

Also, for annual compounding, \( x_{t+1} - x_t = x_0 \times (1+r)^t \) implies that

\[ x_{(t+1)} - x_t = x_0 \times (1+r)^t \times r = x_t \times r. \]

190,520 change in households
0.03309412 Annually Compounded Household Growth Rate, 2010–2060
0.02908183 Annually Compounded Population Growth Rate, 2010–2060

Source: GOPB 2012 Population Projections
Appendix B

Present Value Calculations

Data from the Draft Socioeconomics and Water Resource Economics Study Report

Page 5-5, Table 5-1, No Pump Storage

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<thead>
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<th>Annual, 2026</th>
<th>PV, 2015</th>
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<td>Power-Inline</td>
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<td>Power-Pump Stations</td>
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<td>7,307,733</td>
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<td>Capital Construction</td>
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<td>4,102,715</td>
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<td>Operation, Maintenance &amp; Replacement</td>
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<td>2,575,013</td>
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<td>Power Ops</td>
<td>264,513,000</td>
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<td>Foregone Power</td>
<td>56,401,000</td>
<td>3,345,003</td>
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Page 5-5, Table 5-2, No Pump Storage Configuration

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<td>Foregone Power</td>
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<td>Power-Pump Stations</td>
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Page 5-4, Table 5-4, Pump Storage Configuration

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For Washington County's share of these, see tab “Revenues and Expenses”

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<th>PV, 2015</th>
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For Puget Sound’s share of these, see tab “Revenues and Expenses”

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<td>from equation 5</td>
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Appendix B

Present Value Calculations
## Appendix C

### WCWCD Revenues & Expenses

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<td>Impact Fees</td>
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<td>Notes Payable</td>
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<tr>
<td>Total</td>
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<td>Total</td>
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### LPP Capital Costs

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<td>WCWCD</td>
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<td>Total</td>
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<td>(Baseline NED Assumptions)</td>
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<td>(Pump Storage Social Time Preference)</td>
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### LPP Operation and Power Costs

Note: Since WCWCD is responsible for 94.5% (NS) of capital costs, it was assumed they would be responsible for 94.5% of OM&R costs.
## Appendix D

### Repayment Obligation Scenarios

#### Scenario 1 - $1.4B Cost Option

<table>
<thead>
<tr>
<th>Year</th>
<th>Property Taxes</th>
<th>Water sale revenue</th>
<th>Power sale revenue</th>
<th>Real Estate sale revenue</th>
<th>TOTAL REVENUES</th>
<th>Annual Debt Service</th>
<th>Cumulative Deficit</th>
<th>Deficit w/ Impact Fees and Cumulative Surplus (Deficit)</th>
<th>Repayment Option 1: Annual Surcharge (Deficit) w/ Increased Water Rates</th>
<th>Repayment Option 2: Cumulative Surplus (Deficit) w/ Increased Impact Fees</th>
<th>Repayment Option 3: Cumulative Surplus (Deficit) w/ Increased Impact Fees and Water Rates</th>
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<td>2025</td>
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<tr>
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<td>$2,300,000</td>
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<tr>
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<td>105,487,599</td>
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<td>$0</td>
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<td>$0</td>
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</tbody>
</table>

### Notes:
- **Power sale revenue and Real Estate sale revenue:** Calculated based on the assumption that the property value and power sale rates remain constant.
- **Deficit w/ Impact Fees and Cumulative Surplus (Deficit):** Represents the cumulative impact fees collected and any additional required surcharges to cover the deficit.
- **Repayment Options:**
  - **Option 1:** Annual surcharge (deficit) with increased water rates.
  - **Option 2:** Cumulative surplus (deficit) with increased impact fees.
  - **Option 3:** Cumulative surplus (deficit) with increased impact fees and water rates.

