

Chapter 5

Plan Evaluation and Comparison

An important aspect of the plan formulation process is the evaluation and comparison of the possible effects of the Final Alternatives. This chapter presents results of this evaluation and comparison of the No Action Alternative and Alternatives 1A, 1B, 2A, and 4A, which are described in Chapter 4. This includes a description of the four accounts used to evaluate the alternatives plans and a comparison of the plans based on their completeness, effectiveness, efficiency, and acceptability. For additional detail, see also Appendix A – Plan Formulation, Appendix B – Modeling, Appendix C – Engineering Designs and Costs, and Appendix D – Economics.

Plan Evaluation Methods and Procedures

Four accounts were established to facilitate evaluation of the effects of the Final Alternatives as required by the P&G (WRC 1983): NED, environmental quality (EQ), regional economic development (RED), and other social effects (OSE). Effects of the Final Alternatives are displayed as the difference in conditions, or differences in conditions under each account, compared to the No Action Alternative. Economic benefits were quantified for NED and RED accounts. Additional economic benefits of the Final Alternatives that were not quantified are discussed under the EQ, OSE, and other unquantified benefits sections below.

NED Account

The objective of NED analysis is to determine the change in net value of the Nation's output of goods and services that would result from implementing each final alternative. Beneficial and adverse effects are evaluated in monetary terms and measured as changes in national income among the No Action Alternative and Final Alternatives. Beneficial effects in the NED account are: (1) increases in the economic value of the national output of goods and services from a final alternative, (2) the value of output resulting from external economies caused by a final alternative, and (3) the value associated with the use of otherwise unemployed or underemployed labor resources for the purposes of a final alternative. Adverse effects in the NED account are the opportunity costs of resources used in implementing a final alternative. These adverse effects include: (1) implementation outlays, (2) associated costs, and (3) other direct costs. Specific guidelines, standards, and procedures used in NED analysis are provided in the P&G (WRC 1983).

The NED account typically includes net benefits to the following categories:

- Agricultural water supply,
- M&I water supply,
- Food damage reduction,

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- Power (hydropower),
- Transportation (inland navigation and ocean-going vessel navigation),
- Recreation,
- Commercial fishing,
- Unemployed or underemployed labor resources, and
- Other direct benefits.

For this analysis, the NED account consists of benefit categories associated with the primary and secondary planning objectives, including M&I water supply reliability and other direct benefits categories related to M&I emergency, and Refuge water supply.

Environmental benefits are typically included in the EQ account if monetary units cannot be attributed to these benefits. However, for this analysis, benefits associated with Refuge water supplies were developed as monetary units and are included in the NED account as “other direct benefits.”

Monetized Benefits

Estimating the economic benefits of potential effects is necessary to establish economic feasibility and identify a corresponding final alternative that maximizes net benefits, consistent with Federal objectives (also called the NED Plan). This section summarizes valuation methods and estimates for the benefit categories evaluated. Additional detail for each of the benefit categories evaluated is included in Appendix D – Economic Analysis.

Increased M&I Water Supply Reliability An analysis was performed to value the benefits of improved Bay Area M&I water supply reliability under the Final Alternatives. The CalSim II model was used to estimate possible increases in water supply reliability under the Final Alternatives. Table 5-1 summarizes changes in water supply by water year type and for long-term average conditions. All alternatives would contribute to M&I water supply reliability benefits, except Alternative 2A which is shown to result in a long-term average reduction of 5.4 TAF. Alternative 1A would have the highest M&I water supply reliability benefits (\$12.4 million) followed by Alternative 1B (\$10.3 million), and Alternative 4A (\$9.5 million).

M&I operations for SCVWD reflect the integration of its planned recycled water program, which would provide sustained water supply not dependent on water year type. This would allow SCVWD to store some of its CVP water from wet years in the expanded Los Vaqueros Reservoir, for later use in dry years. Some of these stored supplies may also be made available to Refuges.

Under Alternative 2A, SCVWD’s CVP water stored in the expanded Los Vaqueros Reservoir that is made available to Refuges is 5.4 TAF. Note that the net reduction in water deliveries to SCVWD (5.4 TAF) would be compensated for by the recycled water program. The direct M&I benefits for this alternative remain low in comparison to the other Final Alternatives. M&I water users have increasingly participated in the water transfer market to augment their supplies. M&I water supply reliability benefits were estimated based on the long-term weighted average benefits across all water year types. The analysis relied on values estimated through application

of a water transfer pricing model, and through consideration of the costs associated with conveying the water to the M&I service areas. This method was consistent with the “cost of the most likely alternative” method recommended by the P&G and was an acceptable measure of the preferred approach to estimate NED benefits (willingness to pay).

Table 5-1. M&I Water Supply Reliability Benefits for Final Alternatives

Benefit	Final Alternatives			
	1A	1B	2A	4A
<i>Increase in M&I Water Supply Reliability by Water Year Type (TAF/year)¹</i>				
Wet	-1.2	-4.4	-12.3	3.3
Above Normal	14.5	13.6	-9.7	15.7
Below Normal	14.2	10.8	-4.5	9.0
Dry	20.6	19.2	1.3	11.5
Critical	46.4	42.3	3.0	25.4
Long Term Average	15.5	12.9	-5.4	11.2
<i>NED M&I Water Supply Reliability² Benefits (Annual, \$ millions)³</i>	\$12.4	\$10.3	-\$5.0	\$9.5

Notes:

¹ Values represent increases in water supply reliability as compared against the No Action Alternative. Sacramento Valley 40-30-30 Water Year Hydrologic Classification Index used to define water year types. See Appendix B – Modeling for a description of water supply operations modeling methods and assumptions.

² NED M&I water supply reliability benefits are based on the weighted average increase in water supplies, valued using market-based estimates of the costs of water transfers to Bay Area M&I agencies. See Appendix D – Economic Analysis for detail on NED benefit calculations.

³ October 2015 dollar values.

Key:

M&I = municipal and industrial

NED = National Economic Development

TAF = thousand acre-feet

Various sources of uncertainty exist regarding the future value of M&I water supplies, particularly in dry years when Bay Area M&I water purveyors rely on transfers and other mechanisms to meet demands. In addition to water transfers, Bay Area efforts to increase dry year water supply reliability have considered desalination, recycled water, and aquifer storage and recovery; these actions have a higher cost per unit of water than water transfers. Population growth and climate change are major factors likely to drive the trend toward an increase in the value of water in the future. California’s population is anticipated to grow and increase demand for water, making it increasingly difficult to provide adequate water supplies to maintain a healthy industrial and agricultural economy while also protecting the environment. Shifts in agricultural cropping patterns from field crops to high-valued permanent crops may contribute to future increases in the value of water, and result in a “hardening” of water demand in the agricultural sector. As this trend continues, agriculture may have less flexibility during dry years to transfer water supplies to M&I users. A similar hardening condition may develop in the municipal sector, as conservation actions are increasingly relied upon to balance demands in all year types, rather than being reserved for dry years and drought conditions. Compounding these trends is the uncertainty associated with climate change, which may shift the timing and/or availability of water statewide. All of these factors, in combination, suggest that the value of water is likely to increase in the future across all water use sectors.

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M&I Emergency Water Supply An analysis was performed to value emergency water supplies provided by the Final Alternatives and available to M&I water users in the event of a Delta water supply outage. These disruptions depended upon a variety of factors, including the risk of a seismic or other catastrophic event, vulnerability of non-Delta water supplies, and the timing and duration of the supply disruption. Supply disruptions in an emergency that occurred during prolonged periods of drought may result in significantly higher economic costs than those that coincide with wetter conditions. In addition, supply disruptions that were shorter in duration would result in lower economic costs to water users.

The CalSim II model was used to estimate storage conditions in the expanded reservoir under the Final Alternatives. Table 5-2 shows estimated M&I emergency water supplies available in an expanded Los Vaqueros Reservoir.

Table 5-2. Estimated M&I Emergency Water Supply Benefits of the Final Alternatives

Benefit	Final Alternatives			
	1A	1B	2A	4A
<i>Emergency Water Supplies Available¹ to M&I Water Purveyors by Water Year Type (TAF/year)²</i>				
Wet	194.8	188.8	85.3	86.8
Above Normal	173.5	163.6	65.7	80.7
Below Normal	165.8	161.1	64.3	79.8
Dry	163.9	160.0	66.9	76.2
Critical	113.0	106.4	60.9	65.8
Long Term Average	168.0	162.0	71.2	79.3
<i>NED M&I Emergency Water Supply² Benefits (Annual, \$ millions)^{3,4}</i>	\$24.7	\$23.8	\$10.4	\$11.6

Notes:

¹ Water available for emergency purposes was estimated as the average annual reservoir storage volume with each expanded reservoir alternative, less 70 TAF of existing CCWD dedicated emergency water supply storage. See Appendix B – Modeling for a description of water supply operations modeling methods and assumptions.

