Appendix A: Summary of Economic and Financial Analysis Practices for Water Recycling Projects in California among State and Federal agencies

A.1 INTRODUCTION

The purpose of this technical memo is to provide a summary of economic and financial analysis among different state and federal agencies in California involved in water recycling project funding and approvals. In this review we present commonalities and differences between the agency methods and provide background information for the EATF participants. This summary was the product of conducting a document review on the procedures undertaken by the California Department of Public Health (CDPH), the California Department of Water Resources (DWR), the State Water Resources Control Board (SWB), and the U.S. Bureau of Reclamation (Reclamation). A summary of the documents reviewed and the primary methods for completing economic and financial analyses is tabulated below with supporting information presented in the subsequent sections.

A.2 AGENCY DOCUMENTS

A summary of the time aspects and methodologies used in the various economic and financial analyses discussed in this Technical Memo is presented in Table A.1 below. Overall, time period in the economic analyses ranges from 20 to 100 years, as opposed to the financial analyses that are mostly based on project payment. The constant dollar discount rates used for economic analysis in California are generally 6% and Reclamation (when determining discounted costs and benefits) uses the rate required by Public Law 93-251 (88 Stat. 34), Section 704.39(a) of the Water Resources Council's Rule and Regulations. The discount rate is based upon "the average yield during the preceding fiscal year on interest-bearing marketable securities of the United States which, at the time computation is made, have terms of 15 years or more remaining to maturity." The calculated rate is rounded to the nearest one-eighth of 1 percent. The adjustment (either up or down) is limited to no more than one-quarter of 1 percent for any year. Economic analyses in all agencies use one or more of the following methodologies: Net Present Value, Cost Effectiveness, Benefit to Cost Ratio and other evaluation metrics to assess feasibility of a project. Financial analyses are usually associated with funding of project design and construction.

Table A-1. Summary of agency documents consulted.

AGENCY DOCUMENT	TIME PERIOD DISCOUNT RATE	ECONOMIC ANALYSIS	FINANCIAL ANALYSIS
2.1 **CDPH**			
Safe Drinking Water State Revolving Fund (SDWSRF)	20 years -	No discussion of specific valuation methods.	Conducted by DWR
Statutes Related to CDPH and Recycled Water	20 years (minimum) -	Benefit-Cost Analysis, Net Benefit	No specific methods

AGENCY DOCUMENT	TIME PERIOD DISCOUNT RATE	ECONOMIC ANALYSIS	FINANCIAL ANALYSIS
2.2 **DWR**			

Economic Analysis Guidebook	Economic life of project (50 – 100 years for reservoir projects)
	
	6%
		Three Methods
		• Cost Effectiveness
		• Benefit-Cost Analysis
		  o Net Benefit
		  o Benefit-Cost Ratio
		  o Internal Rate of Return
		• Socioeconomic Analysis
			No specific methods. Presents decision criteria, lists financial costs and lays out cost allocation methods such as the separable cost remaining benefit.

Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies	Less than 100 years Average government bond rates.	Least-cost analysis Completed through National Economic Development account. Evaluated based on: completeness, effectiveness, efficiency, and acceptability	No specific valuation methods
2.3 **SWB**			
Water Reclamation Loan Program Background Information on Economic Analyses of Reclamation Projects	- 6%	Net Present Worth or Net Equivalent Annual Costs	No specific valuation methods
Water Reclamation Loan Program Economic Analysis Workbook	20 years 6%	Describes methods to sum benefits and costs but does not provide a specific valuation method	No specific valuation methods
Interim Guidelines for Economic and Financial Analyses of Water Reclamation Projects	20 years 6.875% Bond interest rate for financial analysis	Selection based on Cost-Effective Analysis. Present Worth is equal to the sum of discounted costs and the salvage value.	Two Methods: • Separable Costs-Remaining Benefits • Alternative Justifiable Expenditure Use a cash flow summary Do not use present value calculations
Water Recycling Funding Program Guidelines	- -	No specific valuation methods	No specific valuation methods
2.4 **RECLAMATION**			
Title XVI Reclamation Manual Directives and Standards	20 years (minimum) -	Cost-Effectiveness Compare proposed project to a non-Federally funded alternative	No specific valuation methods

A.2.1 California Department of Public Health

A.2.1.1Safe Drinking Water State Revolving Fund (SDWSRF) (2009)

The goal of the SDWSRF is to fund projects that address drinking water needs. The SDWSRF evaluates the cost-effectiveness of the proposed plan by assessing all feasible alternatives over a 20 year period. Financial information is derived from the expected water service charges imposed on residential customers and the credit worthiness of the proponent. The expected revenue is based on the current monthly water bill, the projected monthly bill with and without a SDWSRF loan, the rate structure, the estimated project costs, and the ability of the proponent to repay the loan. The interest rate on the loan is 2.5017%. There is no specific guidance on what type of valuation methods should be followed. The financial analysis portion of the evaluation is conducted by DWR and submitted to CDPH.

A.2.1.2 Statutes Related to CDPH and Recycled Water (The Purple Book) (2009)

Statutes and regulations related to water recycling projects are described in the "Purple Book." Under the Urban Water Management Plan, demand management measures are to be identified and evaluated. The evaluation should assess economic factors using a cost-benefit analysis. Grants and loans are awarded if the proponent demonstrates that the proposed demand management method is cost effective by having a net benefit greater than zero. Under the Urban Water Management Plan, proponents are also to identify the possible role for recycled water. Options for recycled water should describe both the technical and economic feasibility of utilizing recycled water and describe financial incentives to undertake and encourage use. Projections are to be done every 5 years to a minimum of 20 years.

A.2.2 Department of Water Resources

Group discussions have noted that DWR traditionally has not funded water recycling projects and currently reviews water recycling projects under the Integrated Regional Water Management Plan. General economic analysis guidance for DWR is provided through two documents, the *Economic Analysis Guidebook* and the *1998 Principles and Guidelines*.

A.2.2.1 Economic Analysis Guidebook (January 2008)

The Economic Analysis Guidebook is based on the Principles and Guidelines Document (1983) discussed below (Section A.2.2.2). The Guidebook outlines three methods for completing an economic analysis:

Cost Effectiveness (CE) – Considers capital costs, annual operation, maintenance, and replacement costs over the lifespan of the proposed project. Whenever possible, externality costs are monetized and included. All costs are discounted using a discount rate (currently set at 6%). The least-costly project is selected.

Benefit-Cost Analysis (BCA) – BCA is the most common method to determine if a project is justified. The decision criteria which may be used are: Net Benefits, Benefit-Cost Ratio, and Internal Rate of Return. All costs and benefits are discounted using a discount rate (currently set at 6%).

Benefits are measured through computing the willingness to pay (WTP). Methods to compute the WTP are: Revealed WTP, Imputed WTP, Expressed WTP, or Benefit transfers. Costs are categorized as: capital, operation, maintenance, and replacements. Whenever possible, externality costs are monetized and included.

Socioeconomic Analysis – Identifies direct and indirect impacts on the affected regional population with a focus on changes in regional population, economic activity, and fiscal impacts to local government.

In addition to an economic analysis, an ecosystem evaluation is to be completed. If ecosystem benefits can be monetized, they should be evaluated through BCA. Benefits can be measured by the same means mentioned above.

