Attachment 8 – Benefits and Cost Analysis

Attachment 8 describes and quantifies the benefits and costs of the Chabot Dam Seismic Upgrade Project. The analysis of benefits and cost for the project is consistent with the physical benefits presented in Attachment 7, *Technical Justification of Projects*.

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8.0 General Principles

The following principles were adhered to during preparation of this attachment.

- *Consistency.* The analysis was completed for the entire project and is consistent with other data and information provided about the Chabot Dam Seismic Upgrade.
- *Completeness.* All new facilities, policies, and actions required to obtain the benefits were revealed and their costs have been included.
- *With-Project and Without-Project Comparison.* The analysis is based on a comparison of expected conditions with and without the project over the period of analysis.
- *Period of Analysis.* The analysis was based on a project life cycle of 100 years as specified by EBMUD. This includes the construction period and operational life.

8.1 Method of Analysis

The economic analysis was performed using standard economic analysis methods and models. To estimate flood damage reduction benefits, we used the Flood Rapid Assessment Model (FRAM), which was developed by CA DWR. To estimate avoided costs associated with the project, we relied on engineering estimates. To estimate avoided recreational losses, we utilized standard willingness-to-pay and consumer surplus values for different types of recreation activities. These values were developed by the U.S. Forest Service for the Pacific Southwest Region.

8.2 Flood Damage Reduction Benefit Analysis (D1)

The following sections describe flood damage reduction benefits and project costs.

Flood Damage Reduction Benefits

Flooding downstream of the Lake Chabot Dam could cause extensive damage to existing residential, commercial, and industrial structures. By reducing flooding damage, this project would reduce the costs of repairing injured buildings, as well as the costs of replacing damaged contents and inventory within affected structures. Flood protection benefits associated with the project also include avoided costs to public areas (e.g., roads), and avoided costs of cleaning up flood-related debris.

As a first step to estimating flood damage reduction benefits, we estimated the clean-up costs associated with flood-related debris (see Attachment 7 for the amount of debris generated under each flood scenario, with and without the project). Using FEMA cost codes of $20 per cubic yard of "cradle-to-grave" removal (FEMA, 2009), we estimate that upgrading the Lake Chabot dam would result in avoided debris removal costs of up to $1.5 Million (under the 500-yr flood scenario). Avoided debris removal costs average about $650,000 between all flooding scenarios.

Next, we input the estimated clean-up costs and the physical flood protection benefits described in Attachment 7 (i.e., residential, commercial, and industrial structures impacted/damaged, households displaced, number of people seeking temporary shelter, and miles of inundated road) into FRAM to estimate the average annual value of flood protection benefits with and without the project. FRAM results indicate that if the dam is removed, average annual damages associated with flooding would amount to $16.4 million. With the project, average annual damages would be approximately $1.6

million. Of this $14.8 million difference, structural damage accounts for $6.3 million and contents and inventory damage comprises $8.3 million. Approximately $150,000 of the overall difference is due to changes in debris removal, and only $60,000 due to differences in road damage.

Of the total structural, content, and inventory damages, residential damages account for approximately $5.7 million, while commercial damages account for roughly $4.9 million. Industrial damages comprise approximately $4 million of these damages.

Table 8.1 shows the present value of flood-related benefits associated with the proposed project over the 100-year project life (using Table 12 from Exhibit C of the SWFM PSP). As shown, the present value benefits amount to approximately $245.5 million (based on a 6% discount rate). Appendix 8.1 provides the detailed outputs of the FRAM model.

Table 8.1. Present value of expected annual damage benefits (USD 2012)

Project: Chabot Dam Seismic Upgrade			
(a)	Expected Annual Damage Without Project		$16,386,342
(b)	Expected Annual Damage With Project (1)		$1,610,590
(c)	Expected Annual Benefit	(a) – (b)	$14,775,752
(d)	Present Value Coefficient		16.62
(e)	**Present Value of Future Benefits Transfer to Table 17, column (d).**	**(c) x (d)**	$245,536,750

In addition the monetized values described above, flood reduction benefits include avoided state and national response and clean-up costs, such as providing food, water, and temporary shelter to displaced persons. As described in Attachment 7, in all yearly inundation scenarios except for the 2- and 10-yr floods, we estimate that the additional amount of displaced households and people seeking temporary shelter given no dam upgrade is larger than the total number of displaced households and persons seeking shelter if the project is implemented. These costs are not included in the FRAM estimate.

In addition, flooding can cause losses to external assets for residential, commercial, and industrial entities. Inundation can cause extensive damage to landscaped areas, which require replacement. Businesses can also experience losses of equipment stored outdoors. Maintaining flood benefits through the dam upgrade would reduce costs associated with replacing landscaping, as well as lost potential income. However, these benefits are not quantified or monetized.

Finally, during a flood, inundated areas would experience economic losses. Regardless of physical replacement costs, companies can lose business either due to damage to the surrounding area, inaccessibility, or displacement of clientele. This period of loss can extend past the actual phase of inundation, if public transportation, utilities, or transportation infrastructure has incurred any damage. These losses represent indirect economic impacts and should not be included in a benefit-cost analysis (as it is assumed that money not spent at these businesses would be spent elsewhere in the local economy). However, these impacts represent potential real losses to individuals within the project area.

Project Costs

There are no additional costs associated with maintaining flood protection benefits under the Chabot Lake Seismic Upgrade Project. If the project is implemented, flood protection benefits would be maintained downstream of Chabot Dam.

8.3 Non-Monetized Benefits Analysis (D2)

The above discussion of flood damage reduction benefits focused upon physical tangible assets (such as structures) that can be monetarily valued. However, the Stormwater Flood Management grant may also result in other types of FDR benefits that are just as important, but cannot easily be quantified. These types of benefits are qualitatively described in this section.

Table 8.2 identifies non-monetized benefits that would accrue from project implementation (using Table 13 from Exhibit C of the SWFM PSP). It is important to note that this table is intended to only identify benefits of the project that cannot be monetized. Thus, although a benefit might apply, a "No" is entered into column 2 if the benefit has been monetized.

Table 8.2. Non-monetized benefits of the Chabot Dam Seismic Upgrade Project

No.	Question	Enter "Yes", "No" or "Neg"
	Community/Social Benefits	
	Will the proposal	
1	**Provide education or technology benefits?**	
	Examples are not limited to, but may include: - Include educational features that should result in water supply, water quality, or flood damage reduction benefits? - Develop, test or document a new technology for water supply, water quality, or flood damage reduction management? - Provide some other education or technological benefit?	No
2	**Provide social recreation or access benefits?**	
	Examples are not limited to, but may include: - Provide new or improved outdoor recreation opportunities? - Provide more access to open space? - Provide some other recreation or public access benefit?	No[1]
3	**Help avoid, reduce or resolve various public water resources conflicts?**	
	Examples are not limited to, but may include: - Provide more opportunities for public involvement in water management? - Help avoid or resolve an existing conflict as evidenced by recurring fines or litigation? - Help meet an existing state mandate (e.g., water quality, water conservation, flood control)?	Yes

No.	Question	Enter "Yes", "No" or "Neg"
4	**Promote social health and safety?**	
	Examples are not limited to, but may include: - Increase urban water supply reliability for fire-fighting and critical services following seismic events? - Reduce risk to life from dam failure or flooding? - Reduce exposure to water-related hazards?	No
5	**Have other social benefits?**	
	Examples are not limited to, but may include: - Redress or increase inequitable distribution of environmental burdens? - Have disproportionate beneficial or adverse effects on disadvantaged communities, Native Americans, or other distinct cultural groups?	Yes
	Environmental Stewardship Benefits:	
	Will the proposal	
6	**Benefit wildlife or habitat in ways that were not quantified in Attachment 7?**	
	Examples are not limited to, but may include: - Cause an increase in the amount or quality of terrestrial, aquatic, riparian or wetland habitat? - Contribute to an existing biological opinion or recovery plan for a listed special status species? - Preserve or restore designated critical habitat of a listed species? - Enhance wildlife protection or habitat?	Yes
7	**Improve water quality in ways that were not quantified in Attachment 7?**	
	Examples are not limited to, but may include: - Cause an improvement in water quality in an impaired water body or sensitive habitat? - Prevent water quality degradation? - Cause some other improvement in water quality?	Yes
8	**Reduce net emissions in ways that were not quantified in Attachment 7?**	
	Examples are not limited to, but may include: - Reduce net production of greenhouse gasses? - Reduce net emissions of other harmful chemicals into the air or water?	Yes
9	**Provide other environmental stewardship benefits, other than those claimed in Sections D1, D3 or D4?**	No
	Sustainability Benefits:	
	Will the proposal	

No.	Question	Enter "Yes", "No" or "Neg"
10	**Improve the overall, long-term management of California groundwater resources?**	
	Examples are not limited to, but may include: - Reduce extraction of non-renewable groundwater? - Promote aquifer storage or recharge?	No
11	**Reduce demand for net diversions for the regions from the Delta?**	
12	**Provide a long-term solution in place of a short-term one?**	
	Examples are not limited to, but may include: - Replace a temporary water supply with a more permanent supply? - Replace a temporary water quality solution with a more permanent solution? - Replace temporary flood control management with a more permanent solution? - Replace temporary habitat with a more permanent solution?	No
13	**Reduce water consumption on a permanent basis?**	
14	**Promote energy savings or replace fossil fuel based energy sources with renewable energy and resources?**	
	Examples are not limited to, but may include: - Reduce net energy use on a permanent basis? - Increase renewable energy production? - Include new buildings or modify buildings to include certified LEED features? - Provide a net increase in recycling or reuse of materials? - Replace unsustainable land or water management practices with recognized sustainable practices?	No
15	**Improve water supply reliability in ways not quantified in Attachment 7?**	
	Examples are not limited to, but may include: - Provide a more flexible mix of water sources? - Reduce likelihood of catastrophic supply outages? - Reduce supply uncertainty? - Reduce supply variability?	No
16	**Other (If the above listed categories do not apply, provide non-monetized benefit description)?**	
In most instances, the "no" indicated for a given benefit does not indicate that the project would not result in that benefit but that the benefit has been quantified and/or elsewhere in the analysis.		

Community/Social Benefits

The Project resolves dam safety issues identified by DWR-Division of Safety of Dams and potentially reduces demand for obtaining emergency supplies through the State Water Project (SWP), which helps to resolve conflict for competing demands.

In addition, this project would result in flood damage reduction benefits and emergency water supply benefits for disadvantaged communities (DACs) located downstream of Chabot Reservoir. At the census tract or block level, there are several areas downstream of Chabot Dam with median household incomes below 80% of the statewide median of $48,706 (2010). Please see Figure 9.2 in Attachment 9, which was produced using DWR's on-line mapping tool for Disadvantaged Communities (DACs),[1] for a map displaying DACs downstream of Chabot Dam. Some of the DAC communities shown in Figure 9.2, particularly those adjacent to the drainage course downstream of Chabot Reservoir, also appear on the inundation maps presented in Attachment 3 of this proposal, which details the flood damage reduction benefits of the Project. These areas would receive flood damage reduction benefits as a result of the Project.

In addition, one of the critical water supply needs of these DAC areas is water supply following a major emergency, including but not limited to an earthquake that limits EBMUD's ability to deliver water across the Delta originating in the Sierra. Emergency storage in Chabot Reservoir could be utilized to meet these needs by provisionally connecting water facilities at Chabot Reservoir to the treatment and supply system at Upper San Leandro Reservoir, which currently serves the DAC areas shown in Figure 9.2 in Attachment 9, or through other provisional options including temporary truck-mounted treatment at Chabot or trucking raw water for non-potable uses.

Environmental Stewardship Benefits

This project would result in a number of environmental stewardship benefits relative to the project baseline. This includes benefits listed under items 6 through 8 of Table 8.2 above, as follows:

- *Wildlife/habitat benefits.* The project would preserve Chabot Reservoir for aquatic habitat uses as compared to the future without the Project. As described in Attachment 7, Lake Chabot is stocked with trout and catfish (there are also bass, crappie, and other fish). This lake habitat and surrounding shore-line ecosystem would be maintained with the project.

- *Water quality benefits.* The dam provides improved water quality downstream because it prevents large amounts of sediment from entering San Leandro Creek, and ultimately San Leandro Bay. Without the dam this silt/sediment would wash down stream, increasing turbidity in San Leandro Creek and Bay.

- *Energy and emissions reductions*. By potentially avoiding the use of imported water in an emergency situation, this project avoids the relatively large energy use (and associated emissions such as NOx, SOx, and CO2) typically associated with importing water via the State Water Project.

8.4 Monetized Benefits Analysis (D3)

This section summarizes monetized costs and benefits associated with project implementation. The benefits described here are in addition to the monetized flood protection benefits described above.

[1]Mapping tool accessed at http://www.water.ca.gov/irwm/grants/resourceslinks.cfm, January 18, 2013.

Project Costs

Capital costs for the project total $18,575,000. Direct construction and implementation costs account for $12,325,000 (about 66%) of total capital costs. Project administration, planning, design, environmental documentation and compliance, and mitigation and monitoring costs account for the remainder of the capital budget.

O&M costs (including periodic replacement costs) of the project would average about $17,250 per year. This includes an estimated $2,000 in watershed staffing costs, $13,000 in annual electricity costs to run the raw water pumps at the dam, $1,000 in maintenance costs associated with dam valves and gates, and a replacement cost of $30,000 for the raw water pump. The estimated life of the pump is 25-years and it was installed in 1992. Thus, it would need replacing three times over the 100-year project life (including once in 2016).

In total, the present value capital and O&M costs associated with the project amount to $16,347,092 over the 100-year project life, beginning in 2016 (the first year following construction) and ending in 2115. These costs are shown in Table 16 in Exhibit C of the SWFM PSP.

Project Benefits

This section describes the monetized benefits of the project, including:

- Avoided dam removal costs
- Avoided cost of accessing alternative emergency supplies
- Avoided costs associated with supplying potable water to Chabot and Willow Park Golf Courses
- Avoided reservoir-related recreation losses (in terms of willingness to pay values per fishing and boating visitor days)

Each of these benefits is described in more detail below.

Benefit: Avoided dam removal costs

EBMUD estimates that the capital costs of removing the dam amount to $22,600,000 (2012 USD). This estimate does not include park, trail, and other restoration efforts that would occur on the site after the dam is removed (for a detailed cost estimate see Appendix 8.2 to this attachment). This analysis assumes that dam removal would begin in October 2014 (the same month and year construction is slated to begin under the with-project scenario) and would be completed in October of 2015. There are no estimated annual O&M costs associated with dam removal.

With construction taking place in 2014 and 2015, the present value costs associated with dam removal amount to $19,244,769. These costs are documented in Table 15 from Exhibit C of the SWFM PSP.

Benefit: Avoided costs of obtaining emergency water supplies

Water levels in the combined storage system of EBMUD, including Chabot reservoir, are an important factor in deciding whether to implement drought management programs and rationing for the region during extended dry periods. By improving Chabot Dam, this project helps assure that up to 10,000 AF

in Chabot Reservoir remains a vital asset to serve the water needs of the East Bay region (e.g., as a source of emergency drinking water supply and other emergencies such as fire suppression) and potentially, the greater Bay Area (i.e., by potentially avoiding imported water supplies).

The loss of 10,000 AF of Lake Chabot's water supply would result in the need to secure additional supplemental water supplies for emergency use. Options for sources of supplemental supply include water transfers (i.e., inter-agency interties for emergency mutual aid), groundwater conjunctive use, and desalination. EBMUD has indicated that the most likely source of supplemental supply would be a short-term emergency water transfer, but water transfers may not always be available in emergency situations.

As described in Attachment 7, for the purposes of this analysis, we assume that EBMUD would access 10,000 AF of emergency supplies from Lake Chabot three times over the project life time of 100 years. Thus, 300 AF represents the average annual benefit of emergency supplies for EBMUD.

EBMUD has determined that $1,100/AF is a reasonable and supportable cost for obtaining emergency water supplies if the dam is removed. This is based on an average of the 9 supplemental supply projects included in Table 2 of EBMUD's Water Supply Management Plan (WSMP) 2040: Component Cost Estimation Evaluations (included in Appendix 8.3). It allows for multiple options, recognizing that should an emergency supply be needed in the future, while water transfers may be the most likely option, they may be in high demand and cost more than $630/AF and/or may be unavailable and another supplemental supply alternative would be required.

Given the cost of $1,100/AF and an average annual physical benefit of 300 AFY, avoided emergency water supply costs will amount to $330,000 per year, on average, over the 100-year project life. However, Chabot Lake is not currently connected to the distribution system. In the event of an emergency that required the use of water from Chabot Lake, EBMUD would need to construct an emergency pipeline to the potable system (e.g., to Upper San Leandro reservoir). EBMUD estimates that this would cost $1,830,000 (Appendix 8.4 includes a more detailed breakdown of costs). This would represent a one-time cost (i.e., would only need to be done the first time supplies from Lake Chabot were accessed), averaging $18,300 per year over the 100-year project life. In addition, EBMUD estimates that energy costs associated with pumping the water would amount to about $500,000 under each emergency situation (a total of $1.5 million for the assumed 3 times that EBMUD will need to access this water). Over the 100-year project life, this would average of $15,000 per year. EBMUD may also experience some additional costs associated with accessing supplies below the lowest outlet of the dam during an emergency. EBMUD was not able to quantify these additional costs.

Thus, the net monetized benefit of avoiding the cost of accessing emergency water supplies amount to $296,700 per year, on average. Over the 100-year project life, the present value of this benefit is $4.45 million, assuming some benefits begin to accrue in 2014 (the year construction is initiated) and a 6% discount rate.

In the event that EBMUD needs to access raw water during an emergency (e.g., for fire suppression), the costs associated with accessing the emergency supply from Chabot Lake will be much less. EBMUD has reported that in the event of an emergency that required raw water, they would likely set up a fill station for trucks to carry water. Based on a similar situation at Lafayette Lake, we estimate the costs associated with setting up and maintaining the fill station would amount to a total of $60,000 ($11,000 in

costs associated with the fill station and pipeline, and about $49,000 in staffing costs), or an average of $6,000 per year over the 100-year project life.

Because we do not know whether a future emergency will require raw water or potable water (and the fact that Lake Chabot has never been accessed for fire suppression purposes), we applied the higher costs of connecting the pipeline to the potable system, resulting in a more conservative estimate of benefits.

Benefit: Avoided costs associated with supplying potable water to Chabot and Willow Park Golf Courses

Currently, Chabot Lake serves as the primary source of water supply for raw water irrigation at both Chabot and Willow Park Golf Courses (both located near the reservoir). Under the without-project scenario, the golf courses would have to switch to irrigating with potable supplies from EBMUD. Thus, the project would result in avoided costs associated with supplying the golf courses with an alternative water source. It also would preserve this amount of potable water supply for other water supply needs in the service area, helping promote overall water supply reliability.

Under the without-project alternative, EBMUD would incur nominal costs to establish a connection to the golf courses via the potable water distribution system. The cost borne by EBMUD to provide treated water is assumed to be about the same as the billing charges to the customer for receiving treated water. This cost amounts to $78,000 annually for the 210 AF/year that would be provided to Chabot and Willow Park Golf Courses. The present value of this benefit over the 100-year project life is approximately $1.17 million, assuming some benefits begin to accrue in 2014 (the year construction is initiated) and a 6% discount rate.

Benefit: Avoided reservoir-related recreation losses (in terms of willingness to pay values per fishing and boating visitor days)

Chabot Lake currently supports 20,000 fishing visitor days (many of which also involve boating), about 16,232 boating visitor days (including boat rentals and private watercraft), 250,000 trail activity days (i.e., hiking, walking, jogging, biking), and 88,000 picnicking days. Based on park employee input, about 9,740 of the boating trips are estimated to involve fishing. As described in Attachment 7, *Technical Justification of Projects*, we categorized these 9,740 trips as boating visitor days to avoid double counting. Thus the net number of fishing trips included in this analysis is 10,260.

Under the without-project scenario, all fishing and boating activities would be lost. It is assumed that if the dam were removed, all other activities at the park would remain the same. It is also assumed that no additional fishing activity would occur in the new stream channel. This is based on the fact that no fishing currently is reported as occurring downstream of the dam or in the stretch of river between Chabot Reservoir and Upper San Leandro Reservoir.

Construction is slated to begin in October of 2014 under both the with- and without-project scenarios (i.e., the seismic upgrades and the dam removal would be initiated at this time). If the dam is removed, fishing and boating activities would be available until construction begins (i.e., the first nine months of 2014). If the dam is not removed and the seismic upgrades are implemented, boating and fishing would not be impacted during construction. Trail activities would be impacted during construction under both

scenarios. However, impacts associated with trail closures during construction are not expected to result in a net change in recreation between the with- and without-project scenarios.

To estimate the monetary value of avoided loss of fishing and boating visitor days if the project is implemented, we relied on visitor day values from the U.S. Forest Service Report: *Updated Outdoor Recreation Use Values on National Forests and Other Public Lands* (Loomis 2005, attached as Appendix 8.5). This report summarizes more than 35 years of the literature on net economic value of outdoor recreation on public lands. The report provides average net willingness to pay or consumer surplus per day for 30 recreation activities at the national level, as well as by region of the United States. For this analysis, we applied values per visitor day for the Pacific Region of the United States, which are based on average values from reports published over the past 35 years. We updated the 2005 values in the report to 2012 values based on the Consumer Price Index (CPI). The resulting values for fishing and boating visitor days are $53.92 and $33.84, respectively.

As described in Attachment 7, we assume that visitor recreation days would not increase substantially at the park in the future, as it already reaches maximum capacity of 5,000 people 20 to 25 times a year.[2]

Table 8.3 provides a summary of the annual monetized recreation-related benefits with the proposed project (e.g., avoided loss of fishing and boating visitor days). As shown, benefits begin to accrue in 2014 (the year that construction begins or, alternatively, the year in which dam removal would be initiated). Beginning in 2015 (the year most construction occurs), the annual value of avoided recreation-related benefits amount to more than $1.1 million. Over the 100-year project life, the present value of avoided recreation losses is approximately $16.54 million.

Annual Benefit and Annual Cost of Avoided Projects

Monetized benefits per unit of physical benefit over the life of the Project are presented in Appendix 8.6 of this Attachment. The analysis was conducted as per the Table 14 instructions from Exhibit C of the SWFM PSP. The analysis evaluates the following avoided costs and losses:

- Avoided emergency water supply costs
- Avoided costs of supplying potable water for golf course irrigation
- Avoided boating recreation losses
- Avoided fishing recreation losses

The analysis shows a total present value of discounted benefits based on unit value of $22,179,450.

Monetized benefits based upon avoided future project costs (i.e., avoided dam removal costs) over the life of the Project are presented below in Table 8.4. The analysis was conducted as per the Table 15 instructions from Exhibit C of the SWFM PSP. In Table 8.4, the unit costs associated with avoided emergency water supply costs ($989) and avoided costs of supplying potable water to the golf courses ($371) were calculated by dividing the total annual cost associated with these benefits by the physical benefit (e.g., 300 AFY for emergency water supply and 210 AFY for raw water supply).

[2] Personal communication, EBRPD representative, Joe Britton, January 23, 2013.

Table 8.3. Avoided recreation losses associated with the project

Type of Benefit Claimed: Avoided recreational losses			
Measure of Benefit Claimed (Name of Units): visitor days			
Additional Information About this Measure:			
(a)	(b)	(c)	(d)
Physical Benefits			
Year/benefit	Change in visitor days resulting from the project	Visitor day value (2012 USD)	Project benefit (2012 USD)
2012			
Fishing[a]	0	$53.92	0
Boating	0	33.84	0
2013			
Fishing	0	53.92	0
Boating	0	33.84	0
2014			
Fishing	2,565	53.92	$138,305
Boating	4,058	33.84	$137,323
2015			
Fishing	10,260	53.92	$553,219
Boating	16,232	33.84	$549,291
2016			
Fishing	10,260	53.92	$553,219
Boating	16,232	33.84	$549,291
2111 (last year of project life)			
Fishing	10,260	53.92	$553,219
Boating	16,232	33.84	$549,291
a. Fishing visitor days that involve boating are included as boating visitor days to avoid double-counting.			

Table 8.4: Annual Costs of Avoided Projects

(All avoided costs shown in 2012 dollars)

Project: Chabot Dam Seismic Upgrade						
	Costs				Discounting Calculations	
(a)	(b)	(c)	(d)	(e)	(f)	(g)
Year	Alternative (Avoided Project Name): _____ Avoided Project Description:					
	Avoided Capital Costs	Avoided Replacement Costs	Avoided Operations and Maintenance Costs	Total Cost Avoided for Individual Alternatives (b) + (c) + (d)	Discount Factor	Discounted Costs (e) x (f)
2012					1.000	**$ -**
2013	$ -				0.943	**$ -**
2014	$5,215,385				0.890	**$4,641,692**
2015	$17,384,615				0.840	**$4,603,077**
2016	$ -				0.792	**$ -**
2115 (last year of project life)	$ -				…	**$ -**
Total Present Value of Discounted Costs (Sum of Column (g))						**$19,244,769**
(%) Avoided Cost Claimed by Project						**100%**
Total Present Value of Discounted Avoided Project Costs Claimed by Alternative Project (Total Present Value of Discounted Costs x % Avoided Cost Claimed by Project)						**$19,244,769**

The total present value of project benefits (not including flood-related benefits) amount to $41.42 million. This includes $22.18 million in benefits (total present value over 100-year project life) from avoided emergency water supply costs, avoided costs associated with supplying potable water to Chabot and Willow Park Golf Courses, and avoided recreation losses, as well as $19.24 in avoided dam removal costs (present value costs).

8.5 Project Benefit and Cost Summary (D4)

Annual Costs of Projects (Table 8.4) was completed for the project, and Proposal Benefits and Costs Summary (Table 17) was completed for the entire proposal (which only includes one project). Tables 8.4 and 8.5 are provided in the following sections.

Project Costs

This section describes and tabulates all costs that would be required to implement and operate the project over its expected life. Costs are presented in Appendix 8.7 of this Attachment. The analysis was conducted as per the Table 16 instructions from Exhibit C of the SWFM PSP.

Capital costs for the project total $18,575,000 (2012 USD). O&M costs (including periodic replacement costs) are estimated to average about $17,250 per year. This includes an estimated $2,000 in watershed staffing costs, $13,000 in annual electricity costs to run the raw water pumps at the dam, $1,000 in maintenance costs associated with dam valves and gates, and a replacement cost of $30,000 for the raw water pump. The estimated life of the pump is 25-years and it was installed in 1992. Thus, it would need replacing three times over the 100-year project life (including once in 2016). In total, the present value capital and O&M costs associated with the project amount to $16,347,265 over the 100-year project life.

Benefits and Costs Summary

The benefits and costs for all projects in this proposal are summarized in Table 8.5 below. As shown, the total present value of project benefits is $267,716,201, with the total present value of project costs being $16,347,265. On net, the project is expected to yield a positive present value net benefit (present value benefits minus present value costs) of $251,368,935.

Table 8.5: Proposal Benefits and Costs Summary

Proposal: Chabot Dam Seismic Upgrade

Agency: EBMUD

Project	Project Proponent	Total Present Value Project Costs (1)	Total Present Value Project Benefits			From Section D2 – Briefly describe the main Non-monetized benefits
			From Section D2 – Flood Damage Reduction (2)	From Section D3 – Monetized (3)	Total	
(a)	(b)	(c)	(d)	(e)	(f) = (d) + (e)	(g)
Lake Chabot Seismic Upgrade Project	EBMUD	$16,347,265	$245,536,750	$22,179,451	$267,716,201	

Appendix 8.1: FRAM Model Output

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DWR Levee Mitigation Prioritization Tool

To Read Instructions:	Read Instructions
To Enter Project Information:	Enter Project Information
To Enter Special Cases:	Enter Special Cases
View Cost-Benefit Analysis:	Cost-Benefit Analysis
View Stage Damage Graph:	Stage v Damage Curve
View AAD Graph (Actual):	Loss Probability Curve

Instructions

Return to Menu

Project information should be entered in the 'Inputs' tab only. Information is required in all cells highlighted green. Example:

Output information is provided in the 'BCA Summary' tab. Project calculations are performed in the sheets described in the Model Map.

Model Map

Sheet Name	Description
Menu:	Front page of model, with links to key sheets
Instructions:	Description of how this model should be used
Inputs:	Project information to be entered by user
BCA Summary:	Summary data resulting from Cost-Benefit Analysis
Assumptions:	Master page containing unit damage assumptions
Depth Damage Curves	Data describing stage damage relationships
Residential:	Direct residential building and contents costs
Commercial & Industrial:	Direct commercial and industrial building and contents costs
Agricultural:	Direct losses to agricultural production
Roads	Direct Losses to roads and infrastructure
Special Cases:	Table for entering information about special case buildings
Without Project EAD	Calculation of Estimated Annual Damages (EAD) without-project
Graph Data	Data used to develop graphical outputs
With Project EAD	Calculation of Estimated Annual Damages (EAD) with-project
Stage v Damage Curve	Graph of flood stage v flood damages

Loss Probability Curve	Graph of flood exceedance probability v flood damages

Inputs

Return to Menu

Project Name:

Cost of Project:

Description:

Number of Events Modeled: 6

	Without Project						With Project					
	Event 1	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**
Average Return Interval (ARI)	2	10	50	100	500	1000	2	10	50	100	500	1000
Annual Probability of Exceedance	0.500	0.100	0.020	0.010	0.002	0.001	0.500	0.100	0.020	0.010	0.002	0.001
Probability of Levee Failure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Water Surface Elevation - channel (f)												
Flood Warning Time (hours)	1	0.7	2.5	2.8	2.9	3.5	1.4	0.9	1.3	3	3.8	3.3
Flood Experience	N	N	N	N	N	N	N	N	N	N	N	N
Period of Inundation (days)												
HEC-FIA DATA INPUTS	Y											
Residential Structural Damages ($)	2,960,000	7,180,000	15,630,000	18,960,000	37,350,000	42,580,000	250,000	1,290,000	3,880,000	5,260,000	8,860,000	19,720,000
Residential Contents Damages ($)	2,270,000	5,370,000	11,340,000	13,470,000	25,150,000	28,360,000	200,000	1,010,000	2,920,000	3,920,000	6,530,000	11,640,000
Residential Debris & Cleanup ($)												
Commercial Structural Damages ($)	160,000	370,000	17,910,000	19,160,000	32,880,000	33,980,000	30,000	60,000	190,000	260,000	440,000	1,340,000
Commercial Contents Damages ($)	500,000	960,000	46,750,000	50,070,000	85,680,000	88,310,000	120,000	220,000	580,000	740,000	1,100,000	2,130,000
Commercial Debris & Cleanup ($)	100,359	273,767	746,982	926,744	1,809,896	2,021,173	10,400	41,328	131,914	185,368	345,805	1,172,789
Industrial Structural Damages ($)	50,000	150,000	14,150,000	15,360,000	26,920,000	27,860,000	0	10,000	70,000	100,000	180,000	360,000
Industrial Contents Damages ($)	160,000	400,000	40,730,000	44,240,000	74,980,000	77,230,000	0	50,000	200,000	270,000	470,000	790,000
Industrial Debris & Cleanup ($)												
Agricultural Structural Damages ($)												
Agricultural Contents Damages ($)												
Agricultural Debris & Cleanup ($)												
Residential Properties												
Ratio Depreciated Value to Replacement Value												
Average Flood depth above ground level (f)												
Rural - Res: Homesteads												
Rural - Other: Barns, sheds												
Urban Res: Single story (no base)												
Urban Res: Single story (basement)												
Urban Res: Two plus story (no base)												
Urban Res: Two plus story (basement)												
Mobile home												
Commercial Properties												
Ratio Depreciated Value to Replacement Value												
Average Flood depth above ground level (f)												
low value building area inundated (sq.f.)												

medium value	building area inundated (sq.f.)												
high value	building area inundated (sq.f.)												
Industrial Properties													
Ratio Depreciated Value to Replacement Value													
Average Flood depth above ground level (f)													
low value	building area inundated (sq.f.)												
medium value	building area inundated (sq.f.)												
high value	building area inundated (sq.f.)												
Agricultural Production													
Corn	ac.												
Rice	ac.												
Walnuts	ac.												
Almonds	ac.												
Cotton	ac.												
Tomatoes	ac.												
Wine Grapes	ac.												
Alfalfa	ac.												
Pasture	ac.												
Safflower	ac.												
Sugar Beets	ac.												
Beans	ac.												
Other	ac.												
Roads													
length of arterial roads inundated (miles)		0.1	0.1	0.5	0.5	1.1	1.2	0	0.0	0.1	0.1	0.2	0.2
length of major roads inundated (miles)		0.03	0.0	2.6	2.6	3.7	3.8	0	0.0	0.0	0.0	0.0	0.0
length of minor roads inundated (miles)		0.112	0.1	6.8	7.3	12.0	13.2	0.005	0.1	0.1	0.1	0.7	1.2
length of unsealed roads inundated (miles)													

Extrapolate Y-intercept N

Summary of Cost-Benefit Analysis

Return to Menu

Project Name: **0**

Description: 0

Proposed project capital cost:	$ -	[Note: construction costs which are assumed to occur in one year.]
Change in annual O&M costs:	$ -	[Note: the change in annual O&M costs compared to without project conditions.]
PV of future O&M costs:	$ -	(at 6% discount rate over 100 years)
PV of future costs	$ -	[Note: the sum of capital costs plus the PV of O&M costs.]

Benefits

	Actual	Potential	
EAD without project	$ 16,386,342	$ 18,297,471	[Note: for stormwater projects use "Potential" damage which ignores storm warning effects.]
EAD with project	$ 1,610,590	$ 1,703,467	
Annual Benefit:	$ 14,775,752	$ 16,594,004	
PV of Future Benefits:	$ 245,536,750	$ 275,751,624	(at 6% discount rate over 100 years)

Cost-Benefit Analysis

	Actual	Potential	
Net Present Value (NPV)	$ 245,536,750	$ 275,751,624	(at 6% discount rate over 100 years)
Benefit:Cost Ratio	0.000	0.000	

NPV Sensitivity to Discount Rate:

	Actual	Potential
4%	$ 362,079,800	$ 406,636,045
5%	$ 293,267,808	$ 329,356,296
6%	$ 245,536,750	$ 275,751,624
7%	$ 210,838,917	$ 236,784,000
8%	$ 184,612,944	$ 207,330,752

Model Assumptions

Residential

Foundation heights

Structure Category	Foundation Height (ft)
Rural - Res: Homesteads	1.5
Rural - Other: Barns, sheds	0
Urban Res: Single story (no base)	1.1
Urban Res: Two plus story (no base)	1.1
Mobile home	2.0
Commercial: Low	1
Commercial: Medium	1
Commercial: High	1
Industrial: Low	0.5
Industrial: Medium	0.5
Industrial: High	0.5

Estimate Replacement Value (assumed proxy for depreciated value)

Structure Category	Unit Cost $/ft^2 (2)	Average Size ft^2 (1)	Construction Cost
Rural - Res: Homesteads	159	1900	302100
Rural - Other: Barns, sheds	98	4000	392000
Urban Res: Single story (no base)	159	1900	302100
Urban Res: Two plus story (no base)	155	2200	341000
Mobile home (3)	98	1180	115640
Commercial: Low	120		0
Commercial: Medium	142		0
Commercial: High	207		0
Industrial: Low	120		0
Industrial: Medium	142		0
Industrial: High	207		0

1. Residential Square Footage Source: Sacramento County Tax Assessor Unit Cost and Commercial/Industrial/Public Square Footage Assumptions Source: Saylor Publications, Inc, 2007 Current Construction Costs

2. Replacement unit cost per square foot reflects average costs in the San Franc

3. According to FEMA guidance, replacement costs per square foot for mobile homes and barns and outbuildings are similar.

