

Appendix D

Cost Model Assumptions

A cost model was developed to evaluate portfolio costs for the Pasadena Water Integrated Resources Plan (WIRP). This appendix gives an overview of the cost model, describes the inputs and assumptions used in the model, and describes the methodology.

D.1 Overview of Cost Model

The purpose of the cost model is to assess portfolio performance against the two quantitative performance measures under the “maintain affordability” objective:

- Total Lifecycle Cost: the total cost of the portfolio, including the costs to other agencies and customers/developers
- Pasadena’s average cost of water: the portion of total cost that is assumed to be paid by PWP, and could potentially affect water rates

In order to quantify both these performance measures, a cost model was developed that calculates annual portfolio costs over the entire planning horizon (from 2010 to 2035) and discounts the total cost back to present value (PV). Annual portfolio costs over time include amortized capital payments, operation and maintenance costs, and MWD costs including treated water purchases and the peaking charge.

D.2 Cost Model Inputs

Cost model inputs include economic assumptions such as inflation rates, capital and operation and maintenance (O&M) costs for each option, planning-level assumptions on potential cost-sharing, and projected MWD imported water rates.

D.2.1 Economic Assumptions

The following basic economic assumptions were used in the model:

- Inflation rate: 3%
- Capital Loan Interest rate: 5.5%
- Capital Loan Payment Period: 30 years
- Discount Rate: 5.5%
- Discount Period: 25 years (from 2010 to 2035)

The assumptions above apply to all new and existing options except for MWD imported water rates, which are expected to increase faster than inflation as discussed subsequently in Section D.2.4.

D.2.2 Options Costs

Planning level estimates of total capital costs and O&M were developed for individual options. All options included in portfolio analyses (refer to Section 5 for the portfolio descriptions) were input to the cost model. Table D-1 provides a summary of capital, annual O&M cost, and purchase costs (\$/AF) inputs.

For on-site stormwater/urban runoff options and graywater options, it is assumed that the capital costs are phased in over time as implementation grows and more devices are installed. As such, the annual capital costs (a function of the number of devices installed in a given year) will increase with inflation. For all other options, it is assumed that capital costs would be paid through a bond or loan. The model calculates capital payments by inflating to the assumed implementation year, then amortizing the payment based on the interest rate and payment period.

Annual O&M and purchases costs (\$/AF) are inflated over time, starting in the assumed implementation year. Note that the only options with purchase costs are recycled water (purchased from the Los Angeles-Glendale water reclamation plant) and ocean desalination (purchased from the project proprietor). In addition, annual conservation costs are expected to vary over time depending on the best management practices that are being implemented in a given year (per Appendix B).

The total cost per year for the project is the sum of the annual capital, O&M, and water purchases.

D.2.3 Existing Local Supply Costs

The intent of the model is to compare relative costs of potential new options. Therefore, sunk costs such as existing capital payments were not included, nor were fixed costs to maintain the existing system. Variable operation and maintenance cost for pumping of groundwater rights and existing spreading credits were included, however, and were assumed to be \$120/AF and inflated over time.

D.2.4 Assumptions on Cost Sharing

One of the performance measures for portfolio analyses was the cost to Pasadena. In order to make relative comparisons among the options and portfolios, assumptions for the portion PWP would pay were made (for purposes of this analysis only). Actual cost-sharing agreements or rebate programs will be determined during implementation and may differ from the assumptions in this study. Options that typically involve some on-site costs to the customer/develop include:

- **Stormwater/Urban Runoff:** Installation of rain barrels, bioswales, and permeable pavement are typically on-site construction costs covered by the customer/developer. For this analysis, it was assumed that PWP would provide rebates for up to 50% of the capital cost of residential rain barrels and residential rain gardens. Residential and commercial/institutional bioswales are implemented on a larger scale (i.e. entire neighborhoods) and this analysis assumes PWP would pay up to 100% of the capital cost. For the porous pavement option, it is assumed

that PWP would pay up to 100% of the additional capital cost over traditional pavement. All on-site operation and maintenance costs are assumed to be paid by the customer/developer. The O&M costs to PWP would be related groundwater pumping to recover new supply yield that was recharged. Note that there is potential cost-sharing of these options with the City of Pasadena Public Works Department.