Financial analysis is based on allocating costs and savings among users. The allocation represents an equitable allocation of costs between the purposes served, not the users. The most common method used for completing the financial analysis is Separable Costs – Remaining Benefits (SCRB). The SCRB method identifies separable costs and allocates joint costs among the project purposes in proportion to each purpose's remaining benefits.

A.2.2.2 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (1983)

The goal of the P&G is to fund projects that contribute to the National Economic Development (NED) while protecting the environment. A project is considered to contribute to the NED if it increases the net value of the national output of goods and service. The projects are evaluated through four accounts:

National Economic Development (NED)

Environmental Quality (EQ)

Regional Economic Development (RED)

Other Social Benefits (OSE)

From the NED, components are considered a benefit if they increase the economic value of the national output of goods and services, the value of the output resulting from external economies caused by the plan, or the value associated with the use of unemployed or underemployed labour. Projects are evaluated on their completeness, effectiveness, efficiency, and acceptability. A sensitivity analysis should be completed on the results.

The Municipal and Industrial (M&I) Water Supply NED Benefit evaluation is based on a series of steps. The first steps involve identifying the relevant study area which will accrue the benefits and costs, estimating the future M&I supply, and projecting the future water use. Projections for supply should be analyzed by time period and include probability estimates. Projections for demand should be categorized by land use, be analyzed for seasonal variations, and assess related factors that will directly affect demand in each afore-mentioned category. The projections are then aggregated into a single projection for each sector, by time period. Based on the projected supply and demand, a determination can be made about the deficit. Alternative plans which would address the deficit without federal funding should be tested for acceptability, effectiveness, efficiency and completeness. The alternatives are then ranked based on a least-cost analysis using costs annualized with the Federal discount rate. The annualized costs from the selected alternative represent the annualized benefits for the proposed Federally-funded project.

Benefits are also derived through willingness to pay (WTP) either from direct or indirect pricing. When possible, the marginal cost should be used to calculate the WTP. Costs considered are implementation outlays (direct costs incurred to undertake the project), associated costs (additional costs to achieve the benefit), and other direct costs.

A.2.3 State Water Resources Control Board

The SWB has four documents related to economic analysis. Generally, the SWB reviews projects where return flows will enter a stream flow. The Interim Guidelines (Section A.2.3.3) holds as the foundation for the economic analysis, but are considered too detailed for applicants. All recycling projects reviewed by the SWB must also be reviewed by the CDPH as per the Memorandum of Agreement from 1996.

A.2.3.1 Water Reclamation Loan Program Background Information on Economic Analyses of Reclamation Projects (1992)

The purpose of the loan program is to improve the financial feasibility of economically-justified projects by providing loans at a subsidized interest rate. Projects should replace freshwater supplies or augment current supplies. Values are discounted using a 6% discount rate. Project alternatives are assessed based on the Net Present Worth of the costs or the Net Equivalent Annual Costs with the unit costs formatted as cost per acre-foot.

A.2.3.2 Water Reclamation Loan Program Economic Analysis Workbook (1995)

The workbook outlines the steps to complete an economic analysis for a proposed reclamation project. Alternatives are worked over a 20 year planning period and 6% discount rate. Economic justification is based on a comparison between the proposed project and the least-cost freshwater alternative for additional supplies. The cost of the proposed project is presented in terms of the discounted cost of the water per acre-foot of fresh water which will be displaced. The benefit is considered to be the discounted cost of the fresh water alternative per acre foot of freshwater displaced.

A.2.3.3 Interim Guidelines for Economic and Financial Analyses of Water Reclamation Projects (1979)

The guidelines outline both economic and financial analysis methods for assessing water reclamation projects. The time horizon for the projects is to be 20 years. For the economic analysis, a discount rate of 6.875% was set. The present worth of the project is calculated as the sum of the discounted costs and the salvage value. The selection of the alternative is done through Cost-Effective Analysis whereby the least-cost alternative which maximizes the net benefit is selected. Benefits considered in the analysis include primary and secondary tangible benefits with benefits from waste treatment classified separately. Analysis of benefits depends on the land use. Costs are also to account for primary and secondary costs.

For the financial analysis, the loan financing rate is based on the bond interest rate. The costs and revenue should be shown through a cash flow summary which is adjusted for inflation. As a cash flow summary is used, net present value calculations are not necessary. Costs should be assigned via cost allocation where costs are divided equitably between various purposes. For projects which serve more than one purpose, the Separable-Cost Remaining-Benefits (SCRB) or the Alternative Justifiable Expenditure method should be utilized. Guidance for pricing of recycled water is also outlined noting that the price charged for recycled water should recover the marginal cost to supply while still being below the price for potable water.

A.2.3.4 Water Recycling Funding Program Guidelines (2008)

The Water Recycling Funding Program Guidelines describe the criteria and process for obtaining funding for the construction of water recycling projects. The grant programs require a facilities planning study. The study is to include: a feasibility study, a detailed evaluation of the selected alternative for a water recycling project, a construction financing plan, a recycled water market assessment, and preliminary recycled water market assurances. The evaluation of alternatives should include an economic analysis, however, specifics of how to complete the economic analysis are not provided.

A.2.4 U.S. Bureau of Reclamation

Three guideline documents pertain to Reclamation's review of Title XVI water reclamation and reuse projects: the Title XVI Directives and Standards document and the Title XVI Water Reclamation and Reuse Program: Final Funding Criteria are discussed below and the third, Principles and Guidelines, was discussed above in Section A.2.2.2. Discussions have indicated that Reclamation primarily uses requirements in the Title XVI Directives and Standards (Section A.2.4.1) to review water reclamation projects.

A.2.4.1 Title XVI Reclamation Manual Directives and Standards (2008)

The purpose of the Directives and Standards is to establish the requirements and a review process for feasibility studies completed under Title XVI. Title XVI of Pub. L. 102-575 provides authority to the Secretary of the Interior functions to investigate and identify opportunities for water reclamation and reuse. Projects are individually authorized by Congress and are typically limited to $20 million per project. The funds can cover a maximum of 25% of design and construction costs to non-federal entities, 50% for completing feasibility studies, and 50% for demonstration projects. Title XVI requires completion of a feasibility study which is to include: projected water demands for the area, all potential recycling water uses, alternative technologies or measures (minimum of two), effect on public health, effect on current water supplies (groundwater and surface water) and development of new supplies, the market for recycled water, and the financial capability of the proponent. For the proposed Title XVI project, the applicant must identify: benefits gained, projected costs, life cycle costs, and cost of project water (dollars per acre-foot). The economic analysis for Title XVI projects compares the proposed project to the most likely alternative which would be implemented in the absence of the Title XVI project qualitative benefits are documented and considered in the overall justification for the project. The selection of the proposed Title XVI project is to be explained in terms of meeting objectives, demands, needs, cost-effectiveness, and other Program criteria. Projections from the study should span for a minimum of 20 years.

A.2.4.2 Title XVI Water Reclamation and Reuse Program: Final Funding Criteria (2010)

Reclamation has developed Funding Criteria to determine the allocation of funding under the Title XVI Water Reclamation and Reuse Program. The criteria are used to prioritize projects to receive federal funding to plan, design, and construct water recycling projects. The extent to which specific projects are funded is dependent upon the availability of federal appropriations.