### Additional Information:
- *Scenario 2 - $2B Cost Option*
- *Scenario 3 - $2.5B Cost Option*
- *Scenario 4 - $3B Cost Option*
- *Scenarios 5 - $3.5B Cost Option*
### Scenario 2 - $1.8B Cost Option

<table>
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<th>Year</th>
<th>Property Taxes</th>
<th>Water sales revenue</th>
<th>Power sales revenue and Surcharges</th>
<th>Impact Fees</th>
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<th>TOTAL REVENUES</th>
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<th>Existing O&amp;M Costs</th>
<th>Annual LID Debt Service</th>
<th>Total Annual LID Debt Service</th>
<th>Net Annual Surplus (Deficit)</th>
<th>Cumulative Surplus (Deficit)</th>
<th>Repayment Option 1: Annual Surplus (Deficit) w/ increased Water Rate revenue</th>
<th>Repayment Option 2: Cumulative Surplus (Deficit) w/ increased Water Rate revenue</th>
<th>Repayment Option 3: Annual Surplus (Deficit) w/ Increased Impact Fees</th>
<th>Repayment Option 4: Cumulative Surplus (Deficit) w/ Increased Impact Fees</th>
<th>Repayment Option 5: Annual Surplus (Deficit) w/ Increased Water Rate and Impact Fees</th>
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<td>$378,131,323</td>
<td>$378,131,323</td>
<td>$378,131,323</td>
</tr>
</tbody>
</table>

---

3: Cumulative Repayment Option
4: Cumulative Surplus (Deficit) w/ Increased Impact Fees
5: Cumulative Surplus (Deficit) w/ Increased Water Rate and Impact Fees

*Note: Repayment Option 3 includes increased Water Rate and Impact Fees.*

---

**Additional Notes:**

- The factor by which water rates need to increase to eliminate the debt by 2062 is 2.78844.
- The factor by which the factor by which water rates need to increase to eliminate the debt by 2062 is 2.37862.
- The factor by which Impact Fees need to increase to eliminate the debt by 2062 is 5.09324.

---

**Revenue Comparison:**

- Water Sale Revenues:
  - Base Case: $36,553,028
  - Impact Fee Case: $32,089,563
  - New Water Price Case: $23,938,934
  - Current Water Price Case: $21,711,266
- O&M Revenues:
  - Base Case: $20,342,549
  - Impact Fee Case: $19,690,896
  - New Water Price Case: $18,498,644
  - Current Water Price Case: $17,947,875

---

**Financial Analysis:**

- Given unchanged water prices, the factor by which water sale revenues need to increase to eliminate the debt by 2062 is 2.78844.
- The factor by which Impact Fees need to increase to eliminate the debt by 2062 is 5.09324.
- The factor by which water prices need to increase to eliminate the debt by 2062 is 2.37862.
Appendix E