- **Conservation Options:** For this analysis, it was assumed that PWP would provide rebates and cover up to approximately 50% of the total conservation program costs. Note that some of the conservation costs include installation of structural conservation best management practices such as water efficiency devices in which the customer/developer would incur some costs.
- **Graywater:** Installation of graywater systems are typically on-site construction costs covered by the customer/developer. For this analysis, it was assumed that PWP would provide rebates and cover up to 50% of the graywater option capital costs, and no on-site operation and maintenance costs.
- **Recycled Water Non-potable Reuse:** Recycled water to non-potable reuse involves construction of a distribution system to deliver water to customers for non-potable uses such as irrigation or cooling towers. The main treatment and conveyance infrastructure would be paid by PWP. However, there are on-site retrofits or construction costs for customers to connect to the system. On-site retrofit/construction costs vary widely from site to site. However, an average retrofit cost of \$2000/AFY was assumed for this analysis, which is a capital costs to the customer/developer. The O&M and purchase costs for this option are the costs of operating the main system, and are a cost to PWP.

All of the options listed above would be eligible for grant funding, which is not reflected in the cost analysis.

There is one option that was evaluated assuming an agency partnership in which PWP would pay costs proportional to the amount of supply credit received. For the Los Angeles County *Devil's Gate storage to Eaton Canyon* option, it was assumed that long-term supply credits to PWP would be approximately 35 percent of the total yield.¹ Therefore, PWP would contribute to a portion of the total capital costs. Operation and maintenance costs associated with recovering PWP supply yield from the groundwater basin would be a cost to PWP.

For all other options, it is assumed that PWP would pay the total cost. Again, actual cost-sharing agreements will need to be negotiated during implementation and may differ from the assumptions in this study.

¹ Note that supply yield is based only on the amount of water spread in Eaton Canyon (not any recharge occurring within Devil's Gate Reservoir).

Table D-1. Cost Summary of Options in Model (2010 dollars)				
Option Category	Option	Total Cost (including customer/developer costs)		
		Capital Cost (\$)	Average Annual O&M Cost (\$/year)	Purchase Cost (\$/AF)
Existing Local Supply	Groundwater Rights and Existing Diversions to Spreading	\$0	\$1,522,080	\$0
Local Surface Water/ Stormwater Diversions	Expanded Arroyo Seco Diversions and Recharge	\$3,400,000	\$289,680	\$0
	Local Treatment Plant (Arroyo Seco)	\$5,900,000	\$275,648	\$0
	Tunnel Water to Brookside Golf Course	\$947,071	\$26,064	\$0
	Devil's Gate storage to Eaton Canyon spreading basins	\$11,000,000	\$439,030	\$0
Recycled Water	Satellite plants for On-site Non-potable Demands	\$11,577,000	\$117,000	\$0
	Indirect Potable Reuse (Tertiary Treatment)	\$4,011,000	\$362,484	\$253
	Indirect Potable Reuse (Advanced Treatment)	\$55,111,000	\$3,705,157	\$253
	Non-Potable Demands (Maximum), with tunnel water augmentation	\$38,600,000	\$140,000	\$253
	Non-Potable Demands (Smaller Phase 1), with tunnel water augmentation	\$15,260,000	\$80,000	\$253
Graywater	Graywater	\$54,000,000	\$1,084,000	\$0
On-site Stormwater/ Urban Runoff	Residential Rain Barrels	\$1,759,000	\$88,000	\$0
	Residential Rain Gardens	\$3,235,500	\$163,336	\$0
	Residential infiltration strip/bioswale	\$10,397,500	\$523,226	\$0
	Commercial Parking Lot Swales	\$10,147,920	\$511,045	\$0
	Permeable Pavement (parking lots)	\$6,035,000	\$4,082	\$0
Imported Water	North of Delta Transfers	\$0	\$0	\$982 (includes wheeling and treatment)
	Groundwater Banking	\$10,000,000	\$115,000	\$1,049 (includes wheeling and treatment)
	Pasadena Groundwater Storage Program (PGSP)	\$36,145,400	\$586,800	MWD Replenishment Rate (see Figure D-1)
Ocean Desal	Ocean Desalination	\$0	\$0	\$2,650
Conservation	Moderate Conservation	\$0	\$2,790,000	\$0
	Aggressive Conservation	\$0	\$4,244,000	\$0
	Maximum Conservation	\$0	\$6,121,000	\$0
	Maximum with Aggressive Single Family Pricing	\$0	\$4,823,565	\$0