A.2.4.3 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (1983)

The description of the P&G is already defined earlier in this document under Section A.2.2.2. Methodologies used to quantify Title XVI project benefits should comply with those described in the Principles and Guidelines.

A.3 SUMMARY

Review of the agency documents found commonalities and differences in the methods used to complete economic analyses. All agencies supported some form of benefit-cost analysis as the basis for the economic analysis. Regarding the evaluation period, all agencies, except for the DWR, used a minimum 20 year time period. DWR's evaluation period is the expected economic life of the project, which is generally assumed to be 50 years for reservoir projects for the purposes of DWR studies and 100 years for joint Reclamation/DWR studies in accordance with Reclamation guidelines. A discount rate of 6% was set by both DWR and SWB; whereas, when conducting an economic analysis using methodologies from the Principles and Guidelines, Reclamation's rate for Title XVI projects is updated yearly based on interest-bearing marketable US securities with at least 15 years remaining until maturity. Reclamation discount rate cannot change by more than a quarter of a percentage point from the previous year. CPDH did not set a specific discount rate. The SWB and DWR were the only agencies to outline specific financial analysis methods, both of which included using a separable-cost remaining-benefit approach. Distinct between the financial guidelines was the requirement by the SWB Interim Guidelines to use a cash flow summary and not net present value.

In addition to the methods, the agencies are linked together through other routes. A significant proportion of the non-federal funding for Title XVI projects comes from the SWB and other California state agencies. The Principles and Guidelines provide technical guidance for both DWR and Reclamation. Currently, Reclamation incorporates an economic analysis using methodologies from the Principles and Guidelines as a factor in determining the priority in which projects will be funded. CDPH is tied to both DWR and SWB: DWR completes the financial analysis component of SDRSRF, and all applications regarding recycled water that are received by the SWB must also be reviewed by CDPH.

Appendix B: Data Verification and Use of Models for Cost Estimation

B.1 Quality Control: Applicant Data Verification and Documentation Practices

B.1.1 Data Verification

The applicant must adhere to the highest standards possible of data validation in conducting economic and financial analyses. The US EPA has produced a Guidance on Environmental Data Verification and Data Validation (EPA/240/R-02/004) to guide the users. This can be found in: http://www.epa.gov/quality/qs-docs/g8-final.pdf

B.1.2 Data Documentation

The applicant should keep source records of the data employed in the economic and financial analyses, in an easily retrievable manner. Ideally, a proposal reviewer should be able to replicate the analyses by the information provided in the data documentation and the application itself. It is also desirable to keep notes on the perceived quality of the information, as revisions of the analysis may come at a later time based on the uncertainty in these estimates.

B.2 Use of modeling for estimation of costs and benefits

Existing water simulation and economic models can aid in estimating benefits, and costs of additional water supplies, reliability or shortages.

B.2.1 Least Cost Planning Simulation Model (LCPSIM)

LCPSIM (**http://www.water.ca.gov/economics/downloads/Models/LCPSIM_Draft_Doc.pdf**) was developed by DWR as a regional urban water service system simulation/optimization model to assess the effects of improved reliability. The model was designed to identify projects that are in the State's economic interest. The objective of the model is to minimize the sum of the cost of reliability enhancement and the cost of unreliability to achieve the most economically efficient balance between the two, (i.e., the least-cost solution). Costs include forgone use costs due to unreliability, costs of shortage contingency measures such as short-term water market transfers, cost of water system operations, and the cost of adding to reliability by adopting regional long-term supply augmentation and demand reduction options. The model accounts for the operation of regional carryover storage and the effect of conservation options on the regional reuse and distribution and treatment costs. Data inputs into the model include annual time series of regional supplies and demands, with data from CALSIM for State Water Project deliveries. The model is data driven and currently uses data developed for the South San Francisco Bay Area and the South Coast Region.

B.2.2 Statewide Agricultural Production Model

SWAP (**http://swap.ucdavis.edu**) is a large scale hydro-economic optimization model of agricultural production in California. Hydro-economic optimization models represent regional scale hydrologic, infrastructural, environmental and economic aspects of water resources systems in a coherent framework (Harou et al., 2009). Current coverage of SWAP includes more than 90 percent of the irrigated crop area in California, mostly concentrated on the Central Valley in what is called Central Valley Production

Model Areas or CVPM regions (Hatchett, 1997). The SWAP model is self-calibrated by construction therefore can provide insightful economic information for decision making. Crop and production factors pricing, costs, agricultural yields and water allocation can be modeled with SWAP under a wide range of soil quality, water quality, climate and agricultural production technology conditions. SWAP provides, cropping patterns, crop revenues, land, water, labor and other supplies usage resulting hydro-economic optimization. Past and current applications of SWAP include ancillary economic loss functions for water shortages in agriculture for CALVIN; salinity in soil and shallow groundwater in the Sacramento-San Joaquin Delta in California (Lund et al., 2007) and south of the Delta (Howitt et al., 2009a; Tanaka et al., 2008), climate change (Howitt et al., 2009c; Medellin-Azuara et al., 2007), and drought impact analysis (Howitt et al., 2009b). Furthermore, SWAP has motivated application of mathematical programming in other regions such as the US-Mexico border basins (Howitt and Medellín-Azuara, 2008; Medellin-Azuara et al., 2009). Shadow values of water shortages up to 5% by region on an average year are provided in section B.3.7.**B.2.3 California Value Integrated Model (CALVIN)**

CALVIN (**http://cee.engr.ucdavis.edu/calvin**) is an economic-engineering optimization model of California developed at the University of California – Davis CALVIN's major innovations are its statewide (rather than project) scale, representation of a broad range of water management options, explicit integration of broad economic objectives, and its consequent applicability to a wide variety of policy, operations, and planning problems.

The CALVIN model uses a 72-year monthly time series of hydrology (1921-1993) to represent system variability. CALVIN manages water infrastructure and demands throughout California's intertied water network to minimize net scarcity and operating costs statewide. The model employs HEC-PRM with a network flow optimization solver developed by the US Army Corps of Engineers (Draper et al., 2003).

Model applications include:

Integrated water management, water markets, capacity expansion

- Perfect and Limited Foresight
- Conjunctive use and Southern California
- Hetch Hetchy restoration
- Climate Change, wet and dry
- Severe sustained drought impacts and adaptation (paleodrought)
- Colorado River delta and Baja California water management
- Ending overdraft in the Tulare Basin
- Cosumnes River restoration and Sacramento area water management
- Reducing Delta exports and increasing Delta outflows

CALVIN has a two ancillary water demand models that cover about 90 percent of the total water demand in California. SWAP is the model utilized for agriculture and is described above and provides value of water shortage in agriculture. Likewise, the urban demand model of CALVIN provides values of water shortage in residential and industrial uses. Both agricultural and urban economic costs of shortage depend on the shortage amount, which require model post-processing. Some values are offered in section B.3.7.

