CHAPTER 3
ECONOMIC PRINCIPLES AND METHODS

This chapter describes Federal economic principles and methods related to plan formulation, calculation of project benefits, and derivation of total annual equivalent benefits. This chapter also will describe potential economic valuation methods and recommend methods to be used for the LVE.

BACKGROUND

Reclamation guidance for the evaluation of water resources project plans is provided by the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC, 1983), approved by the President on February 3, 1983. The P&G provide guidance for measuring the monetary and nonmonetary benefits or effects of Federal water resources projects. However, it is often difficult to fully measure all benefits associated with a multipurpose water resources project. For example, it is difficult to value intangible benefits such as operational flexibility or improvements in general social welfare.

Four accounts are established in the P&G to facilitate evaluation and display the effects of alternative plans:

- **National Economic Development (NED)** – Effects on the national economy, expressed in monetary units.
- **Environmental Quality (EQ)** – Effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be measured in monetary terms.
- **Regional Economic Development (RED)** – Regional incidence of economic effects, income transfers, and employment.
- **Other Social Effects (OSE) –** Urban and community impacts and effects on life, health, and safety.

The NED account is the only required account, although information that could have a bearing on Federal decision-making should be presented in the other accounts. For the purpose of this initial economic evaluation, only the NED account will be considered.

NED FORMULATION APPROACH

In general, the objectives of Congress in Federally financed water resource projects are to enhance regional economic development, the quality of the environment, the well-being of people in the U.S., and national economic development. NED costs and benefits are the decrease or increase in the value of the national output of goods and services expressed in dollars. NED figures measure the costs and benefits to the Nation, rather than to a particular region.

As described in the P&G, water resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to NED. The alternative plan with the greatest net economic benefit (the NED plan) determines the greatest potential Federal investment in the project. If the local sponsor prefers a different plan than the one that maximizes NED, the NED process is used to define the Federal financial interest in the locally preferred plan.

The NED account includes the following *categories of goods and services*: M&I water supply; agricultural floodwater, erosion, and sediment reduction; agricultural drainage and irrigation; urban flood damage reduction; power (hydropower); transportation (including both inland navigation and deep draft navigation); recreation; and commercial fishing. While multipurpose projects may provide additional types of benefits, these categories coincide with project purposes in which an established Federal financial interest exists. Other categories of benefits may be allowed or may be included in Congressional authorization for a specific project.

NED costs are the *opportunity costs of resource use*, and require consideration of the private and public uses that producers and consumers are making of available resources, now and in the future. Due to scarcity, choosing to use a resource for any one purpose costs society the opportunity to use that resource for another purpose. For goods and services produced in a competitive market, price is often used to reflect opportunity cost. Consequently, market prices should be used to determine NED costs provided the market prices reflect the full economic value of a resource to society. The market price approach should reflect the interaction of supply and demand. If market prices do not reflect total resource values, surrogate values may be used that approximate opportunity costs based on an equivalent use or condition.

For M&I water supplies, the conceptual basis for evaluating benefits is society's willingness to pay for the increase in goods and services attributable to the water supply. According to the P&G, when the market price reflects the *marginal cost of water*, that price should be used to calculate willingness to pay for additional water supply. In the absence of a direct measure of the willingness to pay, the benefits are instead measured by the resource cost of the alternative most likely to be implemented in the absence of that alternative.

Other direct benefits in the NED evaluation are those direct effects of a project that are incidental to the purposes or objectives for which the project is being formulated. Other direct benefits may include improvement in commercial/industrial production possibilities (such as reduced water treatment process costs at industrial facilities) or benefits in the nonmarket sector (some types of recreation, for example). For the LVE, other direct benefits might include environmental benefits (reduced impacts to aquatic resources from changing the location and timing of Delta diversions or avoided costs associated with screening diversions) and recreation.

The two primary decision criteria used in a Federal economic analysis are net benefits and the benefit-cost ratio. The *net benefit* is the difference between the net present value of benefits and costs, and measures the extent to which benefits to the Nation exceed project costs. The benefit-cost ratio is calculated by dividing annual project benefits by annual project costs. A benefit-cost ratio greater than one indicates that a project is economically justified.