WCWCD Water Demand with LPP Debt

Appendix F

WCWCD Debt Repayment: Water Rates vs. Impact Fees

**Table:**

| Year  | Current Supply Supply with LPP (GPCD) | Base Per Capita Use from 2005 | Assumed Conservation (GPCD) | Per Capita Use with Conservation | Total Projected Water Demand (ac- ft/yr) | First Scenarios: Total Demand with Increased Water Prices (ac- ft/yr) | First Scenarios: Total Demand with Increased Water Prices and Impact Fees (ac- ft/yr) | First Scenarios: Total Demand with Increased Water Prices and Impact Fees (ac- ft/yr) | Second Scenarios: Total Demand with Increased Water Prices and Impact Fees (ac- ft/yr) | Second Scenarios: Total Demand with Increased Water Prices and Impact Fees (ac- ft/yr) | Second Scenarios: Total Demand with Increased Water Prices and Impact Fees (ac- ft/yr) |
|-------|--------------------------------------|-----------------|-----------------|--------------------------------|-------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|
| 2009  | 82,010                               | 294.3%          | 0%              | 294.3%                        | 55,408                        | 45,739                      | 10,888                      | 17,589                      | 113.2                      | 9,994                      | 16,403                      | 64.3                      | 105.5                      |
| 2010  | 82,010                               | 294.3%          | 1%              | 291.4                        | 54,854                        | 45,282                      | 10,779                      | 17,413                      | 112.0                      | 9,894                      | 16,239                      | 63.7                      | 104.5                      |
| 2020  | 130,840                              | 294.3%          | 5%              | 279.6                        | 87,646                        | 45,821                      | 14,609                      | 23,696                      | 86.6                      | 10,75                      | 22,699                      | 61.1                      | 100.3                      |
| 2030  | 130,840                              | 294.3%          | 9%              | 267.8                        | 124,648                       | 84,164                      | 20,035                      | 32,365                      | 63.8                      | 10,30                      | 30,183                      | 58.5                      | 96.0                       |
| 2040  | 130,840                              | 294.3%          | 12%             | 259.0                        | 162,559                       | 107,842                     | 25,671                      | 41,471                      | 61.7                      | 99.6                       | 23,662                      | 56.6                      | 92.9                       |
| 2050  | 130,840                              | 294.3%          | 16%             | 247.2                        | 196,517                       | 130,859                     | 31,153                      | 50,322                      | 58.8                      | 95.1                       | 28,951                      | 54.0                      | 88.7                       |
| 2060  | 130,840                              | 294.3%          | 18%             | 241.3                        | 232,576                       | 157,252                     | 37,433                      | 60,472                      | 57.4                      | 92.8                       | 34,358                      | 56,394                    | 52.7                       |

*Red = some water from LPP is actually used (total demand > 130,840 acre-feet)*

*Blue = no water from LPP is actually used because water’s so expensive that > 130,840 acre-feet are not demanded*

*Source: 2011 LPP Water Needs Assessment*

**Figure:**

*Increases in Water Revenues vs. Impact Fee Revenues Required*

2.26 If Water Revenues rise by a factor > this, Q_2060 < Q_2010.
1. Paths of Demand, Price, and Revenue when Elasticity is $-\frac{1}{2}$

Suppose the demand for water is given by

$$Q_t = \alpha \beta^t P_t^{-1/2}$$  \hspace{1cm} (1)

where $Q$ is quantity demanded, $P$ is price, $\beta$ is one plus the projected population growth rate, and $t$ denotes the date. Assume price is constant:

$$P_t \equiv P \quad \text{for all } t.$$

Then

$$Q_t = \alpha \beta^t P^{-1/2}$$

$$Q_0 = \alpha P^{-1/2} \quad \text{so}$$

$$Q_t = Q_0 \beta^t \quad \text{(which grows at rate } \beta) \text{ and}$$

total revenue $Q_t P_t = Q_0 \beta^t P = Q_0 P \beta_t \quad \text{(which grows at rate } \beta)\text{).}$

Now suppose there is a new situation, denoted by $\hat{t}$, and suppose we have discovered that the needed total revenue in the new situation is $\gamma$ times the total revenue of the old situation:

$$\hat{Q}_t \hat{P}_t = \gamma \cdot Q_t P_t \hspace{1cm} (2)$$

Suppose as before that

$$\hat{P}_t \equiv \hat{P} \quad \text{for all } t \quad \text{and}$$

$$\hat{Q}_t = \alpha \beta^t \hat{P}^{-1/2}.$$

Then as before, both $\hat{Q}_t$ and $\hat{Q}_t \hat{P}_t$ grow at rate $\beta$, and also $\hat{Q}_t = \hat{Q}_0 \beta^t$.

From (2),

$$\hat{Q}_t \hat{P}_t = \gamma Q_t P_t$$

$$\hat{Q}_0 \beta^t \cdot \hat{P} = \gamma Q_0 \beta^t \cdot P$$

$$\hat{Q}_0 \cdot \hat{P} = \gamma Q_0 \cdot P$$

$$\alpha \hat{P}^{-1/2} \cdot \hat{P} = \gamma \alpha P^{-1/2} \cdot P$$

$$\hat{P}^{1/2} = \gamma P^{1/2}$$

$$\hat{P} = \gamma^2 P \hspace{1cm} (3)$$
Using (3), \( \hat{Q}_t = \hat{Q}_0 \beta^t = \alpha \hat{P}^{-1/2} \beta^t = \alpha (\gamma^2 P)^{-1/2} \beta^t = \gamma^{-1} \alpha P^{-1/2} \beta^t = \gamma^{-1} Q_t \), so 
\[
\hat{Q}_t = \frac{Q_t}{\gamma}.
\] (4)

