Appendix F11
Option Characterization –
Energy Sector Water Use Efficiency

Appendix F11 — Option Characterization – Energy Sector Water Use Efficiency

1.0 Introduction

Options to improve the water use efficiency of the energy sector have been proposed to reduce the water demand in the Colorado River Basin (Basin). A number of energy sector water use efficiency options were submitted for consideration in the Colorado River Basin Water Supply and Demand Study (Study). The submittals are summarized in appendix F2 and the original submittals are available via links from the electronic version of appendix F2 on the compact disc that accompanies this report and the version of appendix F2 on the Study website at http://www.usbr.gov/lc/region/programs/crbstudy.html.

Four options related to energy sector water use efficiency were received. The submitted options were reviewed and organized into two groups according to the specific concept:

- Conversion of Power Plants to Air Cooling
- Water Use Efficiencies in the Oil and Gas Industry

Figure F11-1 shows the general location of major power plants in the Basin and the approximate magnitude of water use for cooling.

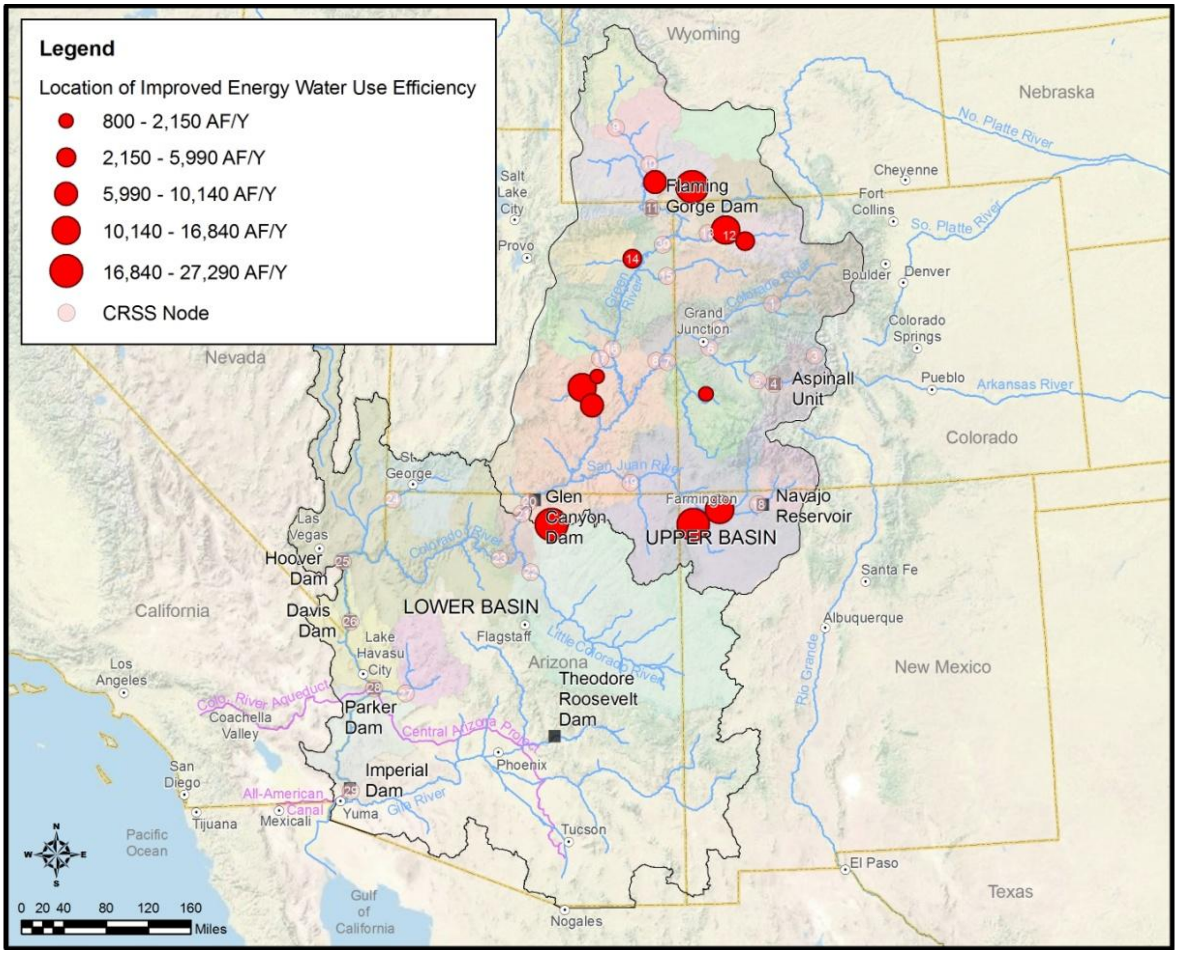
This appendix summarizes the types of options received, the assumptions made and methods used to characterize the options, and the characterization results. Additional detail related to the options characterization is included in appendix F3.. Attachment A of appendix F3 contains more detailed descriptions of the ratings. Attachment B provides the methods used for completing the unit cost calculations. Attachment C presents the detailed characterization information and is available on the compact disc that accompanies this report and on the Study website.