² Sacramento Valley 40-30-30 Water Year Hydrologic Classification Index used to define water year types.

³ NED M&I emergency water supply benefits are based on the weighted average emergency supplies available, valued using market-based estimates of water users' willingness to pay to avoid interruptions in water deliveries. See Appendix D – Economic Analysis for details on NED benefit calculations.

⁴ October 2015 dollar values.

Key:

CCWD = Contra Costa Water District
M&I = municipal and industrial
NED = National Economic Development
TAF = thousand acre-feet

The economic benefits of emergency water supplies were measured according to water users' willingness to pay to avoid interruptions in water deliveries. The value of emergency supplies provided by the reservoir expansion to M&I users was estimated by applying estimated short-run price elasticity to a constant elasticity demand function calibrated to observed price and quantity information from Bay Area water providers. This analysis estimated the value of emergency water supplies in the Bay Area to be about \$3,744 per acre-foot, on average. Multiplying \$3,744 per acre-foot by the total emergency water supply available from the alternatives provided an

estimate of the economic benefit associated with the volume of water supplied. The total was then multiplied by the annual probability of occurrence for an emergency event to obtain the expected annual benefit. The expected annual emergency water supply benefit was then reduced by the expected marginal cost of emergency water delivery to M&I customers. Assumptions and methodologies used in the analysis are described in Appendix D – Economic Analysis.

As shown in Table 5-2, the estimated annual value of NED emergency water supply benefits was \$24.7 million for Alternative 1A and \$23.8 million for Alternative 1B. The difference in these values reflects the operational emphasis of each alternative, which resulted in different simulated average storage conditions in the expanded Los Vaqueros Reservoir over the evaluation timeline.

Various factors affected the economic value attributed to emergency water supplies beyond the volume of water available in storage at the time of a Delta water export emergency. These factors included the assumed level (percent reduction in supplies) and duration of shortage experienced by water users, price elasticity of demand assumptions, and the effect of a Delta emergency (such as a flood or earthquake that breaches one or more Delta islands) on salinity conditions at municipal intakes. A series of sensitivity analyses were performed to assess the effects of key analysis assumptions on the estimated NED benefits of emergency water supplies (see Appendix B – Modeling for a description of these analyses). While these sensitivity analyses resulted in both higher and lower benefit estimates, the average of all sensitivity analyses results was greater than the NED emergency water supply benefits reported in Table 5-2 for each alternative.

Increased Incremental Level 4 Refuge Water Supply Reliability There are a variety of environmental water demands in the Delta and Central Valley that are necessary to satisfy minimum instream flows, achieve desired water quality conditions, and establish desirable wetland habitat and other habitat types. Alternatives formulation focused on providing more reliable water supplies to Refuges, which currently have unmet allocations in all year types. Under the CVPIA, Reclamation delivers water to identified wildlife refuges in the Central Valley as Level 2 supply (firm supply, taken from annual project allocation) and Incremental Level 4 supply (purchased from willing sellers). Incremental Level 4 supply is defined as the increment over Level 2 supplies needed to provide the full quantity of water required for optimal wetlands habitat development to support migratory birds, resident birds, and wildlife in the Refuges, to be acquired from willing sellers or by other voluntary measures. CVPIA authorizes CVP water transfers and exchanges, which have provided opportunities for the Refuge Water Supply Program to acquire much of the annual Incremental Level 4 supplies provided to the Refuges. Full Level 2 supplies have been made available annually to those Refuges with sufficient conveyance capacity except in the drought years 2014 and 2015, but the full amount of Incremental Level 4 water has yet to be delivered to all refuges due to several contributing factors including availability of these water supplies.

The Refuges are the few remaining sizable wetland habitats in the Central Valley and provide habitat and food for migratory birds of the Pacific Flyway and resident bird species, as well as many wildlife species. Wetlands are a major component of Refuges, and the recipient of the vast portion of CVPIA water supplies delivered to the Refuges. Most of the remaining water deliveries are used in habitat support, including water for rivers and streams and irrigation of food crops for migrating and resident waterfowl and other species. Refuge habitat production

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with the final alternatives would be improved with a more reliable water supply due to greater available water for ecosystem functions and food production, and the increased health of Refuges would affect recreation participation.

An analysis was performed to value the benefit of improved Refuge water supply reliability under the Final Alternatives. The CalSim II model was used to estimate potential increases in Refuge water supplies under the Final Alternatives, as summarized in Table 5-3 by water year type.

Table 5-3. Estimated Incremental Level 4 Refuge Water Supply Benefits of the Final Alternatives

Benefit	Final Alternatives			
	1A	1B	2A	4A
<i>Increase in Refuge Incremental Level 4 Water Supplies (TAF/year)¹</i>				
Wet	77.5	96.3	126.1	88.3
Above Normal	33.3	49.2	80.5	44.3
Below Normal	17.2	25.8	49.1	21.3
Dry	13.3	15.1	32.3	12.7
Critical	3.2	1.5	12.2	1.7
Long Term Average	35.8	45.7	69.0	41.2
<i>NED Refuge Water Supply Reliability Benefits² (Annual, \$ millions)³</i>	\$17.9	\$23.6	\$37.4	\$21.1

Notes:

¹ Increase in Incremental Level 4 water supplies as compared with No Action Alternative. Sacramento Valley 40-30-30 Water Year Hydrologic Classification Index used to define water year types. See Appendix B – Modeling for a description of operations modeling methods and assumptions.

² NED Refuge water supply reliability benefits are based on average water year type hydrologic conditions and calculated as the weighted average of the five water year types. See Appendix D – Economic Analysis for detail on NED benefit estimates. Represents the increase in Incremental Level 4 Refuge water supplies provided through the Investigation.

³ October 2015 dollar values.

Key:

NED = National Economic Development

TAF = thousand acre-feet

Table 5-3 provides a summary of the long term average of the Refuge water supply benefits of the Final Alternatives. Alternative 2A would provide the greatest Refuge water supply benefit because meeting Refuge needs is the highest operational priority; 69 TAF/year on average of Incremental Level 4 water would be delivered to the Refuge Water Supply Program for the Refuges. The other Final Alternatives would provide lower Refuge water supply benefits, between 36 and 46 TAF/year on average of Incremental Level 4 water would be delivered to the Refuge Water Supply Program for the Refuges. During dry years, Alternative 2A would deliver an average of 32 TAF/year of Incremental Level 4 water to the Refuge Water Supply Program for the Refuges while the other Final Alternatives would deliver between 13 and 15 TAF/year on average. During critical years, Alternative 2A would deliver an average of 12 TAF/year of Incremental Level 4 water to the Refuge Water Supply Program for the Refuges while the other Final Alternatives would deliver between 1 and 3 TAF/year on average.

The approach to estimating NED Refuge water supply benefits considered the estimated short-term price to purchase water supplies on the open market as the most likely alternative in the absence of a firm water supply from an expanded Los Vaqueros Reservoir. This method was consistent with the “cost of the most likely alternative” method recommended by the P&G and was an acceptable measure of the preferred approach to estimate NED benefits (willingness to pay). The analysis relied on values estimated through application of a water transfer pricing model, with consideration of the costs associated with conveying the water to the Refuges being served. The use of the water transfer pricing model for valuing environmental water supplies is appropriate in this analysis for the following reasons:

- It is consistent with Federal economic valuation policies. The P&G (WRC 1983) recommend the use of actual or simulated market prices, where available, because they represent a close approximation of total willingness to pay value.
- The regression-based pricing model provides an accurate picture of the California water market using a comprehensive set of historical spot market transactions occurring from 1990 through 2016 to simulate market prices based on locations of supplies, location of buyer, type of buyer, length and nature of the contract, water year type, and inflation. The model also adjusts for conveyance losses, conveyance and pumping costs, and other typical transactional costs.
- The California water transfer pricing model used to estimate the cost of refuge water supplies under 2030 conditions is a widely accepted model that has been applied to prior Reclamation studies, including the Shasta Lake Water Resources Investigation and Upper San Joaquin Water Storage Investigation, and other State and local studies.