B.2.3 Integrated Resources Planning Simulator (IRPSIM)

IRPSIM (**http://www.mwdh2o.com/mwdh2o/pages/yourwater/irp/IRPupdate.pdf**) was designed for the Metropolitan Water District of Southern California (MWDSC) as decision support software for their 1996 Integrated Regional Planning Process. It is a sequentially indexing simulation model used to evaluate regional reliability, storage operations, and resource opportunities under a range of hydrologic conditions. Data inputs include regional demand and supply projections generated with the MWD-MAIN model and SWP projections from CALSIM.

B.3 Reference Benefits and Costs for Economic Analysis

This section provides reference benefits and costs to can be employed in economic analysis with some caution. These reference values and methods are the product of previous work from agencies, academics and consultants. We encourage the applicant to consult the referred literature for each benefit and cost categories to either follow the methods to estimate these values or assess the transferability of the values in literature to the project at hand. A great deal of these reference benefits and costs is a compilation from Raucher et al. (2006), a useful supplemental resource to this Economic Analysis Guidance Document.

B.3.2 Water Supply Reliability

Municipalities and agriculture often have a portfolio of water supply sources to meet water demands in wet, dry and average years. As discussed in the Chapter 2, water supply options include groundwater, local diversions, water imports, water recycling and desalination. The yield of each these sources is often linked to climate variability, water stored in the system and operating rules or needs. Water reliability not only refers to quantity but also to quality. For some a given set of water quality standards, blending water sources might be needed Wolff and Kasower (2006) provide an example for this.

Economic benefits of water reliability can be estimated using different methods existing in literature. In this section we describe two approaches: 1) an stochastic optimization approach and 2) contingent valuation approach.

B.3.2.1 Stochastic optimization

One approach for water reliability analysis is to estimate a probability distribution of water yields by source. Input data for this estimation may include historical inflow information, flood damage costs, reservoir operation rules. The objective is to minimize total costs (shortage and operation) considering system's uncertainties. The expected total cost of a water management alternative (such as water supply augmentation through recycling) is obtained and compared to a base case total cost. The difference between these two expected total costs is the benefit from a higher system's water reliability.

Lund et al. (1998) present a probabilistic approach for shortage management in which benefits and costs of water reliability are estimated. They exemplify the methods with a case study for the East Bay Municipal Utility District, that receives water from three sources: 1) pumping from the Sacramento San Joaquin Delta, the reservoir-aqueduct system in the Mokelumne River, and the American River via the projected Folsom South Canal. Results from the modeling provide expected total annual costs for different system operation configurations. More recent developments and extensions of this method include two step optimization deterministic, robust and use of grey numbers for a set of water management alternatives (Rosenberg and Lund, 2009) This allows mapping expected annual costs, water management options and annual water demands.

B.3.2.2 Contingent Valuation

The second approach is contingent valuation, a expressed preference method (Young 2005) in which the water user might be asked to provide an interviewer a value on increased water reliability. In a study by Barakat and Chamberlin, Inc. (1994) residential water users were asked for willingness to pay to avoid water shortages of a given magnitude and frequency. Reductions in service varied from 10% to 50% and frequency ranged from once every three years to once every 30 years. Monthly willingness to pay to avoid shortage ranged from $11 to nearly $17 per month per customer with no significant differences between northern and southern California.

The value of increased water supply reliability is case specific, as local hydrological conditions, storage, and operation conditions among other factors may greatly influence the yield of the portfolio of water supply alternatives. Water recycling may provide a less fluctuating water source for some uses. Water quality considerations should be taken into account as variations waste water treatment effectiveness may end up affecting recycled water availability for certain uses with specific pollution load limits. Without water quality and other non volume considerations, water supply reliability benefits from a water recycling facility should not exceed the difference between the expected minimum cost of a base case without recycling and the same base infrastructure with water recycling.

B.3.3. Instream and Near-Water values

Instream water flow has an economic value not only for habitat but also for also for water-based recreation. Increased instream flows can enhance water quality in some systems not only reducing concentration of pollutants but also reducing temperature. Riparian forests can also be re-established as a result of pulse and increased flows. The economic value of water in this use is often measured in visitor-days per year (Young 2005). Instream flows often compete with offstream uses and instream uses like hydropower generation and water based recreation and even near water uses like camping , hiking, sightseeing, and waterfowl hunting. Young (2005) provides a non-comprehensive synopsis of water level studies including some limitations (Chapter 8). Herein we provide a summary of ranges of values based on Raucher (2006).

Category	Average	Minimum	Maximum	Description	Location	Reference
Instream Recreation						
Canoe/kayaking	$19.28	-	-	per person per day. June 2004 US$	USA	Bergstrom and Cordell, (1991)
Fishing	$39.14	$2.06	$251.49	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Float boating	$32.27	$17.93	$314.37	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Motor boating	$38.13	$5.26	$202.30	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Rowing/other boating	$41.67	-	-	per person per day. June 2004 US$	USA	Bergstrom and Cordell, (1991)
Swimming	$27.09	$2.18	$135.73	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Water skiing	$40.96	-	-	per person per day. June 2004 US$	USA	Bergstrom and Cordell, (1991)
Near Water Recreation	**Average**	**Minimum**	**Maximum**	**Description**	**Location**	**Reference**
Camping	$42.10	$2.01	$223.08	per person per day. June	USA	Rosenberger and

Category	Average	Minimum	Maximum	Description	Location	Reference
				2004 US$		Loomis, (2000)
Hiking	$32.00	$1.86	$260.35	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Picnicking	$44.02	$13.52	$141.82	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Waterfowl hunting	$36.20	$2.59	$170.28	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)
Wildlife Viewing	$37.13	$2.81	$160.82	per person per day. June 2004 US$	USA	Rosenberger and Loomis, (2000)

B.3.4 Green Areas

Areas such as green belts have a value for recreation. Double counting can be avoided by considering the increased value of property due to green belts. Water use in golf courses has perhaps a more explicit commercial value since water is a production factor for a golf club operating under a profit maximization scheme. Below we provide values from literature for both green belts and golf courses.

Greenbelts	Average	Minimum	Maximum	Description	Location	Reference
Immediately adjacent to greenbelt	16%			Increase in property value if immediately adjacent to greenbelt	Southern California, Riverside	Standiford and Scott (2001)
Golf Courses						
Consumer surplus	$25.34			average per day of golf		Loomis and Crespi (1999)
Property in golf course community		10%	50%	increase in property value		SRI
Property near golf course		4%	7%	increase in property value		(Asabere and Huffman, 1996; Bible and Hsieh, 2001; Quang and Grudnitski, 1995; Rinehart and Pompe, 1999)
Property on golf course		7.6%	27%	increase in property value		(Do and Grudnitski, 1995; Owusu-Edusei and SEspey, 2004)
Property on golf course	$13.78			increase in property value per sq-ft		Firth (1990)

B.3.5 Ecosystems, habitat and biota at large

Coastal	Average	Minimum	Maximum	Description	Location	Reference
Protect estuarine region		$29.00	$120.00	Marginal WTP for WQ protect estuarine system. Annual cost person.June 2004 US$	Albemarle-Pamlico, North Carolina	Whitehead et al(1995)
Intrinsic value of beach	$17.00			one-time payment per househeold for beach maintenance	Chicago, Illinois	Croke et al (1987)
Improve WQ of coastal ponds	$111.00			annual cost per household. June 2004 US$	Martha`s Vineyard, Massachusetts	Kaoru (1993)
Endangered and Threatened Species						
Pacific salmon/steelhead	$80.00	$40.00	$112.00	annual per household, June 2004 US$	USA	Loomis and White, (1996)
Water for habitat						
Protection of habitat		$158.00	$386.00	annual per household. Based on WTP to protect Mono Lake, June 2004 US$	June 2004 US$	(Loomis, 1987)
Wetlands						

Coastal	Average	Minimum	Maximum	Description	Location	Reference
Value per area	$12,496.00			NPV of wetland acre using d=3%	June 2004 US$	(Constanza et al., 1989)

B.3.6 Water quality and groundwater benefits

Below we provide a summary of values for improved water quality and groundwater compiled by Raucher (2006).