2.0 Conversion of Power Plants to Air Cooling

This option group includes removing the evaporative cooling systems at the 15 largest power plants in the Basin (figure F11-1) and installing air cooling systems.

Developing yield estimates for these options includes researching historical and estimated future use of water by power plants (Colorado River Water Consultants, 2008a). The 15 largest power plants in the Colorado River Basin region consume approximately 167,000 acre-feet per year (afy) of water. Assuming 95 percent of that amount could be saved by converting to air cooling, about 160,000 afy of yield is potentially available with this concept.

FIGURE F11-1
Location of Major Power Plants within the Basin



When evaluating this option, the following were considered:

- High cost of installing air-cooling systems
- Effect of air-cooling on plant power output during hot weather
- Effect of air cooling on plant efficiency
- Applicability of air-cooling technology to the existing plant systems designed for water-cooled service
- Larger site footprint required for air-cooled system

The timing on conversion of cooling systems at power plants may depend to some degree on the remaining useful life of the existing systems. Some or even all of the 15 plants identified for conversion may be retired over the Study planning period. However, power needs are likely to still exist in the region, and new plants may replace the older plants. For the characterization of this option, it is assumed that a sense of urgency related to water imbalance results in agencies or the federal government moving forward with power plant conversions in conjunction with plant owners, regardless of the remaining useful life of the existing equipment. Feasibility studies to identify the estimated amount of power generation loss due to reductions in efficiency and plans for making up those losses are assumed to take up to 3 years. Revised air quality and noise permits are required for the alternate equipment, and it could take 2 or more years to acquire those permits. Detailed design and construction could take another 5 years, with a total timeframe of at least 10 years.

Costs for energy water use efficiency concepts are based on literature research and previously completed conceptual designs. The costs for decommissioning a wet cooling system and construction of air-cooling systems, plus the increased cost of operation of the power plants, were estimated in the *Study of Long-Term Augmentation Options for the Water Supply of the Colorado River System* (Colorado River Water Consultants, 2008). This study estimated the unit annual costs at approximately $1,300 per acre-foot (af) for plants of 2,000 megawatt (MW) and greater capacity and as much as $4,000 per af for plants smaller than 1,000 MW capacity. Three of the 15 largest plants in the region are larger than 2,000 MW; 4 plants are larger than 1,000 MW and smaller than 2,000 MW; and the remainder are smaller than 1,000 MW (Colorado River Water Consultants, 2008a). Therefore, the unit annual costs will vary at each facility, but the estimated weighted average is about $2,000 per af of water saved.