D.2.5 MWD Imported Water Purchases

PWP purchases treated imported water from MWD. MWD has tiered water rates for water supply, where Tier 1 is set to recover baseline water supply costs and Tier 2 is set to recover higher marginal costs of water supply. During times of surplus water, MWD makes available water at a discounted rate for replenishment. MWD also has a peaking charge that is levied on peak deliveries to member agencies. Since 2006, MWD has increased its full service treated water rates, on average, over 12 percent per year.

In July 2010, MWD has prepared draft water rate projections to 2020. These rate projections show the following average annual rate increases of:

	Average % Increase
Tier 1 Treated Water Rate	6%
Tier 2 Treated Water Rate	6%
Treated Replenishment	7%
Peaking Charge	3%

To project water rates to 2035, CDM applied a 3 percent escalation rate to MWD's 2020 rate projections.

Figure D-1 shows the projected MWD treated water purchase rates over time. For each portfolio, MWD imported water purchases over time are based on the remaining projected demand after conservation and yield from all other supply options. The model applies the Tier 1 rate until purchases meet the current Tier 1 pricing limit for PWP, and then applies the Tier 2 rate for remaining purchases in a given year.

In addition to dollar per acre-foot (\$/AF) purchase rates, MWD charges a peaking fee. The peaking fee is charged for the maximum day use of MWD capacity over the entire year. Figure D-2 shows the projected MWD peaking charge over time. To simplify the analysis, it was assumed that PWP operations would not peak with imported water. However, operational strategies change over the years depending on a number of factors, and this may not be how the system is operated in the future.