Note that in the spreadsheet (worksheets “First Scenario” and “Second Scenario”), \( \hat{Q}_t \hat{P}_t = Q_t P_t + B10 \cdot Q_t P_t = (1 + B10)Q_t P_t \), so the value of \( \gamma \) in (2) is 1 + B10 in the spreadsheet; this is B11 and B19.

The answer to the question “when is \( \hat{Q}_{2060} < Q_{2010} \)?” is, using (4), when
\[
\frac{Q_{2060}}{\gamma} < Q_{2010}
\]
\[
\frac{Q_{2010} \beta^{2060-2010}}{\gamma} < Q_{2010}
\]
\[
\beta^{50} < \gamma.
\]

This underlies B8.

2. Deriving Cost and Benefit Flows from their Present Values given in pages 5-3 to 5-6 of the Draft Socioeconomics and Water Resource Economics Study Report

This section derives relationships used in the spreadsheet tab “DSWRESR,” whose name is the first letters of the “Study Report” named in the title of this section.

The Study Report describes the flows of costs and benefits from 2020 to 2060 (see for example Table 2-1 on page 2-2) in terms of the present value (in 2010) of those flows. Here we derive the implied magnitude of such a flow in our assumed initial year of operation, 2026.

Let the Study Report’s “escalation rate” (the rate of real cost or benefit increases per year) be \( \epsilon \). The Study Report provides the value of \( \epsilon \) but it provides no further information about how the Study Report authors assumed costs and benefits changed over time. In the absence of this information, the best we can do is to assume that their sequence of costs (or benefits) 
\[
\{c_{2020}, c_{2021}, c_{2022}, \ldots, c_{2060}\}
\]
is equal to 
\[
\{c_{2020}, (1+\epsilon)c_{2020}, (1+\epsilon)^2c_{2020}, \ldots, (1+\epsilon)^{40}c_{2020}\}.
\]

Let the Study Report’s discount rate be \( r \) and let the present value in 2020 of this sequence be denoted by \( PV_{2020} \). Then
\[
PV_{2020} = \sum_{t=0}^{40} \frac{(1+\epsilon)^t c_{2020}}{(1+r)^t} = \frac{1 - \left(\frac{1+\epsilon}{1+r}\right)^{41}}{1 - \left(\frac{1+\epsilon}{1+r}\right)} c_{2020},
\]
\[ c_{2020} = \frac{1 - \left( \frac{1+\epsilon}{1+r} \right)^{41} PV_{2020}}{1 - \left( \frac{1+\epsilon}{1+r} \right)^{41}} \text{, and} \]
\[ c_{2026} = (1 + \epsilon)^6 c_{2020} = (1 + \epsilon)^6 \frac{1 - \left( \frac{1+\epsilon}{1+r} \right)^{41} PV_{2020}}{1 - \left( \frac{1+\epsilon}{1+r} \right)^{41}} \text{ PV}_{2020} \text{.} \]

Since \( PV_{2010} = PV_{2020}/(1+r)^{10} \) because the only thing which happens to these flow costs between 2010 and 2020 is discounting, we have
\[ c_{2026} = (1 + \epsilon)^6 (1 + r)^{10} \frac{1 - \left( \frac{1+\epsilon}{1+r} \right)^{41} PV_{2010}}{1 - \left( \frac{1+\epsilon}{1+r} \right)^{41}} \text{.} \quad (5) \]