Other

External damages garden/outdoor areas $/building	$	5,000
Cleanup $/building	$	4,000
Number of residents per residential property		2.6

Commercial / Industrial Buildings

Clean-up costs as a percentage of direct structural damages	30%

Calculation of Other Direct Damages

Percentage of residential direct damages applied as indirect:	25%
Percentage of comm/ind. direct damages applied as indirect:	25%
HEC-FIA only: Percentage all building direct damages applied as indirect	25%
Percentage of roads direct damages applied as indirect:	25%

NPV Calculation

Discount Rate	6%
Time Horizon	100 years

Roads

Cost per mile of highway road inundated (millions)	$	250,000
Cost per mile of major road inundated (millions)	$	100,000
Cost per mile of minor road inundated (millions)	$	30,000
Cost per mile of unsealed road inundated (millions)	$	10,000

Agricultural Damages

	Weighted, Average Annual Damages ($/acre)	Establishment Costs ($/acre)	Land Cleanup & rehabilitation ($/acre)	Total <5 d) ($/acre)	Total (>=5 d) ($/acre)
Corn	$48	$0	$246	$293	$293
Rice	$227	$0	$243	$471	$471

Walnuts	$585	$5,284	$243	$828	$6,112
Almonds	$1,618	$3,514	$243	$1,862	$5,376
Cotton	$301	$0	$246	$547	$547
Tomatoes	$1,015	$0	$235	$1,250	$1,250
Wine Grapes	$3,241	$3,240	$235	$3,476	$6,716
Alfalfa	$250	$246	$243	$493	$739
Pasture	($15)	$82	$272	$257	$339
Safflower	$164	$0	$241	$405	$405
Sugar Beets	$313	$0	$262	$575	$575
Beans	$111	$0	$246	$356	$356
Other	$0	0	$246	$246	$246

Source: Comp Study

Establishment Costs are 50% costs of total establishment costs

Calculation of Actual to Potential Damages Ratio

		Without Project						With Project					
		Event 1	Event 2	Event 3	Event 4	Event	Event 6	Event	Event 2	Event 3	Event 4	Event 5	Event 6
Warning Time:	hours	1	0.7	2.5	2.8	2.9	3.5	1.4	0.9	1.3	3	3.8	3.3
Recent Flood Expe	Y / N	N	N	N	N	N	N	N	N	N	N	N	N
Actual : Potential Ratio		0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.8

Warning Time	Experienced Community	Inexperienced Community
< 2 hours	0.8	0.9
2-12 hours	Linear reduction from 0.8 at 2 hours to 0.4 at 12 hours	0.8
>12 hours	0.4	0.7

Occ_Name	Cat_Name	Occ_Description	Parameter	Depth (ft) above First Finished Floor (FFE)																										
1ST-NB	RES	one story, no basement	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16								
1ST-NB	RES		S	0	2.5	13.4	23.3	32.1	40.1	47.1	53.2	58.6	63.2	67.2	70.5	73.2	75.4	77.2	78.5	79.5	80.2	80.7								
1ST-NB	RES		C	0	2.4	8.1	13.3	17.9	22	25.7	28.8	31.5	33.8	35.7	37.2	38.4	39.2	39.7	40	40	40	40								
2ST-NB	RES	two or more stories, no basement	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16								
2ST-NB	RES		S	0	3	9.3	15.2	20.9	26.3	31.4	36.2	40.7	44.9	48.8	52.4	55.7	58.7	61.4	63.8	65.9	67.7	69.2								
2ST-NB	RES		C	0	1	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	32	33.4	34.7	35.6	36.4	36.9	37.2								
FARM	FAR	Farm Homesteads	Stage	-10	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	13	15	19	21	25								
FARM	FAR		S	0	0	0	0	4	9	13	18	22	27	31	35	38	49	49	49	49	49	49								
FARM	FAR		C	0	0	0	0	0	6	30	54	69	75	78	80	80	80	100	100	100	100	100								
MOBILE	MOB	Mobile homes	Stage	-10	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	13	15	19	21	25								
MOBILE	MOB		S	0	0	0	0	8	44	63	73	78	80	81	82	82	82	82	82	82	82	82								
MOBILE	MOB		C	0	0	0	0	0	27	49	64	70	76	78	79	81	83	83	83	83	83	83								
PUBLIC	PUB	Public buildings	Stage	-10	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	13	15	19	21	25								
PUBLIC	PUB		S	0	0	0	0	8	22	30	35	39	41	44	46	48	49	49	49	49	49	49								
PUBLIC	PUB		C	0	0	0	0	0	17.5	25	30	34	37	39	40.5	41.5	42	42	42	42	42	42								
INDUSTRY	IND	Industrial Buildings	Stage	-10	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	13	15	19	21	25								
INDUSTRY	IND		S	0	0	0	0	4	9	13	18	22	27	31	35	38	49	49	49	49	49	49								
INDUSTRY	IND		C	0	0	0	0	0	72	75	76.5	78	81	84	87	90	96	102	108	114	120	120								
COMMERC	COM	Commercial Buildings	Stage	-10	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	13	15	19	21	25								
COMMERC	COM		S	0	0	0	0	4	9	13	18	22	27	31	35	38	49	49	49	49	49	49								
COMMERC	COM		C	0	0	0	0	0	11	30	54	69	75	78	80	80	80	100	100	100	100	100								
NOT USED																														
SL-NB	RES	split level, no basement	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16								
SL-NB	RES		S	0	6.4	7.2	9.4	12.9	17.4	22.8	28.9	35.5	42.3	49.2	56.1	62.6	68.6	73.9	78.4	81.7	83.8	84.4								
SL-NB	RES		SN	0	2.9	2.1	1.9	1.9	2	2.2	2.4	2.7	3.2	3.8	4.5	5.3	6	6.7	7.4	7.9	8.3	8.7								
SL-NB	RES		C	0	2.2	2.9	4.7	7.5	11.1	15.3	20.1	25.2	30.5	35.7	40.9	45.8	50.2	54.1	57.2	59.4	60.5	60.5								
SL-NB	RES		CN	0	2.2	1.5	1.2	1.3	1.4	1.5	1.6	1.8	2.1	2.5	3	3.5	4.1	4.6	5	5.4	5.7	6								
SL-NB	RES		Struct	N		0.8																								
1ST-B	RES	one story, with basement	Stage	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1ST-B	RES		S	0	0	0.7	0.8	2.4	5.2	9	13.8	19.4	25.5	32	38.7	45.5	52.2	58.6	64.5	69.8	74.2	77.7	80.1	81.1	81.1	81.1	81.1	81.1	81.1	
1ST-B	RES		SN	0	0	1.34	1.06	0.94	0.91	0.88	0.85	0.83	0.85	0.96	1.14	1.37	1.63	1.89	2.14	2.35	2.52	2.66	2.77	2.88	2.88	2.88	2.88	2.88	2.88	
1ST-B	RES		C	0	0.1	0.8	2.1	3.7	5.7	8	10.5	13.2	16	18.9	21.8	24.7	27.4	30	32.4	34.5	36.3	37.7	38.6	39.1	39.1	39.1	39.1	39.1	39.1	
1ST-B	RES		CN	0	1.6	1.16	0.92	0.81	0.78	0.76	0.74	0.72	0.74	0.83	0.98	1.17	1.39	1.6	1.81	1.99	2.13	2.25	2.35	2.45	2.45	2.45	2.45	2.45	2.45	
1ST-B	RES		Struct	N		0.8																								
2ST-B	RES	two or more stories, with basement	Stage	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
2ST-B	RES		S	0	1.7	1.7	1.9	2.9	4.7	7.2	10.2	13.9	17.9	22.3	27	31.9	36.9	41.9	46.9	51.8	56.4	60.8	64.8	68.4	71.4	73.7	75.4	76.4	76.4	
2ST-B	RES		SN	0	2.7	2.7	2.11	1.8	1.66	1.56	1.47	1.37	1.32	1.35	1.5	1.75	2.04	2.34	2.63	2.89	3.13	3.38	3.71	4.22	5.02	6.19	7.79	9.84	12.36	
2ST-B	RES		C	0	0	1	2.3	3.7	5.2	6.8	8.4	10.1	11.9	13.8	15.7	17.7	19.8	22	24.3	26.7	29.1	31.7	34.4	37.2	40	43	46.1	49.3	52.6	
2ST-B	RES		CN	0	0	2.27	1.76	1.49	1.37	1.29	1.21	1.13	1.09	1.11	1.23	1.43	1.67	1.92	2.15	2.36	2.56	2.76	3.04	3.46	4.12	5.08	6.39	8.08	10.15	
2ST-B	RES		Struct	N		0.8																								
SL-B	RES	split level, with basement	Stage	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
SL-B	RES		S	0	0	0	2.5	3.1	4.7	7.2	10.4	14.2	18.5	23.2	28.2	33.4	38.6	43.8	48.8	53.5	57.8	61.6	64.8	67.2	68.8	69.3	69.3	69.3	69.3	
SL-B	RES		SN	0	0	0	1.8	1.6	1.5	1.6	1.6	1.6	1.6	1.7	1.9	2.1	2.4	2.6	2.9	3.2	3.4	3.6	3.9	4.2	4.8	5.7	5.7	5.7	5.7	
SL-B	RES		C	0	0.6	0.7	1.4	2.4	3.8	5.4	7.3	9.4	11.6	13.8	16.1	18.2	20.2	22.1	23.6	24.9	25.8	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	
SL-B	RES		CN	0	2.09	1.49	1.14	1.01	1	1.02	1.03	1.04	1.06	1.12	1.23	1.38	1.57	1.76	1.95	2.13	2.28	2.44	2.44	2.44	2.44	2.44	2.44	2.44	2.44	
SL-B	RES		Struct	N		0.8																								

Residential Buildings

	Without Project						With Project					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
ARI:	2	10	50	100	500	1000	2	10	50	100	500	1000
Probability of Levee Failure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Flood depth above ground level (ft)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Buildings Inundated (no.)												
Rural - Res: Homesteads	0	0	0	0	0	0	0	0	0	0	0	0
Rural - Other: Barns, sheds	0	0	0	0	0	0	0	0	0	0	0	0
Urban Res: Single story (no base)	0	0	0	0	0	0	0	0	0	0	0	0
Urban Res: Two plus story (no base)	0	0	0	0	0	0	0	0	0	0	0	0
Mobile home	0	0	0	0	0	0	0	0	0	0	0	0
Structural Damages												
Rural - Res: Homesteads	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Rural - Other: Barns, sheds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Urban Res: Single story (no base)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Urban Res: Two plus story (no base)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mobile home	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structual Damages HEC-FIA	$ 2,960,000	$ 7,180,000	$ 15,630,000	$ 18,960,000	$ 37,350,000	######	$ 250,000	$ 1,290,000	$ 3,880,000	$ 5,260,000	$ 8,860,000	######
Total Structural Damages	$ 2,960,000	$ 7,180,000	$ 15,630,000	$ 18,960,000	$ 37,350,000	######	$ 250,000	$ 1,290,000	$ 3,880,000	$ 5,260,000	$ 8,860,000	######
Content Damages												
Rural - Res: Homesteads	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Rural - Other: Barns, sheds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Urban Res: Single story (no base)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Urban Res: Two plus story (no base)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mobile home	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contents Damage HEC-FIA	$ 2,270,000	$ 5,370,000	$ 11,340,000	$ 13,470,000	$ 25,150,000	######	$ 200,000	$ 1,010,000	$ 2,920,000	$ 3,920,000	$ 6,530,000	######
Actual:Potential Ratio	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.8
Total Contents Damages: Actual	$ 2,043,000	$ 4,833,000	$ 9,072,000	$ 10,776,000	$ 20,120,000	######	$ 180,000	$ 909,000	$ 2,628,000	$ 3,136,000	$ 5,224,000	######
Total Contents Damages: Potential	$ 2,270,000	$ 5,370,000	$ 11,340,000	$ 13,470,000	$ 25,150,000	######	$ 200,000	$ 1,010,000	$ 2,920,000	$ 3,920,000	$ 6,530,000	######

Residential Buildings

	Without Project						With Project					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
Clean-Up/ Other Costs												
External	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cleanup	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other Costs HEC-FIA	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Other Costs: Potential	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Sum Actual Damages	**$ 5,003,000**	**$ 12,013,000**	**$ 24,702,000**	**$ 29,736,000**	**$ 57,470,000**	######	**$ 430,000**	**$ 2,199,000**	**$ 6,508,000**	**$ 8,396,000**	**$14,084,000**	######
Sum Potential Damages	**$ 5,230,000**	**$ 12,550,000**	**$ 26,970,000**	**$ 32,430,000**	**$ 62,500,000**	######	**$ 450,000**	**$ 2,300,000**	**$ 6,800,000**	**$ 9,180,000**	**$15,390,000**	######
Total Actual Damage with levee failure ($):	**$ 5,003,000**	**$ 12,013,000**	**$ 24,702,000**	**$ 29,736,000**	**$ 57,470,000**	######	**$ 430,000**	**$ 2,199,000**	**$ 6,508,000**	**$ 8,396,000**	**$14,084,000**	######
Total Potential Damage with levee failure ($):	**$ 5,230,000**	**$ 12,550,000**	**$ 26,970,000**	**$ 32,430,000**	**$ 62,500,000**	######	**$ 450,000**	**$ 2,300,000**	**$ 6,800,000**	**$ 9,180,000**	**$15,390,000**	######
Indirect Actual Damage	$ 1,250,750	$ 3,003,250	$ 6,175,500	$ 7,434,000	$ 14,367,500	######	$ 107,500	$ 549,750	$ 1,627,000	$ 2,099,000	$ 3,521,000	######
Indirect Potential Damage	$ 1,307,500	$ 3,137,500	$ 6,742,500	$ 8,107,500	$ 15,625,000	######	$ 112,500	$ 575,000	$ 1,700,000	$ 2,295,000	$ 3,847,500	######

Commercial & Industrial Buildings

	Without Project						With Project					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
ARI:	2	10	50	100	500	1000	2	10	50	100	500	1000
Probability of Levee Failure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Commercial												
'Flood depth above ground level (ft)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
low building size	0	0	0	0	0	0	0	0	0	0	0	0
medium building size	0	0	0	0	0	0	0	0	0	0	0	0
high building size	0	0	0	0	0	0	0	0	0	0	0	0
Industrial												
'Flood depth above ground level (ft)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
low building size	0	0	0	0	0	0	0	0	0	0	0	0
medium building size	0	0	0	0	0	0	0	0	0	0	0	0
high building size	0	0	0	0	0	0	0	0	0	0	0	0
Structural Damages												
Commercial												
low	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
medium	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
high	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Commercial HEC-FIA	$ 160,000	$ 370,000	$ 17,910,000	$ 19,160,000	#########	$33,980,000	$ 30,000	$ 60,000	$ 190,000	$ 260,000	######	$ 1,340,000
Industrial												
low	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
medium	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
high	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Industrial HEC-FIA	$ 50,000	$ 150,000	$ 14,150,000	$ 15,360,000	#########	$27,860,000	$ -	$ 10,000	$ 70,000	$ 100,000	######	$ 360,000
Total Structural Damages	$ 210,000	$ 520,000	$ 32,060,000	$ 34,520,000	#########	$61,840,000	$ 30,000	$ 70,000	$ 260,000	$ 360,000	######	$ 1,700,000
Contents Damages												
Commercial												
low	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
medium	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
high	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Commercial HEC-FIA	$ 500,000	$ 960,000	$ 46,750,000	$ 50,070,000	#########	$88,310,000	$ 120,000	$ 220,000	$ 580,000	$ 740,000	######	$ 2,130,000
Industrial												
low	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
medium	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
high	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Industrial HEC-FIA	$ 160,000	$ 400,000	$ 40,730,000	$ 44,240,000	#########	$77,230,000	$ -	$ 50,000	$ 200,000	$ 270,000	######	$ 790,000
Actual:Potential Ratio	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.8
Total Contents Damages: Actual	$ 594,000	$ 1,224,000	$ 69,984,000	$ 75,448,000	#########	##########	$ 108,000	$ 243,000	$ 702,000	$ 808,000	######	$ 2,336,000

Commercial & Industrial Buildings

	Without Project						With Project					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
Total Contents Damages: Potential	$ 660,000	$ 1,360,000	$ 87,480,000	$ 94,310,000	#########	##########	$ 120,000	$ 270,000	$ 780,000	$ 1,010,000	######	$ 2,920,000
Clean-up/ Other Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Clean-Up/ Other Costs: HEC-FIA	$ 100,359	$ 273,767	$ 746,982	$ 926,744	$ 1,809,896	$ 2,021,173	$ 10,400	$ 41,328	$ 131,914	$ 185,368	######	$ 1,172,789
Sum Actual Damages	**$ 904,359**	**$ 2,017,767**	**$ 102,790,982**	**$ 110,894,744**	#########	##########	**$ 148,400**	**$ 354,328**	**$ 1,093,914**	**$ 1,353,368**	######	**$ 5,208,789**
Sum Potential Damages	**$ 970,359**	**$ 2,153,767**	**$ 120,286,982**	**$ 129,756,744**	#########	##########	**$ 160,400**	**$ 381,328**	**$ 1,171,914**	**$ 1,555,368**	######	**$ 5,792,789**
Total Damage with levee failure ($):	**$ 904,359**	**$ 2,017,767**	**$ 102,790,982**	**$ 110,894,744**	#########	##########	**$ 148,400**	**$ 354,328**	**$ 1,093,914**	**$ 1,353,368**	######	**$ 5,208,789**
Total Damage with levee failure ($):	**$ 970,359**	**$ 2,153,767**	**$ 120,286,982**	**$ 129,756,744**	#########	##########	**$ 160,400**	**$ 381,328**	**$ 1,171,914**	**$ 1,555,368**	######	**$ 5,792,789**
Indirect Actual Damages	$ 226,090	$ 504,442	$ 25,697,746	$ 27,723,686	#########	$49,073,293	$ 37,100	$ 88,582	$ 273,478	$ 338,342	######	$ 1,302,197
Indirect Potentail Damages	$ 242,590	$ 538,442	$ 30,071,746	$ 32,439,186	#########	$57,350,293	$ 40,100	$ 95,332	$ 292,978	$ 388,842	######	$ 1,448,197

Agricultural Damages

		Without Project						With Project					
		Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
ARI:		2	10	50	100	500	1000	2	10	50	100	500	1000
Probability of Levee Failure		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Length of Inundation <5d Y/N		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Agricultural Land Inundated													
Corn	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Walnuts	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Almonds	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Tomatoes	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grape	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Alfalfa	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Safflower	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Sugar Beets	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Beans	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Other	ac.	0	0	0	0	0	0	0	0	0	0	0	0
Potential Damages													
Corn		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Rice		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Walnuts		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Almonds		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cotton		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tomatoes		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Wine Grapes		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alfalfa		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pasture		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Safflower		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Sugar Beets		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Beans		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Other		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Potential Damages		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Damage with levee failure ($):		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Roads

	Without Project						With Project					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
ARI	2	10	50	100	500	1000	2	10	50	100	500	1000
Probability of Levee failure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Roads Inundated												
length of arterial roads inundated (miles)	0.10	0.10	0.50	0.50	1.10	1.20	0.00	0.03	0.10	0.10	0.20	0.20
length of major roads inundated (miles)	0.03	0.04	2.60	2.60	3.70	3.80	0.00	0.03	0.03	0.04	0.04	0.04
length of minor roads inundated (miles)	0.11	0.10	6.79	7.26	11.99	13.20	0.01	0.10	0.10	0.10	0.70	1.20
length of unsealed roads inundated (miles)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potential Damages												
length of arterial roads inundated (miles)	$ 25,000	$ 25,000	$ 125,000	$ 125,000	$ 275,000	$ 300,000	$ -	$ 7,500	$ 25,000	$ 25,000	$ 50,000	$ 50,000
length of major roads inundated (miles)	$ 3,000	$ 4,000	$ 260,000	$ 260,000	$ 370,000	$ 380,000	$ -	$ 3,000	$ 3,000	$ 4,000	$ 4,000	$ 4,000
length of minor roads inundated (miles)	$ 3,360	$ 3,000	$ 203,790	$ 217,680	$ 359,700	$ 396,000	$ 150	$ 3,000	$ 3,000	$ 3,000	$ 21,000	$ 36,000
length of unsealed roads inundated (miles)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Damages:	*$ 31,360*	*$ 32,000*	*$ 588,790*	*$ 602,680*	*#######*	*#######*	*$ 150*	*$ 13,500*	*$ 31,000*	*$ 32,000*	*$ 75,000*	*$ 90,000*
Total Damage with levee failure ($):	$ 31,360	$ 32,000	$ 588,790	$ 602,680	########	########	$ 150	$ 13,500	$ 31,000	$ 32,000	$ 75,000	$ 90,000

Special Cases - Dollar Damages Incurred

Return to Menu

	Without Project						With Project					
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
ARI	2	10	50	100	500	1000	2	10	50	100	500	1000
Probability of Levee failure	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Description / Site ID												
Total Damages:	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Damage with levee failure ($):	0	0	0	0	0	0	0	0	0	0	0	0

Calculation of Without Project EAD

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Y Intercept
Average Recurrence Interval (ARI)	2	10	50	100	500	1000	
AEP	0.500	0.100	0.020	0.010	0.002	0.001	0
Actual Damage to Residential Buildings ($)	$ 5,003,000	$ 12,013,000	$ 24,702,000	$ 29,736,000	$ 57,470,000	$ 65,268,000	
Potential Damage to Residential Buildings ($)	$ 5,230,000	$ 12,550,000	$ 26,970,000	$ 32,430,000	$ 62,500,000	$ 70,940,000	
Actual Damage to Commercial/Industrial Buildings ($)	$ 904,359	$ 2,017,767	$ 102,790,982	$ 110,894,744	###########	###########	
Potential Damage to Commercial/Industrial Buildings ($)	$ 970,359	$ 2,153,767	$ 120,286,982	$ 129,756,744	###########	###########	
Damage to Agriculture ($)	$ -	$ -	$ -	$ -	$ -	$ -	
Damage to Roads ($)	$ 31,360	$ 32,000	$ 588,790	$ 602,680	$ 1,004,700	$ 1,076,000	
Actual Indirect Costs	$ 1,484,680	$ 3,515,692	$ 32,020,443	$ 35,308,356	$ 61,901,974	$ 65,390,293	
Potential Indirect Costs	$ 1,557,930	$ 3,683,942	$ 36,961,443	$ 40,697,356	$ 71,192,474	$ 75,085,293	
Special Cases	$ -	$ -	$ -	$ -	$ -	$ -	
Total Actual Damages	$ 7,423,399	$ 17,578,459	$ 160,102,215	$ 176,541,780	###########	###########	$ 328,027,466
Total Potential Damages	$ 7,789,649	$ 18,419,709	$ 184,807,215	$ 203,486,780	###########	###########	$ 376,502,466
EAD (Actual)	$ 16,386,342						
EAD (Potential)	$ 18,297,471						

Potential Damages

	Without Project							With Project						
Water Surface Elevation - channel (f)	0	0	0	0	0	0		0	0	0	0	0	0	
ARI	2	10	50	100	500	1000		2	10	50	100	500	1000	
Probability of Exceedence (AEP)	0.500	0.100	0.020	0.010	0.002	0.001		0.500	0.100	0.020	0.010	0.002	0.001	
Damages incurred	$ 7,789,649	$ 18,419,709	$ 184,807,215	$ 203,486,780	$ 356,967,070	$ 376,502,466	$ 376,502,466	$ 763,188	$ 3,368,535	$ 10,003,642	$ 13,459,210	$ 22,501,006	$ 46,553,486	$ 46,553,486

Actual Damages

	Without Project							With Project						
Water Surface Elevation - channel (f)	0	0	0	0	0	0		0	0	0	0	0	0	
ARI	2	10	50	100	500	1000		2	10	50	100	500	1000	
Probability of Exceedence (AEP)	0.500	0.100	0.020	0.010	0.002	0.001		0.500	0.100	0.020	0.010	0.002	0.001	
Damages incurred	$ 7,423,399	$ 17,578,459	$ 160,102,215	$ 176,541,780	$ 310,514,570	$ 328,027,466	$ 328,027,466	$ 723,188	$ 3,208,535	$ 9,541,142	$ 12,226,710	$ 20,476,006	$ 42,913,486	$ 42,913,486

Without Project

Water Surface Elevation - channel (f)	2	10	50	100	500	1000
Probability of Exceedence (AEP)	0.500	0.100	0.020	0.010	0.002	0.001
Potential	$ 7,789,649	$ 18,419,709	$ 184,807,215	$ 203,486,780	$ 356,967,070	$ 376,502,466
Actual	$ 7,423,399	$ 17,578,459	$ 160,102,215	$ 176,541,780	$ 310,514,570	$ 328,027,466

With Project

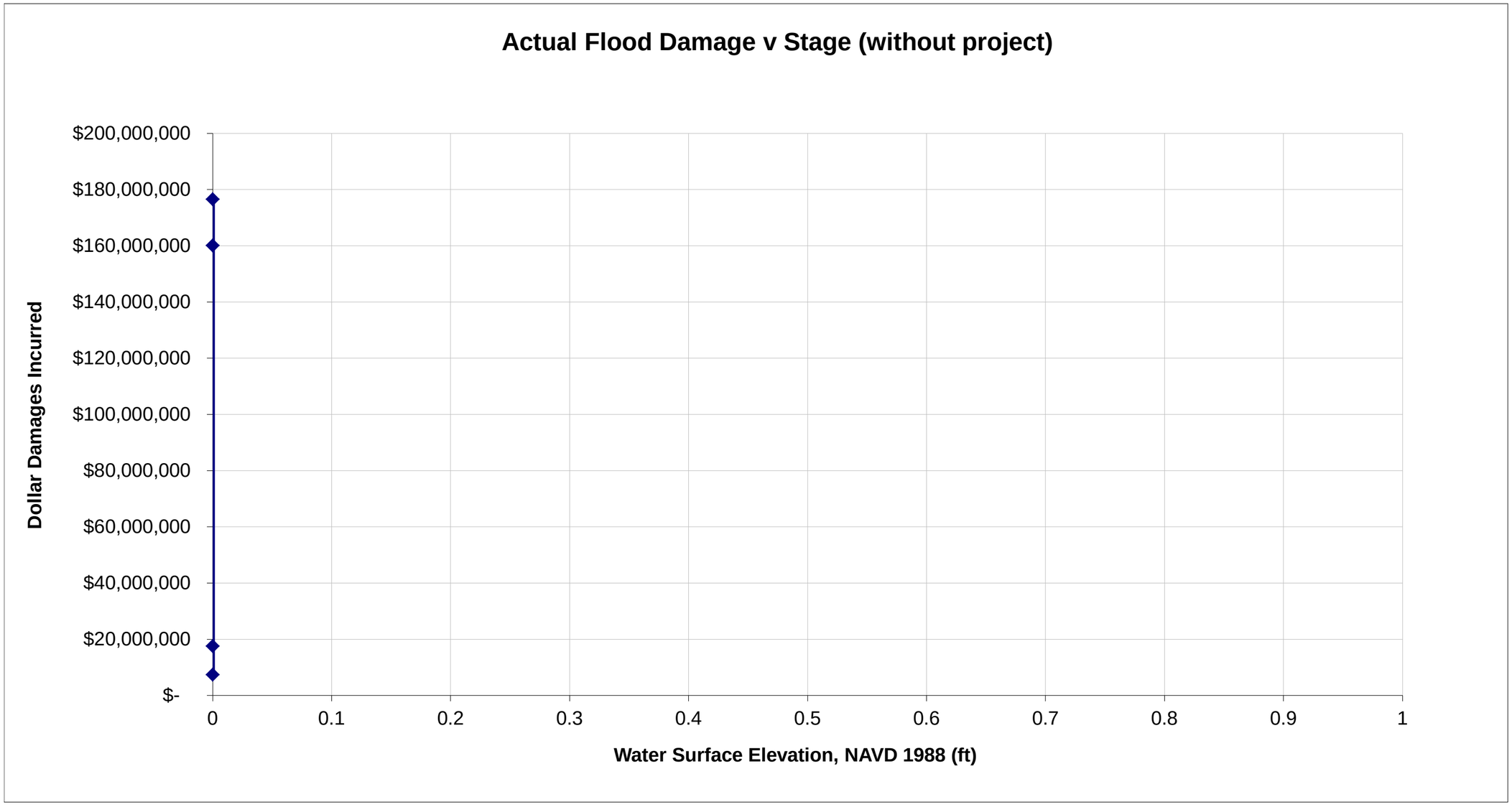
Water Surface Elevation - channel (f)	2	10	50	100	500	1000
Probability of Exceedence (AEP)	0.500	0.100	0.020	0.010	0.002	0.001
Potential	$ 763,188	$ 3,368,535	$ 10,003,642	$ 13,459,210	$ 22,501,006	$ 46,553,486
Actual	$ 723,188	$ 3,208,535	$ 9,541,142	$ 12,226,710	$ 20,476,006	$ 42,913,486

Calculation of With Project EAD

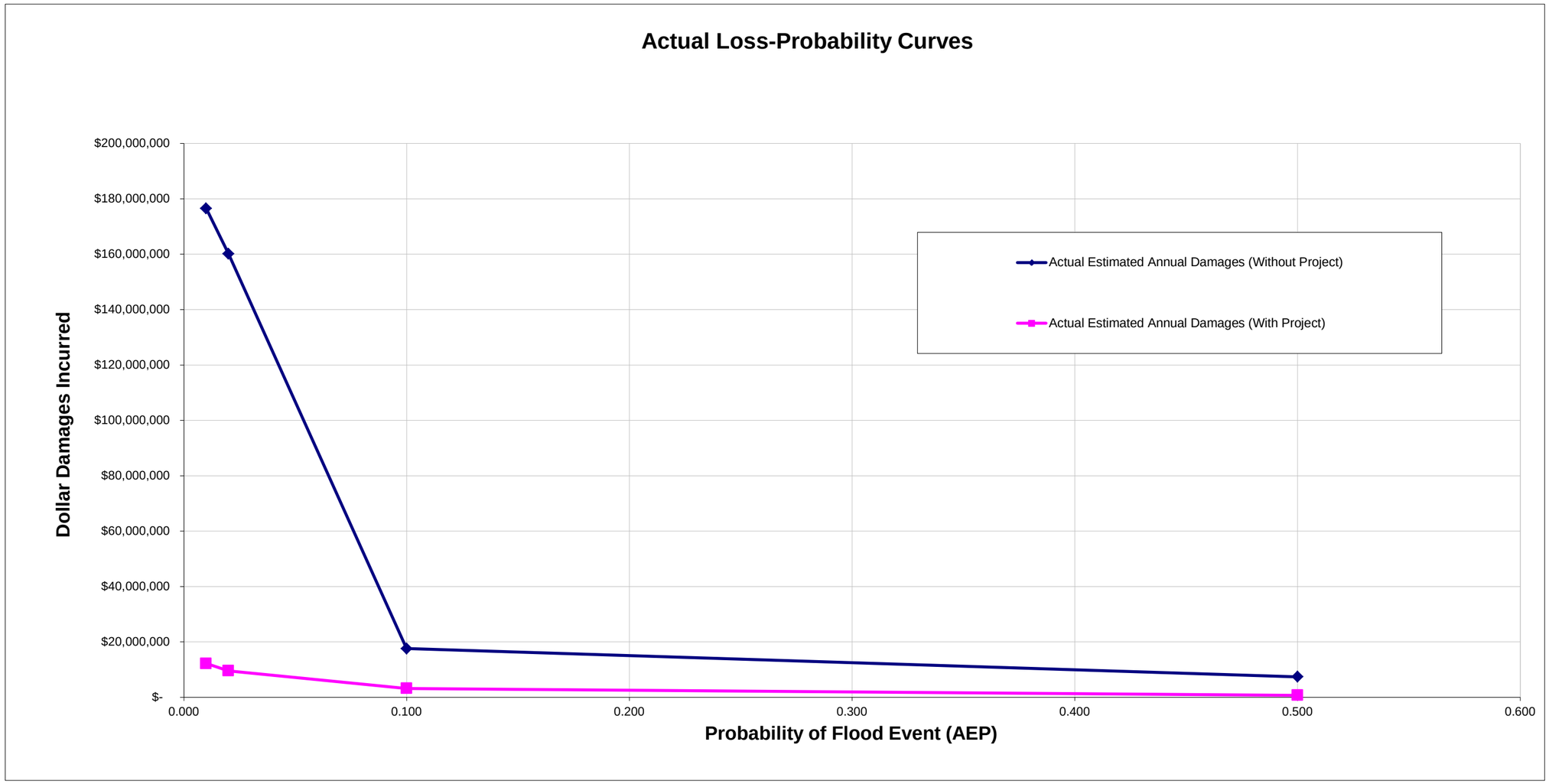
	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	
Average Recurrence Interval (ARI)	2	10	50	100	500	1000	
AEP	0.500	0.100	0.020	0.010	0.002	0.001	0
Actual Damage to Residential Buildings ($)	$ 430,000	$ 2,199,000	$ 6,508,000	$ 8,396,000	$ 14,084,000	$ 29,032,000	
Potential Damage to Residential Buildings ($)	$ 450,000	$ 2,300,000	$ 6,800,000	$ 9,180,000	$ 15,390,000	$ 31,360,000	
Actual Damage to Commercial/Industrial Buildings ($)	$ 148,400	$ 354,328	$ 1,093,914	$ 1,353,368	$ 2,221,805	$ 5,208,789	
Potential Damage to Commercial/Industrial Buildings ($)	$ 160,400	$ 381,328	$ 1,171,914	$ 1,555,368	$ 2,535,805	$ 5,792,789	
Damage to Agriculture ($)	$ -	$ -	$ -	$ -	$ -	$ -	
Damage to Roads ($)	$ 150	$ 13,500	$ 31,000	$ 32,000	$ 75,000	$ 90,000	
Actual Indirect Costs	$ 144,638	$ 641,707	$ 1,908,228	$ 2,445,342	$ 4,095,201	$ 8,582,697	
Potential Indirect Costs	$ 152,638	$ 673,707	$ 2,000,728	$ 2,691,842	$ 4,500,201	$ 9,310,697	
Special Cases	$ -	$ -	$ -	$ -	$ -	$ -	
Total Actual Damages	$ 723,188	$ 3,208,535	$ 9,541,142	$ 12,226,710	$ 20,476,006	$ 42,913,486	$ 42,913,486
Total Potential Damages	$ 763,188	$ 3,368,535	$ 10,003,642	$ 13,459,210	$ 22,501,006	$ 46,553,486	$ 46,553,486

EAD (Actual)	$ 1,610,590
EAD (Potential)	$ 1,703,467

Return to Menu



Return to Menu



Without Project						With Project					
Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
2	10	50	100	500	1000	2	10	50	100	500	1000
758	2,573	7,047	8,911	17,270	19,286	65	280	1,057	1,598	3,377	13,388
71%	44%	44%	42%	43%	43%	100%	87%	63%	54%	40%	25%
18%	34%	33%	34%	33%	33%	0%	8%	23%	28%	36%	44%
11%	22%	23%	24%	24%	24%	0%	5%	14%	18%	24%	31%
538.18	1132.12	3100.68	3742.62	7426.1	8292.98	65	243.6	665.91	862.92	1350.8	3347
136.44	874.82	2325.51	3029.74	5699.1	6364.38	0	22.4	243.11	447.44	1215.72	5890.72
83.38	566.06	1620.81	2138.64	4144.8	4628.64	0	14	147.98	287.64	810.48	4150.28
30	103	282	356	691	771						
30	103	282	356	691	771	3	11	42	64	135	536
2											
4											
6											
8											
4305.44	9056.96	24805.44	29940.96	59408.8	66343.84	520	1948.8	5327.28	6903.36	10806.4	26776
545.76	3499.28	9302.04	12118.96	22796.4	25457.52	0	89.6	972.44	1789.76	4862.88	23562.88
166.76	1132.12	3241.62	4277.28	8289.6	9257.28	0	28	295.96	575.28	1620.96	8300.56
$ 20.00											
$ 86,108.80	$ 181,139.20	$ 496,108.80	$ 598,819.20	$ 1,188,176.00	$ 1,326,876.80	$ 10,400.00	$ 38,976.00	$ 106,545.60	$ 138,067.20	$ 216,128.00	$ 535,520.00
$ 10,915.20	$ 69,985.60	$ 186,040.80	$ 242,379.20	$ 455,928.00	$ 509,150.40	$ -	$ 1,792.00	$ 19,448.80	$ 35,795.20	$ 97,257.60	$ 471,257.60
$ 3,335.20	$ 22,642.40	$ 64,832.40	$ 85,545.60	$ 165,792.00	$ 185,145.60	$ -	$ 560.00	$ 5,919.20	$ 11,505.60	$ 32,419.20	$ 166,011.20
$ 100,359.20	$ 273,767.20	$ 746,982.00	$ 926,744.00	$ 1,809,896.00	$ 2,021,172.80	$ 10,400.00	$ 41,328.00	$ 131,913.60	$ 185,368.00	$ 345,804.80	$ 1,172,788.80
0.1003592	0.2737672	0.746982	0.926744	1.809896	2.0211728	0.0104	0.041328	0.1319136	0.185368	0.3458048	1.1727888

Appendix 8.2: Detailed Dam Removal Cost Estimate

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CHABOT DAM
Construction costs for dam demolition

Description	Quantity	Units	Unit Cost	2014 Cost	Comments
Mobilization, including setting up trailers, etc. (100k for earth contractor, 100k for structural removal contractor	1	LS	$200,000	$200,000	$100k for earthmoving contractor, $100k for structural contractor
Excavate 560,000 CY at dam and downstream channel	560,000	CY	$7	$3,920,000	San Pablo cost, accelerated (=$7/CY)
Haul 560,000 CY of excavated material off site	560,000	CY	$15	$8,400,000	
Demolish Spillway ~7,000 cy of reinforced concrete	7,000	CY	$200	$1,400,000	
Haul and dispose spillway debris off site	7,000	CY	$20	$140,000	
Demolish Tower	1	LS	$300,000	$300,000	WRE/AECOM 1/17/13 estimate to demolish tower
Haul and dispose tower debris off site	1	LS	$30,000	$30,000	Proportional to spillway hauling cost divided by spillway demo cost
Access road improvements	1	LS	$250,000	$250,000	Grading and temporary modifications to haul roads
Final Paving	1	LS	$370,000	$370,000	San Pablo cost, accelerated
Tree Removal	1	LS	$100,000	$100,000	
			subtotal	$15,110,000	
			Overhead and profit (15%)	$2,266,500	
			subtotal with O&P	$17,376,500	
			contingency (30% of subtotal with O&P)	$5,212,950	
			Rounded Total	**$22,600,000**	

Appendix 8.3: EBMUD's Water Supply Management Plan (WSMP) 2040: Component Cost Estimation Evaluations

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Memorandum

Date:	March 21, 2008
To:	EBMUD (Mike Tognolini, Tom Francis)
From:	EDAW Team
Subject:	TECHNICAL MEMORANDUM: WSMP 2040 Component Cost Estimation Evaluations

I. Purpose of Cost Evaluation

Cost is one of several criteria WSMP 2040 is using for screening and evaluating water supply components and portfolios. This memorandum discusses how the cost data was compiled and evaluated to make preliminary cost estimates on a dry year basis for component screening and for constructing portfolios for further evaluation. The cost estimates presented herein are for initial planning purposes only and likely will change in the final evaluation as resources interact within a given portfolio as modeled by the WEAP-EBMUDSIM (W-E) water supply program.