In addition to acquiring supplies on California’s spot market, groundwater was also considered as a potential “least cost alternative” means of providing supplies to the Refuges. However, groundwater acquisitions and exchanges by the RWSP have been historically limited and insufficient in volume to meet Incremental Level 4 targets, particularly in dry years.

Groundwater acquisitions by the RWSP are constrained by groundwater pumping capacity and quality, and are limited by existing environmental approvals. With the implementation of California’s Sustainable Groundwater Management Act, limits are likely to be placed on groundwater pumping in the San Joaquin Valley, which will affect both the volume of supplies available to the Refuges and the prices of those supplies. For these reasons, groundwater is not considered a likely alternative for achieving the volume of firm water supplies that could be provided by an expanded Los Vaqueros Reservoir. Additional information on the valuation of Refuge water supplies, including sensitivity analysis to the valuation approach, is provided in Appendix D – Economic Analysis.

Refuge water supply reliability benefits were estimated based on the long-term weighted average benefits across all water year types. Average annual Refuge water supply reliability benefits are estimated to be about \$37.4 million for Alternative 2A (2015 price levels) (Table 5-3). For Alternatives 1A, 1B, and 4A, the average annual benefits would be about \$17.9, \$23.6, and \$21.1 million, respectively.

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As described previously, a variety of factors suggest that the value of water will increase in the future across all water use sectors, including environmental. Further, total economic value was measured as the combination of market and non-market components. The NED Refuge water supply reliability benefit estimates discussed above were based on short-term, spot-market pricing and represented some portion of the total value or willingness to pay for increased Refuge water supply reliability with the Final Alternatives. Although, the water market price was a good approximation of NED benefit value, it may underestimate the total public willingness to pay for market and non-market components of value.

To address risk and uncertainty of the NED Refuge water supply reliability benefits, a sensitivity analysis was conducted, considering the recreational value of providing firm water supplies to Refuges by using a visitor day-use approach consistent with the P&G (see Appendix D – Economics for a description of this analysis). For example, the sensitivity analysis estimated the total average annual benefits for Alternative 2A to be about \$49.6 million. This value is substantially higher than the benefit estimated using the water transfer pricing model approach (Table 5-3).

Increased Agricultural Water Supply Reliability The Final Alternatives have the potential to improve water supply reliability for SOD CVP agricultural producers. Due to increased plantings of permanent crops and limited groundwater availability, agricultural producers in the region have consistently purchased water from other entities to satisfy crop water demands. The additional water supply from an expanded Los Vaqueros Reservoir has the potential to benefit SOD CVP agricultural producers by offsetting a portion of future water purchase costs. Table 5-4 provides the estimated average annual deliveries to SOD agriculture.

Average annual agricultural water supply reliability benefits would be about \$2.1 million for Alternative 1A (2015 price levels). For Alternatives 1B, 2A, and 4A, the average annual benefits would be about \$0.5, \$0.4, and \$0.4 million, respectively.

For the sensitivity analysis, the Statewide Agricultural Production Model was used (see Appendix D – Economics for a description of this analysis). Statewide Agricultural Production Model is an economic model of irrigated agriculture in California that is frequently applied for feasibility studies and policy analyses. It estimates the value of water supply reliability according to the change in agricultural net income associated with changes in water supply. Statewide Agricultural Production Model resulted in comparable values for NED benefits to those in Table 5-4. For example, Alternative 1A benefits were estimated at \$1.8 million compared to \$1.9 million.

Table 5-4. Estimated Agricultural Water Supply Benefits of the Final Alternatives (TAF/year)

Benefit	Alternative			
	1A	1B	2A	4A
<i>Increase in Agricultural Water Supplies (TAF/year)¹</i>				
Wet	6.8	4.0	4.8	2.3
Above Normal	6.6	-0.8	-0.9	0.3
Below Normal	0.8	0.1	0.1	0.1
Dry	0.4	0.0	-0.9	0.2
Critical	0.6	0.2	0.2	-0.4
Long Term Average	3.4	1.2	1.2	0.8
<i>NED Agricultural Water Supply Reliability Benefits² (Annual, \$ millions)³</i>	\$1.9	\$0.6	\$0.6	\$0.4

Notes:

¹ Increase in water supplies as compared with No Action Alternative. Sacramento Valley 40-30-30 Water Year Hydrologic Classification Index used to define water year types. See Appendix B – Modeling for a description of operations modeling methods and assumptions.

² NED agriculture water supply reliability benefits are based on average water year type hydrologic conditions and calculated as the weighted average of the five water year types. See Appendix D – Economic Analysis for detail on NED benefit estimates.

³ October 2015 dollar values.

Key:

NED = National Economic Development

TAF = thousand acre-feet

Enhanced Recreation Opportunities Expansion of Los Vaqueros Reservoir, along with enhancement to recreation facilities and trails in the Los Vaqueros watershed, would improve access to recreation opportunities around the expanded reservoir and the watershed. CCWD used a visitation model to predict the increase in visitation due to an expanded reservoir. The model of surface storage recreation visitation was based on visitation data for Los Vaqueros Reservoir prior to, and after, Phase 1 reservoir expansion (from 100 to 160 TAF). The statistical model was a set of regression equations that predict total monthly day visits.

To estimate economic benefits, the number of visits were associated with a number of recreation days that were then valued using the *U.S. Army Corps of Engineers’ Unit Day Values for Recreation for Fiscal Year 2015*, published by USACE in October 2014.

For 2030 projected population, the increase in annual recreation days in the watershed resulted in corresponding recreation benefits of \$0.30 million per year (2015 dollars).

Table 5-5 compares the total NED benefits for each alternative.

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Table 5-5. Summary of Estimated Annual Benefits for Final Alternatives (\$ millions)

Benefit Category	Alternative 1A	Alternative 1B	Alternative 2A	Alternative 4A
M&I Water Supplies ¹	\$12.4	\$10.3	-\$5.0	\$9.5
Emergency Water Supplies ²	\$24.7	\$23.8	\$10.4	\$11.6
Incremental Level 4 Refuge Water Supplies ³	\$17.9	\$23.6	\$37.4	\$21.1
Agricultural Water Supplies ⁴	\$1.9	\$0.6	\$0.6	\$0.4
Recreation ⁵	\$0.3	\$0.3	\$0.3	\$0.0
Total Annual NED Benefits⁶	\$57.2	\$58.6	\$43.7	\$42.6

Notes:

¹ Market-based estimates of the cost of water transfers to Bay Area M&I agencies.

² Market-based estimates of water users' willingness to pay to avoid interruptions in water deliveries

³ Market-based estimates of the cost of water transfers to wildlife Refuges in the San Joaquin Valley. Represents the increase in Incremental Level 4 Refuge water supplies provided through the Investigation.

⁴ Market-based estimates of the cost of water transfers to agricultural users in the San Joaquin Valley.

⁵ Visitation days estimates using the U.S. Army Corps of Engineers' Unit Day Values for Recreation for Fiscal Year 2015.

⁶ October 2015 dollar values.

Key:

M&I = municipal and industrial

NED = National Economic Development

Costs

The following sections summarize monetized NED costs and other direct costs for the Final Alternatives. Table 5-6 defines the key components of NED costs.

Table 5-6. Definition of NED Cost Components

Cost Terminology	Definition
Field Cost	Cost estimate for a feature or project from award to construction closeout.
Non-contract Cost	Cost of work or services provided to support feature construction and other work that can be attributed to the feature as a whole. It also includes cost of avoiding and/or mitigating adverse impacts on environmental resources
Construction Cost	Sum of the feature field costs plus non-contract costs.
Interest during Construction	The compound interest calculated by spreading construction cost over the construction period and using the Federal discount rate.
Capital Cost	Sum of the construction costs and interest during construction.
Annual Cost	Sum of interest and amortization of the capital cost, and other annual costs, such as operations, maintenance, and replacement costs.

Key:

NED = National Economic Development

Monetized Cost Summary Table 5-7 summarizes estimated NED field, construction, capital, and annual costs for the Final Alternatives. Additional detail on the development of capital and annual costs is provided in Appendix C – Engineering Designs and Costs. The cost estimates were developed to a feasibility level and all investigation alternatives are projected to be technically feasible, constructible, and could be operated and maintained.