Water Quality	Average	Minimum	Maximum	Description	Location	Reference
Improved Water Quality for eco-services and DW protection	$97.98	-	-	WTP of Ohio residents for improved water quality for ecosystems and drinking	Ohio	(De Zoysa, 1995)
Improved Water Quality for eco-services and DW protection	$7.11	$4.64	$9.58	WTP of Ontario residents	Ontario, Canada?	(Brox et al., 2003)
Maintaing WQ for boating		$29.00	$57.40	WTP of Pennsylvania residents in Monongahela River basin. One time payment	Pennsylvania	(Desvougsges et al., 1987)
Improved WQ from boating to fishing		$15.90	$36.90	WTP of Pennsylvania residents in Monongahela River basin. One time payment	Pennsylvania	(Desvougsges et al., 1987)
Improved WQ from fishing to swimming		$8.70	$18.80	WTP of Pennsylvania residents in Monongahela River basin. One time payment	Pennsylvania	(Desvougsges et al., 1987)
Improved WQ from boating to swimming		$25.10	$60.20	WTP of Pennsylvania residents in Monongahela River basin. One time payment	Pennsylvania	(Desvougsges et al., 1987)
Groundwater						
Value of uncontaminated gw		$46.00	$917.00	per household per year. June 2004 US$		(Henglen et al., 1992; Powell et al., 1994)
Restoration of contaminated gw		$73.00	$1,507.00	per household per year. June 2004 US$		(Boyle et al., 1994)
Increased protection of gw	$66.00			per household per year. June 2004 US$	Ohio	(De Zoysa, 1995)

B.3.7 Willingness to pay for additional water in agricultural and urban water uses.

In this section we provide values from two statewide models for water resources management described in section B-2 of this Appendix namely CALVIN and SWAP. These values assume an average year and are not the result of any particular policy run with the model. Instead, values for marginal willingness to pay for additional water arise from specific water shortage levels in agricultural and urban uses. Details on the methods can be found in each model's website documentation.

	Agriculture water use 5% water shortage		**Urban Water Uses 5% water shortage**	
Region	Range	Average	Range	Average

	($2008/acre-ft)	($2008/acre-ft)	($2008/acre-ft)	($2008/acre-ft)
Central Valley North of Delta	63-101	80	2,397-9,823	6,177
San Francisco Bay Area	63-63	63	1,578-7,326	3,302
Central Valley South of Delta	63-201	118	146-9,186	1,742
Central Coast	167-167	167	2,812-2,812	2,812
South Coast	154-301	217	987-1,932	1,482
Colorado River	119-130	126	350-1,132	724

B.3.8 Cost ranges on increasing water use efficiency and supply.

The values below are based on the California Water Plan Update Volume 2(DWR 2009) expressed in 2008 dollars.

Method	$/Acre-ft
Improved water use efficiency:	
Agriculture	$35 - $900
Urban	$223 - $522
Desalination:	
Groundwater	$500 - $900
Wastewater	$500 - $2000
Seawater	$1000 - $2500
Other:	
Cloud seeding	$20
Recycled water	$300 - $1300

Appendix C: Formulae

Description	*Use*	*Formula or Symbol*
Expected Net Present Value	Discount a stream of costs and benefits over time and uncertainty is accounted.	$ENPV = \sum_{i=1}^{N} P_i \sum_{t=1}^{T} \sum_{j=1}^{M} (B_{ijt} - C_{ijt})(1+r)^{-t}$
Net Present Value	Discount a stream of costs and benefits over time and uncertainty is accounted.	$NPV = \sum_{t=1}^{T} \sum_{j=1}^{m} (B_{jt} - C_{jt})(1+r)^{-t}$
Interest rate or discount rate per period	Specifies the discount or the interest rate or the discount rate to be used in the calculations	r
Number of time periods	Specifies the time period to which the cash, benefit or cost will be discounted.	n
Compound amount factor	Provides the rate of future versus present worth (benefits or costs) at a rate *r* in time period *n*.	$\frac{F}{P} = (1+r)^n$
Present worth factor	It is the inverse of the compound amount factor and provides the ratio between the present and future worth at a rate *r* in time period *n*.	$\frac{P}{F} = \frac{1}{(1+r)^n}$
Sinking fund factor		$\frac{A}{F} = \frac{r}{(1+r)^n - 1}$
Capital recovery factor	Along with the principal, this factor is used to estimate the annual debt service payment, if the project is financed at a rate *r* with a useful life time period *n*.	$\frac{A}{P} = \frac{r(1+1)^n}{(1+r)^n - 1}$
Annual Debt Service	Calculates annual debt payment service for project capital financing period	= Loan Principle x Capital Recovery Factor
Benefit Cost Ratio	Compare present worth of benefits to the present worth of costs	$BC = \sum_{t=1}^{T} \sum_{j=1}^{M} B_{jt}(1+r)^{-t} / \sum_{t=1}^{T} \sum_{j=1}^{M} C_{jt}(1+r)^{-t}$
Annual Value	Transforms a fluctuating time stream of net benefits into an NPV constant stream.	$\sum_{t=0}^{n} \frac{A}{(1+d)^t} = \sum_{t=0}^{n} \frac{NB_t}{(1+d)^t} =$
Internal Rate of Return	Determine what discount rate (*r*) will cause the net present worth to be zero	$ENPV = \sum_{i=1}^{N} P_i \sum_{t=1}^{T} \sum_{j=1}^{M} (B_{ijt} - C_{ijt})(1+r)^{-t}$

CALAG	DWR California Agriculture model
CDPH	California Department of Public Health
CEA	Cost-Effectiveness Analysis
CPUC	California Public Utilities Commission
CWC	California Water Code
DWR	California Department of Water Resources
EATF	Economic Analysis Task Force for Water Recycling Projects in California
ENPV	Expected Net Present Value
ENR	Engineering News Record
EQ	Environmental Quality
IRR	Internal Rate of Return
LBUVC	Lost Beneficial Use Value Calculator (SWRCB)
LCPSIM	DWR Least Cost Planning Simulation Model
MOA	Memorandum of Agreement 1996 between the SWRCB and the CDPH
NCROM	DWR Net Crop Revenue Models
NED	National Economic Development
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
OSE	Other Social Effects
P&G 1983	Economic and Environmental Principles and guidelines for Water and Related Land Resources Implementation Studies
RED	Regional Economic Development
RM D&S FAC-09-03	Representation and Referencing of Cost Estimates in Bureau of Reclamation Documents Used for Planning, Design and Construction
RM D&S Title XVI	Water Reclamation and Reuse Program Feasibility Study Review Process
SCRB	Separable Cost Remaining Benefit Method
SRF	California State Revolving Fund Program
SWAP	Statewide Agricultural Production Model
SWRCB	State Water Resources Control Board
USACE	
Reclamation	U.S. Bureau of Reclamation
USWRC	U.S. Water Resources Council
WRFP	California State Water Resources Control Board's Water Recycling Funding Program
WTP	Wilingness to pay