WSMP 2040 will be using the W-E model to assess the relative costs of alternative water supply portfolios. Each portfolio undergoing evaluation is likely to include water supply projects from most or all of the component categories (e.g. conservation, recycled water, and supplemental supply which includes desalination, groundwater banking, surface storage, and transfers), though the weighting or emphasis given to a particular category will vary by portfolio[1]. Using the W-E model to evaluate relative costs of portfolios requires specification of the upfront capital costs, the annual operating, and maintenance costs, the annual water supply yield, and the operating rules and constraints associated with each project included in a portfolio. In order to consistently evaluate components, common costing assumptions and methods were utilized across all supply components.

[1] In WSMP 2040, projects are termed "components", the building blocks of water supply solution portfolios. Additionally, for the purposes of portfolio construction, component classes are conservation, recycled water, supplemental supply, and rationing.

II. Approach to Cost Estimation

The District has, over the years, attempted to compare the estimated costs associated with the various projects and programs being proposed as water supply portfolio options. Through the performance of those earlier efforts, District staff has identified key issues that must be addressed or considered in order to avoid biased or inconsistent cost comparisons. Table 1 details District guidance as given to the project team:

Table 1
District Cost Comparison Guidance

1. Some EBMUD water supply projects and demand management programs only operate during dry years / drought periods. Others operate year-round, independent of hydrologic conditions. Cost estimates prepared to compare projects and programs must take the period of operation into consideration.
   a. Wet year benefits may or may not be an appropriate cost consideration depending on the particular project or program. A sound methodology is needed to illustrate how such a determination is made, and such a methodology must be followed consistently across the range of solutions reviewed.
   b. Customer rationing can occur in times of drought depending on water availability and system storage. Cost estimates prepared must take into account how rationing may be used to limit water use and how system storage may dictate when a particular project or program is put on-line/implemented to augment water supplies.
   c. Some programs aimed to conserve water are more viable during wet years than dry years, depending on the particulars of the water use and the nature of the particular program.
2. Proposed projects or programs that are expected to operate year-round, adding to the baseload supply as needed to meet customer demands, could also result in an offsetting impact on the use of existing Mokelumne River facilities (as would be sourced were there no proposed project or program in place). The financial impact(s) of the offset (i.e. loss of revenue from reduced potable water sales) should be considered.
3. There is a need to evaluate the degree that existing District supplemental supply projects or drought management programs, such as the Freeport Regional Water Project (FRWP), are operationally impacted when and if a future project or program is implemented. Does that operational impact have a cost impact? For example, would a demand reduction program impact the frequency of use of the FRWP, and if so would the fact that the FRWP was used to a lesser degree have an associated cost?

4. Energy costs can be a significant share of the operational expense for several project types. Power cost can escalate at a rate greater than that predicted for inflation or be relatively flat, based on the power demand and supply situation present at that particular time, on political considerations, and a host of other factors. Since it is more problematic to predict, the factor selected for power cost (and power cost escalation over time) is open to argument. If those costs prove to be a deciding factor in cost comparison based decisions, such a fact must be made clear.
5. Some projects and programs have different lifetimes. Cost evaluations must allow such projects and programs to be compared. Further, the District has developed various procedures that are followed internally for estimating lifecycle costs.
6. The District has developed factors that are used internally for estimating the following:
   a. Depreciation rates;
   b. Life Cycle Considerations; and
   c. Equipment / System Life Expectancy.
7. The District has developed contingency factors that are used to adjust the cost estimates as prepared for projects as based on whether they are in the planning stage, the design stage or the construction stage. Consideration must be given to applying the appropriate factor to a particular project or program as based on the development stage that a particular project or program is at (and making sure that that factor is consistently applied regardless of project or program type).

Regarding EBMUD guidance as noted in point numbers 1 through 3 (of Table 1, above), the project team considered this as part of the development of the approach that will be used to compare costs (as detailed in the sections that follow). Further, the cost analysis takes into consideration existing EBMUD practices as detailed in points 4 through 7 when estimating project and program costs.

A. Data Collection, Compilation and Evaluation

WSMP 2040 used the following procedure to compile the project information needed for cost estimation and W-E modeling.

<u>Step 1 – Initial Project Screening</u>: In the first step, the consulting team, working with EBMUD staff, used exclusion and evaluation criteria to screen the initial list of water projects. Any project not meeting one or more exclusion criterion was shelved and removed from the set of projects that will be considered when constructing the portfolios. The remaining projects advanced to the next step.

Step 2 – Compile Project Cost Information: EBMUD staff, working with the consulting team, compiled available information on project costs, yields, and operating rules for the set of projects remaining after Step 1. A guidance memo and data collection form for compiling cost information was developed to assist EBMUD staff and the consulting team in this effort.

Step 3 – Quality Assurance Review: The consulting team iteratively reviewed with EBMUD staff the compiled cost information to ensure that resulting cost estimates were based on consistent costing assumptions and methods. Most projects involved multiple reviews and refinements before they were finalized.

Step 4 – Draft Project Cost Estimates: Once the consulting team had reviewed and reconciled project cost data compiled by EBMUD and consultant staff, draft project cost estimates were prepared. These estimates were provided to appropriate EBMUD staff for their review and comment.

Step 5 – Final Project Cost Estimates: Following review of the draft project cost estimates, the EDAW team incorporated comments and revised project cost estimates as appropriate. Once reviewed by EBMUD staff and finalized, the cost estimates for the components that move forward into the portfolio assembly stage will be imported into the W-E model.

B. Collecting Cost Data

The following information was collected in a manner so as to be as consistent as possible across projects.

On-line Dates: The data represents a realistic estimate of the earliest year in which a project could, taking into account planning, permitting, and construction requirements, become operational.

Project Capacity and Operating Rules: The minimum, maximum, and expected operational capacities for each project (or project phase) were estimated. Information on the expected operation of the project (e.g. baseload or dry-year supply operation), operating rules and system constraints was collected for each project.

Project Capital Costs: Capital cost estimates were developed for each project. Capital costs estimates account for expected expenditures for planning, design, property acquisition, and construction plus contingency. The amount of contingency was a function of the stage of project planning and design and followed existing EBMUD engineering standard practices (ESP) guidelines.

Useful Life of Equipment/Facilities: Useful lives of equipment/facilities were estimated for each project. In cases where useful lives varied significantly by type of structure or equipment, separate useful lives were estimated. EBMUD ESP guidance was used for establishing the useful lives of major equipment and facilities.

Sunk Capital Costs: Only the going-forward costs are relevant to the economic evaluation of alternative portfolios. Therefore, information on any already sunk capital costs was collected for each project and deducted from the capital cost estimate.

Cost Escalation: Project costs were converted to 2007 constant dollars using the ENR construction cost index to ensure consistent dollar cost comparisons across projects.

Project O&M Costs: Annual operating and maintenance (O&M) costs were compiled for each project. O&M costs were differentiated between fixed, variable (excluding energy), and energy O&M. Included in these assessments were costs for labor, chemicals, disposal, and other (i.e. replacement membranes and parts). Variable and energy O&M were expressed in $/million gallons (MG), while fixed O&M was expressed in $/Yr.

Cost Sharing: Project cost sharing information was collected for each project to determine the share of project capital and O&M costs to be paid by EBMUD that would impact water rates.

Yield Sharing: Project yield sharing information was collected for each project to determine EBMUD's share of project yield.

Conservation levels were evaluated as groupings or combinations of conservation measures. Level A consists of natural savings that would occur due to plumbing codes, etc. and consists of 11 different conservation measures. Level B consists of natural savings plus an additional 10 million gallons per day (MGD) of conservation, and consists of 39 conservation measures. Level C is equivalent to the District's current conservation program and consists of 51 different conservation measures; while Level D consists of the District's current program plus an additional 2 MGD of conservation, and consists of 53 conservation measures. Level E is the maximum voluntary program and consists of 58 conservation measures. Technology and implementation barriers, such as customer acceptance, market saturation, and cost, were used in the analysis of the different conservation levels.

C. Calculating Estimated Costs

EDAW team member M.Cubed prepared a prior Technical Memorandum that specified how costs are to be estimated consistently on a unit basis (see *Cost Criteria for EBMUD WSMP 2040 Solutions Component Projects and Programs*, July 25, 2007). This method was applied to the cost estimation process.

The basis for the *preliminary* cost estimates presented here is on a **per dry-year yield basis**. That is, the total present value of the costs are computed over the life of the project and then spread over the expected yields in dry years only. This implies that any water supply benefits that accrue in other water year types (e.g., wet or normal) are valued at zero but the costs are debited against dry-year yields. This is used only here in the preliminary estimates—the W-E modeling will allow for comparisons between portfolios where multi-year benefits may accrue. The inability to capture these types of benefits in this preliminary estimate illustrates the benefits of using a portfolio planning model such as the W-E model.

The project capital costs were amortized over the economic life of the projects, typically 50 to 100 years[2]. The fixed annual O&M costs were added to these costs, which were then were scaled up by the ratio of expected dry years over the planning sequence. For the preliminary costing analysis, the common assumption of 3 dry years in 10 (reflecting the District's Drought Planning Sequence) was used for most projects, including conservation levels (other dry year occurrences were assumed where appropriate based on available information). Variable O&M and energy costs that would be incurred only in dry years were then added to the annualized fixed costs to compute a total cost per acre-foot of dry-year yield. For projects that operate in all years (i.e. the Regional Desalination project at a lower output level), variable O&M and energy costs for non-dry years were also included in the total cost estimate and then spread over the dry years.

Several key common assumptions were used for all projects:

1. Costs were computed on a constant 2007 dollar basis.
2. A constant discount rate (net of inflation) of 3% was used. This was derived from EBMUD's typical cost of debt.
3. Electricity costs were based on PG&E's current utility rate schedules for industrial (large loads) and commercial (small loads) customers. The most recent California Energy Commission forecast for the *2007 Integrated Energy Policy Report* shows that these rates are expected to remain flat in constant dollar terms through 2012.[3]
4. Where project yield is delivered to the Freeport Regional Water Project, conveyance costs to the Mokelumne Aqueduct were included.
5. Conveyance costs through the Aqueduct were ignored for this step of the cost evaluation because they are dependent on system-wide operations, but will be captured in the W-E analysis.

[2] Review of the detailed cost sheets indicated that capital costs were actually amortized over 30 years.
[3] These rates will be varied to include greenhouse gas (GHG) emission costs incurred under AB 32 requirements in the forthcoming "climate change" scenarios.

Preliminary Results of Planning Cost Estimates

Tables 2, 3 and 4, presented below, summarize the dry-year yields and per unit costs for the supplemental supply projects, recycled water projects, and conservation levels, respectively. The results for each of the three component classes are also summarized in the following section.

Supplemental Supply Project Preliminary Dry-Year Unit Costs

The supplemental supply projects generate yields from 1.5 MGD for the Low Energy Application for Desalination (LEAD) desalination project to 51.2 MGD for Enlarging Pardee Reservoir. The cumulative available yield is about 188 MGD, although not all of this is available due to competition for conveyance capacity through Freeport and Mokelumne. The energy use per million gallons (MG) ranges from none for the LEAD project because it relies on waste steam for energy generation, to consumption of 11,000 kilowatt-hours (kWh) in the Regional Desalination project. Ranked on a cost basis, a Northern California Water Transfer is the least expensive at $630 per acre-foot (AF), with four additional projects less than $1,000 per AF. The four other projects cost in excess of $1,200 per AF, with the LEAD Desalination Project being the most expensive at $2,630.

EBMUD may also seek supplemental supply through spot transfer markets in the future to fill temporary supply shortfalls or respond to unanticipated supply emergencies. Due to the supply uncertainty and likely cost volatility of this option, it is not included as a supplemental supply project in Table 2. Information on spot market water transactions occurring between 2000-01 and 2004-05 is included as an attachment to this TM. Planning assumptions for costs of spot market water utilized by two Bay Area water agencies is also reviewed. Because spot water markets in California historically have been thin and because competition for available spot market water is expected to markedly increase over the next several decades, the prices summarized in the attachment should not be viewed as predictive or representative of likely future market conditions.

Recycled Water Project Preliminary Dry-Year Unit Costs

The recycled water projects produce dry-year yields ranging from 0.2 MGD to 2.8 MGD. Energy use per MG ranges from 1,051 KWh to 5,607 KWh. Preliminary dry year unit costs range from $400 per acre-foot to $6,100 per acre-foot. Three projects have preliminary dry year unit costs under $1,500 per acre-foot (COP Phase 2, RARE Phase 2 and RARE Future Expansion). Five projects have preliminary dry year unit costs between $1,500 and $2,000 per acre-foot (SRVRWP Phases 2 through 4, COP Phase 1, and Lake Chabot Raw Water Expansion Project). Five projects have preliminary unit costs between $2,000 and $3,000 per acre-foot (Franklin Canyon, SRVRWP Phases 5 and 6, North Richmond Plant Expansion, and East Bayshore Phase 2). Four projects have preliminary unit costs in excess of $3,000 per acre-foot (East Bayshore Phase 1B, Reliez Valley Recycled Water Project, San Leandro Phase 3, and the Satellite RWTPs).

Dry year unit costs for the four refinery partnerships may ultimately be lower than shown in Table 3 depending on final cost sharing arrangements. The preliminary unit costs are based on existing Memoranda of Understanding (MOUs) between the refineries and EBMUD and assume the following:

- For COP Phase 1, it is assumed that COP will contribute $7 million toward capital costs, operate and maintain the project, and pay the annual O&M costs.
- For COP Phase 2, it is assumed COP will contribute $2.2 million toward capital costs, operate and maintain the project, and pay the annual O&M costs.
- For RARE Phase 2, it is assumed Chevron will pay all capital costs upfront and that EBMUD will operate and maintain the project and pay annual O&M costs. Additionally it was assumed that EBMUD will receive reimbursement for O&M costs incurred from Chevron.
- For RARE Future Expansion, it is assumed Chevron will pay all capital costs upfront and that EBMUD will operate and maintain the project and pay annual O&M costs. Additionally it was assumed that EBMUD will receive reimbursement for O&M costs incurred from Chevron.

The District's Office of Water Recycling has indicated that final arrangements for these projects may result in EBMUD fully recovering capital and O&M costs from the refineries through upfront capital contributions, annual debt service payments, and annual or monthly payments for O&M. However, because such terms have not been finalized for these projects, the more conservative cost assumptions listed above have been used to prepare the preliminary unit cost estimates.

One key assumption used in evaluating the costs associated with recycled water projects is that all recycled water projects are designed to operate as baseload, rather than dry-year supply. Operating the projects as baseload will reduce the project unit costs from what is shown in Table 3 by about 40 to 60 percent, and would also potentially displace use of Mokelumne River water. The extent of this potential displacement will be investigated using the W-E model.

Conservation Preliminary Dry-Year Unit Costs

The proposed conservation levels generate yields ranging from 9.7 MGD for Level B to 20.8 MGD for Level E. Ranked on a cost basis, Level B is the least expensive at $800 per acre-foot (AF) for dry-year yield, with Levels C, D and E costing $3,200/AF, $4,000/AF and $5,100/AF, respectively. Level A was not evaluated as it represents natural savings and therefore will not incur a cost.

The unit costs for conservation in Table 4 differ from previous estimates prepared by the EDAW team in conjunction with the District in two important respects. First, the unit costs originally prepared were computed by dividing the present value of each conservation level's implementation costs by the sum of water savings over the forecast

period. The unit costs in Table 4, as well as in Tables 2 and 3, were computed by dividing the present value of implementation costs by the discounted sum of water savings over the forecast period. The latter method results in a unit cost that fully recovers capital and O&M costs over the planning period, whereas the former approach understates the true unit costs. Second, the unit costs in Table 4 are the average unit cost per AF of water savings for each conservation level, whereas the original estimates show the unit cost of incremental savings achieved by moving from one implementation level to the next. The unit costs in Table 4 do not credit avoided water delivery and wastewater treatment costs against each conservation level's implementation costs. They are therefore gross, rather than net, unit costs.

The conservation levels in Table 4 are designed to operate as baseload, rather than dry-year supply. Operating the projects as baseload will reduce their unit costs from what is shown in Table 4 by about 60 percent, and may also potentially displace use of Mokelumne River water. The extent of this potential displacement will be investigated using the W-E model.

Table 2 - Supplemental Supply Projects Preliminary Dry Year Yield Unit Cost Estimates[a]

Project ID	Project Name	Online Yr	Operation	Dry Year Yield (MGD)	EBMUD Capital Cost (Mil. $)	EBMUD O&M ($/MG)[c]	Total Energy Use KWh/MG[d]	EBMUD Unit Cost ($/AF, Dry Yield)[e]
SUP-25	Northern California Permanent Water Transfer[b]	2010	Permanent	4.5-44.6	$20.0-$200.0	$649	5,217	**$630**
SUP-11	Buckhorn Canyon Reservoir	2015	Storage	42.0	$243.9	$451	3,667	**$710**
SUP-24	Enlarged Pardee Reservoir	2020	Storage	51.2	$340.3	$324	2,021	**$730**
SUP-22	Enlarge Lower Bear Reservoir	2015	Storage	2.2	$12.1	$418	3,038	**$840**
SUP-09	Bayside Phase 2 Groundwater Project	2013	Conjunctive Use	9.0	$35.4	$853	4,719	**$890**
SUP-21	Inter-Regional Conjunctive Use Project (IR-CUP)/San Joaquin (SJ) Groundwater Banking[f]	2014	Conjunctive Use	17.4	$121.1	$1,051	7,919	**$1,210**
SUP-18	Regional Desalination Project	2012	Dry Year	20.0	$72.4	$3,912	11,000	**$1,940**
SUP-07	Groundwater Banking/Exchange (Sacramento Basin)[f]	2014	Conjunctive Use	4.2	$50.1	$1,326	8,895	**$1,940**
SUP-16	LEAD at C&H Sugar	2012	Baseload	1.5	$23.4	$1,945	0	**$2,630**

Notes:
a. Final dry-year yield unit costs will be derived from WEAP modeling. These values will be different than those shown here for comparative purposes.
b. Northern California Permanent Water Transfer costs were based on recent transfers occurring in the State of California. Note that past water prices are no guarantee of how prices may change in the future.
c. O&M costs for adjusted for dry year and recharge year operations depending on the project. O&M costs for idle years are assumed to be 10% of operating year O&M costs.
d. Approximate costs of pumping water through Freeport intake and Mokelumne aqueducts are incorporated into this table for comparative purposes. The expected actual costs will be estimated by the WEAP model.
e. Rounded to nearest $10/AF
f. For groundwater banking projects (IR-CUP/SJ Groundwater Banking, Groundwater Banking/Exchange in Sacramento Basin and the Bayside Phase 2 Groundwater Project), it is estimated that approximately 10% of the water will be lost to migration and delivery system losses. These losses are reflected in this table.

Table 3 – Recycled Water Projects Preliminary Dry Year Yield Unit Cost Estimates

Project ID	Project Name	Online Year	Expected Operation	Dry Year Yield (MGD)	EBMUD Capital Cost (Mil. $)	EBMUD Variable O&M (d) ($/MG)	Variable Energy Use (KWh/MG)	EBMUD Dry Year Unit Cost (e) ($/AF)
REC-01A	ConocoPhillips RWP Phase 2 (a)	2015	Baseload	0.90	$2.9	$-	3,751	$400
REC-07	RARE Future Expansion (b)	2015	Baseload	1.00	$-	$1,221	5,606	$1,300
REC-06	RARE Phase 2	2012	Baseload	0.50	$-	$1,276	5,606	$1,400
REC-10	SRVRWP Phase 2	2010	Baseload	0.75	$5.0	$849	4,265	$1,600
REC-12	SRVRWP Phase 4	2016	Baseload	0.37	$2.5	$849	4,265	$1,600
REC-01	ConocoPhillips RWP Phase 1	2012	Baseload	2.80	$39.8	$-	3,751	$1,700
REC-16	Lake Chabot Raw Water Expansion Project	2010	Baseload	0.36	$4.7	$468	1,051	$1,800
REC-11	SRVRWP Phase 3	2013	Baseload	0.58	$5.5	$849	4,265	$1,900
REC-04	Franklin Canyon Recycled Water Project	2023	Baseload	0.30	$4.0	$712	4,265	$2,100
REC-05	North Richmond Water Reclamation Plant Expansion	2018	Baseload	1.70	$15.4	$1,186	5,607	$2,200
REC-03	East Bayshore Phase 2 (c)	2014	Baseload	0.60	$9.4	$987	2,679	$2,600
REC-13	SRVRWP Phase 5	2018	Baseload	0.30	$5.4	$849	4,265	$2,700
REC-14	SRVRWP Phase 6	2020	Baseload	0.20	$4.0	$849	4,265	$2,900
REC-02	East Bayshore Phase 1B	2012	Baseload	1.20	$28.0	$987	2,679	$3,400
REC-08	Reliez Valley Recycled Water Project	2015	Baseload	0.19	$3.1	$2,807	4,639	$4,700
REC-09	San Leandro Water Reclamation Facility Expansion Project: Phase 3	2015	Baseload	0.56	$16.3	$1,474	2,509	$5,300
REC-15	Satellite Recycled Water Treatment Plant Projects (Retrofits)	2014	Baseload	0.72	$42.5	$574	1,724	$6,100

Notes:
a. Conditional on implementation of COP Phase 1
b. Conditional on implementation of RARE Phase 2.
c. Conditional on implementation of East Bayshore Phase 1B.
d. Gross variable O&M costs. No credit for avoided costs of water delivery in non-dry years.
e. Rounded to nearest $100.
f. EBMUD will operate and maintain the RARE projects, incurring O&M costs. However, Chevron will reimburse the District for the O&M costs incurred via monthly revenue payments.

Table 4 - Conservation Levels Preliminary Dry Year Yield Unit Cost Estimates							
Project ID	**Project Name**	**Online Year**	**Expected Operation**	**Dry Year Yield [a] (MGD)**	**EBMUD Capital Cost ([b] (Mil. $)**	**EBMUD Variable O&M [c] ($/MG)**	**EBMUD Dry Year Unit Cost [d] ($/AF)**
CON-02	Level B	Spans planning period	Baseload	9.7	$31.4	92	$800
CON-03	Level C	Spans planning period	Baseload	17.3	$225.4	432	$3,200
CON-04	Level D	Spans planning period	Baseload	19.4	$319.4	474	$4,000
CON-05	Level E	Spans planning period	Baseload	20.8	$426.0	693	$5,100

Notes:
a. Dry-year yield by 2040. Yields ramp up over the planning period and do not include yield from Level A (plumbing code). Additionally, the yield of Level E is approximately 1 MGD less than the actual goal; however, any differences in cost due to this disparity are covered in contingencies built into the estimate and are within the rounding of the cost estimate.
b. 2010 present value capital cost
c. Gross variable O&M costs. No credit for avoided wastewater treatment costs or avoided costs of water delivery in non-dry years.
d. Rounded to nearest $100.

Attachment 1 – Information on Recent Spot Water Market Transactions

Attachment 1: Information on Recent Spot Water Market Transactions

Spot and Short-term Option Water Transfers

A spot transaction is defined as a transaction in which water is bought and sold for cash and delivered more or less immediately or within a short period of time. With an option contract, the buyer pays for the right to purchase at a later date a specified quantity of water at a specified price within a specified period of time. Short-term options typically specify a purchase period of less than one year. The buyer of an option pays an upfront cost to acquire the option and pays a second price if they decide to exercise the option. If they decide not to exercise the option, they forgo the payment for the option.

Cost Components of Spot and Short-term Option Water Transfers

In addition to the seller's price for water, which includes the price of the option in the case of option contracts, the buyer incurs several other costs to negotiate the transaction and deliver the purchased water to its service area. These other costs along with the seller price determine the buyer's price for the water. Other costs fall into three main categories, as follows:

- Conveyance/Pumping Costs – these are the costs the buyer must incur to physically transport the water to its service area.
- Carriage Losses – these are the water losses that occur during transport of the water from its area of origin to its final destination. They may consist of physical losses dues to leakage and evaporation, as well as regulatory losses for meeting flow requirements. Carriage losses reduce the amount of water delivered and thus raise the unit price of the water to the buyer.
- Administration and Legal Costs – these are the costs the buyer must incur to negotiate, contract, and manage the transaction. Administrative and legal costs can vary substantially by deal and are infrequently tracked and accounted for. Nonetheless, they can be a significant component cost of any water transaction.

To summarize, the following equation defines the buyer's price for spot and short-term option water:

$$\text{Buyer's Price} = \frac{\text{Purchase Cost} + \text{Conveyance/Pumping Cost} + \text{Admin/Legal Cost}}{\text{Purchase Quantity} - \text{Carriage Losses}}$$

Example Spot and Short-term Water Transfers

EWA Seller Prices

In recent years, the Environmental Water Account (EWA) has been the largest buyer of spot water in California. DWR has published data on EWA purchases for FY 2000-01 through FY 2004-05.[4] This data is summarized in Table A1. The unit prices reported in Table A1 should be viewed as the Seller's price, not the buyer's. The quantities reported by DWR do not include losses, including carriage losses across the Delta. The costs only account for payments to sellers and exclude conveyance/pumping and administrative/legal costs. Thus, the prices shown in Table A1 are indicative of what the EWA has had to pay sellers in recent years to acquire water. Over the five years of reported transactions, seller prices upstream of the Delta have averaged about $80/AF with a standard deviation of about $19/AF. South of Delta seller prices have been considerably higher, averaging about $177/AF with a standard deviation of about $41/AF. Upstream of Delta seller prices were close to one standard deviation higher than the average in 2000-01, a dry year on the Sacramento and San Joaquin Rivers; South of Delta seller prices were close to 1.5 standard deviations higher than the average in 2000-01.

Table A1. EWA Seller Prices

Upstream of Delta				
Fiscal Year	**Water Purchased (AF)**	**Costs**	**Nominal $/AF**	**2005 $ $/AF**
2000-01	105,000	$9,125,000	$86.90	$95.39
2001-02	142,143	$10,660,725	$75.00	$80.77
2002-03	69,914	$5,893,550	$84.30	$88.90
2003-04	120,000	$10,460,000	$87.17	$89.83
2004-05	4,600	$200,000	$43.48	$43.48
			Avg.	$79.67
			St. Dev.	$18.69
South of Delta				
Fiscal Year	**Water Purchased (AF)**	**Costs**	**Nominal $/AF**	**2005 $ $/AF**
2000-01	231,034	$51,048,008	$220.95	$242.54
2001-02	97,400	$17,672,730	$181.44	$195.39
2002-03	145,000	$24,490,000	$168.90	$178.12
2003-04	155,000	$17,110,000	$110.39	$113.76
2004-05	98,516	$17,465,360	$177.28	$177.28
			Avg.	$181.42
			St. Dev.	$41.32

[4] http://www.watertransfers.water.ca.gov/water_trans/water_trans_index.cfm

Upstream of Delta, Yuba County Water Agency accounted for 80% of EWA sales reported in Table A1. Placer County Water Agency accounted for 9% of sales. South of Delta, Kern County Water Agency accounted for 60% of EWA sales, CVP water purchases accounted for 12%, and Santa Clara Valley Water District accounted for 10%.

MWD Sacramento Valley Short-term Options

The Metropolitan Water District of Southern California (MWD) negotiated short-term option contracts in 2003 and 2005 with numerous Sacramento Valley water districts. In 2003, MWD negotiated option agreements with 11 districts for a total of 146,230 AF of water. In 2005, it negotiated with three districts purchase options totaling 125,000 AF. Terms of sale were the same in both years, as follows:

Option Price - $10/AF

Call Price - $90/AF (paid only if option exercised)

Third Party Impact Fee - $5/AF (paid only if option exercised)

Critical Year Premium - $25/AF (paid only if option exercised in critically dry year)

Total Seller Price - $105/AF (non-critically dry year); $130/AF (critically dry year).

Administrative and legal costs were not explicitly accounted by MWD. We estimate they were on the order of $2.50 per acre-foot of optioned water[5]. MWD plans for carriage losses of 20% to move the water through the Delta[6]. Thus, MWD's buyer price, net of conveyance/pumping costs, for these transactions would be about $131/AF for a non-critically dry year transfer and about $163/AF for a critically dry year transfer.

Future MWD Purchases

MWD, in conjunction with the State Water Project Contractors Authority, announced its intention to pursue up to 200,000 acre-feet of water for 2008 from the Central Valley through one-year option transfer agreements.[7] MWD staff reports cited an expected seller price of about $120/AF, consistent with its 2003 and 2005 agreements.

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[5] This estimate is based on a personal communication with Steve Hirsch of MWD, 1/9/2008. Mr. Hirsch estimated that negotiating and contracting required 2.5 to 3 full time employee (FTE) positions over six months. Conveyance and payment processing if the options were called would require an additional 0.5 to 1 FTE over six months. Assuming a fully loaded labor cost of $150,000/Yr/FTE

[6] Email correspondence with Steve Hirsch of MWD, 1/9/2008.

[7] http://www.appeal-democrat.com/common/printer/view.php?db=marysville&id=56936

CCWD Water Transfers Analysis

A 2005 water transfer assessment report prepared for CCWD developed three planning cost estimates for spot market water over the next 25 years: (1) a base estimate; (2) a conservative or pessimistic estimate, and (3) an optimistic estimate.[8]

Base Estimate	-	$306/AF delivered
Conservative Estimate	-	$862/AF delivered
Optimistic Estimate	-	$132/AF delivered

Though not entirely clear from the report, these appear to be buyer, not seller, prices, inclusive of conveyance/pumping, carriage, and administrative costs. The base and conservative estimates reflect assumptions about increasing competition for fresh water supply in California over the next several decades.

This report concluded that spot transactions were a fatally flawed long-term supply option, stating that

> *SB 221 and SB 610 require a 20-year water supply be in place for future real estate development projects. For the purposes of long-term planning and reliability, a Spot Market supply will likely not stand up to any litigation that opposes a project based on SB 221 and SB 610.*[9]

SCVWD 2003 IWRP

The 2003 Integrated Water Resources Plan assumed Santa Clara Valley Water District could purchase up to 60,000 AF of water through spot markets at a price of $225/AF[10]. It is unclear from the report whether this is a seller or buyer price. It also assumed it could secure up to 100,000 AF of water through option agreements at a cost of $200/AF. Again it is unclear if this is a seller or buyer price.

Summary of Recent Sales Data and Planning Estimates

Table A2 summarizes spot and short-term option prices from recent transactions and planning studies.

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[8] WDS (2005). "Water Transfer Alternatives Analysis: Project Number 105245." Prepared to Contra Costa Water District, September 2005.

[9] Ibid. Page 7.

[10] Santa Clara Valley Water District (2003). "Integrated Water Resource Planning Study 2003." Appendix 4, Table A4-7.

Table A2.
Summary of Recent Spot/Short-term Option Sales and Planning Estimates

Buyer	Year	Area of Origin	Actual/ Estimate	Price $/AF	Seller or Buyer Price?
EWA	2000/01-2004/05	Upstream of Delta	Actual	$43 - $95	Seller
EWA	2000/01-2004/05	South of Delta	Actual	$114 - $243	Seller
MWD	2003 & 2005	Upstream of Delta	Actual	$105 - $130	Seller
CCWD	2005 – 2030	Upstream of Delta	Estimate	Base: $306 Conservative: $862 Optimistic: $132	Buyer
SCVWD	Next 10 years	Central Valley	Estimate	$200 - $225	Unknown

Potential Upstream of Delta Sellers

Based on recent transactions, possible sellers of spot and short-term option water upstream of the Delta include:

- Yuba County Water Agency
- Placer County Water Agency
- Glenn-Colusa I. D.
- Western Canal W.D.
- Richvale I.D.
- Sacramento Valley Settlement Contractors
- Sacramento Groundwater Authority

Attachment 2 - WSMP 2040 Component Cost Summary

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	Project Type	Partners	Infrastructure Requirements			Capital Costs (2007 $) - *EBMUD Only Share for Partner Projects*	
			Mokelumne Aqueducts	Freeport Pipeline	Treatment Plant(s)	Category	Cost
Enlarge Pardee Reservoir	Upcountry Surface Storage	None	Used for delivery of raw water to the District	No	Water supply can be treated at any treatment plant		
						Planning	$ 24,400,000
						Engineering/Design	$ 24,400,000
						Property	$ 4,090,000
						Construction	$ 239,500,000
						Construction Contingency	$ 47,900,000
						Subtotal - Capital Costs	**$ 340,290,000**
Enlarge Lower Bear	Upcountry Surface Storage	Amador Water Agency (AWA)	Used for delivery of raw water to the District	No	Water supply can be treated at any treatment plant		
		Calaveras County Water District (CCWD)				Planning	$ 1,010,000
		San Joaquin County (SJC)				Engineering/Design	$ 1,010,000
						Property	$ -
						Construction	$ 7,780,000
						Construction Contingency	$ 2,334,000
						Subtotal - Capital Costs	**$ 12,134,000**
Inter-Regional Conjunctive Use Project (IRCUP)/San Joaquin Basin	Central Valley Conjunctive Use	Eastern San Joaquin Groundwater Basin	Used for delivery of raw water to the District and for delivery of recharge water in wet years to the San Joaquin Basin	No	Water supply can be treated at any treatment plant		
		Amador Water Agency (AWA)				Planning	$ 4,200,000
		Calaveras County Water District (CCWD)				Engineering/Design	$ 4,408,000
						Property	$ 250,000
						Construction	$ 24,237,000
						Construction Contingency	$ 7,271,000
						Subtotal - Capital Costs	**$ 40,366,000**
Groundwater Banking/Exchange (Sacramento Basin)	Central Valley Conjunctive Use	Sacramento County Water Agency (SCWA)	Water will be extracted from the Sacramento Basin and transported to the Mok. Aqueduct via the Freeport Pipeline.	Yes - for delivery of recharge water to the Sacramento Basin in wet years and for the extraction or stored water in dry years.	Water supply must be treated at conventional treatment plants		
		Sacramento Groundwater Authority (SGA)				Planning	$ 1,887,000
						Engineering/Design	$ 2,830,000
						Property	$ 375,000
						Construction	$ 15,345,000
						Construction Contingency	$ 4,604,000
						Subtotal - Capital Costs	**$ 25,041,000**
Buckhorn Canyon Reservoir	Terminal System Surface Storage	None	The Mokelumne Aqueducts are required to transport refill water to the reservoir	Not Used	Water supply must be treated at conventional treatment plants, most likely at Sobrante or USL WTP		
						Planning	$ 10,400,000
						Engineering/Design	$ 15,590,000
						Property	$ -
						Construction	$ 189,520,000
						Construction Contingency	$ 28,428,000
						Subtotal - Capital Costs	**$ 243,938,000**
Bayside Groundwater Project - Phase 2	Terminal System Conjunctive Use	None	Used for delivery of recharge water	Not Used	Treated water will be injected into the ground and then re-treated upon extraction. Re-treatment will be conducted on-site at a new treatment facility		
						Planning	$ 2,856,000
						Engineering/Design	$ 4,284,000
						Property	$ 1,500,000
						Construction	$ 22,300,000
						Construction Contingency	$ 4,460,000
						Subtotal - Capital Costs	**$ 35,400,000**

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	Project Type	Partners	Infrastructure Requirements			Capital Costs (2007 $) - *EBMUD Only Share for Partner Projects*	
			Mokelumne Aqueducts	Freeport Pipeline	Treatment Plant(s)	Category	Cost
Bay Area Regional Desalination Project	Regional Desalination	Contra Costa Water District (CCWD) San Francisco Public Utility Commission Santa Clara Valley Water District (SCVWD)	Used for delivery of desalinated water to the District. A new pipeline will tie into the Mok. Aqueducts between the Delta and the Walnut Creek Pump Station	Not Used	Desalinated water can be treated at any WTP		
						Planning	$ 4,170,000
						Engineering/Design	$ 4,170,000
						Property	$ 340,000
						Construction	$ 56,540,000
						Construction Contingency	$ 14,135,000
						Subtotal - Capital Costs	**$ 79,355,000**
AG-Urban Water Transfers	Water Transfer		Raw water will be diverted from the Sacramento River and transported to the District via the Freeport and Mokelumne Aqueducts	Yes - raw water will be diverted from the Sacramento River and transported to the District via the Freeport and Mokelumne Aqueducts	Water supply must be treated at conventional treatment plants		
						Planning	
						Engineering/Design	
						Site Preparation	
						Construction	
						Construction Contingency	
						Subtotal - Capital Costs	**$ -**
Low Energy Application for Desalination (LEAD) at C&H Sugar	Low energy desalination for industrial use	C&H Sugar	N/A (potable water offsets)	N/A (potable water offsets)	N/A (potable water offsets)		
						Planning	$ 1,490,000
						Engineering/Design	$ 2,980,000
						Site Preparation	
						Construction	$ 15,990,000
						Construction Contingency	$ 2,974,000
						Subtotal - Capital Costs	**$ 23,434,000**

Notes:
1. A negative operational cost means the project will produce incremental income for the District (such as that created by increased hydroelectric generation) .
2. The definition of "Wet", "Dry" and "Idle" year classifications are generic terms used here to differentiate project operations under various hydrologic conditions. The criteria used to define these conditions may be different for each project and do not necessarily
3. A negative water delivery means that water is captured or stored (e.g. for conjunctive use) but no water is delivered to customers. For projects that have "wet year" variable O&M or energy costs, the variable cost is multiplied by the negative water delivery.
4. Relative Priority is the priority given to each project within a given portfolio. Projects are ranked according to their dry year cost and their ability to be turned on and off. Projects that must operated every year (such as Raise Pardee) are given a high priority, regardless of their $/AF cost. These projects will be utilized first in a given portfolio and, depending on drought severity, are followed by other projects that can be toggled.