If we are correct in assuming that the Study Report authors used \( c_t = (1 + \epsilon)^{t-2020} c_{2020} \) then (5) would give the same answer for \( c_{2020} \) regardless of the values of \( \epsilon \) and \( r \). However, the values which (5) gives for \( c_{2020} \) for the two “no pump storage” cases, Tables 5-1 and 5-2 (spreadsheet columns C and J, rows 12–19), slightly differ; so do the values which (5) gives for \( c_{2020} \) for the two “pump storage” cases, Tables 5-3 and 5-4 (spreadsheet columns C and J, rows 29–37). Therefore, the Study Report authors must not have used \( c_t = (1 + \epsilon)^{t-2020} c_{2020} \), but something slightly different. There is no way to know what that was (for example, the text “2024” does not appear in the report), so in column N, averages of the \( c_{2020} \) values derived from (5) for the two “no pump storage” cases given in the Study Report were calculated, and this average was used for the “no pump storage” \( c_{2020} \) in the rest of the spreadsheet. Similarly, in column N, averages of the \( c_{2020} \) values derived from (5) for the two “pump storage” cases given in the Study Report were calculated, and that average was used for the “pump storage” \( c_{2020} \) in the rest of the spreadsheet.

For construction costs the situation is the same except that the years of construction in the Study Report were 2016 to 2019. So
\[ PV_{2016} = \sum_{t=0}^{3} \frac{(1 + \epsilon)^t c_{2016}}{(1 + r)^t} = \frac{1 - \left( \frac{1+\epsilon}{1+r} \right)^{4} PV_{2016}}{1 - \left( \frac{1+\epsilon}{1+r} \right)^{4}} c_{2016} \text{,} \]
\[ c_{2016} = \frac{1 - \left( \frac{1+\epsilon}{1+r} \right)^4}{1 - \left( \frac{1+\epsilon}{1+r} \right)^4} PV_{2016} \text{, and} \]
\[ c_{2015} = c_{2016}/(1 + \epsilon) \text{.} \]

Let the present value for our spreadsheet, in which construction starts in 2015, be denoted by \( PV'_{2015} \), and let our discount rate be \( r' \). The Study Report gives
\[ PV_{2010} \text{. We have} \]

\[
PV'_{2015} = \sum_{t=0}^{3} \frac{(1 + \epsilon)^t c_{2015}}{(1 + r')^t} = \frac{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)^4}{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)} c_{2015}
\]

\[
= \frac{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)^4}{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)} \frac{c_{2016}}{1 + \epsilon}
\]

\[
= \frac{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)^4}{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)} \frac{1}{1 + \epsilon} \frac{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)^4}{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)} PV_{2016}
\]

\[
= \frac{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)^4}{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)} \frac{1}{1 + \epsilon} \frac{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)^4}{1 - \left(\frac{1 + \epsilon}{1 + r'}\right)} \left(1 + r\right)^6 PV_{2010}.
\]

(6)

As before, if we are correct in assuming that the Study Report authors used \( c_t = (1 + \epsilon)^t c_{2016} \) then (6) would give the same answer for \( c_{2016} \) and \( PV'_{2015} \) regardless of the values of \( \epsilon \) and \( r \). However, the values which (6) gives for \( PV'_{2015} \) for the two “no pump storage” cases, Tables 5-1 and 5-2 (spreadsheet columns D and K, row 16) differ by about one-half of one percent; so do the values which (6) gives for \( PV'_{2015} \) for the two “pump storage” cases, Tables 5-3 and 5-4 (spreadsheet columns D and K, row 33). Therefore, the Study Report authors must not have used \( c_t = (1 + \epsilon)^t c_{2016}, \) but something very slightly different. There is no way to know what that was (for example, the text “2017” does not appear in the report), so in column O, averages of the \( PV'_{2015} \) values derived from (6) for the two “no pump storage” cases given in the Study Report were calculated, and this average was used for the “no pump storage” \( PV'_{2015} \) in the rest of the spreadsheet. Similarly, in column O, averages of the \( PV'_{2015} \) values derived from (6) for the two “pump storage” cases given in the Study Report were calculated, and that average was used for the “pump storage” \( PV'_{2015} \) in the rest of the spreadsheet.
Appendix H
Survey of Water Price Elasticity Publications, Gail Blattenberger, PhD