Table 5-7. Estimated Capital and Annual Costs of the Final Alternatives (\$ millions^{1, 2})

Cost Item	Alternative 1A	Alternative 1B	Alternative 2A	Alternative 4A
Opinion of Probable Construction Costs				
275 TAF Dam Raise	\$267.00	\$267.00	\$267.00	\$0.00
Bethany-Transfer Conveyance Facilities	\$144.36	\$144.36	\$144.36	\$144.36
Delta-Transfer Pipeline	\$44.52	\$44.52	\$44.52	\$0.00
Expanded Transfer Pump Station	\$36.00	\$36.00	\$36.00	\$36.00
Existing Transfer Pump Station Modifications	\$10.90	\$10.90	\$10.90	\$10.90
Neroly Pump Station	\$37.00	\$37.00	\$37.00	\$37.00
Pumping Plant #1 Improvement	\$17.80	\$17.80	\$17.80	\$17.80
Los Vaqueros Marina Complex Relocation	\$21.00	\$21.00	\$21.00	\$0.00
Los Vaqueros Watershed Trails	\$0.60	\$0.60	\$0.60	\$0.00
EBMUD Facilities				
Mokelumne Aqueduct Relining	\$12.10	\$12.10	\$12.10	\$12.10
Walnut Creek Pumping Plant Variable Frequency Drives	\$4.00	\$4.00	\$4.00	\$4.00
Expanded Recreation Facilities				
Los Vaqueros Interpretive Center Improvement	\$0.71	\$0.71	\$0.71	\$0.00
Los Vaqueros Watershed Office Barn and Interpretive Features	\$0.74	\$0.74	\$0.74	\$0.00
Total Field Cost	\$596.73	\$596.73	\$596.73	\$262.26
Non-Contract Cost ^{3, 4}	\$239.00	\$239.00	\$239.00	\$105.00
Total Construction Cost	\$835.73	\$835.73	\$835.73	\$367.26
Interest During Construction ⁵	\$92.56	\$92.56	\$92.56	\$50.54
Total Capital Cost	\$928.29	\$928.29	\$928.29	\$417.80
Interest and Amortization	\$33.57	\$33.57	\$33.57	\$15.11
Total Annual Operations, Maintenance, and Replacement ⁶	\$9.85	\$9.85	\$9.85	\$7.75
Increase in Replacement Costs for Existing Facilities ⁷	TBD	TBD	TBD	TBD
Increased in Annual Energy Costs ⁸	\$3.41	\$3.78	\$3.71	\$3.08
Total Annual Cost	\$46.96	\$47.33	\$47.25	\$25.98

Notes:

¹ October 2015 dollar values.

² Totals may not sum exactly due to rounding.

³ Planning, engineering, design, and construction management are assumed 20 percent of the total field costs.

⁴ Environmental and cultural mitigation costs are assumed percent of the total field costs.

⁵ Interest during construction is based on a 3.5 percent Federal discount rate over a seven-year construction period for October 2015 price level cost estimates.

⁶ Operation, Maintenance, and Replacement costs cover only new or modified facilities.

⁷ Increased replacement costs of existing facilities due to reoperation under proposed alternatives are under development. Additional information found in Appendix C – Engineering Appendix.

⁸ Interest and amortization is based on a 3.5 percent Federal discount rate over a 100-year period of analysis.

Key:

EBMUD = East Bay Municipal Utility District

TAF = thousand acre-feet

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Other Direct Costs The P&G identifies an “other cost” category to capture “the cost of resources directly required for a project or plan, but for which no project implementation outlays are made” (WRC 1983). An example of these costs may include the monetized value of the loss or degradation of wildlife habitat. The Final Alternatives would have net beneficial effects on fish and wildlife when evaluated together, and adverse effects on other environmental resources. The net adverse effects listed above were not monetized for the NED account. More of these impacts could be monetized and included in the NED analysis. However, it is not a standard practice for Reclamation to monetize such effects, and there are challenges involved in doing so. Based on both resource constraints and challenges associated with monetizing other environmental impacts, Reclamation chose to not perform this analysis.

Net NED Benefits Summary

The NED benefits and costs are shown in Table 5-8. Additional benefits and costs of the Final Alternatives that have not been monetized are discussed in the EQ, OSE, and other unquantified benefits sections below, and could affect the NED benefits of the project if monetized. Additionally, wildlife enhancement recommendations provided through Fish and Wildlife Coordination Act consultation could increase the cost of the project and increase non-monetized benefits if added to the project.

Table 5-8. Summary of Estimated Annual Costs and Benefits for Final Alternatives (\$ millions¹)

Benefit Category	Alternative 1A	Alternative 1B	Alternative 2A	Alternative 4A
Total Annual NED Benefits	\$57.2	\$58.6	\$43.7	\$42.6
Total Annual Cost ²	\$46.6	\$47.0	\$46.9	\$25.7
Net NED Benefits	\$10.6	\$11.6	(\$3.2)	\$15.9
Benefit Cost/Ratio	1.23	1.25	0.93	1.66

Notes:

¹ October 2015 dollar values

² Annual costs include total capital costs (annualized using based on a 3.5 percent Federal discount rate over a 100-year period of analysis), annual energy costs, and annual operations, maintenance, and replacement costs.

Key:

NED = National Economic Development

EQ Account

The EQ account is a means of integrating information about the EQ resources and NEPA human environment effects (as defined in 40 Code of Federal Regulations 1507.14) of the Final Alternatives into water resources planning. These include ecological, cultural, and aesthetic properties of natural and cultural resources that sustain and enrich human life. The EQ account includes non-monetized positive and negative benefits, while the NED account includes monetized positive and negative benefits.

An evaluation of the ecological, cultural, and aesthetic properties of EQ resources was performed as part of the NEPA environmental review and documentation process. A detailed discussion of possible effects of the Final Alternatives and proposed mitigation measures is included in the 2010 Final EIS/EIR and the 2017 Draft Supplement. These documents provide details on methods, process, procedures, and assumptions used in evaluating environmental effects associated with the projects with each Final Alternative. All of the phases of a proposed project,

including construction and operation, were evaluated in the analysis. The impacts were organized by environmental resource or issue areas that are specified with each impact. Significance criteria were used to define the level at which an impact would be considered significant, in accordance with NEPA and CEQA. Impacts were also identified as beneficial, where appropriate. Each impact was categorized as follows:

- No Impact (NI) – An impact that would cause no adverse change in the environment, as measured by the applicable significance criterion.
- Beneficial Impact (B) – An impact that would cause a beneficial change to the environment, as measured by the applicable significance criterion.
- Less than Significant Impact (LS) – An impact that would cause no substantial adverse change in the environment, as measured by the applicable significance criterion; therefore, no mitigation would be required.
- Less than Significant Impact with Mitigation (LSM) – A significant or potentially significant impact that would be a less than significant level if mitigation measures are implemented. Mitigation measures are applied where feasible to avoid, minimize, rectify, reduce, or compensate for significant impacts of the project, in accordance with the NEPA regulations (40 Code of Federal Regulations 1508.20) and California State CEQA Guidelines (Section 15126.4).
- Significant and Unavoidable Impact (SU) – An impact that is a substantial adverse change in the environment that cannot be avoided or mitigated to a less than significant level if the project is implemented.

Alternatives 1A, 1B, and 2A would be similar in the types of environmental effects, although the level of some effects would vary in the primary study area and across different portions of the extended study area depending on the water operations for each plan. Generally, the adverse effects would be mitigated to less than significant levels with prescribed mitigation measures. Some adverse effects would remain adverse and unavoidable despite practicable measures identified to mitigate effects. However, most adverse effects would be mitigated to the extent practicable. Based on environmental resources studies to date, the Final Alternatives were projected to be environmentally feasible.

All Final Alternatives would provide opportunities to improve the management of water to benefit the environment, including dedicated storage for environmental water. Support for actions to improve the reliability of water supplies delivered to Central Valley Refuges, even if such actions would have impacts to other resources, has been demonstrated at the California state and Federal levels with the signing of the CALFED ROD, Public Law 108-361, and Proposition 1.

No-Impacts and Less than Significant Impacts

The 2017 Draft Supplement has identified the following resource or issue areas as having either no impact or a less than significant impact on resources for all the Final Alternatives:

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- Delta hydrology and water quality
- Delta fisheries and aquatic resources
- Indian Trust Assets
- Growth-inducing effects

Beneficial Impacts

Beneficial impacts were similar for all Final Alternatives. As shown in Table 5-9, the four Final Alternatives were identified to have beneficial impacts on existing populations of the bald eagle and its habitat associated with the reservoir expansion. Short-term socioeconomic benefits were also identified to Contra Costa’s economy through the generation of new income and local employment during construction. Long-term income and local employment benefits from future projects associated with the Final Alternatives were also identified.