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	WET YEAR O&M Costs[1] in 2007 $- *EBMUD Only Share for Partner Projects*					
	WET YEAR[2] Operating Rules, Capacities, and Constraints	WET YEAR Annual Water Deliveries[3] (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)	Fixed O&M ($/YR)
Enlarge Pardee Reservoir	Technically this project operates in wet years, but there is no yield in wet years.	0.0	0	-19,000,000	$ -	$ -
				Project will increase Pardee Powerhouse average annual energy production from 83 GWh/yr to 102 GWh/yr.		
Enlarge Lower Bear	This project will not supply water in wet or normal years.	0.0	0	0	$ -	$ 55,000.00
						EBMUD's Portion of General O&M
Inter-Regional Conjunctive Use Project (IRCUP)/San Joaquin Basin	It is assumed that as much as 8.3 TAF of Mokelumne water will be recharged in wet and normal years (a total of 25 TAF will be recharged, but only 1/3 will belong to EBMUD). Recharge water will not come from EBMUD's Mokelumne water right, but instead from the rights of upcountry participants. Therefore, recharge water is not drafted from Pardee and not accounted for in EBMUDSIM. As a way to define "wet" years, recharge water is assumed available when EBMUD's EOS TSS without supplemental supplies is above 575 TAF.	-8.3	0	0	$8.33	$437,000
			Recharge occurs via recharge ponds so energy is negligible		Recharge pond O&M	General O&M of infrastructure + well replacement at 30 yrs
Groundwater Banking/Exchange (Sacramento Basin)	As much as 3.5 TAF of water is recharged during "wet" years and "above normal" years (a total of 7.0 TAF will be recharged, but only 1/2 will belong to EBMUD). Wet and Normal years are defined as those years when CVP contracts are allowed their full entitlements. The project will not operate in "below normal years".	-3.5	355	0	$ 20.00	$187,625.00
			Energy Required to diver water at Freeport and transport to recharge ponds		Recharge pond O&M and diversion costs.	General O&M of infrastructure + well replacement at 30 yrs
Buckhorn Canyon Reservoir	The project will not supply customer demands in wet or normal years, but will be refilled in these years depending on Mokelumne water availability. In the W-E model, refill water is assumed available when EOS TSS is above 550 TAF without utilizing any supplemental supplies. Once the reservoir reaches it maximum capacity of 143 TAF, refilling stops. All refill water is "drafted" from Pardee and accounted for in EBMUDSIM's TSS calculations.	-20.4	205		$ 2.28	$ 312,500.00
			Energy required to refill the reservoir		Dechlorination costs /AF of replenishment water	General O&M of the dam facilities
Bayside Groundwater Project - Phase 2	It is assumed that as much as 7,560 AFY of Mokelumne water will be injected in wet years. As a way to define "wet" years, recharge water is assumed available when EOS TSS without supplemental supplies is above 575 TAF. Refill water is not drafted from Pardee and is not accounted for in EBMUDSIM	-7.6	0	0	$ 8.40	$ 571,100.00
					Includes ASR well Maintenance	General O&M of infrastructure pipelines and ASR wells + well replacement at 30 yrs

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	WET YEAR O&M Costs[1] in 2007 $- *EBMUD Only Share for Partner Projects*					
	WET YEAR[2] Operating Rules, Capacities, and Constraints	WET YEAR Annual Water Deliveries[3] (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)	Fixed O&M ($/YR)
Bay Area Regional Desalination Project	The project will not produce significant water for EBMUD in non-dry years, however, some production is necessary to ensure the integrity of the RO membranes. Wet and normal year water production was ignored in the W-E model.	4.5	2,443	0	$ 318	$ 496,000.00
			Treatment Energy for minimum flow		Includes membrane replacement & other O&M that fluctuates with product water volume	Includes fixed labor and O&M costs
AG-Urban Water Transfers	No transfers in wet years.	0.0	0	0	$ -	$ -
Low Energy Application for Desalination (LEAD) at C&H Sugar	This project will be a baseload supply and will offset demand in all years. The plant will produce and supply an average annual production in all (wet, normal, and dry) years of 1.2 TAF.	1.2	0	0	$ 134	$ 312,000.00
			Driven by C&H turbine waste heat		Chemical treatment costs	Fixed O&M for infrastructure and membranes

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	DRY YEAR O&M Costs[1] in 2007 $ -- *EBMUD Only Share for Partner Projects*					
	DRY YEAR[2] Operating Rules, Capacities, and Constraints	DRY YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)	Fixed O&M ($/YR)
Enlarge Pardee Reservoir	The project will provide approximately 57 TAF in dry years, but no more than the amount of additional storage provided by the project over the course of a sustained drought. Actual water availability is determined by the EBMUDSIM operations model.	57.0	0	-19,000,000	$ -	$ -
				Project will increase Pardee Powerhouse average annual energy production from 83 GWh/yr to 102 GWh/yr -- assume $87/MWH wholesale price.		
Enlarge Lower Bear	This project will augment the District's Mokelumne water supply by providing 2,500 AF (2.2 MGD) in dry years. This project is triggered when EOS TSS falls below 500 TAF without any supplemental supplies.	2.5	0	0	$ -	$ 55,000.00
						EBMUD's Portion of General O&M
Inter-Regional Conjunctive Use Project (IRCUP)/San Joaquin Basin	As much as 19,500 AFY will be extracted for EBMUD's use in dry years, depending on stored water availability. Water is extracted when EOS TSS with higher priority supplemental supplies is below 500 TAF	19.5	1,446	0	$ 9.00	$679,100.00
			Energy to pump EBMUD's portion of the water and transport to the Mok. Aqueducts		For GAC treatment	General O&M of infrastructure (more O&M in extraction years)
Groundwater Banking/Exchange (Sacramento Basin)	The District will receive up to 4,667 AF of water during dry years, depending on stored water availability. Water is extracted when EOS TSS with higher priority supplemental supplies is below 500 TAF	4.7	1,800	0	$ 9.00	$285,625.00
			Energy to pump EBMUD's portion of the water and transport to the FRWP		For GAC treatment	General O&M of infrastructure (more O&M in extraction years) + well replacement at 30 yrs
Buckhorn Canyon Reservoir	The project will provide 47 TAF in each dry year until available storage is depleted (143 TAF). Water is extracted when EOS TSS with higher priority supplemental supplies is below 500 TAF.	47.0	0	0	$ -	$ 312,500.00
						General O&M of the dam facilities
Bayside Groundwater Project - Phase 2	Up to 10,080 AFY will be extracted in dry years, depending on stored water availability. Water is extracted when EOS TSS with higher priority supplemental supplies is below 500 TAF	10.1	498	0	$ 44.00	$ 1,039,116.00
			Extraction and treatment energy		Includes ASR well maintenance (more intensive in extraction years) & chemical and disposal costs	Includes pipeline, pump station O&M and operation of the treatment facility + well replacement at 30 yrs

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	DRY YEAR O&M Costs[1] in 2007 $ -- *EBMUD Only Share for Partner Projects*					
	DRY YEAR[2] Operating Rules, Capacities, and Constraints	DRY YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)	Fixed O&M ($/YR)
Bay Area Regional Desalination Project	EBMUD's share of the project will allow it to produce up to 20 MGD in dry years. The project is triggered when EOS TSS with higher priority supplemental supplies is below 500 TAF	22.4	2,443	0	$ 318	$ 1,555,800.00
			Treatment Energy		Includes membrane replacement & other O&M that fluctuates with product water volume	Includes fixed labor and O&M costs plus contract labor to maintain/run the facility in dry years
AG-Urban Water Transfers	EBMUD can transfer up to 50 TAF in a given dry year. The project is triggered when EOS TSS with higher priority supplemental supplies is below 500 TAF	50.0	0	0	$ -	$ -
			Water will be pulled out of the Sacramento River via Freeport - include FRWP Energy		Water will be pulled out of the Sacramento River via Freeport - includes FRWP variable costs	Water will be pulled out of the Sacramento River via Freeport - include FRWP fixed costs
Low Energy Application for Desalination (LEAD) at C&H Sugar	This project will be baseload supply and will offset demand in all years. The plant will produce and supply an average annual production in all (wet, normal, and dry) years of 1.2 TAF.	1.2	0	0	$ 134	$ 312,000.00
			Driven by C&H turbine waste heat		Chemical treatment costs	Fixed O&M for infrastructure and membranes

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	IDLE YEAR[2] O&M Costs in 2007 $- *EBMUD Only Share for Partner Projects*		Key Modeling Assumptions
	IDLE YEAR Operating Rules, Capacities, and Constraints	Fixed O&M ($/YR)	
Enlarge Pardee Reservoir	No idle years.		All calculations regarding the Enlarge Pardee Reservoir Project are conducted in EBMUDSIM and passed to WEAP.
Enlarge Lower Bear	No idle years.		
Inter-Regional Conjunctive Use Project (IRCUP)/San Joaquin Basin	The project will be idle when water is neither being extracted or injected	$361,700 For idle years, assume continuation of the annual monitoring program and 10% of all other O&M costs	In future model runs, a 10% aquifer loss will be assumed
Groundwater Banking/Exchange (Sacramento Basin)	The project will be idle when water is neither being extracted or injected	$141,063 For idle years, assume continuation of the annual monitoring program and 10% of all other O&M costs	In future model runs, a 10% aquifer loss will be assumed
Buckhorn Canyon Reservoir	Except under emergency circumstances (such as a failure of the Mokelumne Aqueducts) or for improved operation of the EBMUD system, the Project will be idle in wet and normal years (when EOS TSS is between 500 and 550 TAF) or when the reservoir has been filled to its maximum capacity.	$ 312,500.00 General O&M of the dam facilities	
Bayside Groundwater Project - Phase 2	The project will be idle when water is neither being extracted or injected	$ 571,100.00 General O&M of infrastructure pipelines and ASR wells + well replacement at 30 yrs	In future model runs, a 10% aquifer loss will be assumed

WSMP 2040
Summary of Project Cost Estimate
Supplemental Supply Projects

Project Name	IDLE YEAR[2] O&M Costs in 2007 $- *EBMUD Only Share for Partner Projects*		Key Modeling Assumptions
	IDLE YEAR Operating Rules, Capacities, and Constraints	Fixed O&M ($/YR)	
Bay Area Regional Desalination Project	No idle years. The project must produce a minor amount of water even in wet and normal years.		
AG-Urban Water Transfers	There are no O&M costs when the project is idle.		
Low Energy Application for Desalination (LEAD) at C&H Sugar	No idle years.		

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	Project Type	Partners	Capital Costs (2007 $) - *EBMUD Only Share for Partner Projects*	
			Category	**Cost**
San Ramon Valley Recycled Water Program - Phase 2 Bishop Ranch	Recycling (irrigation only)	Dublin San Ramon Services District (DSRSD)		
			Planning	$ 207,000
			Engineering/Design	$ 305,000
			Property	$ -
			Construction	$ 4,479,000
			Construction Contingency (0%)	$ -
			Subtotal - Capital Costs	**$ 4,991,000**
San Ramon Valley Recycled Water Program - Phase 3 Danville East	Recycling (irrigation only)	Dublin San Ramon Services District (DSRSD)		
			Planning	$ 152,000
			Engineering/Design	$ 461,000
			Property	$ -
			Construction	$ 4,841,000
			Construction Contingency (0%)	$ -
			Subtotal - Capital Costs	**$ 5,454,000**
San Ramon Valley Recycled Water Program - Phase 4 Blackhawk East	Recycling (irrigation only)	Dublin San Ramon Services District (DSRSD)		
			Planning	$ 118,000
			Engineering/Design	$ 211,000
			Property	$ 76,000
			Construction	$ 2,120,000
			Construction Contingency (0%)	$ -
			Subtotal - Capital Costs	**$ 2,525,000**
San Ramon Valley Recycled Water Program - Phase 5 Blackhawk West	Recycling (irrigation only)	Dublin San Ramon Services District (DSRSD)		
			Planning	$ 178,000
			Engineering/Design	$ 444,000
			Property	$ 200,000
			Construction	$ 3,550,000
			Construction Contingency (30%)	$ 1,065,000
			Subtotal - Capital Costs	**$ 5,437,000**
San Ramon Valley Recycled Water Program - Phase 6 Danville West	Recycling (irrigation only)	Dublin San Ramon Services District (DSRSD)		
			Planning	$ 130,000
			Engineering/Design	$ 324,000
			Property	$ 200,000
			Construction	$ 2,591,000
			Construction Contingency (30%)	$ 777,000
			Subtotal - Capital Costs	**$ 4,022,000**
East Bayshore Recycled Water Project - Phase 1B Alameda	Recycling (irrigation only)			
			Planning	$ 518,000
			Engineering/Design	$ 3,111,000
			Property	$ -
			Construction	$ 20,739,000
			Construction Contingency (20%)	$ 4,147,800
			Subtotal - Capital Costs	**$ 27,997,800**

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	Project Type	Partners	Capital Costs (2007 $) - *EBMUD Only Share for Partner Projects*	
			Category	**Cost**
East Bayshore Recycled Water Project - Phase 2 Future Expansion	Recycling (irrigation and commercial)			
			Planning	$ 171,000
			Engineering/Design	$ 1,023,000
			Property	$ 205,000
			Construction	$ 6,822,000
			Construction Contingency (20%)	$ 1,364,400
			Subtotal - Capital Costs	**$ 9,414,400**
San Leandro Water Reclamation Facility Expansion Project - Phase 3 Oakland/Alameda	Recycling (irrigation)			
			Planning	$ 787,000
			Engineering/Design	$ 787,000
			Property	$ 315,000
			Construction	$ 11,500,000
			Construction Contingency (25%)	$ 2,875,000
			Subtotal - Capital Costs	**$ 16,264,000**
Richmond Advanced Recycled Expansion (RARE) Water Project - Phase 2 Additional 0.5 mgd	Recycling (industrial use)	ChevronTexaco Richmond Refinery		
			Planning	$ -
			Engineering/Design	$ -
			Property	$ -
			Construction	$ -
			Construction Contingency (20%)	$ -
			Subtotal - Capital Costs	**$ -**
Richmond Advanced Recycled Expansion (RARE) Water Project - Future Expansion (Expansion from 4.0 to 5.0 mgd)	Recycling (industrial use)	ChevronTexaco Richmond Refinery		
			Planning	$ -
			Engineering/Design	$ -
			Property	$ -
			Construction	$ -
			Construction Contingency (30%)	$ -
			Subtotal - Capital Costs	**$ -**
North Richmond Water Reclamation Plant Expansion Project - Surrounding Area	Potable Water Offset	ChevronTexaco Richmond Refinery		
			Planning	$ 500,000
			Engineering/Design	$ 1,537,000
			Property	$ -
			Construction	$ 10,246,000
			Construction Contingency (30%)	$ 3,073,800
			Subtotal - Capital Costs	**$ 15,356,800**
ConocoPhillips Recycled Water Project, Phase 1	Recycling (industrial use)	ConocoPhillips Refinery (COP)		
			Planning	$ 500,000
			Engineering/Design	$ 2,747,000
			Property	$ -
			Construction	$ 36,622,000
			Construction Contingency (20%)	$ 7,324,400
			Subtotal - Capital Costs	**$ 40,058,400**

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	Project Type	Partners	Capital Costs (2007 $) - *EBMUD Only Share for Partner Projects*	
			Category	**Cost**
ConocoPhillips Recycled Water Project, Phase 2	Recycling (industrial use)	ConocoPhillips Refinery (COP)		
			Planning	$ 177,000
			Engineering/Design	$ 353,000
			Property	$ -
			Construction	$ 3,531,000
			Construction Contingency (30%)	$ 1,059,300
			Subtotal - Capital Costs	**$ 2,920,300**
Franklin Canyon Recycled Water Project	Recycling (irrigation and industrial use)	ConocoPhillips Refinery (COP)		
			Planning	$ 98,000
			Engineering/Design	$ 314,000
			Property	$ -
			Construction	$ 2,765,000
			Construction Contingency (30%)	$ 829,500
			Subtotal - Capital Costs	**$ 4,006,500**
Reliez Valley Recycled Water Project	Potable Water Offset (irrigation)	Central Contra Costa Sanitation District (CCCSD)		
			Planning	$ 106,000
			Engineering/Design	$ 266,000
			Property	$ -
			Construction	$ 2,126,000
			Construction Contingency (30%)	$ 637,800
			Subtotal - Capital Costs	**$ 3,135,800**
Satellite Recycled Water Projects (Retrofits)	Potable Water Offset			
			Planning	$ 820,000
			Engineering/Design	$ 1,920,000
			Property	$ 3,750,000
			Construction	$ 25,740,000
			Construction Contingency (40%)	$ 10,296,000
			Subtotal - Capital Costs	**$ 42,526,000**
Lake Chabot Raw Water Expansion Project	Potable Water Offset			
			Planning	$ 200,000
			Engineering/Design	$ 200,000
			Property	$ -
			Construction	$ 3,331,000
			Construction Contingency (30%)	$ 999,300
			Subtotal - Capital Costs	**$ 4,730,300**

Notes:
1. Variable O&M costs are exclusive of energy costs.

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	WET YEAR O&M Costs in 2007 $- *EBMUD Only Share for Partner Projects*					
	WET YEAR Operating Rules, Capacities, and Constraints	WET YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)[1]	Fixed O&M ($/YR)
San Ramon Valley Recycled Water Program - Phase 2 Bishop Ranch	N/A - Baseload Supply	0.84	1,390	0	$92.00	$0
San Ramon Valley Recycled Water Program - Phase 3 Danville East	N/A - Baseload Supply	0.65	1,390	0	$92.00	$0
San Ramon Valley Recycled Water Program - Phase 4 Blackhawk East	N/A - Baseload Supply	0.41	1,390	0	$92.00	$0
San Ramon Valley Recycled Water Program - Phase 5 Blackhawk West	N/A - Baseload Supply	0.34	1,390	0	$92.00	$0
San Ramon Valley Recycled Water Program - Phase 6 Danville West	N/A - Baseload Supply	0.22	1,390	0	$92.00	$0
East Bayshore Recycled Water Project - Phase 1B Alameda	N/A - Baseload Supply	1.34	870	0	$188.20	$0

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	WET YEAR O&M Costs in 2007 $- *EBMUD Only Share for Partner Projects*					
	WET YEAR Operating Rules, Capacities, and Constraints	WET YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)[1]	Fixed O&M ($/YR)
East Bayshore Recycled Water Project - Phase 2 Future Expansion	N/A - Baseload Supply	0.67	870	0	$188.20	$0
San Leandro Water Reclamation Facility Expansion Project - Phase 3 Oakland/Alameda	N/A - Baseload Supply	0.63	820	0	$355.30	$0
Richmond Advanced Recycled Expansion (RARE) Water Project - Phase 2 Additional 0.5 mgd	N/A - Baseload Supply	0.56	1,830	0	$205.70	$0
Richmond Advanced Recycled Expansion (RARE) Water Project - Future Expansion (Expansion from 4.0 to 5.0 mgd)	N/A - Baseload Supply	1.12	1,830	0	$187.90	$0
North Richmond Water Reclamation Plant Expansion Project - Surrounding Area	N/A - Baseload Supply	1.90	1,830	0	$176.30	$0
ConocoPhillips Recycled Water Project, Phase 1	N/A - Baseload Supply	3.14	1,220	0	$0.00	$0

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	WET YEAR O&M Costs in 2007 $- *EBMUD Only Share for Partner Projects*					
	WET YEAR Operating Rules, Capacities, and Constraints	WET YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)[1]	Fixed O&M ($/YR)
ConocoPhillips Recycled Water Project, Phase 2	N/A - Baseload Supply	1.01	1,220	0	$0.00	$0
Franklin Canyon Recycled Water Project	N/A - Baseload Supply	0.34	1,390	0	$47.60	$0
Reliez Valley Recycled Water Project	N/A - Baseload Supply	0.21	1,510	0	$683.40	$0
Satellite Recycled Water Projects (Retrofits)	N/A - Baseload Supply	0.80 - mid-point of yield range, assuming **five** satellite projects are constructed.	560	0	$101.50	$20,000
Lake Chabot Raw Water Expansion Project	N/A - Baseload Supply	0.40	340	0	$100.00	$0

Notes:
1. Variable O&M costs are exclusive of energy costs.

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	DRY YEAR O&M Costs in 2007 $ -- *EBMUD Only Share for Partner Projects*						Key O&M Assumptions
	DRY YEAR Operating Rules, Capacities, and Constraints	DRY YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)[1]	Fixed O&M ($/YR)	
San Ramon Valley Recycled Water Program - Phase 2 Bishop Ranch	N/A	0.84	1,390	0	$92.00	$0	Estimated O&M costs based on actual O&M costs from the San Ramon Valley Reycled Water Program - Phase 1 (2006-2007 data). Annual O&M costs are split with DSRSD and are based on the volume of RW delivered to each agency; this percentage varies. No new labor is required.
San Ramon Valley Recycled Water Program - Phase 3 Danville East	N/A	0.65	1,390	0	$92.00	$0	Estimated O&M costs based on actual O&M costs from the San Ramon Valley Reycled Water Program - Phase 1 (2006-2007 data). Annual O&M costs are split with DSRSD and are based on the volume of RW delivered to each agency; this percentage varies. No new labor is required.
San Ramon Valley Recycled Water Program - Phase 4 Blackhawk East	N/A	0.41	1,390	0	$92.00	$0	Estimated O&M costs based on actual O&M costs from the San Ramon Valley Reycled Water Program - Phase 1 (2006-2007 data). Annual O&M costs are split with DSRSD and are based on the volume of RW delivered to each agency; this percentage varies. No new labor is required.
San Ramon Valley Recycled Water Program - Phase 5 Blackhawk West	N/A	0.34	1,390	0	$92.00	$0	EBMUD will pay 100% of O&M costs. Estimated O&M costs were based on actual O&M costs from San Ramon Valley Recycled Water Program - Phase 1 (2006-2007 data). No new labor is required.
San Ramon Valley Recycled Water Program - Phase 6 Danville West	N/A	0.22	1,390	0	$92.00	$0	EBMUD will pay 100% of O&M costs. Estimated O&M costs were based on actual O&M costs from San Ramon Valley Recycled Water Program - Phase 1 (2006-2007 data). No new labor is required.
East Bayshore Recycled Water Project - Phase 1B Alameda	N/A	1.34	870	0	$188.20	$0	EBMUD will pay 100% of O&M costs. Average annual production takes into account max/min usage for irrigation users (high in summer/low in winter). Industrial users have steady usage year-round.

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	DRY YEAR O&M Costs in 2007 $ -- *EBMUD Only Share for Partner Projects*						Key O&M Assumptions
	DRY YEAR Operating Rules, Capacities, and Constraints	DRY YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)[1]	Fixed O&M ($/YR)	
East Bayshore Recycled Water Project - Phase 2 Future Expansion	N/A	0.67	870	0	$188.20	$0	EBMUD will pay 100% of O&M costs. Average annual production takes into account max/min usage for irrigation users (high in summer/low in winter). Industrial users have steady usage year-round.
San Leandro Water Reclamation Facility Expansion Project - Phase 3 Oakland/Alameda	N/A	0.63	820	0	$355.30	$0	Only 498 AFY (54%) of the total 962 AFY demand to areas North of the SLWPCP will be new deliveries. Therefore, capital and O&M costs associated with providing tertiary treated water to existing customers is not included, and where appropriate, costs have been reduced by 46% to estimate costs associated with new potable water offsets.
Richmond Advanced Recycled Expansion (RARE) Water Project - Phase 2 Additional 0.5 mgd	N/A	0.56	1,830	0	$205.70	$0	Construction cost estimate (capital cost) includes $250,000 for increase in WCWD sewer connection fee. Cost of high purity recycled water for Chevron will be set to recover 100% of EBMUD's capital cost (debt service or 100% Chevron funding). EBMUD will pay for O&M costs; Chevron will reimburse O&M expenses.
Richmond Advanced Recycled Expansion (RARE) Water Project - Future Expansion (Expansion from 4.0 to 5.0 mgd)	N/A	1.12	1,830	0	$187.90	$0	Construction cost estimate (capital cost) includes $250,000 for increase in WCWD sewer connection fee. Cost of high purity recycled water for Chevron will be set to recover 100% of EBMUD's capital cost (debt service or 100% Chevron funding). EBMUD will pay for O&M costs; Chevron will reimburse O&M expenses.
North Richmond Water Reclamation Plant Expansion Project - Surrounding Area	N/A	1.90	1,830	0	$176.30	$0	EBMUD will pay 100% of capital and O&M costs. Assumes pumping from plant will not be required.
ConocoPhillips Recycled Water Project, Phase 1	N/A	3.14	1,220	0	$0.00	$0	ConocoPhillips will pay $7 million toward capital costs. $135,000 of capital costs has been expended. (The sunk costs and COP contribution have already been deducted from the capital cost subtotal). ConocoPhillips will pay 100% of O&M costs; EBMUD will reimburse O&M expenses.

WSMP 2040
Summary of Project Cost Estimate
Recycled Water Projects

Project Name	DRY YEAR O&M Costs in 2007 $ -- *EBMUD Only Share for Partner Projects*						Key O&M Assumptions
	DRY YEAR Operating Rules, Capacities, and Constraints	DRY YEAR Annual Water Deliveries (TAF/YR)	Energy (KWh/AF)	Energy (KWh/YR)	Variable O&M ($/AF)[1]	Fixed O&M ($/YR)	
ConocoPhillips Recycled Water Project, Phase 2	N/A	1.01	1,220	0	$0.00	$0	ConocoPhillips will pay $2.2 million toward capital costs (this value has already been deducted from the capital cost subtotal). ConocoPhillips will pay 100% of capital and O&M costs; EBMUD will reimburse O&M expenses.
Franklin Canyon Recycled Water Project	N/A	0.34	1,390	0	$47.60	$0	EBMUD will cover 50% of capital costs and 100% of O&M costs. One day per week of labor required (one full-time employee costs $80,000/year, 5 days a week, 50 weeks/year; therefore 1 day/week will cost $16,000/year.
Reliez Valley Recycled Water Project	N/A	0.21	1,510	0	$683.40	$0	EBMUD will pay 100% of O&M costs. Annual energy costs based on 15.3 cents/kwh, pumping 10 hours per day. Other O&M costs based on 3% of construction subtotal plus the purchase of RW from CCCSD at $130/AF.
Satellite Recycled Water Projects (Retrofits)	N/A	0.80 - mid-point of yield range, assuming five satellite projects are constructed.	560	0	$101.50	$20,000	EBMUD will pay 100% of O&M costs. Ultraviolet (UV) disinfection with residual chlorination used. Sludge is returned to wastewater flows for processing at main plant. Membranes replaced every 10 years. Annual fixed O&M set to 1/10 of membrane replacement cost. Labor costs absorbed by existing staff. Other O&M costs include materials, supplies, UV bulb replacement.
Lake Chabot Raw Water Expansion Project	N/A	0.40	340	0	$100.00	$0	EBMUD will pay 100% of O&M costs. O&M and energy estimates are incremental (i.e. they are in addition to and do not include existing costs.) Labor costs estimated from San Leandro Recycled Water Expansion by EBMUD - assumes labor is ~$400/AF of RW produced and delivered.

Notes:
1. Variable O&M costs are exclusive of energy costs.

Attachment 3 - WSMP 2040 Component Descriptions

Project: Bay Area Regional Desalination Project

District Contact: Hasan Abdullah

Status: Conceptual/Planning

First Year of Operation: 2012 (if approved)

Type of Project: Desalination

Project Overview

The Bay Area's four largest water agencies, EBMUD, CCWD, SFPUC and SCVWD, are jointly exploring the development of regional desalination facilities that would benefit over 5.4 million Bay Area residents and businesses served by these agencies. The Bay Area Regional Desalination Project could consist of one or more desalination facilities, with an ultimate total capacity of up to 71 million gallons per day (MGD). An interagency agreement will be approved by the regional partners prior to the initiation of pilot testing work or future phases of the project.

A feasibility study completed in June of 2007 identified the East Contra Costa site as the most ideal and conceivable project location. A desalination plant constructed at this site would be near the EBMUD Mokelumne Aqueducts, the CCWD Contra Costa Canal, and CCWD's Multipurpose Pipeline (MPP). At the East Contra Costa site, water would be desalinated using one-pass or two-pass reverse osmosis (RO).The desalinated water would be transported to the Mokelumne Aqueducts via a pump station and a 3-mile-long, 4-foot-diameter pipeline. Water distributed through the Mokelumne Aqueducts would undergo downstream treatment.

Capacity Information

Dry Year Production:	71 MGD (20 MGD to EBMUD). EBMUD will get about 28% of production yield in dry years.
Wet/Normal Year Production:	4 MGD. An offline desalination plant must sustain a reduced flow to maintain the integrity of the RO membranes. For that reason, the wet year production was estimated to be 20 percent of dry year operations[1].
Production depends on (Water Source):	San Francisco Bay
Project will be operated:	Intermittently as a dry-year supplemental supply, when the District's total reservoir storage falls below 65%. In these years the District will get 20 MGD. The W-E model will be used to determine when and how often that happens.

[1] Bay Area Regional Desalination Feasibility Study. June, 2007.

Opportunities and Challenges Summary

Opportunities

- Regional desalination would meet EBMUD's dry year water supply needs. It would also provide an alternative source of water to EBMUD's existing Pardee Reservoir supplies.
- This project could also be used during emergencies and to allow for maintenance or repairs of other major facilities.
- By reducing dependence on water from Pardee Reservoir, delivered to the District through the San-Francisco Bay Delta via the Mokelumne Aqueducts, this project will also help mitigate EBMUD's susceptibility to seismic and flood risks in the Delta.

Challenges

- Construction and operation of a water intake structure in the Bay could result in some potential effects. Juvenile salmonids use the Bay as a migratory pathway to the ocean during early life stages. Other sensitive species may also be potentially affected by the intake facility.
- Regional desalination would require obtaining numerous permits and approvals for construction and operation. Major permits/approvals include potentially amending EBMUD's Central Valley Project water service contract (depending on the location of the alternative), state and federal Endangered Species Act compliance, Section 404 of the Clean Water Act, Section 106 of the National Historic Preservation Act, and NPDES permit from the Regional Water Quality Control Board (RWQCB) for the discharge of the brine.
- Uncertainty exists in terms of the potential impacts of discharging the brine and may depend on the availability of sufficient amounts of water to dilute the brine before discharge. The ability to obtain discharge permits may be problematic.
- While desalination is a continually improving technology that is used in the Middle East, there has been little experience with it in North America on such a large scale. The facility required by EBMUD would be one of the largest facilities in the world.

Desalination is an energy intensive use. Estimated annual operation and maintenance costs associated with this alternative are approximately 300% greater than those of other alternatives studied for the Freeport Environmental Impact Report (EIR).

Project: Bayside Groundwater – Phase 2

District Contact: Ken Minn, Mike Tognolini
Status: Planning
Reference Used: Bayside Groundwater Project Phase 1 Draft EIR and Final EIR
First Year of Operation: 2013 years
Type of Project: Groundwater

Project Overview

This alternative would involve developing Phase 2 of a conjunctive use project (Aquifer Storage and Recovery Project) within the South East Bay Plain (SEBP) Groundwater Basin by utilizing existing Phase 1 facilities and constructing new Phase 2 facilities to store treated water in an East Bay aquifer during years when surplus water is available for later use during a drought. Phase 2 will add 9 MGD (extraction rate) to the existing 1 MGD phase 1 project (for a total project capacity of 10 MGD). Hence for the purpose of the WSMP 2040, only 9 MGD of additional supply will be considered in yield estimate.

In this project, potable (treated) water from EBMUD's distribution system will be injected into the basin for storage and extracted later for dry year use. Storage would be accomplished via direct injection at three ASR sites. One ASR site is currently in existence and is known as the District-owned "McMillan Site". Two new sites (currently not located) are assumed for the purpose of this estimate.

For the development of the McMillan Site, and for project-costing purposes, it is assumed that an existing ASR well located on leased property owned by the Oro Loma Sanitation District (OLSD) will be replaced with a new well on the McMillian property. In addition, a second (new) well will be installed on the same site and use the Phase 1 facilities. A treatment plant, as will be constructed on the McMillan site during Phase 1 efforts, will also serve Phase 2 needs for that well field (location) without requiring significant modifications and hence will not be a cost factor for Phase 2. It is assumed that the other two Phase 2 well sites will in turn each require a treatment plant (i.e., at each location / site). Since the water injected is "treated" water, the treatment plants are designed under these assumptions to assume that water extracted will only need "partial" re-treatment, such that water supplied to the distribution system meets DPH requirements (that is, there are no pre-treatment costs associated with the injected water). In summary, each of the three ASR sites will contain a total of 2 ASR wells (for a total of 6 project wells, all of which are "new") and one treatment plant (for a total of 3 treatment plants, two of which are "new" and one of which is "existing and therefore does not require capital construction costs").

Total of Phase 1 and Phase 2 project injection capacity is 10 MGD (i.e., 11,200 AFY). Hence each well will be capable of extracting at a calculated rate of 10 MGD / 6 wells or 1.67 MGD per well. Existing distribution system pressure will be used to accomplish injection (i.e., there will be no power costs / pumping costs associated with injection). The wells would extract the total volume injected (i.e. no losses during storage). Hence, the extraction capability of each well = 33,600 AF / 3 yrs / 6 wells = 1,867 AFY/well = 1.67 MGD / well. Pumping / Power costs will occur during the extraction process.

Based on historic hydrology, injection would occur 4 out of every 10 years, on average, and extraction would occur in 3 out of 10 years. In reality, there is no sequential order for injection and extraction phases. Given hydrologic conditions will dictate the sequence.

Over a long period of time, the amount of injection will exceed that of extraction. However, for the purpose of this analysis, injection volume is assumed equal to extraction volume over a 10 year period, and within that 10 year period there are 3 dry years, 4 wet years, and 3 "other" years (when neither injection nor extraction occurs).

The following project assumptions are included in the Phase 2 evaluation (some of which are also detailed above):

- 2 new ARS well sites (+ 1 existing District-owned site)
- 2 new treatment plants (+ 1 existing plant for which no construction $ is required)
- 6 new ASR wells (includes the replacement of the Phase 1 well)
- Each well site is adjacent to a transmission/distribution line, therefore each site would only require an intertie (=3 interties) *(since the Phase 1 well is assumed to be replaced with a new well on the "McMillan Site", it is assumed a new intertie is also required at the McMillan Site)*
- Expanded monitoring will be required at two of the well sites. (The McMillan site has existing monitoring that meets the Phase 2 needs and will continue to be implemented at that site.)
- A new pipeline or upgrade of the existing pipeline will be needed along Grant Avenue to provide a higher capacity (for injection and extraction operations) at the McMillan Site / Phase 1 facilities.

Operational Information

Wet and Normal Year Operation:	Assuming injection occurs every 4 out of 10 years at a rate of 6.75 MGD = 7,560 AFY.
Dry Year Operation:	Assuming extraction occurs every 3 out of 10 years at a rate of 9 MGD = 10,080 AFY.

Capacity Information (Does not include the 1 MGD yield of Phase 1)

Average Dry Year Production:	The project will provide **10,080 AF/yr** during a three year drought. However, the project has the capacity to operate up to 11,200 AF/yr (10 MGD).
Average Wet Year Production:	0 AF/yr (injection only in wet years)
Production depends on (water source):	Availability of 'surplus' potable water in 'wet' years.

Opportunities and Challenges Summary

<u>Opportunities</u>

- Further development of the South East Bay Plain (SEBP) Groundwater Basin would involve constructing additional facilities to store water in the East Bay aquifers during years in which surplus water is available for later use during dry years when supplemental supplies are needed.

- In general, water would be injected via wells during surplus years to store that surplus, treated water as sourced from EBMUD's distribution system. During dry years, water would be extracted, re-treated, and distributed. Phase 2 of this project would deliver the 30,240 AFY stored (in addition to the 3,360 stored as part of Phase 1 facilities integrated into Phase 2).
- Would require two additional well sites, interties to distribution pipeline(s), an expanded monitoring system, and two new treatment plants adjacent to the new well sites (there is a possibility that one centralized treatment system could be constructed, although to conservatively estimate cost that was not assumed).

Challenges / Considerations

- A Final EIR was certified in November 2005 for Phase 1 along with the Programmatic EIR for Phase 2. Comments included safety of radon in groundwater, potential subsidence issues related to pumping, water quality, and potential effect of the project on the Niles Cone Groundwater Basin. Phase 1 operation may verify that impacts can be avoided.
- Future expansion of the project (Phase 2 = 9 MGD in addition to the 1 MGD Phase 1) would require a new EIR, developed based on the Programmatic EIR. A new EIR will include a full public disclosure process and outreach efforts.
- Water quality/health/environmental justice concerns from local residents (e.g., Heron Bay Task Force) have been addressed as part of Phase 1 development. However, they also could continue to be areas of concern as Phase 2 proceeds.

Other considerations:

- Flexibility (Concept #1) - This project could exist at other locations within the SEBP.
- Flexibility (Concept # 2) - The project can be phased (perhaps a 5 MGD interim step for example). A larger project is also possible.
- Option to Utilize Existing Staff - Staffing is required for the operation and maintenance of the project, although there is the possibility that existing staff assignments can be re-assigned to accommodate require O&M work / tasks.
- Baseload Supply Option - Since the operation can be considered a pump (from basin) then treat / supply to distraction system and customers, the project can be considered as a facility that could contribute to the baseload supply (running 24/7)
- No "Electric" cost associated with injection operation – Distribution system pressure is sufficient for injection operations
- Local Storage – Since the project is located within the EBMUD service area, it offers a local source of stored water for use during times of need / emergency
- No 10% loss need be applied - Since this is an already "full" basin with associated boundary conditions, there is no need to assume a loss factor (i.e., similar factors as would be applied to other groundwater projects – the 10% factor for stored water lost due to migration – need not be applied)

- Limited Treatment Costs - Extracted water needs only partial treatment (referred to as “re-treatment” in this text) due to the fact that water injected is treated water as supplied via the existing EBMUD distribution system.
- Reliability - Since this project will use surplus water and underground storage, it is reliable and resistant to natural disasters, emergency situations and surface water supply outages as may result from a variety of reasons.