In addition to yield, timing, and cost, the conversions of power plants to air cooling was characterized against several other criteria. A summary of the findings for all criteria is shown below. Key considerations related to technical feasibility, permitting, legal, and policy issues were largely covered in the descriptions above related to estimating option timing. The technology is proven and reliable, resulting in a high feasibility rating. In regard to implementation, there is likely to be pushback from the power industry because of increased costs and reductions in efficiency, as well as potential pushback from the public because of potential increased costs of energy to the greater community. The long-term viability is believed to be high because once the technology is installed and paid for, there is little risk of the system not achieving the reduced water demand. Based on the investment and infrastructure required, the operational flexibility is limited because the criterion penalizes options that have high debt service costs even when the option is put into an idle mode. Although the option conserves water use in the energy generation process, it is projected to reduce energy generation by 10 to 15 percent. Applying the "fenceline" concept described in appendix F3 to the options characterization implies that the reduced generation is outside of the "fenceline", resulting in a neutral score. When considering hydropower, water quality, recreation, and other environmental impacts, this concept could result in reduced diversion for these Upper Basin power plants and increased water in the river system. It is also unknown how this water would be used by others, which could result in a change in how downstream river reaches are operated. Because of these unknowns, neutral conditions were assumed for these criteria. Socioeconomic impacts are difficult to fully assess because jobs will be created with all of these options. There is also likely to be a combination of positive and adverse impacts in the regions in which the power plants are located. Without more-detailed assessments, neutral conditions were assumed for socioeconomics.

3.0 Water Use Efficiencies in the Oil and Gas Industry

This concept includes increased regulation on oil and gas exploration to protect water resources from contamination and use of treatment processes to make the byproduct water available as a new supply instead of disposing the water to evaporation lagoons or deep wells. These byproduct waters typically have total dissolved solids concentrations of up to 15,000 milligrams per liter (Colorado River Water Consultants, 2008b), and desalination of the water is required to render it suitable for use as a new supply. The energy required for desalination, along with the energy required to transport the water to central locations of treatment and use, leads to total energy requirements of 4,700 kilowatt hours per af. This concept also includes maximizing efficiency of use of water at oil and gas refineries. Although described here for completeness, the treatment and use of the natural gas byproduct water is included in the local supply category and is not characterized here. Also, increased reuse of industrial type waters is covered in the industrial reuse category and not characterized here.

4.0 Results

A summary of the characterization findings are shown in table F11-1. The top portion of the table shows the estimated quantity of yield, earliest timing of implementation, and estimated cost. The bottom portion of the table shows the 17 criteria and associated ratings ("A" through "E") and is color-scaled. In general, "C" is typically designated as mostly neutral (yellow); "A" is largely positive (greed); and "E" is largely negative (red). Refer to appendix F2 for specific criteria descriptions and rating scales.

5.0 References

Colorado River Water Consultants. 2008a. *Technical Evaluation of Options for Long-Term Augmentation of the Colorado River System, Reduction of Power Plant Consumptive Water Usage for Colorado River Augmentation.*

Colorado River Water Consultants. 2008b. *Technical Evaluation of Options for Long-Term Augmentation of the Colorado River System, Coal Bed Methane-Produced Water.*

TABLE F10-1
Summary Characterization Ratings for Energy Sector Water Use Efficiency Options K=thousand

	Criteria		
Representative Option	Quantity of Yield	Timing	Cost
Energy Conservation-Air Cooling	160,000	10	2,000
	0K 20K 40K 60K 80K 100K 120K 140K 160K 180K	0 1 2 3 4 5 6 7 8 9 10	0 500 1000 1500 2000

	Criteria																
Representative Option	Quantity of Yield	Timing	Cost	Technical Feasibility	Implementation Risk	Long-Term Viability	Operational Flexibility	Permitting	Energy Needs	Energy Source	Other Environmental	Recreation	Socioeconomics	Policy	Legal	Hydropower	Water Quality
Energy Conservation-Air Cooling	D	B	C	A	B	A	E	B	E	E	C	B	C	C	A	B	C