Table 5-9. Summary of Beneficial Impacts of the Final Alternatives

Resource Category	Environmental Effect	Alternative			
		1A	1B	2A	4A
Biological	Construction activities would result in direct and indirect benefits to existing populations of and habitat for bald eagles.	B	B	B	B
Socioeconomic	Construction could temporarily generate new income and local employment that could benefit Contra Costa County’s economy.	B	B	B	B
Socioeconomic	Construction of the proposed project, when combined with construction of other future projects, could have a beneficial effect on income and local employment.	B	B	B	B

Key:
B = beneficial

Significant and Unavoidable Impacts

As shown in Table 5-10, significant and unavoidable impacts were identified for agricultural resources or issue areas. All Final Alternatives were identified as having significant and unavoidable impacts on Prime Farmland, Unique Farmland, or Farmland of Statewide Importance which would be permanently converted to nonagricultural use because of reservoir expansion. No other immitigable impacts were identified for the proposed alternatives.

Table 5-10. Summary of Significant and Unavoidable Impacts of the Final Alternatives

Resource Category	Environmental Effect	Alternative			
		1A	1B	2A	4A
Agricultural	The project would permanently convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use.	SU	SU	SU	SU

Key:
SU = significant and unavoidable

Less than Significant Impacts with Mitigation

Several resource and issue areas would be affected by the Final Alternatives. However, these impacts would be reduced to less than significant with mitigation. These less than significant impacts with mitigation are summarized in Table 5-11.

Table 5-11. Summary of Less than Significant with Mitigation Impacts of the Final Alternatives

Resource Category	Environmental Effect	Alternative			
		1A	1B	2A	4A
Geology, Soils, and Seismicity	The project could result in substantial soil erosion or the loss of topsoil.	LSM	LSM	LSM	LSM
	Project components could be located on expansive or corrosive soils or on a geologic unit or soil that is unstable or could become unstable as a result of the project or construction activities.	LSM	LSM	LSM	LSM
Local Hydrology, Drainage, and Water Quality	During construction and operations, the project could violate water quality standards through increased erosion and sedimentation to local waterways, release of fuels or other hazardous materials during construction, or dewatering of excavated areas, or could otherwise result in substantial water quality degradation.	LSM	LSM	LSM	LSM
	The project could create or contribute runoff water that would exceed the capacity of existing or planned drainage infrastructure or provide substantial additional sources of polluted runoff.	LSM	LSM	LSM	LSM
Biological	Project construction could affect the following NCCP habitat types (California Department of Fish and Wildlife (CDFW) sensitive plant communities in parentheses): natural seasonal wetland (i.e., bulrush-cattail series, northern claypan vernal pool, bush seepweed and, saltgrass series), valley/foothill riparian (i.e., Fremont cottonwood series and valley oak series), grassland (i.e., purple needlegrass series) and valley/foothill woodland forest (i.e., blue oak series).	LSM	LSM	LSM	LSM
	Project construction could affect potentially jurisdictional wetlands, waters of the U.S., or streambeds and banks.	LSM	LSM	LSM	LSM
	Project construction could affect special-status plant populations, including brittlescale, San Joaquin spearscale, Brewer's dwarf-flax, and Mason's lilaepsis.	LSM	LSM	LSM	LSM
	Project construction would result in impacts on California red-legged frog and California tiger salamander, aquatic breeding habitat for these species, and upland aestivation habitat.	LSM	LSM	LSM	LSM
	Project construction would result in direct and indirect impacts on existing populations of and habitat for western pond turtle.	LSM	LSM	LSM	LSM
	Project construction would result in direct and indirect impacts on listed vernal pool fairy shrimp and their habitat, and on the non-listed midvalley fairy shrimp.	LSM	LSM	LSM	LSM

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Table 5-11. Summary of Less than Significant with Mitigation Impacts of the Final Alternatives (contd.)

Resource Category	Environmental Effect	Alternative			
		1A	1B	2A	4A
Biological	Project construction would have temporary and permanent impacts on potential San Joaquin kit fox habitat.	LSM/LS	LSM/LS	LSM/LS	LSM/NI
	Project construction would result in temporary and permanent loss of habitat for burrowing owl.	LSM	LSM	LSM	LSM
	Project construction activities would result in direct and indirect impacts on existing populations of and habitat for the golden eagle, bald eagle, and Swainson's hawk.	LSM/B (bald eagle)	LSM/B (bald eagle)	LSM/B (bald eagle)	LSM/B (bald eagle)
	Project construction and increased reservoir water levels would result in temporary and permanent loss of potential and occupied habitat for Alameda whipsnake.	LSM	LSM	LSM	LSM
	Project construction activities could result in direct and indirect impacts on valley elderberry longhorn beetle and its habitat.	LSM	LSM	LSM	LS
	Project construction activities could affect active breeding bird nest sites and new powerlines could affect migratory birds.	LSM	LSM	LSM	LSM
	Project construction activities could affect designated critical habitat for listed species (vernal pool fairy shrimp and Contra Costa goldfields)	LSM	LSM	LSM	LSM
	Project construction activities could affect non-listed special-status reptile species (San Joaquin coachwhip and coast horned lizard).	LSM	LSM	LSM	LSM
	Project construction activities could affect non-listed special-status mammal species (American badger, special-status bats, and San Joaquin pocket mouse).	LSM	LSM	LSM	LSM
	Project could result in inconsistency with local and regional conservation plans, or local plans or ordinances protecting biological resources.	LSM	LSM	LSM	LSM
Land Use	Project construction activities within designated Airport Land Use Compatibility Zones near the Byron Airport could cause potential temporary height impacts by conflicting with Federal Acquisition Regulation (FAR) Part 77 surfaces during construction	LSM	LSM	LSM	LSM
	Project construction activities within Airport Influence Area for Byron Airport could cause potential temporary flight hazards through: the creation of glare or distracting light; the generation of dust or smoke, which could impair pilot visibility; or could attract an increased number of birds.	LSM	LSM	LSM	LSM
Agriculture	Temporary construction activities associated with the project could temporarily affect the agricultural use of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance.	LSM	LSM	LSM	LSM
	The project could involve changes in the environment that, due to their location or nature, could contribute to cumulative impacts from conversion of Important Farmland to non-agricultural uses.	LSM	LSM	LSM	LSM

Table 5-11. Summary of Less than Significant with Mitigation Impacts of the Final Alternatives (contd.)

Resource Category	Environmental Effect	Alternative			
		1A	1B	2A	4A
Transportation and Circulation	Project construction activities would intermittently and temporarily increase traffic congestion due to vehicle trips generated by construction workers and vehicles on area roadways.	LSM	LSM	LSM	LSM
	Project construction activities would intermittently and temporarily impede access to local streets or adjacent uses, including access for emergency vehicles.	LSM	LSM	LSM	LSM
	Project construction activities would intermittently and temporarily increase potential traffic safety hazards for vehicles, bicyclists, and pedestrians on public roadways due to increased traffic volumes.	LSM	LSM	LSM	LSM
	Construction of the proposed project, when combined with construction of other future projects, could contribute to construction-related short-term cumulative impacts to traffic and transportation (traffic congestion, access, parking, traffic safety, and pavement wear and tear).	LSM	LSM	LSM	LSM
Air Quality	Project construction could temporarily generate reactive organic gas (ROG), nitrous oxide (NO _x), carbon monoxide (CO), and particulate matter (PM) 10 emissions. Emissions of ROG, NO _x , and PM10 could potentially contribute to existing nonattainment conditions and degrade air quality.	LSM	LSM	LSM	LSM
	Project construction and/or operation could expose sensitive receptors to substantial pollutant concentrations.	LSM	LSM	LSM	LSM
	Development and operation of the project would result in a cumulative increase of criteria pollutant emissions.	LSM	LSM	LSM	LSM
Noise	Construction of facilities under the proposed project could generate noise levels that exceed the Contra Costa County or Alameda County noise standards at nearby sensitive receptors if construction activities are carried out during noise-sensitive hours, causing sleep disturbance and/or annoyance.	LSM	LSM	LSM	LSM
	Project operation would generate traffic, stationary source, and area source noise similar to existing noise associated with current operations.	LSM	LSM	LSM	LSM
Utilities and Public Service Systems	Construction of the project could temporarily disrupt utility services during construction such that a public health hazard could be created or an extended service disruption could result.	LSM	LSM	LSM	LSM
	Construction of the project could increase the solid waste generation such that the capacity of local landfills could be exceeded.	LSM	LSM	LSM	LSM
	The proposed project, when combined with other planned projects or projects under construction in the area, could have a cumulative impact to public services and utilities, local landfill capacity, and existing energy demand and consumption.	LSM	LSM	LSM	LSM

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Table 5-11. Summary of Less than Significant with Mitigation Impacts of the Final Alternatives (contd.)