Project: Buckhorn Canyon Reservoir

District Contact: Bob Lau, Mike Goldberg

Status: Planning

First Year of Operation: Net yet in operation/unknown.

Type of Project: Surface Storage

Project Overview

This component would involve constructing a dam for a terminal reservoir at Buckhorn Canyon, north of Castro Valley, about one-eighth mile up the eastern arm of EBMUD's Upper San Leandro (USL) Reservoir. The reservoir will provide a maximum capacity of 143 thousand acre-feet (TAF) of useable storage. Of this total, 114 TAF could be diverted to the Lafayette Aqueducts.

The project would increase water supply reliability in dry years through additional storage. In addition to drought reliability, this project will significantly improve emergency standby storage by adding additional storage in the District's terminal system.

Project components include:

- Earth fill dam with spillway crest at 745-feet;
- A new 5,100 HP pumping plant would take water from the Moraga aqueduct to the Buckhorn reservoir;
- Inlet and outlet would be via a new 6,200 foot tunnel and 23,000 foot pipeline.

When available, water will be pumped via a new pumping plant from the Moraga Aqueduct to fill the reservoir. During dry years, water would flow via gravity back to the Lafayette Aqueducts and be treated at any of the District's WTP or would flow via gravity to the USL WTP.

Capacity Information

Dry Year Production:	This project will create 143 thousand acre-feet (TAF) of useable storage. It is assumed that a volume of water equivalent to the increase in storage will be available for customer deliveries over a three year drought sequence. In other words, the project will provide 43 MGD in each dry year up to three dry years in a row (water availability could be sustained for longer droughts if less than 43 MGD was taken in the initial drought years).
Wet/Normal Year Production:	0 MGD

Production depends on (Water Source):	Varies
Project will be operated:	Continuously (year round) as base supply in all years.

Opportunities and Challenges Summary

Opportunities

- The entire inundation area is owned by EBMUD.
- An existing terminal reservoir is located nearby; spills from the Buckhorn reservoir would be captured in USL reservoir.
- Good location relative to water treatment plants.
- Will increase emergency terminal reservoir storage and provide local water supply if the Mokelumne Aqueducts were to fail.

Challenges

- Inundation of known habitat for Alameda whipsnake, sensitive fish species, and 40 acres of waters of the United States.
- For the larger options, it was determined in the Freeport EIR that a large Buckhorn Reservoir would have construction impacts worse than other reservoir alternatives considered.
- Significant local opposition could cause project delays.

Project: Enlarge Lower Bear River Reservoir

District Contact: Leslie Dumas (RMC) & Tom Francis

Status: Conceptual per Amador Water Agency (AWA); they are forming a partnership between Calaveras County Water District (CCWD), EBMUD and, more recently, San Joaquin County (SJC) to conduct the feasibility study to raise Lower Bear Dam. The study will be completed by early 2008.

First Year of Operation: 2015

Type of Project: Surface Storage

Project Overview

The reservoir is located 35 miles northeast of Jackson. Land surrounding Upper and Lower Bear River Reservoir is owned by the U.S. Forest Service and PG&E/Stewardship Council. The Bear River Reservoirs (Upper and Lower) provide water to five counties as well as many agencies and other users, including: Alameda, Contra Costa, San Joaquin, Amador, and Calaveras Counties, Jackson Valley Irrigation District (JVID), Amador Water Agency (AWA), North San Joaquin Water Conservation District, Woodbridge Irrigation District (WID), EBMUD, and senior appropriators [Mokelumne, Amador, and Calaveras IRWMP, October 2006].

Raising the existing Lower Bear dam by 32 feet is a likely alternative identified as a means to increase surface water storage capacity in the upper Mokelumne watershed. The water will be diverted to AWA, CCWD, SJC and EBMUD service areas to serve future customer demands. In the short term, the water could be directed for other temporary uses downstream until Amador and Calaveras need the water to supply development. Coordination is desired to minimize and/or mitigate negative impacts on the River system as well as maximize potential benefits to stakeholders, upstream and downstream within both regions.

A report prepared for AWA and CCWD, “Water Supply Alternatives” (1991, revised 2005) reviewed the operation studies prepared by PG&E in their application to FERC as provided to the consultant by the Agency and District. The information indicated that an increase in 26,000 AF of storage provides an average increase in water yield of about 18,300 AF. The Report also tabulated the monthly releases from the reservoir for a dry period beginning in June 1928, when the dam spilled, to June 1936 when the dam spilled once again. For water supply, the safe yield of a reservoir is defined as the amount of water that can be safely drafted annually without deficiencies during a critical dry period. For the dry period as tabulated, the safe yield is about 10,000 AF. EBMUD’s share in increased yield is expected to be 25%. Based on 1991 report [revised in 2005], this project would therefore be expected to supply 4,500 AF in wet years and 2,500 AF in dry years.

Capacity Information

Dry Year Production:	2,500 AF (2.2 MGD)
Wet/Normal Year Production:	4,500 AF (4.0MGD)
Production depends on (Water Source):	Hydrologic conditions on the Mokelumne River
Project will be operated:	Continuously (year round) as base supply and it will increase supply reliability in dry years.

Opportunities and Challenges Summary

Opportunities

- As identified in the Freeport EIR, raising Lower Bear River Reservoir would provide 26,000 AF of additional storage.
- Benefits listed in the Mokelumne, Amador, and Calaveras IRWMP (October 2006) indicate that this project will provide additional water supply and reduce flood risk.

Challenges

- Would cause the inundation of recreation facilities (private camps, resort, RV area, campgrounds, marina, day use areas, trails, snowmobile trail).
- Would inundate habitat for several special status species including the Federal candidate mountain yellow-legged frog, and various bird species including willow flycatcher, bald eagle, and California spotted owl.
- Potential to damage up to six prehistoric sites known to exist near Lower Bear River Reservoir.
- Area includes both U.S. Forest Service and PG&E/Stewardship Council lands.
- This project was eliminated from the Freeport study due to the small size.
- Water quality considerations relating to potential copper contamination of Lower Bear River Reservoir.

Project: Enlarge Pardee Reservoir

District Contact: Bob Lau
Status: Planning
First Year of Operation: 2020
Type of Project: Surface Storage

Project Overview

Pardee Reservoir has a total storage capacity of approximately 198,000 AF. The reservoir is impounded by a 350 foot-high concrete curved gravity dam on the Mokelumne River. A separate uncontrolled spillway structure is located south of the dam.

The enlarged reservoir would have a maximum water supply elevation of 601 feet, 33 feet higher than the present maximum reservoir level. During winter and spring, the maximum reservoir water level would reach an elevation of 614 feet during periods of high river flows. Maximum reservoir storage would be increased by approximately 172 thousand acre-feet (TAF), making more water available during drought years.

This alternative would involve enlarging EBMUD's existing Pardee Reservoir by:

- Constructing a replacement dam about 0.75 mile downstream of the existing dam;
- Constructing saddle dams;
- Refurbishing the existing intake structure and intake tunnel;
- Replacing the Pardee powerhouse and transmission lines;
- Relocating Pardee Dam and Stoney Creek Roads, replacing the Highway 49 bridge crossing of the Mokelumne River, and removing the existing Middle Bar Road bridge, which is currently closed to traffic because of its poor condition; and
- Relocating recreation facilities above the new shoreline.

Capacity Information

Dry Year Production:	This project will create 172 TAF of additional storage. It is assumed that a volume of water equivalent to the increase in storage will be available for customer deliveries over a three year drought sequence. In other words, the project will provide 51 MGD in each dry year up to three dry years in a row (water availability could be sustained for longer droughts if less than 51 MGD was taken in the initial drought years)
Wet/Normal Year Production:	0 MGD
Production depends on (water source):	Hydrologic conditions on the Mokelumne River
Project will be operated:	Continuously (year round) as base supply and it will increase supply reliability in dry years.

Opportunities and Challenges Summary

Opportunities

- Provides a high quality supplemental water source.
- Enlarging the reservoir could provide environmental benefits to the Mokelumne River downstream of Camanche Reservoir by potentially providing increased flows and additional cold water storage for releases to the river.
- Enlarging the reservoir could provide additional water supply to meet EBMUD's dry year needs.
- Would replace or refurbish some of the older portions of EBMUD's water supply system, including Pardee Dam, the intake structure, and the intake tunnel.
- The Project will increase Pardee Powerhouse average annual energy production from 83 GWh/yr to 102 GWh/yr, resulting in additional revenue.
- Higher reservoir levels and control of water pressure at the upstream end of the Mokelumne Aqueducts will boost gravity flow rates and thereby reduce energy used periodically at Walnut Creek Pumping Station for water delivery
- It is assumed that O&M will remain relatively the same as the current dam and powerhouse. Also, because old equipment will be replaced by newer, more reliable equipment, repairs and maintenance may actually decline after the equipment is broken in. Therefore, no additional significant O&M is assumed for this project.

Challenges

- Uncertainty exists regarding environmental, biological, and cultural impacts. Although it does not appear that the affected area supports unique or rare resources, the magnitude of the impact to biological resources is large (the enlarged reservoir would cover an additional 1,200 acres at its maximum elevation).
- Raising Pardee would require obtaining numerous permits and approvals for construction and operation. Major authorizations relate to compliance with state and federal Endangered Species Acts, Section 404 of the Clean Water Act, and Section 106 of the National Historic Preservation Act.
- This project would require relocating Pardee Dam and Stoney Creek Roads, replacing the Highway 49 bridge crossing of the Mokelumne River, and removing the existing Middle Bar Road Bridge.
- Recreation facilities would need to be relocated above the new shoreline. Inundation of approximately 1–1.5 miles of the upstream Mokelumne River channel may affect whitewater boating opportunities on the Electra Whitewater run. However, the reservoir operation plan would minimize these effects by lowering the reservoir elevation during summer months to preserve the whitewater run.
- Additional or revised water rights would have to be obtained from the SWRCB and FERC would be the federal lead agency to review an application for amendment of the existing FERC license.
- The project would not provide an alternative source of water to protect against a major incident on the Mokelumne River, nor would it protect against possible

outages associated with a major earthquake that could disrupt the Mokelumne Aqueducts across the Delta.

Project: Groundwater Banking/Exchange (Sacramento Basin)

Contact: Tom Francis
Status: Pre-planning
References Used: Freeport EIR Vol II, p. 7-18; Freeport EIR Vol II, p. 6-5
First Year of Operation: 2014
Type of Project: Groundwater banking/exchange

Project Overview

EBMUD would participate in the construction of facilities to provide in-lieu or artificial groundwater recharge and recovery in the Sacramento County area. The primary goal of this program would be to provide additional dry year supplies. While there are multiple options for obtaining water for basin recharge, three possible alternatives are described below. In general, EBMUD would provide financial support in developing, and in some cases operating, the facilities to recharge the groundwater basin. In exchange, the District would receive either groundwater extracted from the basin or surface water in exchange for local groundwater use.

Under Option 1, described and costed herein, the project would involve operating a groundwater storage and recovery program in Sacramento County's Central County Basin. It would enhance further the level of in-lieu groundwater recharge that would occur under the other alternatives and would artificially recharge the basin. In this option, groundwater recharge facilities and additional withdrawal facilities would be constructed. Specifically, water would be diverted from the Sacramento River at FRWP under a new filing by SCWA, transported to the recharge facilities using FRWP facilities, and stored in the groundwater basin. Surface water would be purposefully introduced to the groundwater basin via 39 acres of recharge ponds percolating water continuously over an average of 4 out of 10 years (wet water years). Approximately 7,000 acre-feet (AF) of water would be recharged each of the four years. EBMUD would partner in the cost of the operations and would be entitled to ½ of the volume of water stored.

Under Option 2, water districts in the area north of the Lower American River, which compose the Sacramento Groundwater Authority (a joint powers authority formed in 1998), would operate groundwater facilities to provide in-lieu surface water supplies. In wet years, additional surface water available under SCWA's water entitlements would be provided to these districts. In dry years, these districts would forgo some or all of their typical diversions from the Lower American River and would rely more heavily on groundwater, allowing their surface entitlements to flow downstream to SCWA's point of diversion. The capacity of the basin to provide for the water exchange is not clear, and surface water diversion facilities would be required under this alternative.

Finally, in Option 3, EBMUD would provide financial support to the Sacramento Regional County Sanitation District (SRCSD) to develop recycled water production capabilities in the Central County Basin. This recycled water would be provided to local agricultural irrigators currently using groundwater as their source of water. The 'unused' groundwater would subsequently be banked via the in-lieu exchange for dry year use by both Sacramento water agencies and EBMUD.

In all three options described above, water diversions from the Sacramento River would be reduced in dry years and groundwater would be extracted and used by SCWA to meet some or all if its Zone 40 service area demands. Groundwater would be extracted

over an average of three (dry) years out of 10 using seven extraction wells. It is estimated that 28,000 AF would be extracted over the three dry-year period with half the water belonging to Sacramento County and the remaining half provided to EBMUD.

The capacity of the basin to operate a groundwater recharge and extraction program has not been proven; however, for purposes of this analysis, it is assumed adequate for storing and extracting necessary groundwater. The extracted stored groundwater would be conveyed to the Mokelumne Aqueducts via the Freeport facilities for distribution to the District's existing WTPs for treatment; only GAC treatment will be conducted prior to distribution to the aqueducts. Additionally, it is assumed that this project can only operate when the FRWP is operating in order to meet the minimum flow requirements for the FRWP pipeline.

For this project, the following facilities are assumed to be constructed for project operation:

- 39 acres of recharge ponds
- 3 extraction wells (including 1 back-up well), each capable of pumping at 2,000 gpm for 24 hours per day for a period of 12 months
- Five miles of pipeline from the Freeport Regional Water Project (FRWP) pipeline to the well field/recharge area
- Intertie at the FRWP pipeline
- Pump station for the new pipeline
- Granular activated carbon (GAC) treatment system either at the well field or at the intertie with the FRWP pipeline.

Additional costs will be incurred under this project for monitoring (groundwater elevation and quality monitoring), right-of-way acquisitions, and valve fittings and appurtances.

Operational Information

Dry Year Operation:	The District will receive 4,667 AF of water during dry, extraction years, estimated to occur 3 out of every 10 years.
Wet Year Operation:	7,000 AF of water would be recharged during wet years on the Sacramento River, estimated to occur 4 out of every 10 years.
Normal Year Operation:	No operation in "normal" years.

Other Assumptions:

- Half of volume recharged belongs to project partners and is not considered in estimate of volume produced for EBMUD

Capacity Information

Dry Year Production:	4,667 AFY (or 4.167 MGD)
Wet/Normal Year Production:	0 AFY
Production depends on (water source):	Sacramento or American River

Opportunities and Challenges Summary

Opportunities

- Through an as yet to be identified partnership with either Sacramento regional water agencies / water districts, a CVP contractor, a northern California agency, and/or another agencies that may wish to enter into a deal with EBMUD for unassigned FRWP capacity, EBMUD would receive a certain quantity of water during wet years that in turn would be stored in the groundwater basin, and also EBMUD would “mutually” operate the groundwater banking project with SCWA (and share in banked water).
- In wet years, surface water made available to EBMUD would be stored. In dry years, EBMUD would access that water.
- The project may be operated in multiple ways using various sources of water for basin augmentation, including recycled water or wet-year surface water.
- Proposed Project: Operate an aquifer storage and recovery program (ASR) in Sacramento County's Central County Basin. Water would be diverted from the Sacramento River and stored in the groundwater basin. During dry years, water would be extracted and used by EBMUD. Groundwater injection facilities and additional withdrawal facilities would be constructed.

Challenges

- EBMUD may be limited by Water Code Section 1220, which prohibits the export of groundwater from a basin unless a voter-approved AB 3030 plan is in place that specifically allows for the export of groundwater.
- The potential environmental effects of such a program have not been studied.
- Limited information is available to accurately determine how stored groundwater would interact with native groundwater and whether stored groundwater would be available when it is needed for withdrawal.
- Active operation of the groundwater basin could result in environmental effects such as saturation of near-surface soils, which could lead to impacts to structures due to increased settling.
- Operation of the groundwater basin may result in substantial fluctuations of groundwater levels, possibly affecting existing groundwater users, particularly if groundwater levels are further reduced as a result of significant withdrawals during dry years.

- Diversions from the Sacramento River also have the potential to result in minor impacts species listed as threatened or endangered under the federal Endangered Species Act.
- The feasibility of obtaining the necessary agreements and approvals to operate the groundwater basin as an active recharge and recovery area is highly uncertain.
- Due to the project size, the project must operate when FRWP is operating in order to meet minimum pipeline flows.
- If EBMUD's Mokelumne Water Rights are utilized in a storage scheme, the project may require reopening the 1958 agreement with the foothill agencies (in which Mokelumne River water storage is limited only to Pardee and Camanche reservoirs).
- Assume approximately 10% of stored water is lost due to migration (Note: this loss is not reflected in volumes shown above, but will be estimated in the WEAP modeling).

Project: Low Energy Application for Desalination (LEAD) at C&H Sugar

District Contacts: Hasan Abdullah, Tom Francis and Mike Tognolini

Status: Planning

First Year of Operation: 2012

Type of Project: Desalination

Project Overview

The LEAD project would draw from a portion of the 23 MGD of Carquinez Strait water that C&H uses, following its use in plant operations, to produce up to1.5 MGD of potable-quality water for use by C&H in place of potable water from the EBMUD water distribution System. The LEAD project is unique in that it would use recovered steam to provide the power needed to operate the desalination facility. The steam energy would be recovered by replacing existing steam pressure-reducing equipment with a modern power generating unit. The objectives for this project are to:

- Produce up to 1.5 MGD of industrial water to reduce C&H's current demand for potable water by up to 70 percent;
- Improve EBMUD's water supply reliability during droughts;
- Use recovered steam energy that is currently being lost to provide all of the power needed for the desalination facility, with no increased demands on fossil fuels; and
- Allow EBMUD to share information with other water agencies on using recovered steam to power desalination facilities.

Capacity Information

Average Annual Production:	When the plant is operating, it will operate at 1.5 MGD; It may not operate everyday, therefore average annual production will be approximately 1.1MGD
Max Capacity:	1.5 MGD
Production depends on (Water Source):	San Francisco Bay and operation of the C&H Plant.
Project will be operated:	Continuously (year round) as base supply in all years.

Opportunities and Challenges Summary

<u>Opportunities</u>

- Producing potable quality water from the Carquinez Strait to partially offset EBMUD's second largest potable water user. A next phase larger capacity project (6.5 MGD) is possible at this site for supplying potable water to other EBMUD customers
- Create a local water supply west of the Delta that would be of critical value during emergencies such as earthquakes, levee failure or other natural disasters.

- Produce potable quality water from desalination using energy recovered from an alternative energy source (steam) that is currently being lost through pressure reducing stations. The project can therefore be operated with no increased demand on the power grid and no increased use of non-renewable energy sources.
- Bolster public faith and resource agency confidence in desalination as being a practical solution to California's water issues.
- The impact of thermal discharges on Carquinez Strait will be reduced as the concentrate from the desalination plant will have a lower temperature and when mixed with the cooling water return flows would result in overall cooling of the combined return flows.
- No new facilities would need to be constructed in the environmentally sensitive areas/habitats such as the river bed or surface water bodies. The facilities to divert the feedwater from the Carquinez Strait are already in-place and used routinely.
- The desalination plant meets EBMUD's service flexibility requirements. In the event that the food production plant shuts down or changes its demand for water, the study illustrated that EBMUD's customers in the City of Crockett and areas immediately nearby (e.g., within locations less than 2 miles from the proposed desalination facility) have existing water demands in excess of the rate produced.
- Potable water off-set by this project will be stored in EBMUD's reservoirs, resulting in increased releases to the Mokelumne River in wet and normal years, and reduced customer rationing in drought years.
- If implemented, per the 1998 FERC agreement, EBMUD will dedicate up to 20% of the project yield (245 AF) to fishery resources.
- This project will be located within the industrial footprint of already existing facilities (replacing abandoned or unused equipment). Environmental justice is not expected to be an issue.
- Growth-inducement is not expected to be an issue for this project.
- This project may have a potentially beneficial cumulative effect on the environment and fisheries resources/habitats.

<u>Challenges</u>

- A potentially adverse impact may arise from the slight salinity increase (7%) of the discharge water; however, the increase is very minor compared to the natural variations experienced at this location.
- Other adverse environmental impacts are not expected from the project.
- New permits or modifications of existing permits will be required for implementing this project (potential permitting agencies include Regional Water Quality Control Board (RWQCB), State Water Resources Control Board (SWRCB), California Department of Fish and Game (CDFG), Bay Conservation and Development Commission (BCDC), NOAA Fisheries, and United States Fish and Wildlife Service (USFWS).
- Labor compliance requirements associated with Proposition 50 funding. (May not be a "challenge")
- The potential impacts of the blended cooling water discharge on fish/biological resources are very important. Bioassays and toxicity tests will be performed on both the return flows and the blended return flows with the concentrate from the desalting facility. Due to the relatively minor increase in salinity, bioassay/toxicity tests may not be required by the agencies.

- Since this project will be one of the first sea/bay water desalination full-scale projects in the Bay Area, some opposition may develop, not necessarily specifically against the project but perhaps against desalination as a water supply option. However, major opposition is not expected.

Project: Mokelumne Inter-Regional Conjunctive Use Project (IRCUP)/San Joaquin (SJ) Groundwater Banking

District Contact: Tom Francis
Status: Planning
References Used: Mokelumne IR-CUP Draft Concept Proposal p. 2, 5, and 7-9
First Year of Operation: 2012 (if implemented)
Type of Project: Surface Storage, Groundwater Storage, Water Transfer

Project Overview

The IRCUP/SJ Groundwater Banking project is a conceptual project to conjunctively manage a portion of the Mokelumne River water supplies by storing it in the Eastern San Joaquin Groundwater Basin for subsequent regional use to meet diverse needs of project partners. The project is based on the premise of a two- or three-way groundwater banking, exchange and transfer between project partners to provide water supply sustainability and reliability benefits to Amador and Calaveras Counties (in the case of a three-way partnership), and San Joaquin Counties and the East Bay Municipal Utility District (EBMUD) service area (under either partnership alternative). The project will also demonstrate the benefits of improved conjunctive management as part of the overall Integrated Conjunctive Use Program for the Eastern San Joaquin Groundwater Basin. The concept of an inter-regional conjunctive use project is flexible and expandable and could take many forms or be split into several different projects.

The project has been conceived to utilize existing conditions and opportunities to the advantage of all stakeholders. As a result, the representative project elements, briefly summarized below, assume a three-way partnership between EBMUD, San Joaquin County and the up-country Amador and Calaveras County entities.

Surface Water Supply. Amador County and Calaveras County water purveyors would secure additional surface water rights through a "partial assignment" under the 1927 State Filings, which pre-committed a major portion of the Mokelumne River's flow for their future use. The new *Mokelumne River Forum* assignment would allow diversions from the River to be used within Amador and Calaveras Counties, and other water diversions could be banked in the Eastern San Joaquin Groundwater Basin for later use in Amador, Calaveras, and San Joaquin Counties and in EBMUD service area.

Wheeling Facilities. Through multi-lateral agreements among the parties, EBMUD facilities would be used to convey water to San Joaquin County. The project partners could initially rely on EBMUD's existing facilities to exchange the banked water to Amador and Calaveras Counties; however, the following new facilities would be required for the project:

- Five miles of pipeline from the Mokelumne Aqueducts to the well field & recharge ponds
- New Intertie with the Mokelumne Aqueduct
- New pump station for diverting and transporting water to/from the Mokelumne Aqueducts to the well field/recharge site

Groundwater Recharge & Storage. A portion of the Mokelumne River supply would be conveyed through the facilities described above for storage and regional use in the Eastern San Joaquin Groundwater Basin (Basin). Various in-lieu and direct recharge

projects located in North San Joaquin Water Conservation District, Stockton East Water District, Central San Joaquin Water Conservation District and/or Woodbridge Irrigation District could be used to recharge water in wet years for use in dry years. For the purposes of this project, it is assumed that groundwater recharge would occur via 137 acres of recharge basin. Recharge is expected to occur in 7 years out of on average 10 year period. Also, it is assumed that no pretreatment of Mokelumne River water is required prior to recharge.

Regional use facilities would be operated as part of the overall ICU Program in a way that is consistent with objectives adopted under the GBA's Groundwater Management Plan to contribute toward the goal of solving the groundwater overdraft in the critical areas within San Joaquin County. If the project proves to be feasible in helping to reverse the overdraft condition in the groundwater basin, some or all of the partners could pursue additional phases to expand the conjunctive use projects.

Groundwater Extraction. Water stored in the Eastern San Joaquin Groundwater Basin will be extracted for use in dry years. For the purposes of this project, it is assumed that groundwater extraction would occur via 13 wells (plus 2 back-up extraction wells). Dry year extractions would occur during 3 of an average 10-year period, and pumping would occur over 24 hours per day, 12 months of the drought year. It is also assumed that each well is capable of pumping at a rate of 2,000 gallons per minute, and that a total of 58,625 AF of water would be extracted over the 3 year period. This water would be shared with 1/3rd remaining in the Eastern San Joaquin Groundwater Basin, 1/3rd would be extracted and used by the foothill agencies in Amador and Calaveras Counties (most likely through in-lieu exchanges), and the remaining 1/3rd (19,500 AFY for each of the three years) would be extracted, treated with granular activate carbon (GAC) onsite or at the intertie location, and transported to the District's service via the Mokelumne Aqueduct. While GAC treatment will remove most organic constituents, it is assumed that the blending that would occur in the aqueducts will reduce the concentration of metals and salts to concentrations capable of being treated at the District's existing water treatment plants.

Additional Assumptions. In addition to the above assumptions, it is assumed that miscellaneous monitoring will be required for this project. Specifically, monitoring will be required for groundwater elevations and quality and land subsidence.

Operational Information

Wet/Normal Year Operation:	It is assumed that 25,000 AFY will be recharged in 7 of an average 10-year period (during non-dry years) for a total recharge volume of 175,000 AF over the 7 year period.
Dry Year Operation:	It is assumed that 19,500 AFY will be extracted in 3 of an average 10-year period (in dry years) for a total extraction volume of 58,500 AF over a 3 year drought

Capacity Information

Average Annual Production:	19,543 AF each year for a 3 year period.

Production depends on
(water source): Water availability in the Mokelumne River

Assumes: EBMUD gets 1/3 yield for 1/3 of cost and approximately 10% of stored water is lost due to migration (Note: this loss is not reflected in volumes shown above).

Opportunities and Challenges Summary

Opportunities

- The Mokelumne Inter-Regional Conjunctive Use Project (IRCUP) is based on the premise of a three-way groundwater banking, exchange and transfer between project partners to provide water supply sustainability and reliability benefits to Amador, Calaveras, and San Joaquin Counties and the EBMUD service area.
    1. San Joaquin County benefits by higher groundwater levels for all beneficial uses from increased surface water supply, regional assistance in building groundwater recharge facilities, and prevention of further saline intrusion.
    2. Amador and Calaveras Counties benefit through more reliable supplies in normal and dry years and avoid costs of developing major new water supply and storage infrastructure.
    3. EBMUD benefits by meeting a portion of its dry year needs from reliable groundwater storage.
    4. The regions benefit through development of greater supply reliability and flexibility through improved integrated regional water management.
- An IRCUP project concept of this nature (preliminary phase using existing facilities) may provide a range of average annual yields from 10,000 to possibly 50,000 AF for conjunctive use and groundwater banking.
- The concept of an inter-regional conjunctive use project is flexible and expandable and could take many forms or be split into several different projects.
- Help to alleviate longstanding stakeholders water conflicts along the Mokelumne River.
- EBMUD also desires to work collaboratively with other Mokelumne River stakeholders to resolve conflicts and overcome institutional barriers that have limited progress towards lasting solutions that solve the water and natural resources management problems in the region.

Challenges

- Each participating agency will need to negotiate institutional arrangements.
- Likely requires renegotiation of 1958 agreement between EBMUD and Foothill agencies.
- The historically competing interests, different water needs, and different values among Forum members.
- To enhance the capacity of flow capture and utilization for the project partners, additional on-stream or off-stream storage and regulating facilities may be needed.
- Existing San Joaquin County groundwater ordinance may be barrier to out-of-county.

Project: Permanent Agricultural-Urban Water Transfer

District Contact:
Status:
Reference Used:
First Year of Operation: 2009
Type of Project: Permanent Water Right Transfer

Project Overview

EBMUD could purchase a permanent water right from an agricultural entity located either in the Sacramento River Valley or a State Water Project contractor. The water would be available in every year. However, the Table A SWP water rights are likely to have a lower reliability associated with them as the SWP deliveries are curtailed in droughts, just when EBMUD would use these to supplement district supplies. The Sacramento water rights, on the other hand, tend to be senior to other rights and thus are not curtailed in drought years.

Recently agricultural water agencies have been making long-term and permanent transfers of water rights to urban water utilities. These transfers have been most notable in the Sacramento region and among State Water Project contractors. Table 1 below lists a selection of these transfers with terms and prices.[2] These transfers range from 5,000 to 16,000 acre-feet.

Ag-Urban Transfer		Year	AF	$/AF	period
GSWC-Folsom	lease	1994	5,000	$240	per year
NatomasCMWC-ASUS	permanent	2004	5,000	$2,500	perpetuity
Berenda Mesa WD-Coachella VWD	permanent	2005	16,000	$3,000	perpetuity
NatomasCMWC-GSWC	permanent	2006	5,000	$2,100	10 years
NatomasCMWC-Folsom	permanent	2007	8,000	$4,000	perpetuity
TLBWSD-Coachella VWD	permanent	2007	5,250	NA	perpetuity

The cost has been escalating, at least in the Sacramento region, from $2,500 per acre-foot to $4,000 in 2007. Also, the NCMWC-GSWC 10-year lease agreement equals $4,000 per acre-foot in perpetuity at a 7.7% discount rate, which is consistent with the weighted average cost of capital for these water utilities. For this reason, it appears reasonable to assume that a water transfer from an entity in the Sacramento region will cost $4,000 per acre-foot in a one-time payment.

Annual conveyance costs from the Freeport Regional Water Project would be in addition to these costs. Those costs are presumed to be the same as reported for the Sacramento County Groundwater Banking and Exchange Project.

Capacity Information

The amount of the transfer would depend on the available transmission capacity through the FRWP in the years in which the transfer is most likely to occur. This would depend on whether other resources, such as the Sacramento County Groundwater Banking and

[2] The Environmental Impact Report on the Monterey Amendment prepared by the Department of Water Resources lists 14 Table A transfers. Not all are listed because price information is not readily available and they occurred prior to 2004.

Exchange Project, are already scheduled to use the FRWP. Thus, the size of the transfer will be calculated based on the results from the WEAP model runs.

Opportunities and Challenges Summary

Opportunities

- Agricultural water agencies, particularly mutual water companies or districts with land-owner based voting rules, have been more willing to participate in water transfers in the Sacramento Valley. The economic value of water applied to agricultural land has been relatively stagnant compared to the value of the water itself. For example, the recent transfers at $4,000 per acre-foot imply that agricultural land values would have to exceed $10,000 per acre to be competitive. The only crop for which the value exceeded this amount is vineyards; the rest ranged from $2,500 to $8,000 per acre.
- Agriculture uses approximately 70% of the applied water in California, yet delivers less than 5% of the state's economic product. Transferring a relatively small proportion of the agricultural water allotment would greatly increase the amount available to urban water agencies on a proportionate basis. The differential in economic value per acre-foot used is substantial, so significant opportunities for gains from trade exist.
- Water transfers between economic uses have relatively less significant environmental impacts compared to fixed infrastructure projects because adverse impacts can be netted against gains from reduced applications. However, these types of transfers still require EIRs.

Challenges / Considerations

- EBMUD is unlikely to need this water supply every year, unlike as is the case with the water transfers listed above. If the EBMUD takes this water three years out of ten, then the cost at FRWP rises from $204 to $680 per acre-foot.
- The SWRCB must review and approve any long-term transfers. This review focuses on environmental impacts evaluated under CEQA.
- Many such transfers have raised concerns about third-party impacts on individuals and firms that supply the local agricultural industry. As a result many transfers have included requirements for urban water agencies to pay compensation to other parties in the agricultural district.

Project: ConocoPhillips Recycled Water Project, Phase 1

District Contact: Linda Hu; Florence Wedington; Alice Towey

Status: Planning

First Year of Operation: 2012

Type of Project: Recycling (industrial use)

Project Overview

EBMUD is currently investigating the potential for a recycled water project at the ConocoPhillips (COP) Refinery in Rodeo. EBMUD and COP entered into a Memorandum of Understanding (MOU) to evaluate the feasibility of developing the ConocoPhillips Recycled Water Project (COPRWP). The total project, as proposed, would deliver up to 3,875 AFY (3.46 MGD) of high-purity recycled water to replace potable water use at the COP Refinery in three phases:

- Phase 1A – up to 1,934 AFY (1.73 MGD) to feedwater system for boilers
- Phase 1B - up to 963 AFY (0.86 MGD) to half of the cooling towers
- Phase 2 – up to 963 AFY (0.86 MGD) to the remaining half of the cooling towers.

This project is the implementation of Phases 1A and 1B, jointly referred to as Phase 1 and have a total capacity of 2.8 MGD.

Several potential supply sources for the COPRWP include the Pinole-Hercules WWTP, the Rodeo WWTP, and/or the COP WWTP (the last option was not evaluated further). EBMUD and COP have completed the first and second phases of the technical study, with results indicating that the project is feasible. The parties, in cooperation with the wastewater agencies, are now proceeding with additional studies and negotiations.

The proposed COPRWP would use all available dry weather wastewater flows from the supply treatment plants, and the project may therefore not be implemented concurrently with the Franklin Canyon Recycled Water Project. The project components include:

- High-purity recycled water treatment facility located on COP Refinery property in Rodeo (including MF and RO units and other associated equipment)
- Conveyance facilities, including:
    - Pump station improvements/upgrades to convey design flows
    - Construction of new pipeline from Pinole-Hercules to Rodeo (called the Phase 1 High Cost option) or slip-lining of existing pipeline (called the Phase 2 Low Cost option)

It is important to note that, while the two options as described above (new pipeline versus slip-lining) create essentially the same project, a key difference between the two options may be the speed by which the project is implemented.

Capacity Information

Average Annual Production:	3,136 AFY
Max Capacity:	TBD
Minimum Capacity:	TBD
Production depends on (water source):	Supply
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally - for use in dry years and recharge in wet years)

Opportunities and Challenges Summary

Opportunities

- Planning studies indicate project feasibility
- COP is cooperative project partner

Challenges

- Supply availability

Assumptions

- EBMUD will pay capital costs minus a $7 million contribution from COP. COP will operate and maintain the plant following construction in addition to paying debt servicing on capital costs.

Project: ConocoPhillips Recycled Water Project, Phase 2

District Contact: Linda Hu; Florence Wedington; Alice Towey
Status: Planning
First Year of Operation: 2015
Type of Project: Recycling (industrial use)

Project Overview

EBMUD is currently investigating the potential for a recycled water project at the ConocoPhillips (COP) Refinery in Rodeo. EBMUD and COP entered into a Memorandum of Understanding (MOU) to evaluate the feasibility of developing the ConocoPhillips Recycled Water Project (COPRWP). The total project, as proposed, would deliver up to 3,875 AFY (3.46 MGD) of high-purity recycled water to replace potable water use at the COP Refinery in three phases:

- Phase 1A – up to 1,934 AFY (1.73 MGD) to feedwater system for boilers
- Phase 1B - up to 963 AFY (0.86 MGD) to half of the cooling towers
- Phase 2 – up to 963 AFY (0.86 MGD) to the remaining half of the cooling towers.

This project is the implementation of Phase 2 with a total capacity of 0.86 MGD.

Several potential supply sources for the COPRWP include the Pinole-Hercules WWTP, the Rodeo WWTP, and/or the COP WWTP (the last option was not evaluated further). EBMUD and COP have completed the first and second phases of the technical study, with results indicating that the project is feasible. The parties, in cooperation with the wastewater agencies, are now proceeding with additional studies and negotiations.

The proposed COPRWP would use all available dry weather wastewater flows from the supply treatment plants, and the project may therefore not be implemented concurrently with the Franklin Canyon Recycled Water Project. The project components (for Phase 2 only) include:

- Expansion of the high-purity recycled water treatment facility located on COP Refinery property in Rodeo (including MF and RO units and other associated equipment)

As with Phase 1 of this project, a high cost option and a low cost option were evaluated. The high cost option includes construction of new pipeline from Pinole-Hercules to Rodeo, whereas the low cost option includes the slip-lining of existing pipeline. As with Phase 1 of this project the option selected may affect the speed by which the project is implemented.

Capacity Information

Average Annual Production:	1,008 AFY
Max Capacity:	TBD
Minimum Capacity:	TBD
Production depends on (water source):	Supply

Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally - for use in dry years and recharge in wet years)

Opportunities and Challenges Summary

Opportunities

- Planning studies indicate project feasibility.
- COP is cooperative project partner.

Challenges

- Supply availability
- Funding availability

Assumptions

- EBMUD will pay capital costs minus a $2.2 million contribution from COP. COP will operate and maintain the plant following construction in addition to paying debt servicing on capital costs.