Appendix E: Glossary
Adapted from DWR (2008)

Benefits
Benefits are the values of goods and services produced by the project. Different types of benefits include:

- Primary vs. secondary: *primary benefits* are the increased values of goods or services and/or the reduction in costs, damage, or losses to those directly affected by the project (primary beneficiaries). *Secondary (indirect) benefits* are the net values that accrue to persons other than primary beneficiaries as a result of economic activity induced by or stemming from a project. Generally only primary benefits are included in benefit/costs analyses.
- Tangible vs. Intangible: *tangible benefits*, either primary or secondary, can be expressed in monetary terms. *Intangibl*e benefits cannot be expressed in monetary terms.
- Private vs. public: *private benefits* are obtained from goods and services purchased by individual producers and consumers through markets. *Public benefits* are obtained from providing "public" goods and services, i.e., goods that are consumed by society as a whole (national defense, police protection, highways, parks, etc.). Consumption of these goods by one individual does not preclude consumption by other individuals.

Benefit-Cost Analysis
A type of economic analysis that identifies and measures (usually in monetary terms) the different primary benefits and costs of proposed projects and then compares them with each other to determine if the benefits of the project exceed its costs over the analysis period. Benefit-cost analysis is the principal method used to determine if a project is economically justified. Benefit-cost comparisons of projects are most commonly made using these criteria:

- Net benefits: determined by estimating discounted benefits and costs over the study period, and then subtracting discounted costs from the discounted benefits. The optimum scale of development for a project occurs where net benefits are at a maximum. However, the net benefit criterion does not take into account the absolute level of costs involved to achieve project benefits, thus it is most appropriately used when comparing projects of similar sizes and objectives.
- Benefit/cost (B/C) ratio: determined by dividing discounted benefits by discounted costs. A project is economically feasible if its B/C ratio is greater than 1.00. The B/C ratio is a measure of relative rather than absolute merit, thus it can be used to select from projects of different scales and objectives. However, the most economic use of a resource rarely occurs at the scale of development where the B/C ratio is at maximum. Thus, a net benefit analysis may be needed to size an alternative once it is selected using the B/C ratio.
- Internal rate of return (IRR): determines the rate of return, or discount rate, which equates project discounted benefits with discounted costs. If the computed rate of return is greater than a specified discount rate, then the project is determined to be economically feasible. Although the IRR criterion usually produces the same result as the net benefits or B/C

ratio criteria, it is possible for the IRR to compute more than one solution depending upon the time stream of benefits and costs.

Beneficiary Pays Principle

"A principle which states that the beneficiaries of a high quality or improved environment should compensate resource users for the ongoing costs of maintaining ecological functions, environmental services and attributes that do not bring market benefits and are not required of all people. This principle requires that any additional costs associated with the provision of positive non-market benefits be reimbursed" (Markandya, 2001, p. 18).

For the CALFED Program, a fundamental philosophy is that costs should, to the extent possible, be paid by the beneficiaries of the program actions.

Consumer Surplus

The value consumers place on goods in excess of prices paid for those goods and it is graphically shown as the area under a demand curve but above the market equilibrium price determined by the intersection of the demand and supply curves.

Contingent Valuation/Choice Methods

Survey methods used to determine people's willingness to pay for goods and services in the absence of market data. Contingent valuation surveys ask how much people would be willing to spend for specific goods and services. Contingent choice surveys ask people to state preferences for different goods and services based upon their costs. An alternative application of this method is to ask people how much they would be willing to accept in order to give up a specified amenity or benefit.

Costs

All costs necessary to obtain project benefits over the analysis period. Conceptually, all costs in the economic analysis should reflect the opportunity costs of using resources to construct and operate the project. Practically, however, the cost information used in the analysis is often limited to the actual purchase expenditures which are used in financial analyses:

- Capital: expenditures necessary to complete the project so operations can commence. Capital costs (e.g., construction, "fixed" or "first" costs) include expenditures for land, structures, materials, equipment, and labor, as well as allowances for contingencies. Financial costs (such as interest during construction and long-term debt service interest) are not included, although they are important in a financial analysis.
- Operation, maintenance and replacement: include the project's annual administrative, maintenance, energy and replacement costs and are often called "variable costs" because they vary with different levels of project output.

Cost Allocation

Cost allocation is the process by which financial costs of a project are distributed equitably among project purposes. A common cost-allocation method is Separable Costs-Remaining Benefits which distributes costs among the project purposes by identifying separate costs and allocating joint costs or joint savings in proportion to each purpose's remaining benefits.

Cost-Effectiveness
Comparing alternatives to meet a stated objective and using the least cost alternative as the selective alternative.

Cost-Effectiveness Analysis
Economic analysis method used when benefits cannot be monetized easily or when choosing between different technologies for the a particular project. The most common method of cost-effective analysis is the least-cost method which identifies the least cost option for achieving a set benefit or objective. Another method is the constant cost method which calculates the cost per unit of benefit. Cost-effectiveness analysis can also be combined with incremental cost analysis to measure changes in costs and outputs among alternative plans.

Crop Budgets
Descriptions of hypothetical farm sizes for various crops, "sample" establishment/production operating and overhead costs, yields, and prices received by growers. The University of California Crop Extension Office publishes budgets for crops throughout the state.

Demand Curve
A graphical representation of the amount of a good demanded at different prices with prices plotted on the vertical (y) axis and quantity purchased on the horizontal (x) axis. Demand curves generally slope downward (to the right) because people generally purchase less of a good as its price increases.

Discounting
A process used to adjust for the time value of money. Even if there is no inflation, a dollar received today is worth more than one received in the future because a dollar received today can be put to immediate use. Adjusting for different time periods is accomplished by estimating the present value of each benefit and cost in the future. Present values are calculated with a simple formula ($P = F / (1 + r)n$), which involves dividing the future dollar amount of benefit or cost by a discount factor $(1 + r)$ raised to the nth power. In this equation, P equals the present value of the future cash flow, F = future cash flow, r = discount rate, and n = number of time periods into the future that the benefit or cost occurs. Alternatively, present value "factors" for different discount rates and analysis years may be found in financial tables. All annual costs and benefits are discounted using the same discount rate and total discounted benefits and costs can then be summed for the entire analysis period and directly compared to each other.

Discount Rate
The discount rate is used to adjust dollars received or spent at different times to dollars of a common value, usually present day dollars ("present worth" or "present value"). Although there are different methods for determining discount rates, generally the value to use for this rate for an economic analysis is the real (i.e., excluding inflation) rate of return that could be expected if the money were instead invested in another project. In other words, the discount rate is a measure of forgone investment (i.e., "opportunity cost") if the money allocated to the project were instead

invested elsewhere.