Resource Category	Environmental Effect	Alternatives			
		1A	1B	2A	4A
Hazardous Materials/Public Health	During construction and operation of the project components, hazardous materials such as oil, grease, or fuel could be accidentally released, thereby exposing construction workers and CCWD personnel to hazardous materials or accidentally releasing hazardous materials into the soil, groundwater, and/or nearby surface water bodies.	LSM	LSM	LSM	LSM
	Improper handling or use of flammable or combustible materials such as internal combustion equipment could result in wildland fires.	LSM	LSM	LSM	LSM
	Construction of pipeline within 0.25 miles of a school has the potential to release hazardous materials and emit hazardous emissions.	LSM	LSM	LSM	LSM
Visual Resources	The proposed project could have a substantial, demonstrable negative aesthetic effect on a scenic vista, or could substantially degrade the existing visual character or quality of the site and its surroundings.	LSM	LSM	LSM	LS
Recreation	Construction of the project would result in short-term reduction of recreational opportunities in the project area, but would enhance recreational opportunities in the long-term.	LSM	LSM	LSM	LSM
Cultural and Paleontological	Construction and management of project components could cause a substantial adverse change in the significance of a historical resource, as defined in Section 15064.5, or historic property or historic district, as defined in Section 106 (36 Code of Federal Regulations 800).	LSM	LSM	LSM	LSM
	Deep excavation associated with pipeline installation, foundation excavation, slope grading, and other deep ground disturbing activities could encounter and destroy paleontological resources in certain geologic formations underlying the project area.	LSM	LSM	LSM	LSM
	Construction and management of project components could disturb human remains, including those interred outside formal cemeteries.	LSM	LSM	LSM	LSM
	Construction and management of project components could result in adverse cumulative impacts to historical, cultural, and/or paleontological resources.	LSM	LSM	LSM	LSM
Environmental Justice	Project construction activities could cause disproportionate impact to minority and low-income communities in the area due to construction related traffic and air quality impacts.	LSM	LSM	LSM	LSM

Notes:

B = beneficial
 CCWD = Contra Costa Water District
 CO = carbon monoxide
 CDFW = California Department of Fish and Wildlife
 FAR = Federal Acquisition Regulation
 LS = less than significant

LSM = less than significant with mitigation
 NCCP = Natural Community Conservation Plan
 NI = no impact
 NO_x = nitrous oxide
 PM = particulate matter
 ROG = reactive organic gas
 U.S. = United States

RED Account

The RED account displays changes in the distribution of regional economic activity that result from each final alternative. According to the P&G, two measures of regional effects are regional income and regional employment. A region is defined as an area that encounters “significant” income and employment effects. Income and employment effects are further divided into “positive” and “negative” effects. Each of the four categories (positive income, positive

employment, negative income, and negative employment) is equal to the sum of NED effects that accrue in a region, plus transfers between and outside the region (i.e., positive income effects equal the NED benefits in the region plus the transfers of income to the region from outside the region). Transfers could come from implementation outlays, transfers of basic economic activity, indirect effects, and induced effects. The positive (and negative) effects on regional employment are directly parallel to effects on income; therefore, the analysis of regional employment effects is organized in the same categories as regional income effects.

The Final Alternatives may affect the regional economy as a result of the following factors:

1. Los Vaqueros Reservoir raise to 275 TAF would introduce short-term construction expenditures.
2. Increased reservoir levels and improvement access to trails and marina would increase recreational visitation and spending.
3. Los Vaqueros Reservoir raise and associated new facilities would introduce long-term facility operations, maintenance, and replacement expenditures.

OSE Account

The OSE account displays and integrates information on the final alternative effects from perspectives that are not reflected in the other three accounts. Categories include urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and conservation. Both the beneficial and adverse effects in the OSE account are expected to be similar across all final alternatives.

The extended study area is also a region of considerable ethnic and cultural diversity, high population growth, and an increasing proportion of minority representation. The Final Alternatives would have little, if any, disproportionate effect on a particular population or socioeconomic group.

There could be some short-term effects associated with all Final Alternatives, including:

1. Temporary construction-related benefits flowing to local communities in the areas of the final alternative features.
2. Short-term adverse effects that could occur to those directly affected by construction activities related to pressures on housing, public services, and transportation.

Comparison of Final Alternatives

This section presents a comparison of the Final Alternatives leading to the identification of a plan recommended for implementation. Four evaluation criteria were used based on the P&G for water resources planning to compare and rank the alternatives: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. These criteria are described below.

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Completeness

Completeness is a determination of whether a plan includes all elements necessary to realize planned benefits and the degree to which the intended benefits might depend on the actions of others. Important factors considered in evaluating the completeness of the Final Alternatives included (1) authorization, (2) planning objective(s), (3) reliability or durability, (4) physical implementability, and (5) environmental resources.

Authorization

Authorization for Reclamation, DWR, and CCWD to participate in this project was obtained from the following laws and legislation: CALFED (Public Law 108-361), California Water Code Section 227, and the CCWD Principles of Participation, CCWD Board's Resolution 03-24 and Measure N.

Planning Objectives

All Final Alternatives would meet primary planning objective of providing additional Refuge water supplies, but to different degrees because of the operational focus of each alternative. All Final Alternatives would also meet the secondary planning objective of providing water quality benefits to CCWD users. Alternatives 1A, 1B, and 4A would meet the primary planning objective of increasing reliability of M&I supplies to the SBA and other Local Agency Partners, as well as provide increased emergency water supplies. Therefore, Alternatives 1A, 1B, and 4A were ranked high. Alternative 2A would result in net decrease in M&I supply reliability, but would provide increased emergency water supplies. Therefore Alternative 2A was ranked moderate.

Reliability

All of the Final Alternatives were ranked high in reliability, as they were expected to meet their objectives. The current Los Vaqueros Reservoir has been successful in reliably meeting its water supply and quality objectives and should continue to do so in the future. None of the Final Alternatives would depend on the completion of other local or regional projects.

Physical Implementability

All of the Final Alternatives could be physically constructed or implemented within the study area and were ranked high in this factor.

Environmental Resources

All of the Final Alternatives would avoid adverse environmental impacts or successfully mitigate for unavoidable adverse impacts. The 2017 Draft Supplement provides more details on the ability of Final Alternatives to avoid or mitigate for potential environmental, water, and cultural resources impacts. A major component of all alternatives is increased delivery or wheeling to support the availability of Refuge water supplies, resulting in positive environmental benefits to wildlife Refuges. Therefore, all alternatives were ranked high.

Overall Completeness Ranking

Alternatives 1A, 1B, and 4A would fulfill all aspects of the completeness categories and all have the highest overall ranking. Alternative 2A would not fulfill on planning objectives and has a Moderate-High overall ranking. Table 5-12 summarizes the overall relative rankings of the Final Alternatives.

Table 5-12. Overall Completeness Ranking for Final Alternatives

Completeness Criteria	Alternative 1A	Alternative 1B	Alternative 2A	Alternative 4A
Authorization	High	High	High	High
Planning Objectives	High	High	Moderate	High
Reliability	High	High	High	High
Physical Implementability	High	High	High	High
Environmental Resources	High	High	High	High
Overall Ranking	High	High	Moderate-High	High

Effectiveness

Effectiveness is the extent to which a final alternative would alleviate problems and achieve objectives. Several factors were considered in evaluating the effectiveness of the Final Alternatives in meeting the planning objectives. The factors included (1) M&I water supply reliability, (2) emergency water supply, (3) environmental water supply, and (4) water quality.

M&I Water Supply Reliability

Table 5-1 shows that Alternative 2A would result in net reduction of M&I supply deliveries, while the other alternatives would result in comparable increase in water supply reliability benefits. Alternatives 1A, 1B, and 4A were ranked high for M&I water supply reliability, while Alternatives 2A ranked low.