Project: East Bayshore Recycled Water Project – Phase 1B Alameda

District Contact: Linda Hu; Florence Wedington

Status: Planning

First Year of Operation: 2012 (timing can change pending funding)

Type of Project: Recycling (irrigation only)

Project Overview

This East Bayshore Recycled Water Project (EBRWP) will provide tertiary treated recycled water from EBMUD's Main WWTP in Oakland to portions of Alameda, Albany, Berkeley, Emeryville, and Oakland. Uses include irrigation of parks, schools, and golf courses and industrial and commercial uses. Phase 1A is anticipated to begin operating in mid-2008. Phase 1A project includes the construction of a new 2.88 MGD recycled water tertiary-treatment facility (RWTTF), a 1.5 MG storage tank, pump station, and transmission and distribution pipelines. Service to Phase 1A customers is expected to begin in mid-2008 and all customers for Phase 1A will be connected to the system by mid-2009.

Phase 1B of the project involves pipeline extensions to serve users located in northern Alameda. A large portion of the potential demand consists of users in areas slated for redevelopment (i.e. areas currently occupied by the Alameda Naval Air Station).

Capacity Information

Average Annual Production:	1.2 MGD (1,340 AFY)
Max Capacity :	1.7 MGD
Minimum Capacity:	0.5 MGD
Production depends on (water source):	Customer demand
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Extension of existing distribution system
- Users located in compact geographic area
- Redevelopment of Alameda Naval Air Station may allow for implementation of comprehensive recycled water program in the area
- Recycled water source is EBMUD's Main WWTP with appropriate 80 MGD supply
- Potential WRDA appropriations available with recently approved $25 million federal authorization. If appropriations are secured, federal funding would match 75% of project capital costs.
- Potential benefits to adjacent wetlands.

Challenges

- Requires pipeline to cross the estuary, but potential benefit to partner with USACE if WRDA funding is secured
- Alameda Naval Air Station redevelopment schedule could be subject to change

Project: East Bayshore Recycled Water Project – Phase 2 Future Expansion

District Contact: Linda Hu; Florence Wedington

Status: Planning

First Year of Operation: 2014 (timing can change pending funding)

Type of Project: Recycling (irrigation, and commercial)

Project Overview

For general overview of the East Bayshore Recycled Water Project – Phase 2 Future Expansion, see EBRWP Phase 1B description.

The EBRWP Phase 2 project involves pipeline extensions to serve users located in the downtown Oakland area. Most potential users would be located close to existing EBRWP transmission pipeline alignments, and would therefore only require construction of short sections of laterals. This phase of the project will also expand use of recycled water to areas such as West Oakland, a disadvantaged community. There is also a potential future benefit to wetlands in the Lake Merritt area.

Capacity Information

Average Annual Production:	0.6 MGD (670 AFY)
Max Capacity:	0.6 MGD
Minimum Capacity:	0.1 MGD
Production depends on (water source):	Customer demand
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Extension of existing pipeline only
- Recycled water source is EBMUD's Main WWTP with approximately 80 MGD supply
- New building construction/urban in-fill development would allow for implementation of comprehensive recycled water program in the area
- Cost sharing opportunity with new development
- Potential WRDA appropriations available with recently approved $25 million federal authorization. If appropriations are secured, federal funding would match 75% of project capital costs.
- Potential benefits to adjacent wetlands.

Challenges

- Requires pipeline installation in highly urban areas
- New building construction/urban in-fill development schedule unknown at this time
- Funding availability

Project: Franklin Canyon Recycled Water Project

District Contact: Linda Hu; Florence Wedington

Status: Conceptual

First Year of Operation: 2020

Type of Project: Recycling (irrigation and industrial use)

Project Overview

The proposed project would deliver up to 340 AFY (0.3 MGD) of recycled water to replace potable water uses at the Conoco Phillips (COP) carbon plant and at the Franklin Canyon golf course (golf course).

Recycled water supply sources for the project include the Pinole-Hercules WWTP and potentially the Rodeo WWTP. Treated wastewater currently flows via a connector pipe from the Pinole-Hercules WWTP to a joint bay outfall at the Rodeo WWTP. The connector pipe is the closest supply source to serve the Franklin Canyon area. Both WWTPs currently produce secondary treated wastewater with potential plans for future tertiary treatment upgrades. Current average dry weather flows are 3.6 mgd (Pinole/Hercules) and 0.75 mgd (Rodeo). Average dry weather flows for Rodeo are anticipated to remain constant until the year 2040, while Pinole/Hercules flows are anticipated to increase to 4.0 mgd by the year 2015, and remain constant thereafter.

The major assumptions considered in the development of the cost estimate are as follows:

- Construction of tie-in facility on the Pinole/Hercules treated effluent pipeline in Rodeo.
- Construction of 150-hp booster pump station adjacent to the tie-in facility (includes one 50-hp spare pump).
- Construction of recycled water transmission mains, including:
    - 17,700-ft of 8-inch pipe from tie-in to Franklin Canyon golf course.
    - 1,700-ft of 4-inch lateral to COP carbon plant.
- EBMUD to provide cost sharing for 1.2-mgd of treatment capacity upgrades at the Pinole/Hercules WWTP (upgrade from secondary to tertiary).[1]

Capacity Information

Average Annual Production:	0.3 MGD (340 AFY)
Max Capacity:	0.3 MGD
Minimum Capacity:	0.2 MGD

[1] Assumes that EBMUD will share approximately ½ of the cost of upgrades necessary to supply peak hour flows for the Franklin Canyon recycled water project.

Production depends on (water source):	Pinole/Hercules/Rodeo supply availability; funding
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

Opportunities

- A potentially less costly project alternative may consist of the COP recycled water project moving forward, and installation of a recycled water transmission line directly from the COP refinery to serve the Franklin Canyon area. Such a pipeline would potentially be shorter (and therefore less costly) than a pipeline to the main Pinole/Hercules effluent pipeline in Rodeo.
- EBMUD and COP have been working together on the developing COP recycled water project.

Challenges

- Available supply must be confirmed if other local recycled water projects move forward (i.e. COP recycled water project). Depending on yield of COP recycled water project, the Franklin Canyon recycled water project may not happen concurrently due to supply limitations.
- Water quality requirements for process water at COP carbon plant would need to be evaluated.

Project: Lake Chabot Raw Water Expansion Project

District Contact: Linda Hu, Florence Wedington

Status: Conceptual

First Year of Operation: TBD

Type of Project: Potable water offset

Project Overview

EBMUD currently provides 0.21 MGD of raw water from Lake Chabot on an average annual basis to Lake Cabot Golf Course (0.13 MGD) and Willow Park Golf Course (0.08 MGD) for irrigation. This project is an expansion of the existing use of raw water from Lake Chabot and would entail expanding raw water use by providing water to the Sequoyah Country Club, Oakland Zoo and other nearby customers for irrigation and other non-potable water uses.

Capacity Information

Average Annual Production:	400 AFY (0.35 MGD)
Max Capacity:	1.4 MGD during peak irrigation months
Minimum Capacity:	TBD
Production depends on (water source):	Lake Chabot
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Expansion of existing project
- No additional treatment required
- Opportunity for public outreach/education

<u>Challenges</u>

- Public health concerns from potential contact with untreated water.
- Minor potable water offset would result from the project

Project: North Richmond Water Reclamation Plant Expansion Project – Surrounding Area

District Contact: Linda Hu, Florence Wedington

Status: Conceptual

First Year of Operation: TBD

Type of Project: Potable water offset

Project Overview

This project is an expansion of the District's North Richmond Water Reclamation Plant (NRWRP) to serve potential recycled water customers in the surrounding area. Currently, the NRWRP has the capacity to produce a max day flow of 5.4 MGD and a peak hourly flow of 6.4 MGD. Recycled water produced at the plant is used by the ChevronTexaco Richmond Refinery in three of its four cooling towers. The plant is producing recycled water at approximately 4 MGD annual average with peak flows at the plant's capacity.

The purpose of this project is to expand use of recycled water in the water reclamation plant vicinity and at the refinery. In a 2005 memorandum, the District identified 45 potential recycled water customers within and adjacent to the NRWRP study area. These customers represented a maximum day demand of 0.7 MGD. Additionally, in their Recycled Water TM #2, the District indicated that the fourth cooling tower at the refinery could use 1 MGD of recycled water.

Facilities to be included in the project (per the 2005 TM and recent information from the District) are an expansion of the existing tertiary treatment facilities, an additional booster pump station, 1,700 linear feet of new pipeline and customer retrofits at 15 sites. It was assumed that no new storage facilities would be required for delivery of recycled water to urban customers. Also, assumed is that the existing recycled water pipeline and facilities from the NRWRP to the Chevron Refinery has the capacity to transmit sufficient supplies to feed all four cooling towers at the refinery.

Capacity Information

Average Annual Production:	150 to 1,900 AF/yr (0.2 – 1.7 MGD)
Max Capacity:	5.4 MGD
Minimum Capacity:	TBD
Production depends on (water source):	Local wastewater streams.
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

Opportunities

- Expansion of existing project with large recycled water user (existing relationship)
- Can be implemented in two phases (cooling tower vs urban irrigation).
- Refinery may prefer a more reliable water supply.

Challenges

- Cannot be co-implemented with RARE as RARE would use all remaining secondary influent from WCWD during dry weather. Supply from WCWD is limited and dependent on growth; however, RARE could also potentially use Chevron's effluent in the future, thereby freeing up future WCWD supply as it develops for this expansion.
- Groundwater impact analyses may be required.

Project: Reliez Valley Recycled Water Project

District Contact: Linda Hu, Florence Wedington

Status: Conceptual

First Year of Operation: 2015

Type of Project: Potable water offset (irrigation)

Project Overview

This project would involve partnership with the Central Contra Costa Sanitation District (Central San) to obtain recycled water from their existing system and distribute it to the Queen of the Heaven Cemetery, Oakmont Memorial Park, Tri-Vista Golf Course and City of Pleasant Hill for landscape irrigation. The project will consist primarily of one pump station and 11,500 LF of pipe.

Capacity Information

Average Annual Production:	110 to 210 AF/yr (0.1 – 0.19 MGD)
Max Capacity:	N/A
Minimum Capacity:	N/A
Production depends on (water source):	CCSD local wastewater streams.
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

Opportunities

- Expansion of existing relationship to partnership with large recycled water producer
- Phaseability
- Recycled water production in place; distribution project only

Challenges

- Minor potable water offset (relative to need for water)
- EIR may be required
- Water quality/health concerns from local residents.

Project: Richmond Advanced Recycled Expansion (RARE) Water Project – Phase 2 Additional 0.5 MGD

District Contact: Linda Hu; Florence Wedington; Alice Towey

Status: Planning

First Year of Operation: 2012 (supply dependent)

Type of Project: Recycling (industrial use)

Project Overview

The RARE project consists of construction and operation of an advanced recycled water treatment plant within the Chevron Refinery property in Richmond. The treatment plant would produce high-purity recycled water for use in Chevron's steam boilers. The source water for the RARE treatment plant would be secondary effluent from the West County Water District (WCWD) water pollution control plant. The RARE treatment plant would be located on Chevron property but owned and operated by EBMUD in parallel with its existing North Richmond Water Reclamation Plant (NRWRP).

The RARE treatment plant is designed for an ultimate capacity of 4.0 mgd with an initial phase of 3.5 mgd of installed membrane capacity. Phase 2 consists of installation of additional MF and RO membrane modules to expand the plant capacity from 3.5 mgd to 4.0 mgd. One possible water source for the expansion would be WCWD treated wastewater, as currently supplied to the RARE project (called the Phase 2 Low Cost option). However, if WCWD supply is unavailable, the RARE expansion project may take water from the Chevron Refinery's wastewater effluent stream (called the Phase 2 High Cost option). Under that scenario, an additional pipeline and pump station would be required to convey flows from Chevron's effluent stream to the RARE treatment plant site. A key difference between the two source options is the implementation date: using WCWD water is supply dependent whereas using the Chevron Refinery's wastewater stream would allow the project to be implemented by as early as 2010.

During dry weather, the RARE project, in conjunction with the NRWRP, would use all of the available supply from WCWD and may require supplementation with potable water service.

Capacity Information

Average Annual Production:	0.5 MGD (560 AFY)
Max Capacity:	0.5 MGD
Minimum Capacity:	0.5 MGD
Production depends on (water source):	Supply
Project will be operated:	Continuously as baseload supply in all years (year round)

Opportunities and Challenges Summary

Opportunities

- Expansion of existing system. Only requires installation of additional membrane capacity (and possibly additional pipe and pump station facilities)
- Chevron is established EBMUD project partner, opportunity for cost sharing

Challenges

- Supply availability

Assumptions

- Chevron will pay full capital costs upfront. EBMUD will operate and maintain the plant following construction; however, Chevron will cover all O&M costs through monthly revenue payments to the District.

Project: Richmond Advanced Recycled Expansion (RARE) Water Project – Future Expansion (Expansion from 4.0 to 5.0 MGD)

District Contact: Linda Hu; Florence Wedington; Alice Towey

Status: Planning

First Year of Operation: 2015 (supply dependent)

Type of Project: Recycling (industrial use)

Project Overview

For general overview, see RARE phase 2 description.

The RARE expansion project includes expanding the RARE project's ultimate capacity from 4.0 to 5.0 mgd. It includes expansions of the MF and RO treatment system, and additional pump station and pipeline capacities. One possible water source for the expansion would be WCWD treated wastewater, as currently supplied to the RARE project (called the Phase 2 Low Cost option). However, if that source is unavailable, the project may take water from the Chevron Refinery's wastewater effluent stream (called the Phase 2 High Cost option). Under that scenario, an additional pipeline and pump station would be required to convey flows from Chevron's effluent stream to the RARE treatment plant site. A key difference between the two source options is the implementation date: using WCWD water is supply dependent whereas using the Chevron Refinery's wastewater stream is more likely to occur at an earlier date.

Capacity Information

Average Annual Production:	1.0 MGD (1,120 AFY)
Max Capacity:	1.0 MGD
Minimum Capacity:	1.0 MGD
Production depends on (water source):	Supply
Project will be operated:	Continuously as baseload supply in all years (year round)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Expansion of existing system.
- Chevron is existing EBMUD project partner, opportunity for cost sharing

<u>Challenges</u>

- Supply availability

Assumptions

- Chevron will pay full capital costs upfront. EBMUD will operate and maintain the plant following construction; however, Chevron will cover all O&M costs through monthly revenue payments to the District.

Project: San Leandro Water Reclamation Facility Expansion Project – Phase 3 Oakland/Alameda

District Contact: Linda Hu; Florence Wedington

Status: Conceptual

First Year of Operation: 2015 (estimated)

Type of Project: Recycled water irrigation

Project Overview

As part of EBMUD's San Leandro Recycled Water Project, The current San Leandro Water Reclamation Facility (SLWRF) provides approximately 0.4 mgd of disinfected secondary recycled water produced by the City of San Leandro's Water Pollution Control Plant (WPCP) for irrigation at the Metropolitan Golf Links in Oakland, the Chuck Corcia Golf Complex, and Harbor Bay Parkway in Alameda.

The WSMP 2040 water recycling team coordinated with the City of San Leandro regarding the City's own recycled water program. The program currently consists of approximately 0.5 mgd of recycled water service to the Monarch Bay golf course and small City parks. Based on City input, the build-out demand for the City's program would likely remain below 1.0 mgd in the 2040 timeframe. Therefore wastewater supply limitations are not thought to be a limiting factor.

EBMUD's Phase 3 project consists of adding additional recycled water customers in the Oakland/Alameda area, including irrigation meters at the Oakland Airport, plus providing upgraded tertiary treated recycled water to all customers. The following components are anticipated for the Phase 3 Project.

- 0.45 mgd Tertiary treatment plant upgrades
- Pump station upgrades to install additional horsepower to supply increased demands
- Customer site retrofits to serve demands at the Oakland Airport and other various potential users north and south of the San Leandro Water Pollution Control Plant.
- Construct/upgrade transmission mains.

Capacity Information

Average Annual Production:	630 AFY of new potable water offsets (The project will actually provide 1,120 AFY, but only 630 AFY will be new)
Production depends on (water source):	
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

Opportunities

- Based on input from the City of San Leandro, the build-out demand for the City's program would likely remain below 1.0 mgd in the 2040 timeframe. Therefore wastewater supply limitations are not thought to be a limiting factor for the Phase 3 project.
- Existing distribution pipelines and pump station may be re-used for the phase 3 project, although they may require upsizing to serve the increased demands.
- There are opportunities for cost sharing with the City of San Leandro.

Challenges

- Expansion of committed project; supply availability depends on City's plans for recycling.

Project: San Ramon Valley Recycled Water Program (SRVRWP) – Phase 2 Bishop Ranch

District Contact: Linda Hu; Florence Wedington

Status: Planned

First Year of Operation: Earliest estimate is 2010 if WRDA funding is available

Type of Project: Recycling (irrigation only)

Project Overview

This is the second phase of the San Ramon Valley Recycled Water Project which is a part of the joint regional program between EBMUD and Dublin San Ramon Services District (DSRSD), serving tertiary treated recycled water to customers within the Bishop Ranch area. The two agencies formed a Joint Powers Authority known as DSRSD-EBMUD Recycled Water Authority (DERWA) in 1995. Phase 1 of the SRVRWP began water delivery of approximately 0.7mgd in February 2006.

Phase 2 includes the following components:

- Distribution pipelines throughout Bishop Ranch and along Bollinger Canyon Road (ranging in size from 4 to 16-inches)
- Customer retrofits at individual use sites

Capacity Information

Average Annual Production:	0.75 MGD (840 AFY)
Max Capacity:	0.75 MGD (or 5.7 MGD for DERWA treatment plant at buildout – includes all phases)
Minimum Capacity:	0.3 MGD
Production depends on (water source):	Construction of DERWA Phase 2 by Army Corps of Engineers
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Significant planning work has been completed; project is close to implementation
- Straightforward construction (pipelines only)
- $2.8 million WRDA funding secured for Phase 2A
- Pursuing $4.1 million WRDA funding for Phase 2B

Project: San Ramon Valley Recycled Water Program – Phase 3 Danville East

District Contact: Linda Hu; Florence Wedington

Status: Planned

First Year of Operation: Estimated at 2013 if WRDA funding is available

Type of Project: Recycling (irrigation only)

Project Overview

This is the third phase of the San Ramon Valley Recycled Water Project which is a part of the joint regional program between EBMUD and Dublin San Ramon Services District (DSRSD), serving tertiary treated recycled water to customers in northern San Ramon and southeastern Danville. The two agencies formed a Joint Powers Authority known as DSRSD-EBMUD Recycled Water Authority (DERWA) in 1995. Phase 1 of the SRVRWP began water delivery of approximately 0.7mgd in February 2006.

Phase 3 includes the following components:

- Distribution pipelines (ranging in size from 4 to 16-inches)
- Pump station
- Storage tank (currently in construction)
- Customer retrofits at individual use sites

Capacity Information

Average Annual Production:	0.58 MGD (650 AFY)
Max Capacity:	0.58 MGD
Minimum Capacity:	0.3 MGD (or 5.7 MGD for DERWA treatment plant at buildout – includes all phases)
Production depends on (water source):	
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

Opportunities

- Significant planning work has been completed; project is close to implementation
- A portion of the pipeline in Camino Tassajara and within the Alamo Creek Development has been constructed. The tank is currently in construction.

Challenges

- Continue to lobby for WRDA appropriations

Project: San Ramon Valley Recycled Water Program – Phase 4 Blackhawk East

District Contact: Linda Hu; Florence Wedington

Status: Planned

First Year of Operation: Estimated at 2016 if WRDA funding is available

Type of Project: Recycling (irrigation only)

This is the fourth phase of the joint regional program between EBMUD and Dublin San Ramon Services District (DSRSD), serving tertiary treated recycled water to customers within eastern Blackhawk. The two agencies formed a Joint Powers Authority known as DSRSD-EBMUD Recycled Water Authority (DERWA) in 1995. Phase 1 of the SRVRWP began water delivery of approximately 0.7mgd in February 2006.

Phase 4 includes the following components:

- Distribution pipelines (ranging in size from 4 to 12-inches)
- Pump station
- Customer retrofits at individual use sites

Capacity Information

Average Annual Production:	0.37 MGD (410 AFY)
Max Capacity:	0.37 MGD (or 5.7 MGD for DERWA treatment plant at buildout – includes all phases)
Minimum Capacity (MGD):	0.3 MGD
Production depends on (water source):	Supply is available but pending arrangement between DSRSD and other agency
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Significant planning work has been completed

<u>Challenges</u>

- WRDA funding availability
- Supply is available but pending arrangement between DSRSD and other agency

Project: San Ramon Valley Recycled Water Project – Phase 5 Blackhawk West

District Contact: Linda Hu; Florence Wedington

Status: Conceptual

First Year of Operation: Unknown

Type of Project: Recycling (irrigation only)

Project Overview

This is a conceptual fifth phase of the San Ramon Valley Recycled Water Project which is a part of the joint regional program between EBMUD and Dublin San Ramon Services District (DSRSD), serving tertiary treated recycled water to customers within eastern Blackhawk. The two agencies formed a Joint Powers Authority known as DSRSD-EBMUD Recycled Water Authority (DERWA) in 1995. Phase 1 of the SRVRWP began water delivery of approximately 0.7mgd in February 2006.

Phase 5 would serve the western portion of the Blackhawk Country Club currently not included in Phase 4. Required facilities include transmission mains, laterals, tie-in facilities to the existing SRVRWP transmission pipes, a booster pump station and customer site retrofits.

Capacity Information

Average Annual Production:	0.3 MGD (340 AFY)
Max Capacity:	0.3 MGD
Minimum Capacity:	0.2 MGD
Production depends on (water source):	Supply availability; funding
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Expansion of existing project.

<u>Challenges</u>

- Funding availability
- Potential recycled water supply limitations

Project: San Ramon Valley Recycled Water Program – Phase 6 Danville West

District Contact: Linda Hu; Florence Wedington

Status: Conceptual

First Year of Operation: Unknown

Type of Project: Recycling (irrigation only)

Project Overview

This is a conceptual sixth phase of the San Ramon Valley Recycled Water Project which is a part of the joint regional program between EBMUD and Dublin San Ramon Services District (DSRSD), serving tertiary treated recycled water to customers within eastern Blackhawk. The two agencies formed a Joint Powers Authority known as DSRSD-EBMUD Recycled Water Authority (DERWA) in 1995. Phase 1 of the SRVRWP began water delivery of approximately 0.7mgd in February 2006.

Phase 6 would serve users located along Camino Tassajara northwest of the intersection with Blackhawk Road. Required facilities include transmission mains, laterals, tie-in facilities to the existing SRVRWP transmission project, a booster pump station and customer site retrofits.

Capacity Information

Average Annual Production:	0.2 MGD (220 AFY)
Max Capacity:	0.2 MGD
Minimum Capacity:	0.1 MGD
Production depends on (water source):	Supply availability; funding
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

<u>Opportunities</u>

- Expansion of existing project.

<u>Challenges</u>

- Funding availability
- Potential recycled water supply limitations

Project: Satellite Recycled Water Projects (Retrofits)

District Contact: Linda Hu, Florence Wedington

Status: Conceptual

First Year of Operation: TBD

Type of Project: Potable water offset

Project Overview

This project consists of several satellite recycled water treatment plants (SRWTP) to cost-effectively provide recycled water to large users located remotely from where the District's main centralized system is located. In general, a SRWTP would take raw sewage from a wastewater collection pipeline and treat it at a tertiary level for local use.

In January 2005, EBMUD completed a study to determine the feasibility of constructing a SRWTP. The study explored technologies available for satellite treatment systems, identified three potential customers for a SRWTP demonstration, and included a cost-benefit analysis. A membrane bioreactor (MBR) was recommended as the preferred treatment technology for an SRWTP.

For the purposes of the WSMP, five satellite plants were evaluated as described below:

- Rolling Hills Cemetery, San Pablo/Richmond – This project would develop recycled water for irrigation of a future 45-acre cemetery expansion. The project yield would be approximately 50 to 200 AFY. The main potential constraint will be wastewater availability in the area.
- Diablo Country Club, Diablo Valley – This project was evaluated as part of the 1996 SRVRWP Facilities Plan, and would develop recycled water for golf course and landscape irrigation. The project would yield around 200 AFY. The main potential constraint will be the availability of wastewater in the area.
- Mountain View and St. Mary's Cemeteries, Oakland - The Mountain View Cemetery was previously evaluated as part of the 2005 Satellite Treatment Feasibility Study; no fatal flaws were found. The project would develop between 100 and 200 AFY of recycled water for irrigation of a future 40-acre cemetery expansion. One main project constraint may be high retrofit costs.
- Rossmoor Golf Course, Rossmoor Valley – Recycled water produced as part of this project would irrigate the golf course and landscaping at Rossmoor Country Club, in local parks and HOA landscaping. This project would develop approximately 100 to 150 AFY of recycled water, with the main potential constraint being the availability of wastewater.
- Moraga Country Club, Moraga – This project would develop between 100 and 200 AFY of recycled water for use irrigating the golf course and landscaping at Moraga Country Club, and landscape irrigation at St. Mary's College and Central Park. The main potential project constraint is the availability of wastewater.

Larger-scale new development could also be a likely candidate for Satellite Recycled Water Treatment, in addition to providing opportunities for cost sharing. However, this current cost analysis is based on retrofitting existing users and offsetting potable water use.

Capacity Information

Average Annual Production:	550 to 950 AF/yr
Max Capacity:	TBD
Minimum Capacity:	TBD
Production depends on (water source):	Local wastewater streams.
Project will be operated:	Continuously as baseload supply in all years (year round) (seasonally)

Opportunities and Challenges Summary

Opportunities

- Large local users near wastewater source
- Can be implemented in phases
- Irrigators users may prefer a more reliable water supply
- If new development, cost sharing opportunities available

Challenges

- Volume of local wastewater may constrain production rates and project yields
- Would require full EIR (could complete a programmatic EIR and then tier off)
- Water quality/health concerns from local residents
- Groundwater impact analyses may be required

Appendix 8.4: Emergency Pipeline Estimated Costs

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Lake Chabot to USL Water Treatment Plant - Emergency pipeline connection
Construction cost estimate - Jan 2013

- Material = 12-inch pvc
- Length = 3.5 miles = 18,500 feet
- Installation conditions= dificult access/staging; cross -country; at grade/gravel pad; minor clearing/grubbing; minor compaction; as-is when done; anchoring every 100-feet

Item	Unit cost	Quantity	Total
12-inch PVC	$40/LF	18,500	$740,000
Anchors	$20/each	200	$4,000
Mobilization	$125,000	LS	$125,000
Installation	$20/LF	18,500	$370,000
Demobilization	$125,000	LS	$125,000
		Construction subtotal =	$1,364,000
		Design (10%) =	$136,400
		Construction management (15%) =	$204,600
		Contingency (20%) =	$272,800
		TOTAL =	**$1,830,000**

Appendix 8.5: *Updated Outdoor Recreation Use Values on National Forests and Other Public Lands* (Loomis 2005)

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United States
Department of
Agriculture

Forest Service

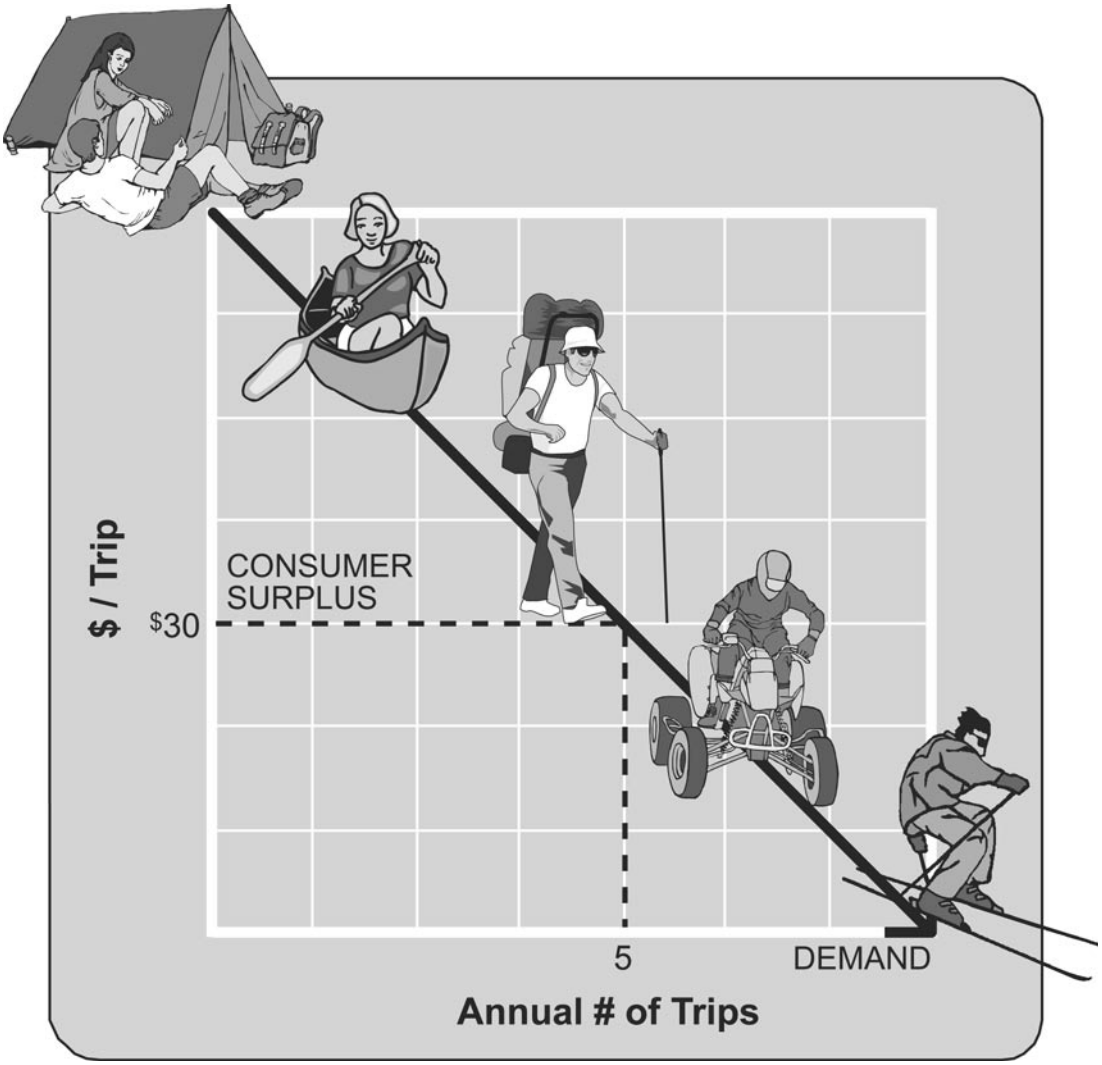
Pacific Northwest
Research Station

General Technical
Report
PNW-GTR-658

October 2005

Updated Outdoor Recreation Use Values on National Forests and Other Public Lands

John Loomis



The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

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Abstract

Loomis, John. 2005. Updated outdoor recreation use values on national forests and other public lands. Gen. Tech. Rep. PNW-GTR-658. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 26 p.

This report summarizes more than 30 years of the literature on net economic value of outdoor recreation on public lands. The report provides average net willingness to pay or consumer surplus per day for 30 recreation activities at the national level. Values per day by recreation activity are also presented by census region of the United States. Detailed tables provide the average value per day as well as the standard error for calculating confidence intervals. Guidance for using these values in performing benefit transfer to unstudied sites is also provided. The report provides a link to a Web site where the spreadsheet that underlies the averages calculated in this report is available.

Keywords: Benefit transfer, consumer surplus, recreation use values, willingness to pay.

Executive Summary

This report presents updated average values per visitor-day of outdoor recreation opportunities commonly found at national forests, with emphasis on the Pacific Northwest region. The use of past valuation information for current policy analysis is called benefit transfer (Brookshire and Neill 1992). In this report, the term "value" is used to mean net willingness to pay or consumer surplus, a measure commonly used for benefit-cost analysis or economic efficiency analysis by federal agencies such as the U.S. Army Corps of Engineers, Bureau of Reclamation (U.S. Water Resources Council 1979, 1983) and U.S. Environmental Protection Agency.

This report updates past USDA Forest Service-sponsored reviews of the literature on outdoor recreation use valuation by including recent analyses and estimates through the year 2003. Adding studies from this period to past reviews results in a database on outdoor recreation use valuation that spans 1967 to 2003; 1,239 estimates obtained from the literature provide values for 30 outdoor recreation activities. This update includes new recreation activities such as snorkeling, scuba diving, and birdwatching that were not part of the Rosenberger and Loomis (2001) report. The values presented in this report are averages of values per day from original or primary Contingent Valuation Method or Travel Cost Method studies (see Loomis and Walsh 1997 for more details on these two valuation methods). To standardize the units of recreation use, average values are reported per visitor-day. The average visitor-day value is reported for each activity by census region when available, and specifically broken out into greater detail for the Pacific Northwest. The complete spreadsheet providing the results of the individual studies is available at: http://www.fs.fed.us/pnw/data/RecValues.htm.

Although the report provides average values for all regions of the United States, the values for the Pacific Northwest are separated out. Based on the existing literature, hunting on public lands in the Pacific Northwest has an average value of $35 per day, fishing averages $42 per day, and wildlife viewing is $35 per day. Hiking has a value of $24 per day in the Pacific Northwest.

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Introduction

The USDA Forest Service and other federal land management agencies including the National Park Service, U.S. Fish and Wildlife Service, and USDI Bureau of Land Management require information on values of recreation. Whether for land management planning or Government Performance and Results Act (GPRA) of 1993, these requirements feed directly into a need for credible measures of benefits. In this case, we are interested in developing credible measures of benefits for outdoor recreation.

This report is intended to serve two functions. First, it provides information from a literature review of economic studies conducted in the United States, spanning 1967 to 2003, that estimated outdoor recreation use values. Second, this report provides some basic guidelines on performing benefit transfers in the context of recreation use valuation. This report is not a cookbook for benefit transfers, but instead it is to be used as a guide to the empirical estimates available (a more complete discussion of benefit transfer protocols can be found in Rosenberger and Loomis 2001). Per federal government benefit-cost guidelines (U.S. Water Resources Council 1979, 1983), economic value is defined as visitor's net willingness to pay or consumer surplus (Freeman 1993). The values summarized in this report are averages of original or primary Contingent Valuation Method (CVM) or Travel Cost Method (TCM) studies (see Loomis and Walsh 1997 for more details on these two valuation methods). The values reported in this publication are unweighted or simple averages where each study and each estimate from each study is given equal weight. This is the same approach used by Rosenberger and Loomis (2001). However, by using the spreadsheet, an analyst could construct a weighted average by using any reasonable criteria such as study sample size or survey response rate, etc. To standardize the units of recreation use, average values are reported per visitor-day.

Data

Literature Review Efforts, Past and Present

We provide data on outdoor recreation use values based on empirical research conducted from 1967 to 2003 in the United States. This data is the compilation of five literature reviews conducted over the last 20 years. The first review covered the literature on outdoor recreation and forest amenity use value estimation from the mid-1960s to 1982, collecting 93 benefit estimates in all (Sorg and Loomis 1984). The second review covered outdoor recreation use valuation studies from 1968 to 1988, building on the first review, but focusing primarily on the 1983–88 period (Walsh et al. 1988, 1992). That second review increased the number of benefit

estimates to 287 estimates. A third literature review on the subject covered the period 1968–93 (MacNair 1993). A fourth literature review on outdoor recreation use valuation, focusing on studies reported from 1988 to 1998 (Loomis et al. 1999). Rosenberger and Loomis (2001) then merged the results of the fourth review with the MacNair (1993) database. The main emphasis was to improve on coding procedures used in the past review efforts to focus on use value estimates for all recreation activity categories identified by USDA Forest Service documents. Fishing benefit studies were not emphasized, as this was the focus of a separate review sponsored by the U.S. Fish and Wildlife Service, and published by Industrial Economics, Inc. (Markowski et al. 1997). Fishing studies coded in the MacNair (1993) database that were from the Walsh et al. (1988) review were sufficient in number and coverage for valuation of fishing for statistical purposes. This report represents the fifth literature review, adding new studies from 1998 through 2003. In this new review, we were able to obtain 479 new observations.

Data Sources and Coding Procedures

Coding fields include reference citation to the research, benefit measure(s) reported, methodology used, recreation activity investigated, recreation site characteristics, and user or sample population characteristics.

A concerted effort was made to locate studies on activities that were not previously investigated and recreation activities of particular interest to the USDA Forest Service, especially the Pacific Northwest Region. Computerized databases, such as American Economic Association's ECONLIT and Thomson's ISI Web of Science were searched for published literature along with the University of Michigan's dissertation and master's thesis abstracts. Gray literature was located by using conference proceedings, bibliographies on valuation studies (Carson et al. 1994), and access to working papers. Details of studies conducted from 1967 to 1988 were obtained primarily from MacNair's (1993) database that coded the Walsh et al. (1988, 1992) literature review. A few study details were obtained directly from the Walsh et al. (1988) review that were not included in the MacNair (1993) database.

For consistency and to allow merging of the new studies with studies compiled by Rosenberger and Loomis (2001), the same master coding sheet was used for the base. The spreadsheet dataset and code sheet contains 126 fields. The main coding fields include reference citation to the research, benefit measure(s) reported, methodology used, recreation activity investigated, recreation site characteristics, and user or sample population characteristics. Study reference citation details include, in part, author, year of study, and source of study results. Benefit measure(s) details include, in part, the monetary estimate provided by the study (converted to activity-day units by using information provided in the study report), the units in which the estimate is reported (e.g., day, trip, season, or year), and benefit measures temporally adjusted for inflationary trends to 2004 dollars. An activity-day represents

the typical amount of time a person pursues an activity within a 24-hour period. This unit was chosen because of its ease in being converted to other visitation/participation units (e.g., recreation visitor-days, trips, seasons).