Elasticity Measurements West/US Studies

Elasticity

Study

1 Agathe & Billings
2 Agathe & Billings
3 Agathe & Billings
4 Agathe & Billings
5 Agathe & Billings
6 Berry & Bonen
7 Billings & Agathe
8 Billings
9 Billings & Day
10 Cusato & Ryan
11 Conley
12 Gershon
13 Griffin & Chang
14 Hewitt & Hanemann
15 Howe & Lineweaver
16 Howe
17 Jones & Morris
18 Lyman
19 Lyman
20 Moncur
21 Morgan
22 Morgan & Smolen
23 Nieswiadomy
24 Nieswiadomy & Molina
25 Nieswiadomy & Molina
26 Pint
27 Pint
28 Renwick & Archibald
29 Renwick & Archibald
30 Renwick & Archibald
31 Renwick & Archibald
32 Timmins
33 Weber
34 Williams
35 Williams
36 Young
Elasticity Measurements Foreign Studies

Elasticity

Study

1 AlQunaibet & Johnston
2 Hanke & deMare
3 Hansen
4 Hoglund
5 Katzman
Elasticity Measurements Utah Studies

Elasticity

Study

1 CH2M Hill
2 CH2M Hill
3 CUWCD Pricing Policy Study
4 Gardiner & Schick
5 Hansen & Narayanan
6 Hughes & Gross
Elasticity Measurements Utah Studies

Elasticity

Study

1 CH2M-Hill
2 CH2M-Hill
3 CUWCD Pricing Policy Study
4 Gardiner & Schick
5 Hansen & Narayanan
6 Hughes & Gross
Elasticity Measurements East/US Studies

1 Carver & Boland
2 Cavanagh, Haneman & Stavins
3 Chicoine & Ramurthy
4 Clarke
5 Cochrane & Cotton
6 Danielson
7 Danielson
8 Deller, Chicoine, & Ramamurthy
9 Foster & Beattie
10 Fout
11 Gibbs
12 Gottlieb
13 Gottlieb
14 Grima
15 Hogarty & Mackay
16 Hogarty & Mackay
17 Howe & Lineweaver
18 Martin & Wilder
19 Martin & Wilder
20 Nieswiadomy & Cobb
21 Nieswiadomy & Cobb
22 Schafer & David
23 Schneider & Whittach
24 Stevens, Miller, Willis
25 Stevens, Miller, Willis
26 Stevens, Miller, Willis
27 Turnovsky
28 Turnovsky
29 Williams
30 Williams
31 Williams
32 Williams & Suh
33 Wong
34 Wong
35 Wong
36 Wong
37 Wong
38 Wong
Elasticity Measurements Aggregate Customer Studies

![Graph showing elasticity measurements across different studies, with data points for various authors such as AlQunaibet & Johnston, Agathe Billings Dobra Raffee, Berry & Bonen, Billings & Agathe, Billings, Billings & Day, Carver & Boland, Casuto & Ryan, CH2M-Hill, Cochrane & Cotton, Conley, Foster & Beattie, Griffin & Chang, Grima, Hansen, Hansen & Narayanan, Hoglund, Hughes & Gross, Morgan & Smolen, Nieswiadomy, Nieswiadomy & Cobb, Schafer & David, Schneider & Whitfach, Stevens, Miller, Willis, Wang, and Young. Each study is represented by a marker on the graph, with error bars indicating variability.]
Elasticity Measurements Studies with Large Price Changes

Elasticity

Study

1 Agathe & Billings
2 Agathe & Billings
3 Agathe & Billings
4 Agathe & Billings
5 Agathe & Billings
6 Billings & Agathe
7 Billings & Day
8 Casuto & Ryan
9 Cavanagh, Haneman & Stavins
10 Nieswiadomy & Molina
11 Nieswiadomy & Molina
12 Pint
13 Pint
14 Renwick & Archibald
15 Renwick & Archibald
16 Renwick & Archibald
17 Renwick & Archibald
18 Timmins
19 Weber
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