Emergency Water Supply

Table 5-2 shows the amount of emergency water supplies that would be available from each final alternative, representing the average volume of water available in the reservoir at any given time, less 70 TAF reserved by CCWD for its own emergency use. This available supplies could be used to meet supply reliability needs in the event of a major supply disruption, such as an earthquake or levee failure in the Delta. Although Alternatives 1A, 1B, and Alternative 2A would have the same proposed reservoir expansion size of 275 TAF, emergency supply benefits would be different due to the difference in operations and resulting average storage in the expanded reservoir. Alternative 1A and 1B would provide the most emergency storage and would rank high. Alternative 2A and 4A would store less emergency water, and would be ranked moderate. Because the No Action Alternative would not include a physical connection between the Los Vaqueros Project and Bethany Reservoir, no emergency supplies would be available to SBA and other SOD beneficiaries. The Transfer-Bethany pipeline, included in Alternative 4A, would allow for realizing emergency supply benefits without raising the existing 160 TAF dam.

Refuge Water Supply

For the primary planning objective of developing Refuge water supplies, Final Alternatives were evaluated on their ability to increase delivery of Incremental Level 4 supplies to Refuges. Water that would be made available for Refuge water supply benefits is shown in Table 5-3. Alternative 2A would provide the largest volume of water dedicated to Incremental Level 4 Refuge water supply purposes and was ranked high. Alternatives 1B and 4A were ranked moderate. Alternative 1A was ranked low, providing the lowest Refuge water supplies volumes among the alternatives.

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Agricultural Water Supply Reliability

Table 5-4 shows that Alternative 1A would result in largest increase of agricultural deliveries SOD, while the other Final Alternatives would result in lower, but comparable increases. Alternative 1A was ranked high, and Alternatives 1B, 2A, and 4A were moderate.

Bay Area Water Quality

For the secondary planning objective of Bay Area water quality, there would be limited changes in water quality due to the mixing of delivered supplies through the Los Vaqueros Project facilities in Bethany Reservoir. An option to connect the Los Vaqueros Project directly to the South Bay Aqueduct was not carried forward. Delivering to Bethany Reservoir would provide more operational flexibility, as it would allow for deliveries to SBA and other SOD beneficiaries, including Refuges. For in-Delta partners, including CCWD, Brentwood, and ECCID water quality would see greater improvements under several of the alternatives. The stored water in an expanded Los Vaqueros Reservoir would increase their ability to mix current water supplies with water from an expanded Los Vaqueros Reservoir for better water quality. Therefore, Alternatives 1A, 1B, and 2A ranked low-moderate, while Alternative 4A was ranked low.

Overall Effectiveness Ranking

Table 5-13 summarizes how each of the Final Alternatives was ranked for relative effectiveness. Alternatives 1A and 1B were ranked as having moderate to high effectiveness. Alternative 4A was ranked moderate. Alternative 2A was ranked moderate-low because of its negative impact on M&I water supply reliability.

Table 5-13. Overall Effectiveness Ranking for Final Alternatives

Effectiveness Criteria	Alternative 1A	Alternative 1B	Alternative 2A	Alternative 4A
M&I Water Supply Reliability	High	Moderate	Low	Moderate
Emergency Water Supply	High	High	Moderate	Moderate
Refuge Water Supply	Low	Moderate	High	Moderate
Agricultural Water Supplies	High	Moderate	Moderate	Moderate
Bay Area Water Quality	Low – Moderate	Low – Moderate	Low – Moderate	Low
Overall Ranking	Moderate-High	Moderate-High	Moderate-Low	Moderate

Key:
M&I – municipal and industrial

Efficiency

This evaluation criteria is a measure of how efficiently an alternative alleviates identified problems while realizing specified objectives. Possible approaches to evaluating efficiency include (1) dollars per unit of economic benefit, (2) least cost of attaining an objective, (3) and reduced opportunity costs relative to accomplishments of other alternatives. In this analysis, efficiency of each final alternative was evaluated using its estimated net economic benefit and benefit-cost ratio, which is presented in Table 5-8.

Alternative 1B would have the highest total NED benefit, followed closely by Alternative 1A. Alternatives 2A and 4B would come third in total NED benefits. However, when considering net NED benefits (total NED benefits less total costs), Alternative 4A would have the highest net NED benefit, followed by Alternatives 1B and 1A. Alternative 2A would result in negative net NED benefits, and benefit-cost ratio less than 1. Therefore Alternative 4A was ranked high. Alternatives 1A and 1B were ranked moderate. Alternative 2A was ranked low.

Acceptability

This is the workability and viability of a plan concerning its acceptance by other Federal agencies, state and local governments, and public interest groups and individuals. Final alternatives were ranked from low to high in terms of acceptability. Factors used in evaluating acceptability included (1) Federal, California state, and local financial support, (2) consistency with CCWD's Principles of Participation, (3) consistency with CALFED objectives, and (4) acceptance by environmental or other stakeholders.

Federal, State, and Local Financial Support

All Final Alternatives would be consistent with existing Federal and California state laws and regulations that govern Delta operations. Some Local Partner Agency operations may require additional water right permits for the diversion and storage of their water supplies. All the operation scenarios under the Final Alternatives were designed to meet these existing rules. The Final Alternatives would also seek permits and work to minimize construction-related impacts that may temporarily violate any air quality, noise, or water quality standards.

Consistency with CCWD's Principles of Participation

All Final Alternatives are consistent with CCWD's Principles of Participation (see Chapter 2 for these principles).

Consistency with CALFED Program Objectives

CALFED objectives include water quality, levees, water supply, and ecosystem restoration. All Final Alternatives were consistent with CALFED goals to promote regional solutions through improved water supply reliability, emergency water supplies, and management of the Delta.

Acceptance by Environmental or Other Stakeholders

No new Delta intakes were proposed in the Final Alternatives, and no impacts on Delta fisheries would occur. Therefore, no opposition to the Final Alternatives from environmental or other special interest groups was expected. As mentioned above, all Final Alternatives would provide Refuge water supply benefits by increasing delivery of Incremental Level 4 supplies to Refuges. All Final Alternatives are expected to be supported by environmental groups.

Overall Acceptability Ranking

Table 5-14 shows the overall ranking of the Final Alternatives for relative acceptability. All Final Alternatives were ranked high.

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Table 5-14. Acceptability Ranking for the Final Alternatives

Acceptability Criteria	Alternative 1A	Alternative 1B	Alternative 2A	Alternative 4A
Federal, State, and Local Financial Support	High	High	High	High
Consistency with CCWD's Principles of Participation	High	High	High	High
Consistency with CALFED Objectives	High	High	High	High
Acceptance by Environmental or Other Stakeholders	High	High	High	High
Overall Ranking	High	High	High	High

Key:
 CALFED = CALFED Bay-Delta Program
 CCWD = Contra Costa Water District

Summary

As summarized in Table 5-15, Alternatives 1A, 1B, and 4A were ranked moderate-high. Alternative 2A ranked moderate-low due to lower scores for effectiveness and efficiency. All Final Alternatives ranked high or moderate-high for completeness, as they would meet and satisfy all objectives for this criterion. All Final Alternatives ranked high for acceptability. Alternative 4A ranked moderate for effectiveness due to lower project benefits relative to the other Final Alternatives, and high for efficiency because it would have the highest benefit-cost ratio. Alternative 2A ranked moderate-low for effectiveness and low for efficiency because it would result in negative M&I, emergency, and agricultural water supply benefits and would not have a benefit-cost ratio greater than one.