Value-Per-Day Tables by Activity and Region

New data were combined with old data to create a database of 1,239 observations spanning 1967 through 2003. This table (table 1) presents data for the 30 activities. Information that can be observed includes the number of studies, number of estimates, mean/average, standard error, and range of values. In brief, the activities most commonly found include hunting, fishing, wildlife viewing, and camping. The average estimate of consumer surplus is $47.64 per person per day across all 1,239 observations.

Table 1—Summary statistics on average consumer surplus values per person per day by activity from original recreation benefit studies, 1967–2003

Activity	Studies	Estimates	Mean	Standard error	Range of estimates	
	- - - Number - - -		*- - - - - - - - - - - 2004 dollars - - - - - - - - - - -*			
Backpacking	1	6	52.10	9.29	26.82	80.34
Birdwatching	4	8	29.60	8.35	5.80	78.46
Camping	29	48	37.19	5.77	2.03	224.53
Cross-country skiing	8	12	31.38	3.41	14.05	48.38
Downhill skiing	5	5	33.49	8.48	15.05	63.11
Fishing	129	177	47.16	4.81	2.08	556.82
Floatboating/rafting/canoeing	20	81	100.91	9.56	2.70	394.82
General recreation	15	39	35.10	8.69	1.42	257.51
Going to the beach	5	33	39.43	5.06	3.78	117.82
Hiking	21	68	30.84	4.33	0.40	262.04
Horseback riding	1	1	18.12		18.12	18.12
Hunting	192	277	46.92	2.20	2.60	250.90
Motorboating	15	32	46.27	7.43	3.78	203.62
Mountain biking	7	32	73.78	12.11	20.86	295.69
Off-road vehicle driving	4	10	22.92	3.95	5.24	40.86
Other recreation	15	16	48.70	11.57	5.71	206.82
Picnicking	8	13	41.46	10.69	8.94	142.74
Pleasure driving (which may include sightseeing)	4	11	59.23	18.84	3.02	167.74
Rock climbing	4	27	56.26	6.86	26.62	135.82
Scuba diving	2	24	32.36	11.21	2.81	250.04
Sightseeing	15	28	36.84	8.80	.65	209.77
Snorkeling	1	9	30.31	15.36	5.23	135.29
Snowmobiling	3	8	36.29	13.24	10.79	124.44
Swimming	11	26	42.68	6.14	2.20	134.34
Visiting environmental education centers	1	1	6.01		6.01	6.01
Visiting arboretums	1	1	13.54		13.54	13.54
Visiting aquariums	1	1	28.31		28.31	28.31
Waterskiing	1	4	49.02	12.72	15.13	70.07
Wildlife viewing	69	240	42.36	2.64	2.40	347.88
Windsurfing	1	1	395.47		395.47	395.47

Table 2 breaks down the information further by subdividing the activities by region. Six regions are used that roughly follow U.S. Census Regions: Alaska, Intermountain, Northeast, Pacific Coast (USDA Pacific Southwest and Pacific Northwest Regions [R5 and R6]), Southeast, and our own construct, Multiple Area. Multiple Area was included, as several of the studies spanned more than one region. Figure 1 illustrates the geographic regions used for this analysis. This update provides 354 observations in the Intermountain area, 306 in the Northeast, 281 in the Southeast, 186 in the Pacific Coast, 26 in Alaska, and only 86 in the Multiple Area studies. Deciding upon the best degree of geographic aggregation is a tradeoff between greater geographic specificity, which enhances accuracy in benefit transfer, and smaller sample sizes within each region, which reduces accuracy. Considering this tradeoff, it was desirable to use regions broader than Forest Service administrative regions. This increased the sample size in each cell. Second, for some recreation activities, if smaller administrative regions were used it would lead to numerous blank cells, indicating no values for that activity in that region. Finally, the larger censuslike regions correspond to the Resources Planning Act (RPA) assessment regions, so there is some connection to Government Performance and Results Act and RPA regions.

Table 2 also presents average recreation values of empirical studies conducted in wilderness areas by region. Of the 1,239 total studies, 108 were found to be in wilderness areas.

Table 3 provides more detail about each activity in each region, including standard error and minimum and maximum values for each activity. The region with the least amount of activity values was Alaska, with eight recreation activities having values. None of the regions had values for all 30 recreation activities.

Table 4 presents averages specific to the Pacific Northwest Region (R6), Oregon and Washington. As can be seen, there are relatively few studies, although they produce a large number of benefit estimates for the different sites and variants of valuation techniques used in each study. There are quite a few fishing, hiking, hunting, and wildlife viewing studies and estimates.

Many of the estimates in table 4 (specifically, camping, off-road vehicles, picknicking, sightseeing, and swimming) are from a USDA Forest Service-commissioned study by Bergstrom et al. (1996). Many of the hunting and fishing studies are from Brown and Hay (1987) from the USFWS hunting and fishing survey, and from Rowe et al. (1985). Most of the hiking value estimates came from Hilger's (1998) master's thesis on wilderness day hikers, and Englin and Shonkwiler (1995).

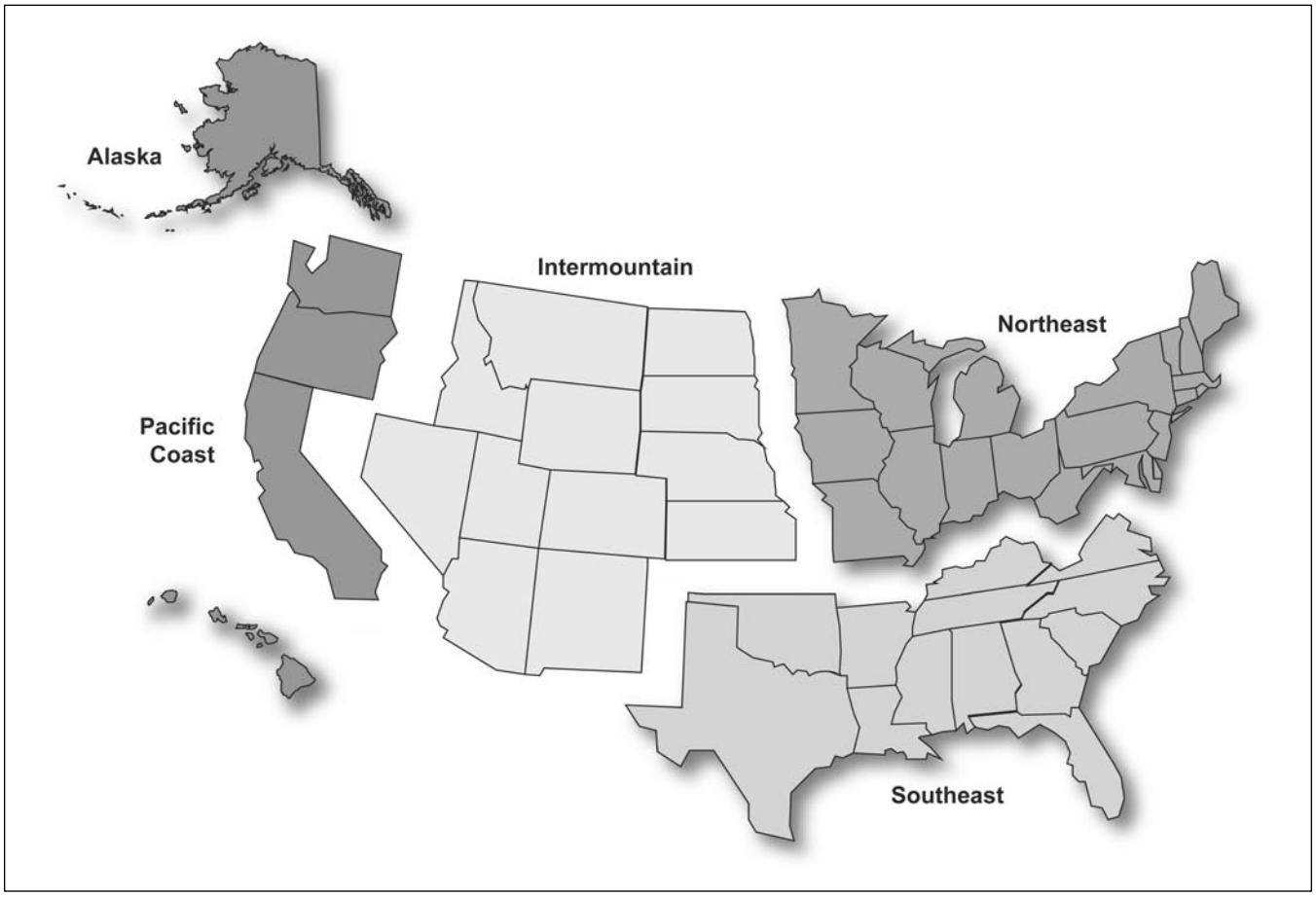

Figure 1—Study regions.

Tables 1, 3, and 4 present the standard error of the mean. This statistic is calculated from the standard deviation and the square root of sample size. The standard error of the mean is used to construct the confidence interval around the population mean. For example, a 95-percent confidence interval around the population mean is formed by adding and subtracting 1.96 standard errors from the mean. Thus in table 1 for camping, the mean is $37.19, and the standard error is $5.77. The 95-percent confidence interval is $25.88 to $48.50. We expect that there is only a 5 percent chance, given the data we have, that the true population mean for camping lies outside of this range.

Tables 1 and 3 contain maximum and minimum values for each activity and region. Although some of these maximum values may appear quite large or minimum values appear quite small, these study values were checked against the original study as were our calculations. Thus, all the values included in the report were used in calculating the averages. The user can access the spreadsheet data to calculate averages with what they consider to be outliers removed if they wish.

Table 2—Summary statistics on average consumer surplus values per person per day by activity and region, 1967 to 2003

	Alaska		Inter-mountain		Multiple area studies		Northeast		Pacific Coast		Southeast		Total	
Activity	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
		2004 dollars		*2004 dollars*		*2004 dollars*		*2004 dollars*		*2004 dollars*		*2004 dollars*		*2004 dollars*
Backpacking									6	52.10				
Birdwatching							3	34.86			5	26.46		
Camping			21	34.72	2	11.82	10	33.11	4	104.35	11	25.79		
Cross-country skiing			7	29.88	1	15.20	3	34.60	1	48.38				
Downhill skiing			3	39.62	1	23.53			1	25.08				
Fishing	4	61.99	48	49.57	14	47.53	69	32.60	15	44.36	27	79.21		
Floatboating/rafting/canoeing	1	18.16	22	67.70	1	34.01	6	88.32	4	27.84	47	127.46		
General recreation	1	14.84	12	48.46	3	4.00	5	16.87	9	32.35	9	42.77		
Going to the beach							22	42.60			11	33.12		
Hiking	1	15.52	7	38.53	1	25.04	3	75.18	49	23.24	7	60.38		
Horseback riding					1	18.12								
Hunting	7	65.68	109	48.55	12	61.69	87	47.45	18	45.49	44	35.36		
Motorboating			7	53.68	1	34.36	3	29.68	8	26.94	13	58.92		
Mountain biking			6	184.48	1	21.13	1	40.93	16	49.68	8	49.62		
Off-road vehicle driving			7	22.81	1	23.93			1	40.37	1	5.24		
Other recreation			10	56.35	1	20.83			1	74.47	4	30.07		
Picnicking			5	28.27	1	18.83	2	56.45	3	64.22	2	36.62		
Pleasure driving	3	8.41	4	69.74	1	36.46	1	21.35			2	144.78		
Rock climbing			3	50.45	12	26.82	1	102.89			11	85.70		
Scuba diving							14	17.92	10	52.60				
Sightseeing	1	15.84	11	23.58	1	17.83	2	121.43	4	20.27	9	46.06		
Snorkeling									9	30.31				
Snowmobiling			8	36.29										
Swimming			1	29.54	1	23.56	7	22.21	4	27.29	13	60.92		
Visiting environmental education centers							1	6.01						
Visiting arboretums											1	13.54		
Visiting aquariums											1	28.31		
Waterskiing			2	56.96	1	67.00	1	15.13						
Wildlife viewing	8	49.33	61	37.24	29	56.36	65	31.30	23	72.48	54	40.10		
Windsurfing											1	395.47		
All activities in wilderness			32	41.68	17	28.46	8	25.48	46	26.22	5	118.67	108	35.38

Table 3—Detailed descriptive statistics on average consumer surplus values per person per day by activity and region, 1967 to 2003

Area and activity	N	Mean	Standard error	Minimum	Maximum
			2004 dollars		
Alaska region:					
Fishing	4	61.99	9.22	45.60	81.94
Floatboating/rafting/canoeing	1	18.16		18.16	18.16
General recreation	1	14.84		14.84	14.84
Hiking	1	15.52		15.52	15.52
Hunting	7	65.68	4.81	47.06	85.45
Pleasure driving	3	8.41	3.67	3.02	15.43
Sightseeing	1	15.84		15.84	15.84
Wildlife viewing	8	49.33	9.49	10.69	84.40
Intermountain area studies:					
Camping	21	34.72	6.64	2.03	116.66
Cross-country skiing	7	29.88	4.58	14.05	46.49
Downhill skiing	3	39.62	13.88	15.05	63.11
Fishing	48	49.57	6.96	8.96	227.28
Floatboating/rafting/canoeing	22	67.70	14.33	2.70	316.42
General recreation	12	48.46	20.92	7.91	257.51
Hiking	7	38.53	7.84	12.85	75.76
Hunting	109	48.55	3.35	2.60	169.31
Motorboating	7	53.68	25.93	5.29	203.62
Mountain biking	6	184.48	41.05	65.88	295.69
Off-road vehicle driving	7	22.81	4.31	7.96	40.86
Other recreation	10	56.35	17.36	12.17	206.82
Picnicking	5	28.27	4.09	13.61	38.76
Pleasure driving	4	69.74	33.23	26.41	167.74
Rock climbing	3	50.45	7.58	35.78	61.14
Sightseeing	11	23.58	8.65	.65	100.73
Snowmobiling	8	36.29	13.24	10.79	124.44
Swimming	1	29.54		29.54	29.54
Waterskiing	2	56.96	13.09	43.87	70.07
Wildlife viewing	61	37.24	3.30	5.26	193.91
Multiple area studies:					
Camping	2	11.82	2.00	9.82	13.82
Cross-country skiing	1	15.20		15.20	15.20
Downhill skiing	1	23.53		23.53	23.53
Fishing	14	47.53	10.49	2.40	126.00
Floatboating/rafting/canoeing	1	34.01		34.01	34.01
General recreation	3	4.00	2.03	1.97	8.05
Hiking	1	25.04		25.04	25.04
Horseback riding	1	18.12		18.12	18.12
Hunting	12	61.69	23.05	6.00	232.58
Motorboating	1	34.36		34.36	34.36
Mountain biking	1	21.13		21.13	21.13
Off-road vehicle driving	1	23.93		23.93	23.93
Other recreation	1	20.83		20.83	20.83
Picnicking	1	18.83		18.83	18.83
Pleasure driving	1	36.46		36.46	36.46

Table 3—Detailed descriptive statistics on average consumer surplus values per person per day by activity and region, 1967 to 2003 (continued)

Area and activity	N	Mean	Standard error	Minimum	Maximum
			2004 dollars		
Rock climbing	12	26.82	.04	26.62	26.92
Sightseeing	1	17.83		17.83	17.83
Swimming	1	23.56		23.56	23.56
Waterskiing	1	67.00		67.00	67.00
Wildlife viewing	29	56.36	12.38	3.00	313.99
Northeast area:					
Birdwatching	3	34.86	22.20	5.80	78.46
Camping	10	33.11	6.32	6.73	66.44
Cross-country skiing	3	34.60	2.82	29.70	39.49
Fishing	69	32.60	5.46	2.08	253.13
Floatboating/rafting/canoeing	6	88.32	22.93	20.08	143.50
General recreation	5	16.87	8.08	1.97	46.69
Going to the beach	22	42.60	7.03	3.78	117.82
Hiking	3	75.18	12.83	49.80	91.10
Hunting	87	47.45	4.03	4.16	250.90
Motorboating	3	29.68	25.21	3.78	80.10
Mountain biking	1	40.93		40.93	40.93
Picnicking	2	56.45	47.51	8.94	103.96
Pleasure driving	1	21.35		21.35	21.35
Rock climbing	1	102.89		102.89	102.89
Scuba diving	14	17.92	3.43	2.81	45.00
Sightseeing	2	121.43	88.36	33.07	209.77
Swimming	7	22.21	6.14	2.20	50.10
Visiting environmental education centers	1	6.01		6.01	6.01
Waterskiing	1	15.13		15.13	15.13
Wildlife viewing	65	31.30	2.18	2.40	96.30
Pacific coast area studies:					
Backpacking	6	52.10	9.29	26.82	80.34
Camping	4	104.35	45.38	7.45	224.53
Cross-country skiing	1	48.38		48.38	48.38
Downhill skiing	1	25.08		25.08	25.08
Fishing	15	44.36	8.68	4.43	103.50
Floatboating/rafting/canoeing	4	27.84	1.01	25.21	29.58
General recreation	9	32.35	14.38	1.42	125.57
Hiking	49	23.24	2.65	.40	129.62
Hunting	18	45.49	7.73	6.25	111.36
Motorboating	8	26.94	5.90	12.48	64.08
Mountain biking	16	49.68	2.74	31.70	78.74
Off-road vehicle driving	1	40.37		40.37	40.37
Other recreation	1	74.47		74.47	74.47
Picnicking	3	64.22	39.66	15.19	142.74
Scuba diving	10	52.60	25.86	5.23	250.04
Sightseeing	4	20.27	13.51	5.23	60.77
Snorkeling	9	30.31	15.36	5.23	135.29
Swimming	4	27.29	11.35	6.06	58.90
Wildlife viewing	23	72.48	16.90	7.09	347.88

Table 3—Detailed descriptive statistics on average consumer surplus values per person per day by activity and region, 1967 to 2003 (continued)

Area and activity	N	Mean	Standard error	Minimum	Maximum
			2004 dollars		
Southeast area studies:					
Birdwatching	5	26.46	6.41	9.44	43.27
Camping	11	25.79	8.09	3.30	65.02
Fishing	27	79.21	23.65	3.60	556.82
Floatboating/rafting/canoeing	47	127.46	13.45	18.05	394.82
General recreation	9	42.77	20.51	5.02	189.46
Going to the beach	11	33.12	5.76	6.79	53.83
Hiking	7	60.38	34.46	1.87	262.04
Hunting	44	35.36	2.86	5.69	82.80
Motorboating	13	58.92	9.59	6.91	134.34
Mountain biking	8	49.62	5.39	20.86	67.52
Off-road vehicle driving	1	5.24		5.24	5.24
Other recreation	4	30.07	11.33	5.71	57.19
Picnicking	2	36.62	8.06	28.56	44.69
Pleasure driving	2	144.78	21.72	123.06	166.49
Rock climbing	11	85.70	9.78	39.28	135.82
Sightseeing	9	46.06	13.70	7.92	112.70
Swimming	13	60.92	9.00	13.64	134.34
Visiting arboretums	1	13.54		13.54	13.54
Visiting aquariums	1	28.31		28.31	28.31
Wildlife viewing	54	40.10	3.20	2.86	134.34
Windsurfing	1	395.47		395.47	395.47

Table 4—Pacific Northwest (Oregon and Washington) consumer surplus per person per day

Activity	Average value	Number of estimates	Number of studies	Standard error
	2004 dollars			
Camping	92.72	2	2	17.44
Downhill skiing	25.08	1	1	
Fishing	41.98	11	5	9.42
Hiking	23.98	40	5	3.14
Hunting	35.27	8	5	9.22
Motorboating	12.48	1	1	
Mountain biking	49.68	16	1	2.73
Off-road vehicle driving	40.37	1	1	
Picknicking	34.74	1	1	
Sightseeing	60.77	1	1	
Swimming	6.06	1	1	
Wildlife viewing	35.00	6	3	2.40

Using Value Tables and Database for Benefit Transfer to Unstudied Recreation Sites on National Forests

Benefit transfer is a term referring to the application of existing valuation information to new sites or unstudied national forests. The two simplest types of benefit transfer involve either using the simple average consumer surplus or value-per-day information from the previous tables, or selecting from the spreadsheet data to more closely match the available studies to the features of the recreation site or national forest for which values are needed. In the nomenclature of benefit transfer, the site with existing valuation data is typically called the "study" site, and the site to which values are transferred is called the "policy" site. It would be preferable to value recreation at the policy site by using that site's specific data (from campground fee receipts, wilderness permits, trail registers, etc.) to estimate a site-specific Travel Cost Method (TCM) demand model to calculate consumer surplus, but this is often not possible. Therefore, benefit transfer can be used, as a "second-best" strategy, for evaluating management and policy impacts. Including a well-prepared benefit transfer is much better than not including recreation economic values in the economic analysis. Some decisionmakers tend to overlook resources that have been omitted from economic analysis and incorrectly assume that those that have been included are more economically important when it may only mean that those included in the analysis are easier to measure.

Benefit transfer can be used, as a "second-best" strategy, for evaluating management and policy impacts. Including a well-prepared benefit transfer is much better than not including recreation economic values in the economic analysis.

Thus, benefit transfer is a practical way to evaluate management and policy impacts when primary research is not possible or justified because of limited time or budget constraints.

Benefit Transfer Methods

There are two broad approaches to benefit transfer: (1) value transfer, and (2) function transfer (fig. 2). Value transfers encompass the transfer of (1-a) a single (point) benefit estimate from a study site, or (1-b) a measure of central tendency (such as an average value) for several benefit estimates from a study site or sites, or (1-c) administratively approved estimates. Administratively approved value estimates will be discussed in conjunction with the measure of central tendency discussion (hereafter average-value transfer will refer to both (1-b) and (1-c)). Function transfers encompass the transfer of (2-a) a function for benefit, willingness to pay, or demand from a study site, or (2-b) a meta-regression analysis function statistically estimated from several study sites. Benefit function transfers tailor the function to fit the specifics of the policy site by setting the values of independent variables such as socioeconomic characteristics, extent of market and environmental impact, and

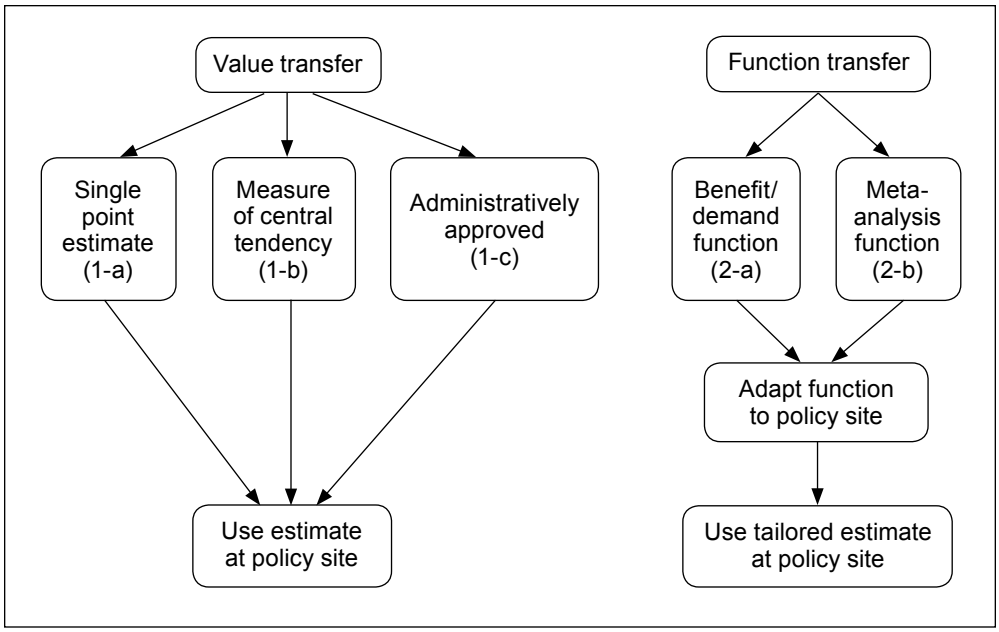

Figure 2—Benefit transfer approaches (from Rosenberger and Loomis 2001).

other measurable characteristics that systematically differ between the study site(s) and the policy site to the values at the policy site. The adapted or tailored benefit function is then used to "forecast" a benefit measure for the policy site.

In this section we define and identify what the benefit measures are, what they mean, and how they were estimated.

Single-Point Estimate Transfer

A single-point estimate benefit transfer is based on using an estimate from a single relevant primary research study (or range of point estimates if more than one study is relevant) obtained from the spreadsheet data. The primary steps to performing a single-point estimate transfer include identifying and quantifying the effect of management- or policy-induced changes on recreation use, and locating and transferring a "unit" consumer surplus measure. The detailed list of the steps involved in single-point estimate transfers were given by Rosenberger and Loomis (2001) as:

1. Identify the resources affected by a proposed action or alternative.
2. Translate resource impacts to changes in recreational use.
3. Estimate recreation use changes.
4. Search the spreadsheet data for relevant study sites.
5. Assess relevance and applicability of study site data.
6. Select a benefit measure from a single relevant study or a range of benefit measures if more than one study is relevant.
7. Multiply benefit measure by total change in recreation use.

We provide information in this report that aids in identifying study site benefit measures from the literature.[1 2] The spreadsheet includes studies conducted from 1967 through 2003 in the United States and Canada. There are 593 studies and 1,239 benefit measures identified. The spreadsheet includes a full reference, recreation activity, geographic region, methodology used, etc., for each observation.

It is important to note that all "unit" benefit measures provided in this report are in consumer surplus per activity-day per person. Therefore, when translating resource impacts into recreation use changes, these impacts should be expressed in activity days.

The simplicity with which the steps to performing a single-point estimate transfer are presented may be misleading. This will become apparent when the information on the conditions for benefit transfers are taken into account as identified below. See Boyle and Bergstrom (1992) for an example of how to critically filter existing research for applicability to a policy site context. In their example, they located five studies that measured the benefit of white-water rafting. They then filtered the studies by three idealized technical considerations (Boyle and Bergstrom 1992: 659):

> (1) the nonmarket commodity of the site must be identical to the nonmarket commodity to be valued at the policy site; (2) the populations affected by the nonmarket commodity at the study site and the policy site have identical characteristics; and (3) the assignment of property rights at both sites must lead to the same theoretically appropriate welfare measure (e.g., willingness to pay versus willingness to accept compensation).

Their filtering of each study based on these considerations left them with no ideal benefit measures to transfer to their policy site. They stated that this is likely to be the case for many transfer scenarios in which "a small number of potential study sites are available and the value(s) estimate at these study sites may not be applicable to the issue at the policy site" (p. 660). Therefore, when performing critical single-point estimate benefit transfers, the original reporting of the study results must be obtained in order to determine its applicability to the evaluation issue at hand.

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[1] Another database that contains recreation use values in addition to other values for the environment is the Environmental Valuation Reference Inventory™ (EVRI™). This is a subscription database and can be found at http://www.evri.ec.gc.ca/evri/.

[2] Use of trade or firms names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Average-Value Transfer

An average-value transfer is based on using a measure of central tendency of all or subsets of relevant and applicable studies as the transfer measure for a policy site. The primary steps to performing an average-value transfer include identifying and quantifying the management- or policy-induced changes on recreation use, and locating and transferring a "unit" average consumer surplus measure. Rosenberger and Loomis (2001) provided a detailed list of the steps involved in average-value transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Estimate recreation use changes.
4. Search the spreadsheet for relevant study sites.
5. Assess relevance and applicability of study site data.
6. Use average-value provided in table 2 for that activity in that region or calculate an average of a subset of applicable study values.
7. Multiply benefit value by total change in recreation use.

Guidance for Performing an Accurate Benefit Transfer

There are several conditions required for performing an accurate benefit transfer (Desvousges et al. 1992). This section illustrates the application of these conditions for a hypothetical benefit transfer. For each condition we provide the name of the relevant variables in the spreadsheet. The exact definition of each of these variables is given in table 5.

The purpose of checking the correspondence of variables for the candidate studies to be transferred against the policy site in need of values is to ensure they are reasonably similar in most characteristics that affect the value of recreation (e.g., determinants of demand and supply). Accuracy in benefit transfer would be improved if there is a good match between the natural environment (e.g., forest) at the sites with values and the sites for which you need values (e.g., forest). This point can best be illustrated by an example. If one only had values in the spreadsheet for mountain biking in the high desert of Moab, Utah, and needed values for mountain biking in the evergreen forests of the El Dorado National Forest near Sacramento in northern California, there would be a mismatch between the natural environment (as well as differences between a small rural town of Moab versus a large urban city of Sacramento, on the demand side). The following factors or variables are worth checking in the spreadsheet to determine whether the average value from the table can be transferred or whether the analyst should select a subset of studies from

Table 5—Variable definitions in spreadsheet

Code #	Variable	Coding
General study characteristics		
V000	STUDYID	Study number
V001	ORIGDATA	1,0; 1 = This is the first study to use this data
V002	AUTHOR(s)	Name(s)
V003	STUDY TITLE	Text
V004	SOURCE/VOL/PAGES	Text
V005	PUBDATE	Month (if available) and year of publication
V005A	DATAANAL	Year of publication
V006	PUBLISHER	Text
V007	DOCUMENT TYPE	1 = journal; 2 = book; 3 = proceedings; 4 = report; 5 = thesis or dissertation; 6 = working paper
V008	CTRY NAME	USA, Canada
Benefit measures		
V009	BENMEAS	1 = willingness to pay (WTP); 2 = willingness to accept (WTA)
V010	MEAN/MED	1,0; 1 = mean, 0 = median (mean should be reported where possible)
V011	DOLVALUE	Value converted to per person per day in 2004 dollars
V011org	ORIGVAL	Original value printed in report
V012	YEARVAL	Year of data
V012a	YEARVALUSED	Year that the given values are based on
V013	ORIGVALUNITS	1 = day; 2 = trip; 3 = year; 4 = season
V013a	AVGTRIP	Average days per trip
V013aa	REPESTASK	Reported, estimated, or asked author
V013b	ORIGNUM	Original number of people per group for ORIGVAL
V014	STD ER	Standard error of mean/median WTP for $ value or study average value
V015	CI'S	1,0; 1 = confidence interval included in report
V016	NATIONAL	1,0; 1 = national
V017	MULTI-STATE	1,0; 1 = multistate
V018	STATE	1,0; 1 = state
V019	ST NAMES	Type in two-letter state abbreviation (e.g., CO for Colorado).
V019b	REGION	U.S. Forest Service Regions 1 thru 10 (11 is all regions); 100 for U.S. national, 101 for Canada
V019cc	Region for Tables	1 = NE (Forest Service area R9); 2 = SE (R8); 3 = Intermountain (R1, R2, R3, R4); 4 = Pacific Coast (R5, R6); 5 = Alaska (R10); 6 = Multiple area studies (R11); there is no region 7
V019ccc	Region for Category	1 = Northeast; 2 = Southeast; 3 = Intermountain; 4 = Pacific Coast; 5 = Alaska; 6 = Multiple area studies (R11)
V19b1	CENSUSREG	Census regions of the USA, 1 thru 5 (and 6 is all regions); 100 is U.S. National, 101 is for Canada
V020	ESTSELEC	1 = author recommendation; 0 = other
V021	AVGSITIME	Average onsite time per trip, in hours (convert multiple days by using 12 hours/day)
V022	GROUPSIZE	Average number of people in group
V023	TOTSITEVIS	Number of visits to the area/site per year in total or per person
V023a	TOTSITDES	Description of the units of number of visits data
V024	SEASLNGTH	Season length converted to days (e.g., hunting period allowed)
V025	ALL/NO-SQ	1,0; 1 = Yes, valued for existing condition; 0 = No

Table 5—Variable definitions in spreadsheet (continued)

Code #	Variable	Coding
V026	CHGVAL	1,0; 1 = Yes, valued for change in quality; 0 = No
V026b	DOLVALCHG	$ value of change
V027	CHGDESCRIP	Text description of change
V028	CHGSIZE	% change, absolute change
V029	STDYSPONSOR	0 = industry; 1 = university; 2 = government; 3 = environmental/ conservation; 4 = multiple category of sponsors; 5 = others
V030	NUMSVYSRET	Number of surveys returned
V030a	NUMUSE	Number of usable surveys
V031	RESPRATE	Response rate percentage
V0331a	RESUSE	Response rate of usable surveys
V032	MAILSVY	1,0; 1 = some studies will have more than 1 survey mode; mail survey includes those mailed out to people but also those that were given to people and needed to be mailed back
V033	PHONESVY	1,0; 1 = phone survey used in the study
V034	INPERSON	1,0; 1 = in person used in the study
V035	SAMPFRAME	1 = on-site; 2 = user list; 3 = general population; 4 = others;
V036	VALMETHOD	1 = contingent valuation method, 0 =travel cost method, 2 = both
V037	GEOGAREA	Geographic area of visitor origin (average one-way distance in miles
Details of CVM application		
V038	PAYVEHICLE	1 = trip cost; 2 = entrance fee/license; 3 = annual pass; 4 = others
V039	OECVM	1,0; 1 = open-ended CVM question
V040	ITBID	1,0; 1 = iterative bidding used
V041	CONJOINT	1,0; 1 = conjoint (rating scale approach)
V042	ST&RP	1,0; 1 = combined stated and revealed preference
V043	PAYCARD	1,0; 1 = payment card
V044	MIDPTS	1 = midpoint; 2 = amount circled (refers to payment card)
V045	PCCAMHUPLF	1,0; 1 = Cameron-Huppert likelihood function (refers to payment card)
V046	DCCVM	1,0; 1 = dichotomous choice or referendum
V047	SB	1 = (SB) single bound; 2 = (DB,MB) double bound or multiple bound
V048	DCSTAT	1 = logit; 2 = probit; 3 = nonparametric; 4 = semi-nonparametric
V049	CVWTPEQ	1,0; 1 = WTPEQ, if equation estimate for any CVM, 0 = no; equation (refers to open-ended CVM)
V050	CVEQTYPE	1 = OLS; 2 = 2SLS; 3 = TOBIT; 4 = others (refers to open-ended CVM)
V051	HNNEGMEAN	1 = no neg (log of Bid or 1/B*(ln(1+expBo)); 2 = neg allowed.
V052	CVUPTRUNC	1,0; 1 = upper limit; 0 = no upper limit of integration
V053	CVOUTLIE	1,0; 1 = removed or “trimmed” outliers; 0 = if not or full sample
V054	PROTESTR	1,0; 1 = protest responses removed; 0 = all observations used
Details of TCM application		
V055	TCMTYPE	1 = zonal; 2 = individual; 3 = RUM/MNL
V056	TCMEQTYPE	1 = OLS; 2 = 2SLS or SUR; 3 = TOBIT; 4 = count data (POISSON, neg binomial); 5 = others (includes MNL, NMNL, when TCMTYPE = 3)
V057	TRUNCADJ	1,0; 1 = truncation adjustment
V058	ENDOGSTRT	1,0; 1 = corrected for endogenous stratification
V059	TRAVTIMEVAR	1,0; 1 = separate variable given for travel time
V060	OPCOSTIME	Wage rate in percent

Table 5—Variable definitions in spreadsheet (continued)

Code #	Variable	Coding
V060a	OPCTINC	1,0; 1 = V060 has value coded; 0 otherwise
V061	COSTMILE	$ per mile used in study year
V061a	COSTKM	$ per km used in study year
V062	SUBS	1,0; 1 = price of substitute or availability of substitute variable included in demand function
V063	SITEQUAL	1,0; 1 = site quality or facility (indicated by author)
V064	HEDTCM	1,0; 1 = hedonic TCM
V065	LHSFUNCFRM	1 = linear; 2 = log; Poisson, negative binomial; 3 = other
V066	RHSFUNCFRM	1 = linear; 2 = log; 3 = other
V067	EXPENDAT	1,0; 1 = expenditure data included in the study/report (e.g., lodging, food, equipment, etc.)
V068	TCMWTPTRUNC	1,0; 1 = upper limit of integration truncated, at max observed TC
V069	TCMOUTLIE	1,0; 1 = outliers or multidestination trips explicitly removed
Study location		
V070A	GENDES	General description of area studied
V070	COUNTY	1,0; 1 = county
V071	CTY NAME	County name
V072	SITE NAME	Name of site
V073	LAKE/RESERVOIR	1,0; 1 = lake/reservoir
V074	LAKE NAME	Text
V075	ESTBAY	1,0; 1 = site is estuary or bay
V076	OCEAN	0 if not ocean; 1 = Atlantic; 2 = Pacific; 3 = Gulf of Mexico
V077	RIVER	1,0; 1 = recreation site is river based
V078	RIVNAME	Name of the river
V079	GREAT LAKES	1,0; 1 = great lakes
V080	AREASIZE	Size of recreation area in acres
V081	NAT FOREST	1,0; 1 = national forest
V082	NFNAME	Name of national forest
V083	NATPARK	1,0; 1 = national park
V084	N.P.NAME	Name of national park
V084bbb	NP,NF,Other	Whether in national park, national forest, or other
V085	NRAREA	1,0; 1 = national recreation area
V086	NRANAME	Name of national recreation area
V087	W/L AREA	1,0; (1 = wildlife refuge or game management area)
V088	W/L AREA NAME	Name of refuge or mgmt area
V089	WILDERNESS	1,0; 1 = recreation use is in wilderness area
V090	WILDNAME	Name of wilderness area
V091	STPARKFOR	1,0; 1 = recreation use is in state park or state forest
V092	STPKNAME	Name of state park
V093	PUBLIC	1,0; 1 = public land including federal, state, county/city
V094	PRIVATE	1,0; 1 = private land
V095	W/L SPECIES	1 = BGAME (deer, elk, etc.); 2 = SGAME (rabbit, quail, dove, etc.); 3 = WTRFWL (duck, geese); 4 = threatened and endangered; 5 = songbirds; 6 = raptors, hawks, eagles, etc.; 7 = fish; 8 = general wildlife
V095a	W/L SPECIES 2	
V095b	W/L SPECIES 3	
V095c	W/L SPECIES 4	

Table 5—Variable definitions in spreadsheet (continued)

Code #	Variable	Coding
V096	FOREST	1,0; 1 = recreation area in forest; 0 = otherwise
V097	ENV TYPE	1 = wetland, 2 = riparian; 0 = otherwise
V098	WATERQUAL	1,0; 1 = water quality was valued or focus of study
V099	AIRQUAL	1,0; 1 = air quality was valued or focus of study
V100	DEVELOP	1,0; 1 = site studied had developed recreation facilities (such as arranged tables etc., e.g., camping, boating, etc.)
V101	DISPERSED	1,0; 1 = site studied was dispersed recreation with no formal site or facilities (e.g., hunting, hiking, etc.)
V102	ROSCLASS	1 = primitive; 2 = SPNM (semiprimitive nonmotorized); 3 = SPM (semiprimitive motorized); 4 = RN (roaded natural); 5 = rural; 6 = urban; 7 = various
V103	ACT TYPE 1	1 = camping; 2 = picnicking; 3 = swimming; 4 = sightseeing; 5 = off-road vehicle driving; 6 = motorboating; 7 = floatboating/rafting/canoeing; 8 = hiking; 9 = mountain biking; 10 = downhill skiing; 11 = cross-country skiing; 12 = snowmobiling; 13 = snowplay; 14 = hunting; 15 = fishing; 16 = wildlife viewing; 17 = horseback riding; 18 = resort; 19 = rock climbing; 20 = general recreation; 21 = other recreation; 22 = visiting wilderness; 23 = waterskiing; 24 = pleasure driving (can include sightseeing); 25 = visiting arboretums; 26 = going to the beach; 27 = relaxing outdoors; 28 = visiting aquariums; 29 = scuba diving; 30 = windsurfing; 31 = bird watching; 32 = snorkeling; 33 = backpacking; 34 = visiting environmental education centers
V104	ACT TYPE 2	One of the above categories of ACTTYPE except one already chosen
V105	ACT TYPE 3	One of the above categories of ACTTYPE except one already chosen
V106	ACT TYPE 4	One of the above categories of ACTTYPE except one already chosen
V107	NUMACT	Number of activities site offers or typical visitor could participate in at site
V108	AVGINC	Average income of visitors
V109	AVGED	Average education of visitors
V110	AVGAGE	Average age of visitors
V111	AVGSEX	(% female); 1 = female; 0 = male; or percent female for group
V112	RESIDENTS	1,0; 1 = residents only; 0 = both
V113	USEEXP	1,0; 1 = very experienced (level of user experience with site); 0 = otherwise
V114	SUCESRATE	Percentage of success rate in hunting
V115	BAG	Number of animals (in hunting)
V116	HOUR	1,0; 1 if bag reported is per hour, zero otherwise
V117	DAY	1,0; 1 if bag reported is per day
V118	TRIP	1,0; 1 if bag reported is per trip
V118a	YEAR	1,0; 1 if bag reported is per year
V119	HIQUAL	1,0; 1 = author states site is of high quality (e.g., popular, unique, well-known, only in the region, etc.)
V120	DATAYEAR	Year data collected
V121	SAMPSIZE	Total sample size used in analysis
V122	NUMTCZONES	Number of zones or origins in zonal TCM.
V123	MULTSITE	1,0; 1 = yes
V124	NUMSITES	Number of sites modeled in multisite or RUM models
V125	CHOICEOC	Number of choice occasions (frequency)
V126	COMMENTS (COMMENTS2 and COMMENTS3)	Text field where coder can write anything special or unusual about study or details about recreation site or area where study was performed

the spreadsheet data from which to calculate average value based on studies that more closely match the study site.