Economic Analysis
Determines if a project represents the best use of resources over the analysis period and is therefore economically justified. The economic analysis answers questions such as: should the project be built at all, should it be built now, or should it be built to a different configuration or size? A project is economically justified if its expected total discounted benefits exceed project discounted costs over the analysis period. The comparison of benefits and costs must be done using with and without project conditions and not before and after conditions.

Ecosystem
An interdependent community of plants and animals interacting with one another and with the chemical and physical factors making up their environment.

Ecosystem Functions
The self-sustaining processes (physical, chemical and biological) of an ecosystem, many of which result in services that have value to humans.

Ecosystem Services

In addition to providing services for plant and animal life, ecosystems provide goods and services which are valuable to humans, including improved water supply and quality, flood damage reduction, recreation, scientific investigation and commercial products (fish, berries, wood products, etc.).

Ecosystem Structure
Includes all of an ecosystem's complex physical and socioeconomic characteristics.

Ecosystem Valuation Methods
Methods to estimate consumers' "willingness to pay" for ecosystem goods and services not normally found in the marketplace. Four general types of methods can be used:

- Revealed willingness to pay: measures value of ecosystem goods and services based upon actual prices paid for these products or related goods and services (using hedonic pricing and travel cost methods).
- Imputed willingness to pay: measures value of ecosystem goods and services based upon the (1) cost of avoiding damage caused by the loss of these services, (2) cost of replacing ecosystem services, or (3) cost of providing substitute services.
- Expressed willingness to pay: measures value of ecosystem goods and services based upon consumer surveys (using contingent valuation/choices methods).
- Benefit transfers: measures value of ecosystem goods and services by transferring available information from studies already completed in another location and/or context.

Externalities
Costs (or benefits) imposed upon others from the activities of producers or consumers for which no compensation is received.

Expected Net Present Value (ENPV)

The Expected Net Present Value is a generalized for the Net Present Value in which the probability of occurrence of an event or state is taken into account. The Expected Net Present Value provides a single summary number from a larger broader set of costs and benefits over time *discounted* at a specific rate to the present. If the ENPV is positive, it means the expected benefits of the project exceed its expected costs and the alternative is desirable, relative to no action (a common base case). In general, alternatives with the highest ENPV per unit budget cost should be funded.

The formulation of the ENPV is as follows:

$$ENPV = \sum_{i=1}^{N} P_i \sum_{t=1}^{T} \sum_{j=1}^{M} (B_{ijt} - C_{ijt})(1+r)^{-t} \qquad (2.1)$$

Where, P_i is the probability *i* over the set of *N* probabilities of an event or state to occur; B_{ijt} is the benefit of alternative *j* over on time *t*; C_{ijt} is the cost of alternative *j* in time *t*, and *r* is the discount rate. If uncertainty is neglected, ENPV becomes the more common Net Present Value criterion.

Federal Decision Criteria

The federal *Principles and Guidelines* identify four broad decision criteria for the evaluation of all federal plans:

- Completeness: the extent to which a given plan has all the necessary investments and other actions to ensure the realization of the planned effects.
- Effectiveness: the extent to which an alternative plan accomplishes its planning objectives.
- Efficiency: the extent to which an alternative plan is the most cost-effective means of accomplishing its planning objectives and is the criteria which is addressed by the economic analysis.
- Acceptability: the workability and viability of the alternative plans with respect to acceptance by state and local entities and the public as well as compatibility with existing laws, regulations, and public policies.

Project *justification* is determined by how well a proposed project meets all four criteria.

Federal Objective

The federal *Principles and Guidelines* state that the federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, in accordance with national environmental statues, applicable executive orders, and other federal planning requirements.

Federal Planning Accounts

The federal *Principles and Guidelines* establish four planning accounts to facilitate project planning:

- National Economic Development (NED): displays contributions to national economic development which are increases in the net value of the national output of goods and services, expressed in monetary units, and which are the direct net benefits that accrue in the planning area and the rest of the Nation.
- Environmental Quality (EQ): displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans (discussed below).
- Regional Economic Development (RED): displays changes in the distribution of regional economic activity (e.g., income and employment).
- Other Social Effects (OSE): displays plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation and other effects.

Display of the national economic development and environmental quality accounts is required whereas display of the other two accounts is discretionary.

Federal Planning Process

The federal planning process consists of six steps as described in the *Principles & Guidelines*: (1) specification of water and related land resources problems and opportunities; (2) inventory, forecast and analysis of water related land resources within the study area; (3) identification of alternative plans; (4) evaluation of the effects of alternative plans; (5) comparison of the alternative plans; and (6) selection of the recommended plan based upon the comparison of the alternative plans. *Plan formulation* consists of the third, fourth and fifth planning steps. It is a highly iterative process that involves cycling through the formulation, evaluation, and comparison steps many times to develop a reasonable range of alternative plans and then narrow those plans down to a "final array" of feasible plans from which a single plan can be identified for implementation.

Federal Plans

The criteria for selecting the recommended federal plan differ depending on the type of plan. While the NED Plan is common to all agencies that follow the P&G, the Corps has authority to implement other plans as well:

- National Economic Development Plan: for single project purposes, such as water supply or flood damage reduction where project outputs can be measured in dollars, project selection is based on maximizing net monetary benefits.
- National Ecosystem Restoration Plan: the Corps incorporated ecosystem restoration as a project purpose in response to the increasing national emphasis on environmental restoration and preservation; however, the Corps does not place monetary values on ecosystem benefits. The Bureau does not have authority for national ecosystem restoration plans (as of September 2005).
- Combined NED/NER Plan: Corps' projects that produce both NED and NER benefits

will result in a "best" recommended plan so that no alternative plan has a higher excess of NED monetary benefits plus NER non-monetary benefits over project costs. This plan shall attempt to maximize the sum of net NED and NER benefits and to offer the best balance between two federal objectives.

- Locally Preferred Plan: Projects may deviate from the NED, NER or combined NED/NER Plans if requested by the non-federal sponsor. For example, if the sponsor prefers a more costly plan and the increased scope of the plan is not sufficient to warrant full federal participation based on the NED analysis, the Locally Preferred Plan may be approved as long as the sponsor pays the difference in costs between the NED (or NED/NER) plans and the LPP.

Federal *Principles and Guidelines*
Economic analyses conducted by federal agencies working with water and related land resource problems (such as the Corps and the Bureau) must follow the *Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* published by the Water Resources Council in March, 1983. The first "principles" part of the *P&G* establishes project planning policies to be followed whereas the second "guidelines" part describes "how to" procedures.

Financial Analysis
The procedure to determine financial feasibility through the determination of expenditures and incomes of or other financial impacts on the agency implementing the project, recycled water users, or others affected by the project.

Determines if project beneficiaries are willing and able to raise sufficient funds to construct and operate a project over its repayment period. The financial analysis answers questions such as: who benefits from a project, who will repay project costs and will they be able to meet repayment obligations? A project is financially feasible if beneficiaries are able to pay for reimbursable costs over the repayment period, sufficient capital is authorized and available to finance construction to completion, and estimated revenues are sufficient to cover reimbursable costs over the repayment period.