Table 5-15. Summary Comparison of Final Alternatives

Alternative	Comparison Criteria				Overall Relative Ranking
	Completeness	Effectiveness	Efficiency	Acceptability	
No Action Alternative	Would include none of the elements required to achieve benefits	Would include none of the elements required to achieve benefits	No cost would be accrued by the No Action Alternative; there would be no economic benefits	Would include none of the elements required to achieve benefits	N/A
Alternative 1A	Would achieve all planning objectives; high reliability and no dependency on other projects; physically implementable; impacts would be avoidable or could be mitigated with net positive environmental benefits	Highest M&I, emergency, and agricultural water supply benefits; lower Refuge water benefits	Positive net NED benefit of \$10.6 million/year; Benefit-Cost ratio of 1.23	Federal and California state support; consistent with CCWD's Board Principles of Participation and CALFED goals; environmental and stakeholder support	Moderate-High
<i>Relative Rank</i>	<i>High</i>	<i>Moderate-High</i>	<i>Moderate</i>	<i>High</i>	
Alternative 1B	Similar to Alternative 1A	High emergency water supply benefits; moderate M&I and agricultural water supply benefits; moderate Refuge water benefits	Positive net NED benefit of \$11.6 million/year; Benefit-Cost ratio of 1.25	Similar to Alternative 1A	Moderate-High
<i>Relative Rank</i>	<i>High</i>	<i>Moderate-High</i>	<i>Moderate</i>	<i>High</i>	
Alternative 2A	Similar to Alternative 1A, except some planning objectives are not met in all water year types	Highest Refuge water benefits; negative long term average M&I benefits; moderate emergency, and agricultural water supply benefits	Cost would be slightly higher than quantified benefits (net NED benefit of -\$3.2 million/year); Benefit-Cost ratio of 0.93	Similar to Alternative 1A	Moderate-Low
<i>Relative Rank</i>	<i>High</i>	<i>Moderate-Low</i>	<i>Low</i>	<i>High</i>	
Alternative 4A	Similar to Alternative 1A	Moderate M&I, emergency, and agricultural water supply benefits; moderate Refuge water benefits	Highest net NED benefit of \$16.9 million/year; Benefit-Cost ratio of 1.66	Similar to Alternative 1A	Moderate-High
<i>Relative Rank</i>	<i>High</i>	<i>Moderate</i>	<i>High</i>	<i>High</i>	

Key:
CALFED = CALFED Bay-Delta Program

CCWD = Contra Costa Water District
M&I = municipal and industrial

N/A = not applicable
NED = National Economic Development

Sensitivity and Uncertainty

Key areas of uncertainty for this evaluation and comparison of Final Alternatives include uncertainties associated with Delta future conditions, estimated total costs for proposed facilities, and estimated economic benefits. These areas of uncertainty are summarized below.

Future Delta Conditions

The Delta ecosystem is in decline, with several of its resident and migratory fish species listed for protection under the Federal ESA and/or CESA. To address the impacts of Delta water operations and water quality deterioration on Delta ecosystem and fish populations, several environmental flow goals and objectives in the Delta and Central Valley have been established through legal mandates aimed at maintenance and recovery of endangered and threatened fisheries and wildlife. These objectives are outlined in programs such as the CALFED Ecosystem Restoration Program, CVPIA Anadromous Fish Restoration Program, and in BOs that govern the operation of Delta facilities. Further, the State Water Board is currently reviewing or planning to review various regulatory requirements for flow, in an upstream from the Delta, and Delta water quality. Therefore, uncertainty exists about future program objectives and regulatory requirements affecting the Delta.

There are additional ongoing efforts, led by California, to develop new strategies for a sustainable Delta ecosystem that would continue to support its economic functions, including water supply conveyance. Efforts within the legal Delta are subject to requirements set forth in the Delta Stewardship Council's Delta Plan. Ongoing projects and programs, including California WaterFix and EcoRestore initiatives, have the potential to significantly alter water management in the Delta. Therefore, uncertainty exists about the future conditions and management of the Delta.

Facilities Cost

Feasibility-level construction cost estimates, or opinions of probable construction cost for project alternatives, were considered compatible with the Association for the Advancement of Cost Engineering cost estimate classification system as Class 4 cost estimates. The furnished opinions of probable construction costs were more definitive than traditional Class 4 cost estimates, in that unit price detail were furnished in place of strict reliance on equipment factoring or other parametric methods. Therefore, the actual classification rating and resulting accuracy range of the furnished opinions of probable construction costs may trend somewhere between a Class 4 and a Class 3 effort. Consequently, the expected accuracy of the furnished opinions of probable construction costs was considered between minus 15 percent to 20 percent on the low side, to between plus 20 percent to 25 percent on the high side. The impact of this uncertainty on the overall findings of this analysis is limited because of the comparative nature of this analysis and the consistent use of the cost estimating approach across all alternatives.

Economic Benefits

The economic benefits estimated in this analysis relied on various methodologies and assumptions. Changes in these methods or assumptions would alter the estimated benefits and could affect the applicability of the methods applied to estimate the benefits. Some of the key assumptions used in this analysis are summarized below.

Refuge Benefits Assumptions

- The Refuge water supply benefits associated with providing Incremental Level 4 Refuge water supplies would be equivalent to or less than the cost of obtaining the same volume of water supplies through short-term water market purchases.
- The Refuge water supply benefits associated with the Final Alternatives would be considered in addition to the existing Incremental Level 4 Refuge water deliveries.
- The cost of obtaining water supplies through short-term water market purchases were estimated using the Water Pricing Model, which uses historical transactions in California’s water market from 1991-2016 to estimate water transfer costs. The costs depend on the water year type, type of buyer, and geographic location. Costs also include conveyance costs through the Delta.
- Refuge water supplies were valued using forecasted costs of water market purchases at 2030 conditions.

Table 5-16 shows the sensitivity of the overall benefit-cost ratio to different valuation assumptions for Refuge water supply benefits:

- Costs of water market purchases at existing conditions (rather than 2030 conditions) using the Water Pricing Model (see Appendix D – Economic Analysis).
- The average historical cost of water acquisitions by the RWSP for the period 2006-2016. The average estimated cost is \$158 per acre-foot, which does not include conveyance costs, and includes a mix of short-term and long-term acquisitions (see Appendix D – Economic Analysis).
- Unit values for Delta export water as recommended by the California Water Commission, Water Storage Investment Program in their Technical Reference Document, for 2030 and 2045 conditions (CWC 2016).
- Increased recreational participation (visitor days) related to improved Refuge habitat conditions (see Appendix D – Economic Analysis for a discussion of this valuation methodology).

Overall, the benefit-cost ratio is sensitive to the methodology for valuing the refuge supplies. Specifically, the benefit-cost ratio of the NED Plan remains greater than 1 across all methods and assumptions in Table 5-16. The benefit-cost ratio of the LPP is greater than 1 for those methods that are adjusted for expected future conditions, and slightly less than 1 if only the historical cost data are used. This analysis demonstrates that the value of Refuge benefits would need to decrease substantially before the NED plan would become economically infeasible. Similarly, the value of Refuge benefits would need to decrease by more than half for the LPP to become economically infeasible. Given that historical data on the cost of water on the spot market indicates increasing prices in the future, there is sufficient confidence in the method used to value the Refuge water supply component of the benefit-cost ratio.

Chapter 5
Plan Evaluation and Comparison

Table 5-16. Sensitivity of Overall Benefit-Cost Ratio to Value of Refuge Water Supply Benefit

Valuation Method	Alternative 1A	Alternative 1B (LPP)	Alternative 2A	Alternative 4A (NED Plan)
Water Pricing Model 2030 Conditions ¹	1.23	1.25	0.93	1.66
Water Pricing Model, Existing Conditions	1.01	0.96	0.47	1.19
RWSP Historic Average, \$158	0.96	0.90	0.37	1.09
Delta Export 2030 Conditions (TRD, WSIP)	1.08	1.05	0.62	1.33
Delta Export 2045 Conditions (TRD, WSIP)	1.28	1.29	1.01	1.73
Increased Recreation Participation	1.43	1.50	1.19	2.09

Note:

¹ Method used in this Feasibility Report.

Key:

CALFED = CALFED Bay-Delta Program

CCWD = Contra Costa Water District

TRD = Technical Reference Document (California Water Commission, Water Storage Investment Program, 2016).

WSIP = Water Supply Investment Program

Urban Water Supply Reliability Assumptions

- The benefits from improved water supply reliability to the Bay Area were estimated in the Investigation by considering the costs of obtaining additional water supply through short-term water market purchases and long-term purchases of groundwater banking capacity. A key assumption involved in this analysis was that the estimated costs of the identified water supply alternatives were an appropriate measure of the economic benefit to urban water consumers.
- The costs of future water market purchases were estimated through the application of results from a statistical analysis of historical water market activity. Changes in future water supply and demand characteristics, and subsequent water market conditions, would affect the ability of the economic model to predict future water market prices.

Emergency Water Supply Assumptions

- Emergency water supplies provided by an expanded Los Vaqueros Reservoir were estimated through application of a short-term demand function. The price elasticity of demand was obtained from previous studies of residential water demand in California. The results of the analysis were highly sensitive to the selection of price elasticity of demand. As a result, relatively small changes in the assumed elasticity could lead to large changes in estimated benefits.
- The level and duration of water supply shortages to the Bay Area were obtained from previous studies. Analysis of the possible effects of Delta water supply outages on the Bay Area is ongoing. As a result, the assumptions employed in this analysis may change.