1. The activities to be valued should be identical, or at least similar; see spreadsheet variables, ACT TYPE1, ACT TYPE 2, and ACT TYPE 3.
2. The general geographic region of the study sites and the policy site should be identical or at least similar; see spreadsheet variables ST NAMES, REGION (USFS Regions 1 through 10) and CTY NAME (when available).
3. The type of public land at the study sites and the policy site should be identical or at least similar; see spreadsheet variables PUBLIC, PRIVATE, NAT FOREST, NATPARK, NRAREA (national recreation area), W/L AREA (state or federal wildlife area), WILDERNESS, STPARKFOR (state park or state forest).
4. For wildlife recreation, similar species should be valued in both cases. For example, for valuation of big game hunting, one should use existing big game hunting studies, not waterfowl or upland game bird hunting studies; see spreadsheet variables W/L SPECIES, W/L SPECIES 2, W/L SPECIES 3.
5. The type of population and magnitude of the human population at the study site and policy site should be similar (i.e., rural to rural, or urban to urban); see spreadsheet variables AVGED, AVGAGE, RESIDENTS.
6. Level of facility development and recreation opportunity spectrum classification should be similar between the study sites and the policy site; see spreadsheet variables DEVELOP, DISPERSED, ROSCLASS.
7. The environmental resource and the natural setting of the resource at the study site and the resource at the policy site should be similar. As mentioned in the example above, it would be desirable to transfer values of a particular recreation activity that occurred in the same environmental setting or ecosystem type. Thus camping in a forest might yield different values than camping at the beach. See spreadsheet variables FOREST, ENV TYPE, LAKE/RESERVOIR, ESTBAY (estuary/bay), OCEAN, RIVER, GREAT LAKES.
8. The markets or determinants of demand (similarity of demographic profiles between the two populations and their cultural aspects) for the study site and the policy site should be similar. That is, similar levels of income, racial composition, degree of ruralness. Unfortunately, most studies did not report demographics, but check spreadsheet variable AVGINC. If there are no observations for this demographic variable, inspection of spreadsheet variables such as ST NAMES and CTY NAME (when available) may be instructive. For example, a camping study in North Dakota might not yield accurate

values for camping at the Angeles National Forest outside of Los Angeles owing to differences in income levels and racial composition of the two populations.

9. The conditions and quality of the recreation activity experiences (e.g., intensity, duration, and skill requirements) are similar between the study site and the policy site. It is not accurate to transfer the value per day for rafting down the Colorado River in Grand Canyon National Park to rafting down the Colorado River in the White River National Forest paralleling I-70 in Glenwood Canyon.

Keep in mind that most of the original research studies reported in the database were not designed for future benefit-transfer applications. The information requirements expressed in the above conditions are not always met in the reporting of data and results from primary research. In addition to weighing the benefits of more information from expensive primary research, the implicit cost of performing benefit transfers under conditions of incomplete information should be accounted for. Therefore, benefit transfer practitioners need to be pragmatic in their applications of the method when considering the many limitations imposed upon them by the limited availability of existing studies. It is this author's opinion that in many cases, even a rough approximation of the average value per day from a conservative benefit transfer is better than simply ignoring the economic value of recreation in forest plans or environmental impact statements.

Validity and Reliability of Benefit Transfers

There are at least two sources of error in benefit transfer that influence the reliability and validity of the resulting benefit estimates. First is the underlying variability in the original study estimates. If the original study reports the standard error of the estimate, then a confidence interval for transferred point estimates can be calculated. This confidence interval provides the statistical range in which we would expect the original estimate to be some large percentage of the time (e.g., a 95-percent confidence interval means the estimate would be within the calculated range 95 percent of the time). However, this confidence interval does not account for the additional error associated with transferring the estimate from the original study site to the policy site.

Several recent studies have tested the convergent validity and reliability of different benefit-transfer methods (Desvousges et al. 1998, Downing and Ozuna 1996, Kirchhoff et al. 1997, Loomis et al. 1995, Rosenberger and Loomis 2000). The methods tested include single-point estimate, average-value, demand-function, and meta-regression-analysis transfers. Although the above studies show that some of

the methods are relatively more valid and reliable than other methods, the general indication is that benefit transfer cannot replace original research, especially when the costs of being wrong are high. In tests of the benefit-transfer methods within the same geographic region, transferred values were very similar to the "true" values and errors were in the range of 4 to 40 percent when using benefit-function transfer (Loomis 1992). In other cases, the disparity between the "true" value and the "tailored" value was quite large. These errors were typically in the range of 50 to 80 percent when using meta-regression benefit transfer as compared with in-sample study values used to estimate the meta-regression (Rosenberger and Loomis 2000) and a comparison to new out-of-sample study values not used to estimate the original meta-regression (Shrestha and Loomis 2003).

Other Potential Limitations of Benefit Transfers

Several other factors can also influence the accuracy of any particular benefit transfer. Factors that affect the accuracy of any specific benefit transfer include:

- The quality of the original study.
- A limited number of studies investigating an activity's economic value, thus restricting the pool of estimates and studies from which to draw information.
- Different research methods across study sites for a specific recreation activity, including differences in what question(s) was asked, how it was asked, what was affected by the management or policy action, how the environmental impacts were measured, and how these impacts affect recreation use.
- Different statistical methods used for estimating models, which can lead to large differences in values estimated. This also includes issues such as the overall impact of model mis-specification and choice of functional form of the demand function (Adamowicz et al. 1989).
- Unique sites and conditions of existing studies used for valuing recreation activities. See the variables SITE NAME, LAKE NAME, N.P. NAME, W/L AREA NAME, STPKNAME to ensure there is similarity of the study site and policy site.

The above listed factors can lead to bias or error in, and restrict the robustness of, the benefit-transfer process. An overriding objective of the benefit-transfer process is to minimize mean square error between the "true" value and the transferred value of impacts at the policy site. However, the original or "true" values are themselves approximations and are therefore subject to error. As such, any information

transferred from a study site to a policy site is accomplished with varying degrees of confidence in the applicability and precision of the information.

Nonetheless it is our belief that national forest decisionmaking involving tradeoffs between types of recreation (motorized vs. nonmotorized), and other multiple-use tradeoffs can often be improved by inclusion of even approximate estimates of nonmarket recreation values.

A Note on Definition of Benefit Measures and Use in Policy Analyses

All of the benefit estimates provided by this report, either recorded from the literature review or "forecasted" by adapting benefit functions, are average consumer surplus per person per activity-day. In the case of a single study, the estimate is the average consumer surplus of the average individual values reported in the study. In the case of several studies, the estimate is the average of the study samples' average consumer surpluses from all included studies.

Consumer surplus is the value of a recreation activity beyond what must be paid to enjoy it.[3] When the change in recreation supply or days is small and localized, consumer surplus is equivalent to a "virtual" market price for a recreation activity (Rosenthal and Brown 1985). A general assumption when applying the benefit estimates is that the estimates are constant across all levels of resource impacts and perceived changes for an individual. This assumption may be plausible for small changes in visitation, but it may be unrealistic for large changes (Morey 1994). However, this assumption is necessary for some of the simple approaches to benefit transfers such as point-estimate or average-value transfer. If the analyst is evaluating a large-scale ecosystem change, then an original study will often be necessary (and warranted), or a benefit-function transfer approach that incorporates the quality of the resource would be necessary to accurately capture the change in benefits. Such a benefit-function transfer approach would be to apply a demand curve that contains a resource quality variable or apply a contingent valuation method willingness-to-pay equation that contains the relevant resource quality variables for the change being evaluated.

[3] There are two prominent types of consumer surplus estimated by using slightly different definitions of the demand function: Marshallian consumer surplus based on an ordinary demand function, and Hicksian surplus based on either a compensated demand function or elicited directly by using hypothetical market techniques. The difference between these measures is due to the income effect (Willig 1976). Because outdoor recreation expenditures are a relatively small percentage of total expenditures (income), differences between the two measures are expected to be negligible.

Simply stated, the benefit-transfer estimate of a management- or policy-induced change in recreation is the average consumer surplus estimates for the average individual from the literature aggregated for the particular change in use of the natural resource. The change in recreational use of a resource may be induced either through a price change for participating in an activity (e.g., fee change or location of the site) or through a quality change in the recreation site.

Details of Spreadsheet Coding

Often times in performing benefit transfer, it is more appropriate to compute an average value per visitor-day from empirical studies that closely match the policy site, rather than just using an overall average for the region. To facilitate doing this, the spreadsheet contains numerous details about each of the studies.

Details of the recreation site include, in part, its geographic location, whether it was on public or private land, the type of public land (e.g., national park, national forest, state park, state forest), the state, the USDA Forest Service Region, and land type (e.g., lake, forest, wetland, grassland, river). In many cases, specific details about the recreation site were not provided either because of incomplete reporting or because the activity was not linked with a specific site. Details of the user population characteristics include, in part, average age, average income, average education, and proportion female.

Methodology details include survey mode (e.g., mail, telephone, in-person, use of secondary data), response rate for primary data collection studies, and sample frame (e.g., onsite users, general population). Methodology details are further divided between the application of revealed preference (RP) and stated preference (SP) modeling when appropriate. Details of RP modeling include, in part, identifying the model type (e.g., individual travel cost, zonal travel cost, random utility models), use of travel time or substitute sites in the model specification, and functional form (double log, linear, semilog, log-linear). Details of SP modeling include, in part, identifying the model type (e.g., conjoint analysis, contingent valuation models), the elicitation technique for contingent valuation models (e.g., open ended, dichotomous choice, iterative bidding, payment card), and functional form.

The details of each study were coded to the extent that they could be gleaned from the research-reporting venue. However, not every study could be fully coded (table 5). This was either because information was not reported or was not collected for a study. For example, very few of the studies in the literature review reported any details about the user population. This and other factors are indicative of the lack of consistent and complete data reporting that further limits the ability to perform critical benefit transfers.

Summary

This report provides updated average values and a spreadsheet that gives information on outdoor recreation use valuation studies, including study source, benefit measures, recreation activity, valuation methodology, and geographic region. This literature review spans 1967 to 2003 and covers more than 20 recreation activities.

Guidance on performing various benefit-transfer methods is also provided in this report. Benefit transfer is the use of past empirical benefit estimates to assess and analyze current management and policy actions. Two benefit-transfer approaches (single-point estimates, average values) were discussed in detail.

A research effort such as this is really never complete, as new studies appear every year. Some of these studies could fill important gaps in the existing literature or increase the small sample of valuation studies for that activity in that region. Augmenting this database with new studies every 5 years is probably a worthwhile undertaking to keep the database current and of greatest use for field personnel.

Augmenting this database with new studies every 5 years is probably a worthwhile undertaking to keep the database current and of greatest use for field personnel.

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Appendix 8.6: Annual Benefits Table

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Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
2012	Avoided emergency water supply costs	AF						1.000	
	Avoided costs of supplying potable water for golf course irrigation	AF						1.000	
	Avoided boating recreation losses	Visitor days						1.000	
	Avoided fishing recreation losses	Visitor days						1.000	
2013	Avoided emergency water supply costs	AF						0.943	
	Avoided costs of supplying potable water for golf course irrigation	AF						0.943	
	Avoided boating recreation losses	Visitor days						0.943	
	Avoided fishing recreation losses	Visitor days						0.943	
2014	Avoided emergency water supply costs	AF	225	300	75	$ 989.00	$ 74,175.00	0.890	**$ 66,015.49**
	Avoided costs of supplying potable water for golf course irrigation	AF	158	210	52	$ 371.43	$ 19,314.29	0.890	**$ 17,189.65**
	Avoided boating recreation losses	Visitor days	12,174	16,232	4,058	$ 33.84	$ 137,322.72	0.890	**$ 122,216.73**
	Avoided fishing recreation losses	Visitor days	7,695	10,260	2,565	$ 53.92	$ 138,304.80	0.890	**$ 123,090.78**
2015	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.840	**$ 249,115.04**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.840	**$ 65,490.30**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.840	**$ 461,195.21**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.840	**$ 464,493.51**
2016	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.792	**$ 235,014.19**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.792	**$ 61,783.31**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.792	**$ 435,089.83**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.792	**$ 438,201.42**
2017	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.747	**$ 221,711.50**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.747	**$ 58,286.14**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.747	**$ 410,462.10**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.747	**$ 413,397.57**
2018	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.705	**$ 209,161.79**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.705	**$ 54,986.92**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.705	**$ 387,228.40**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.705	**$ 389,997.71**
2019	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.665	**$ 197,322.45**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.665	**$ 51,874.45**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.665	**$ 365,309.81**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.665	**$ 367,922.36**
2020	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.627	**$ 186,153.25**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.627	**$ 48,938.16**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.627	**$ 344,631.89**
...	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.627	**$ 347,096.57**
2021	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.592	**$ 175,616.27**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.592	**$ 46,168.08**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.592	**$ 325,124.43**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.592	**$ 327,449.59**
2022	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.558	**$ 165,675.73**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.558	**$ 43,554.79**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.558	**$ 306,721.16**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.558	**$ 308,914.71**
2023	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.527	**$ 156,297.86**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.527	**$ 41,089.43**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.527	**$ 289,359.58**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.527	**$ 291,428.97**
2024	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.497	**$ 147,450.81**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.497	**$ 38,763.61**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.497	**$ 272,980.74**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.497	**$ 274,932.99**
2025	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.469	**$ 139,104.54**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.469	**$ 36,569.44**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.469	**$ 257,529.00**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.469	**$ 259,370.75**
2026	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.442	**$ 131,230.70**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.442	**$ 34,499.48**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.442	**$ 242,951.89**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.442	**$ 244,689.39**
2027	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.417	**$ 123,802.54**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.417	**$ 32,546.67**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.417	**$ 229,199.89**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.417	**$ 230,839.04**
2028	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.394	**$ 116,794.85**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.394	**$ 30,704.41**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.394	**$ 216,226.31**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.394	**$ 217,772.68**
2029	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.371	**$ 110,183.82**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.371	**$ 28,966.42**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.371	**$ 203,987.09**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.371	**$ 205,445.93**
2030	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.350	**$ 103,947.00**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.350	**$ 27,326.82**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.350	**$ 192,440.65**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.350	**$ 193,816.91**
2031	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.331	**$ 98,063.21**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.331	**$ 25,780.01**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.331	**$ 181,547.78**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.331	**$ 182,846.14**
2032	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.312	**$ 92,512.46**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.312	**$ 24,320.77**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.312	**$ 171,271.49**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.312	**$ 172,496.36**
2033	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.294	**$ 87,275.91**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.294	**$ 22,944.12**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.294	**$ 161,576.88**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.294	**$ 162,732.42**
2034	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.278	**$ 82,335.76**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.278	**$ 21,645.40**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.278	**$ 152,431.02**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.278	**$ 153,521.15**
2035	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.262	**$ 77,675.25**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.262	**$ 20,420.19**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.262	**$ 143,802.85**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.262	**$ 144,831.27**
2036	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.247	**$ 73,278.54**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.247	**$ 19,264.33**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.247	**$ 135,663.06**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.247	**$ 136,633.27**
2037	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.233	**$ 69,130.69**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.233	**$ 18,173.89**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.233	**$ 127,984.02**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.233	**$ 128,899.32**
2038	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.220	**$ 65,217.64**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.220	**$ 17,145.18**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.220	**$ 120,739.64**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.220	**$ 121,603.13**
2039	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.207	**$ 61,526.07**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.207	**$ 16,174.70**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.207	**$ 113,905.32**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.207	**$ 114,719.93**
2040	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.196	**$ 58,043.46**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.196	**$ 15,259.15**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.196	**$ 107,457.85**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.196	**$ 108,226.35**
2041	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.185	**$ 54,757.98**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.185	**$ 14,395.43**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.185	**$ 101,375.33**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.185	**$ 102,100.33**
2042	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.174	**$ 51,658.48**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.174	**$ 13,580.59**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.174	**$ 95,637.11**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.174	**$ 96,321.07**
2043	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.164	**$ 48,734.41**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.164	**$ 12,811.88**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.164	**$ 90,223.69**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.164	**$ 90,868.93**
2044	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.155	**$ 45,975.86**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.155	**$ 12,086.68**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.155	**$ 85,116.68**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.155	**$ 85,725.41**
2045	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.146	**$ 43,373.45**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.146	**$ 11,402.53**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.146	**$ 80,298.76**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.146	**$ 80,873.03**
2046	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.138	**$ 40,918.35**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.138	**$ 10,757.10**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.138	**$ 75,753.55**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.138	**$ 76,295.31**
2047	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.130	**$ 38,602.22**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.130	**$ 10,148.21**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.130	**$ 71,465.61**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.130	**$ 71,976.70**
2048	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.123	**$ 36,417.19**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.123	**$ 9,573.78**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.123	**$ 67,420.39**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.123	**$ 67,902.55**
2049	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.116	**$ 34,355.84**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.116	**$ 9,031.87**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.116	**$ 63,604.14**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.116	**$ 64,059.01**
2050	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.109	**$ 32,411.17**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.109	**$ 8,520.63**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.109	**$ 60,003.90**
...	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.109	**$ 60,433.03**
2051	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.103	**$ 30,576.57**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.103	**$ 8,038.33**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.103	**$ 56,607.46**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.103	**$ 57,012.29**
2052	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.097	**$ 28,845.82**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.097	**$ 7,583.33**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.097	**$ 53,403.26**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.097	**$ 53,785.18**
2053	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.092	**$ 27,213.04**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.092	**$ 7,154.09**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.092	**$ 50,380.43**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.092	**$ 50,740.74**
2054	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.087	**$ 25,672.68**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.087	**$ 6,749.14**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.087	**$ 47,528.71**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.087	**$ 47,868.62**
2055	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.082	**$ 24,219.51**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.082	**$ 6,367.11**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.082	**$ 44,838.41**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.082	**$ 45,159.08**
2056	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.077	**$ 22,848.59**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.077	**$ 6,006.71**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.077	**$ 42,300.38**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.077	**$ 42,602.90**
2057	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.073	**$ 21,555.28**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.073	**$ 5,666.71**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.073	**$ 39,906.02**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.073	**$ 40,191.42**
2058	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.069	**$ 20,335.17**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.069	**$ 5,345.95**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.069	**$ 37,647.19**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.069	**$ 37,916.43**
2059	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.065	**$ 19,184.12**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.065	**$ 5,043.35**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.065	**$ 35,516.22**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.065	**$ 35,770.22**
2060	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.061	**$ 18,098.23**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.061	**$ 4,757.88**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.061	**$ 33,505.87**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.061	**$ 33,745.49**
2061	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.058	**$ 17,073.80**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.058	**$ 4,488.56**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.058	**$ 31,609.31**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.058	**$ 31,835.37**
2062	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.054	**$ 16,107.36**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.054	**$ 4,234.49**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.054	**$ 29,820.10**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.054	**$ 30,033.36**
2063	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.051	**$ 15,195.62**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.051	**$ 3,994.80**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.051	**$ 28,132.17**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.051	**$ 28,333.36**
2064	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.048	**$ 14,335.49**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.048	**$ 3,768.68**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.048	**$ 26,539.78**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.048	**$ 26,729.59**
2065	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.046	**$ 13,524.05**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.046	**$ 3,555.36**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.046	**$ 25,037.53**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.046	**$ 25,216.59**
2066	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.043	**$ 12,758.54**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.043	**$ 3,354.11**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.043	**$ 23,620.31**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.043	**$ 23,789.24**
2067	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.041	**$ 12,036.35**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.041	**$ 3,164.26**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.041	**$ 22,283.31**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.041	**$ 22,442.68**
2068	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.038	**$ 11,355.05**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.038	**$ 2,985.15**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.038	**$ 21,022.00**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.038	**$ 21,172.34**
2069	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.036	**$ 10,712.31**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.036	**$ 2,816.18**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.036	**$ 19,832.07**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.036	**$ 19,973.90**
2070	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.034	**$ 10,105.96**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.034	**$ 2,656.77**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.034	**$ 18,709.50**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.034	**$ 18,843.30**
2071	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.032	**$ 9,533.92**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.032	**$ 2,506.39**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.032	**$ 17,650.47**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.032	**$ 17,776.70**
2072	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.030	**$ 8,994.26**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.030	**$ 2,364.52**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.030	**$ 16,651.39**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.030	**$ 16,770.47**
2073	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.029	**$ 8,485.15**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.029	**$ 2,230.68**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.029	**$ 15,708.86**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.029	**$ 15,821.20**
2074	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.027	**$ 8,004.86**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.027	**$ 2,104.41**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.027	**$ 14,819.68**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.027	**$ 14,925.66**
2075	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.025	**$ 7,551.76**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.025	**$ 1,985.30**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.025	**$ 13,980.83**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.025	**$ 14,080.81**
2076	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.024	**$ 7,124.30**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.024	**$ 1,872.92**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.024	**$ 13,189.46**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.024	**$ 13,283.79**
2077	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.023	**$ 6,721.04**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.023	**$ 1,766.91**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.023	**$ 12,442.89**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.023	**$ 12,531.87**
2078	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.021	**$ 6,340.60**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.021	**$ 1,666.89**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.021	**$ 11,738.57**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.021	**$ 11,822.52**
2079	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.020	**$ 5,981.70**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.020	**$ 1,572.54**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.020	**$ 11,074.12**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.020	**$ 11,153.32**
2080	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.019	**$ 5,643.11**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.019	**$ 1,483.53**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.019	**$ 10,447.29**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.019	**$ 10,522.00**
2081	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.018	**$ 5,323.69**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.018	**$ 1,399.55**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.018	**$ 9,855.93**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.018	**$ 9,926.42**
2082	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.017	**$ 5,022.35**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.017	**$ 1,320.33**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.017	**$ 9,298.05**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.017	**$ 9,364.54**
2083	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.016	**$ 4,738.07**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.016	**$ 1,245.60**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.016	**$ 8,771.74**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.016	**$ 8,834.48**
2084	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.015	**$ 4,469.87**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.015	**$ 1,175.09**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.015	**$ 8,275.23**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.015	**$ 8,334.41**
2085	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.014	**$ 4,216.86**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.014	**$ 1,108.58**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.014	**$ 7,806.82**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.014	**$ 7,862.65**
2086	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.013	**$ 3,978.17**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.013	**$ 1,045.83**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.013	**$ 7,364.93**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.013	**$ 7,417.60**
2087	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.013	**$ 3,752.99**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.013	**$ 986.63**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.013	**$ 6,948.04**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.013	**$ 6,997.73**
2088	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.012	**$ 3,540.56**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.012	**$ 930.78**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.012	**$ 6,554.76**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.012	**$ 6,601.63**
2089	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.011	**$ 3,340.15**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.011	**$ 878.10**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.011	**$ 6,183.73**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.011	**$ 6,227.96**
2090	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.011	**$ 3,151.08**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.011	**$ 828.39**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.011	**$ 5,833.71**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.011	**$ 5,875.43**
2091	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.010	**$ 2,972.72**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.010	**$ 781.50**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.010	**$ 5,503.50**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.010	**$ 5,542.86**
2092	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.009	**$ 2,804.45**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.009	**$ 737.27**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.009	**$ 5,191.98**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.009	**$ 5,229.11**
2093	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.009	**$ 2,645.71**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.009	**$ 695.54**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.009	**$ 4,898.10**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.009	**$ 4,933.13**
2094	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.008	**$ 2,495.95**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.008	**$ 656.17**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.008	**$ 4,620.85**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.008	**$ 4,653.89**
2095	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.008	**$ 2,354.67**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.008	**$ 619.02**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.008	**$ 4,359.29**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.008	**$ 4,390.46**
2096	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.007	**$ 2,221.39**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.007	**$ 583.99**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.007	**$ 4,112.54**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.007	**$ 4,141.95**
2097	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.007	**$ 2,095.65**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.007	**$ 550.93**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.007	**$ 3,879.75**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.007	**$ 3,907.50**
2098	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.007	**$ 1,977.03**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.007	**$ 519.74**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.007	**$ 3,660.14**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.007	**$ 3,686.32**
2099	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.006	**$ 1,865.12**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.006	**$ 490.33**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.006	**$ 3,452.96**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.006	**$ 3,477.66**
2100	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.006	**$ 1,759.55**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value [1]	Annual $ Value [1] (f) x (g)	Discount Factor [1]	Discounted Benefits [1] (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.006	**$ 462.57**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.006	**$ 3,257.51**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.006	**$ 3,280.81**
2101	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.006	**$ 1,659.95**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.006	**$ 436.39**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.006	**$ 3,073.13**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.006	**$ 3,095.10**
2102	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.005	**$ 1,565.99**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.005	**$ 411.69**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.005	**$ 2,899.18**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.005	**$ 2,919.91**
2103	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.005	**$ 1,477.35**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.005	**$ 388.38**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.005	**$ 2,735.07**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.005	**$ 2,754.63**
2104	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.005	**$ 1,393.73**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.005	**$ 366.40**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.005	**$ 2,580.26**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.005	**$ 2,598.71**
2105	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.004	**$ 1,314.84**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.004	**$ 345.66**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.004	**$ 2,434.20**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.004	**$ 2,451.61**
2106	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.004	**$ 1,240.41**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.004	**$ 326.09**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.004	**$ 2,296.42**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.004	**$ 2,312.84**
2107	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.004	**$ 1,170.20**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.004	**$ 307.64**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.004	**$ 2,166.43**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.004	**$ 2,181.93**
2108	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.004	**$ 1,103.96**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: Chabot Dam Seismic Upgrade Project

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	**Without Project**	**With Project**	**Change Resulting from Project (e) – (d)**	Unit $ Value (1)	Annual $ Value (1) (f) x (g)	Discount Factor (1)	Discounted Benefits (1) (h) x (i)
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.004	**$ 290.22**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.004	**$ 2,043.80**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.004	**$ 2,058.42**
2109	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.004	**$ 1,041.47**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.004	**$ 273.80**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.004	**$ 1,928.12**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.004	**$ 1,941.91**
2110	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.003	**$ 982.52**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.003	**$ 258.30**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.003	**$ 1,818.98**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.003	**$ 1,831.99**
2111	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.003	**$ 926.91**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.003	**$ 243.68**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.003	**$ 1,716.02**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.003	**$ 1,728.29**
2112	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.003	**$ 874.44**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.003	**$ 229.88**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.003	**$ 1,618.88**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.003	**$ 1,630.46**
2113	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.003	**$ 824.95**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.003	**$ 216.87**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.003	**$ 1,527.25**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.003	**$ 1,538.17**
2114	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.003	**$ 778.25**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.003	**$ 204.60**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.003	**$ 1,440.80**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.003	**$ 1,451.11**
2115	Avoided emergency water supply costs	AF	0	300	300	$ 989.00	$ 296,700.00	0.002	**$ 734.20**
	Avoided costs of supplying potable water for golf course irrigation	AF	0	210	210	$ 371.43	$ 78,000.00	0.002	**$ 193.01**
	Avoided boating recreation losses	Visitor days	0	16,232	16,232	$ 33.84	$ 549,290.88	0.002	**$ 1,359.25**
	Avoided fishing recreation losses	Visitor days	0	10,260	10,260	$ 53.92	$ 553,219.20	0.002	**$ 1,368.97**
								Total Present Value of Discounted Benefits Based on Unit Value	**$ 22,179,450.73**
Comments:									

(1) Complete these columns if dollar value is being claimed for the benefit.

Appendix 8.7: Annual Costs Table

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Table 16 – Annual Costs of Project (All costs should be in 2012 Dollars) Project: Chabot Dam Seismic Upgrade										
	Initial Costs Grand Total Cost from Table 6 (row (i), column (d))	Adjusted Grant Total Cost[1]	Annual Costs [2]						Discounting Calculations	
			Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +…+ (g)	Discount Factor	Discounted Project Costs (h) x (i)
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2010	$ 102,272.73							$ 102,272.73	1.124	$ 114,913.64
2011	$ 409,090.91							$ 409,090.91	1.060	$ 433,636.36
2012	$ 418,636.36							$ 418,636.36	1.000	$ 418,636.36
2013	$ 770,000.00							$ 770,000.00	0.943	$ 726,415.09
2014	$ 4,584,615.38							$ 4,584,615.38	0.890	$ 4,080,291.37
2015	$ 12,290,384.62							$ 12,290,384.62	0.840	$ 10,319,243.92
2016			2,000.00	$ 13,000.00	$ 1,000.00	$ 30,000.00		$ 46,000.00	0.792	$ 36,436.31
2017			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.747	$ 11,956.13
2018			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.705	$ 11,279.37
2019			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.665	$ 10,640.91
2020			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.627	$ 10,038.60
2021			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.592	$ 9,470.38
2022			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.558	$ 8,934.32
2023			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.527	$ 8,428.60
2024			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.497	$ 7,951.51
2025			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.469	$ 7,501.42
2026			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.442	$ 7,076.82
2027			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.417	$ 6,676.24
2028			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.394	$ 6,298.34
2029			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.371	$ 5,941.83
2030			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.350	$ 5,605.50
2031			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.331	$ 5,288.21
2032			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.312	$ 4,988.88
2033			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.294	$ 4,706.49
2034			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.278	$ 4,440.08
2035			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.262	$ 4,188.76
2036			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.247	$ 3,951.66
2037			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.233	$ 3,727.98
2038			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.220	$ 3,516.96
2039			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.207	$ 3,317.89

Table 16 – Annual Costs of Project (All costs should be in 2012 Dollars) Project: Chabot Dam Seismic Upgrade										
	Initial Costs Grand Total Cost from Table 6 (row (i), column (d))	Adjusted Grant Total Cost[1]	Annual Costs [2]						Discounting Calculations	
			Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +…+ (g)	Discount Factor	Discounted Project Costs (h) x (i)
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2040			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.196	$ 3,130.08
2041			2,000.00	$ 13,000.00	$ 1,000.00	$ 30,000.00		$ 46,000.00	0.185	$ 8,489.61
2042			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.174	$ 2,785.76
2043			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.164	$ 2,628.08
2044			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.155	$ 2,479.32
2045			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.146	$ 2,338.98
2046			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.138	$ 2,206.58
2047			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.130	$ 2,081.68
2048			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.123	$ 1,963.85
2049			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.116	$ 1,852.69
2050			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.109	$ 1,747.82
2051			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.103	$ 1,648.89
2052			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.097	$ 1,555.56
2053			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.092	$ 1,467.50
2054			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.087	$ 1,384.44
2055			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.082	$ 1,306.07
2056			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.077	$ 1,232.15
2057			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.073	$ 1,162.40
2058			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.069	$ 1,096.60
2059			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.065	$ 1,034.53
2060			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.061	$ 975.97
2061			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.058	$ 920.73
2062			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.054	$ 868.61
2063			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.051	$ 819.45
2064			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.048	$ 773.06
2065			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.046	$ 729.30
2066			2,000.00	$ 13,000.00	$ 1,000.00	$ 30,000.00		$ 46,000.00	0.043	$ 1,978.07
2067			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.041	$ 649.08
2068			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.038	$ 612.34
2069			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.036	$ 577.68

Table 16 – Annual Costs of Project (All costs should be in 2012 Dollars) Project: Chabot Dam Seismic Upgrade										
	Initial Costs Grand Total Cost from Table 6 (row (i), column (d))	Adjusted Grant Total Cost[1]	Annual Costs [2]						Discounting Calculations	
			Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +…+ (g)	Discount Factor	Discounted Project Costs (h) x (i)
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2070			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.034	$ 544.98
2071			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.032	$ 514.13
2072			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.030	$ 485.03
2073			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.029	$ 457.57
2074			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.027	$ 431.67
2075			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.025	$ 407.24
2076			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.024	$ 384.19
2077			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.023	$ 362.44
2078			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.021	$ 341.93
2079			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.020	$ 322.57
2080			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.019	$ 304.31
2081			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.018	$ 287.09
2082			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.017	$ 270.84
2083			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.016	$ 255.51
2084			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.015	$ 241.04
2085			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.014	$ 227.40
2086			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.013	$ 214.53
2087			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.013	$ 202.39
2088			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.012	$ 190.93
2089			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.011	$ 180.12
2090			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.011	$ 169.93
2091			2,000.00	$ 13,000.00	$ 1,000.00	$ 30,000.00		$ 46,000.00	0.010	$ 460.89
2092			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.009	$ 151.23
2093			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.009	$ 142.67
2094			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.008	$ 134.60
2095			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.008	$ 126.98
2096			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.007	$ 119.79
2097			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.007	$ 113.01
2098			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.007	$ 106.61
2099			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.006	$ 100.58

Table 16 – Annual Costs of Project (All costs should be in 2012 Dollars) Project: Chabot Dam Seismic Upgrade										
	Initial Costs Grand Total Cost from Table 6 (row (i), column (d))	Adjusted Grant Total Cost[1]	Annual Costs [2]						Discounting Calculations	
			Admin	Operation	Maintenance	Replacement	Other	Total Costs (a) +…+ (g)	Discount Factor	Discounted Project Costs (h) x (i)
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2100			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.006	$ 94.89
2101			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.006	$ 89.52
2102			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.005	$ 84.45
2103			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.005	$ 79.67
2104			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.005	$ 75.16
2105			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.004	$ 70.90
2106			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.004	$ 66.89
2107			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.004	$ 63.10
2108			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.004	$ 59.53
2109			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.004	$ 56.16
2110			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.003	$ 52.98
2111			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.003	$ 49.98
2112			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.003	$ 47.16
2113			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.003	$ 44.49
2114			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.003	$ 41.97
2115			2,000.00	$ 13,000.00	$ 1,000.00			$ 16,000.00	0.002	$ 39.59
	$ 18,575,000.00	$ -	$ 200,000.00	$ 1,300,000.00	$ 100,000.00	$ 120,000.00	$ -	$ 20,295,000.00		$ 16,347,265.48
Total Present Value of Discounted Costs (Sum of Column (j)) Transfer to Table 17, column (c), Proposal Benefits and Costs Summaries										
Comments:										

(1) If any, based on opportunity costs, sunk costs and associated costs

(2) The incremental change in O&M costs attributable to the project