Forgone Investment Value
If construction occurs over several years, then the future value of these expenditures must be determined in an economic analysis by multiplying these monetary costs by a future value factor (which is the reciprocal of the present value factor). These future value adjustments reflect the value of other investments that could have been pursued if the project were not undertaken ("opportunity costs"). Forgone investment value is often erroneously called "interest during construction" which is the financial interest paid on borrowed funds during construction.

Hedonic Pricing Method
This method can be used to estimate economic benefits associated with environmental amenities (such as aesthetic views or proximity to recreational sites) or environmental costs (such as the effects of air, water or noise pollution). Most hedonic price applications use differences in residential housing prices to estimate the value of the environmental amenities.

Incremental Cost Analysis
Incremental cost analysis computes the change in cost per unit of output that results from different sizes of project alternatives. This analysis determines which alternative has (a) the greatest increase in output for the least cost increase and (b) the lowest incremental costs per unit of output relative to other cost-effective plans.

Input/Output Analysis

A quantitative description of the relationship among industries within an economy which shows the interdependence among various sectors of the economy as they combine to meet a given final demand for goods and services.

Interest During Construction
The financial compound interest paid on borrowed funds during construction.

Least Cost Planning Simulation Model (LCPSIM)
A DWR PC-based regional urban water service system simulation/optimization model that assesses the economic benefits and costs of increasing reliability. Documentation is available at http://www.water.ca.gov/economics/downloads/Models/LCPSIM_Draft_Doc.pdf.

Life Cycle Cost Analysis
Life-cycle cost analysis (LCCA) is a method for assessing and comparing the total costs of alternatives. It takes into account all costs of acquiring, owning, and disposing of facilities and related equipment. LCCA is especially useful when project alternatives that fulfill the same performance requirements, but differ with respect to initial costs and operating costs, have to be compared in order to identify the one that maximizes net cost savings. The three key variables in a LCCA include identifying and evaluating for each alternative all pertinent costs, the period of time over which these costs can be compared, and the appropriate discount rate.

Mathematical Programming
A mathematical solution to an objective function (such as maximizing or minimizing a specific variable) subject to a set of constraints. A common mathematical programming tool is linear programming, whose objective function and constraint equations are expressed as linear relationships.

Net Crop Revenue Model
A DWR PC-spreadsheet program which estimates average net crop revenues for important crops for recent years in California counties and regions.

Opportunity Costs
The value of productivity forgone by not investing a resource in the next optimal project.

Payment Capacity
A measure of the maximum ability of most agricultural producers in a specific area to pay for water at their head gate, on a per acre-foot basis, over a specified period. Payment capacity is the difference between gross returns from the sale of crops and the costs of production (including an

imputed cost for the grower's own labor and management), excluding the cost of water.

Planning Time Horizons
Different planning time horizons may be used for feasibility analyses:

- Economic life: The period in which the project is economically viable, which means that the incremental benefits of continued use exceed the incremental costs of that use.
- Physical life: The period in which the project can no longer physically perform its intended function. Economic life may be shorter than physical life but not vice versa.
- Analysis period: The length of time over which a project's consequences are included in a study. Typical analysis periods for structural water resource projects are 50 to 100 years and 5 to 25 years for nonstructural projects.
- Short- vs. long-term: Short-term is the period of time in which capital investments cannot be changed, compared to the long-term in which new capital investments can be undertaken.
- Financing period: The length of time required for bond repayment or other required paybacks, which may be shorter or longer than the period of analysis. This time horizon is only relevant for financial analyses.

Producer Surplus
This is the benefit producers receive if prices received for goods exceed production costs for those goods. This value is graphically shown as the area above a supply curve but less than the market equilibrium price determined by the intersection of the demand and supply curves.

Regression Analysis
Statistically assesses the relative contribution of one or more independent variables upon a dependent variable.

Risk
The probability that some undesirable event will occur which is usually linked with a description of the corresponding consequences of that event.

Socioeconomic Impact Analysis
A type of economic analysis that focuses upon changes in regional population, secondary economic and fiscal effects expected to occur from proposed projects. Results from socioeconomic impact analyses are often included in environmental impact studies/reports and, for federal studies, are included in the Regional Economic Development and/or Other Social Effects planning accounts.

Supply Curve
A graphical representation of the amount of a good produced at different process with prices plotted on the vertical (y) axis and quantity produced on the horizontal (x) axis. Supply curves generally slope upward (to the right) because suppliers generally produce more of a good as its price increases.

Statewide Agricultural Production Model (SWAP)

SWAP is an economic-optimization model for major crops and agricultural regions in California and uses Positive Mathematical Programming. Recently, SWAP is being benchmarked with CALAG (see above) to model economic analysis of agriculture in California. Model details can be found at http://swap.ucdavis.edu

Total Surplus
The sum of consumer and producer surplus minus any associated production costs which represents the total economic value of a good.

Trade-off analysis
Displays all monetary and non-monetary effects of a project such that the "gains and losses"

Travel Cost Method
Used to estimate the value of recreational and/or ecosystem benefits assuming that the time and travel costs people incur to visit sites can be used as indicators of their willingness to pay for benefits obtained at those sites.

Uncertainty
Situations without sureness, whether or not described by a probability distribution.

Willingness to Accept
The amount of money that an individual would be willing to accept as payment in order to forego a good or service.

Willingness to Pay
The amount of money that an individual would be willing to pay for a good or service, which indicates the benefit of that good to that individual.

Without vs. With Conditions
Economic analysis (as well as all aspects of project evaluation) must focus upon the change in conditions expected to occur "without" the project vs. "with" the project. The "without" project conditions, which not only include historical and existing conditions but also future without project conditions, become the baseline from which all project effects (positive and negative) are compared. Thus, the estimation of the existing and future without project conditions is a critical step in the economic analysis. Often the "without" vs. "with" comparison is confused with a "before" and a "after" comparison, but this is not correct because some of the benefits forecasted to occur in the future with the project may also have occurred even without the project and therefore they should not be attributed to the project.

Appendix F. Additional Resources

F.1 Contact Information on Water Recycling

California Department of Water Resources
Nancy King,
Recycling and Water Desalinization Section,
Division of Statewide Integrated Water Management
king@water.ca.gov
Tel. (916) 651 7200

State Water Resources Control Board
Daniel Newton
Chief Watery Recycling Funding Program
Division of Financial Assistance
16 th floor 1001 I Street, Sacramento California
dnewton@waterboards.ca.gov
Tel. (916)324 8404

U.S. Bureau of Reclamation
http://www.usbr.gov/WaterSMART/contact.html

F.2Water Recycling Funding Programs

Water Smart (Reclamation)

http://www.usbr.gov/WaterSMART/

Water Recycling Funding Program (Waterboards).
http://www.swrcb.ca.gov/water_issues/programs/grants_loans/water_recycling/index.shtml

All funding programs (DWR)

http://www.dwr.water.ca.gov/nav/nav.cfm?loc=t&id=103

F.3 Online Resources

Water Recycling Regulations in California

http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Waterrecycling.aspx

Water Recycling Publications

http://www.water.ca.gov/recycling/Publications/

Research WateReuse Foundation

http://www.swrcb.ca.gov/water_issues/programs/grants_loans/water_recycling/research.shtml

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