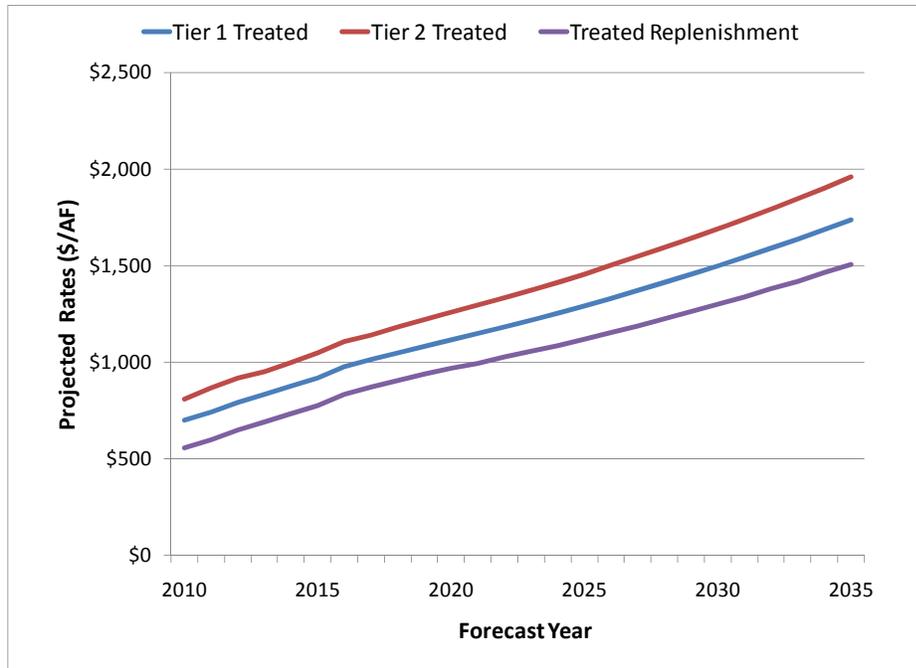


Figure D-1. MWD Water Rate Forecast

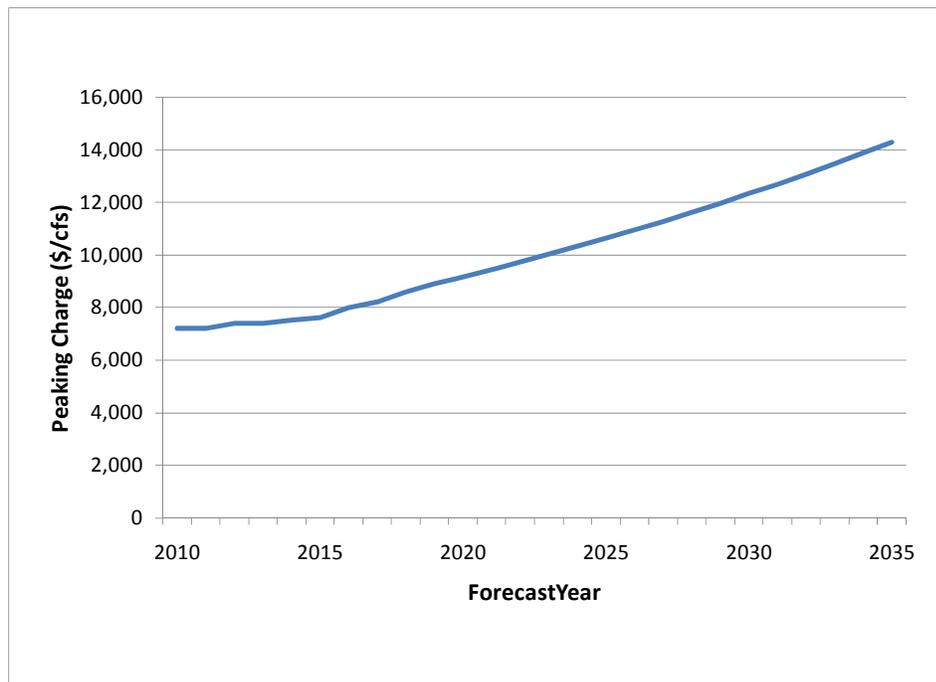


Figure D-2. MWD Water Peaking Charge

D.3 Calculation of Performance Measures

The purpose of the cost model is to assess portfolio performance against the two quantitative performance measures under the “maintain affordability” objective:

- Total Lifecycle Cost: the total cost of the portfolio, including the costs to other agencies and customers/developers, and partnering agencies
- Pasadena’s average cost of water: the portion of total cost that is assumed to be paid by PWP, and could potentially affect water rates

For each portfolio, the total costs and the costs to PWP are calculated in parallel on an annual basis over the planning horizon (2010 to 2035). Portfolio cost calculations are divided into four general steps:

- 1) Calculate total annual operation and maintenance costs of existing groundwater pumping over the planning horizon, and discount to present value
- 2) Calculate the total annual cost of new options (capital, O&M, and purchases) over the planning horizon, and discount to present value.
- 3) Calculate imported water costs for each portfolio (annual purchases and peaking charges), and discount to present value
- 4) Add total present value costs for each portfolio (sum of Steps 1 through 3 above)

There is an additional calculation step for the ‘Pasadena’s average cost of water’ performance measure, which evaluated based on the dollar per acre-foot (\$/AF) cost. To determine the overall \$/AF cost of each portfolio, the total present value cost (from Step 4) was divided by the total projected water demand before conservation over the planning horizon, also discounted to present value.

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