The net benefits and costs of alternative plans are compared to identify the plan that reasonably maximizes net benefits, or the NED plan. This is not necessarily the plan with the greatest benefits,

but rather the plan that maximizes benefits given the cost to the Nation. Section 1.10.2 of the P&G requires that the NED plan is selected unless the Secretary of the Interior grants an exception.

ECONOMIC VALUATION METHODS

Economic valuation methods generally fall into one of two categories: market valuation or nonmarket valuation. Market values refer to conditions for which a price can be observed, such as for human consumptive uses. Nonmarket valuation methods usually apply to resources for which it is difficult or inappropriate to apply monetary values, such as ecosystem restoration or wildlife conservation. The three objectives of the LVE relate to consumptive uses and therefore can be valued using market-based techniques.

Market values may be determined by one of two basic methods: user value (willingness to pay) or least-cost alternative to accomplish the same goals. The potential application of these methods to the three objectives of the LVE is summarized in **Table 3.1**.

TABLE 3.1
SUMMARY OF APPLICABLE MARKET VALUATION METHODS

Benefit Group	User Value (willingness to pay)	Least-Cost Alternative
Bay Area Water Supply Reliability	Market value of water in M&I use	Least cost to obtain the next unit of M&I supply reliability
EWA Replacement Water Supply	Market value of water purchased by the EWA	Least cost to obtain the same unit of EWA water supply
Bay Area Water Quality	Not applicable	Least cost to obtain the same improvement in M&I water quality

Key: EWA = Environmental Water Account M&I = municipal and industrial

User-Value Valuation Method (Willingness to Pay)

The user-value, or willingness to pay, method refers to the value of the resource to the consumer. Markets may be used to estimate the maximum value for which a resource user is willing to pay. From a commercial or industrial perspective, this might represent the contribution of additional water supplies to production and, ultimately, profits. From a domestic perspective, this might represent the value that a homeowner places on their ability to water their lawn or fill their swimming pool.

Applying the user-value method to M&I water supplies, for example, requires an understanding of both domestic and commercial/industrial water uses. Domestic user preferences for water use, and willingness to avoid shortages, often are determined by surveying the water users. However, these surveys can be cumbersome and generate inaccurate responses. Also, differences in population and water use make it difficult to apply survey results at a regional level. Applying the user-value method to industrial and commercial uses requires estimating the output value of goods and services, such as the price of a computer chip. However, industrial market values include profit margins and other competitive criteria, and their use may result in overestimated water values.

Least-Cost Alternative Method

The least-cost alternative method identifies the lowest cost of obtaining or developing the next unit of a resource to meet a particular objective. The net benefit would be calculated by subtracting the cost of developing the project under consideration from the cost of the alternative unit. For water supply reliability, for example, the least-cost alternative represents the next unit of water supply the water user would purchase or develop if the project under consideration were not in place.

RECOMMENDED VALUATION APPROACHES

This section describes available and recommended methods to value economic contributions to the three purposes or objectives of the LVE: EWA replacement supplies, Bay Area water supply reliability, and Bay Area water quality.

EWA Replacement Supplies

The recommended method for assessing the benefits of a lower cost EWA implementation is the *cost effectiveness* approach. This approach is based on the premise that water supplies and operations for EWA purposes developed through the LVE project would have the same outputs with respect to water quantity, timing and location of supplies, and environmental benefits as under existing conditions (no increase in EWA water supplies or increase in EWA actions to protect fish). Because EWA actions are not expected to change as a result of the source of the water (storage in an expanded Los Vaqueros reservoir versus transfer market purchase), the corresponding program benefits are expected to be the same.

Different alternatives would vary in benefits with respect to (1) quantity of water for EWA purposes and (2) cost of developing the water through the LVE project. The LVE water development cost will be compared in this report to the cost of implementing the EWA program as conceived under the long-term EIS/EIR (scheduled for completion in fall 2007), and will be measured as the cost of obtaining EWA supplies on the water transfer spot market.

Bay Area Water Supply Reliability

User-values for water can be cumbersome to obtain and difficult to extrapolate from surveys to populations, and may overstate benefits to users. For this reason, it is recommended that the *least-cost alternative method* be used to establish the benefit value for measuring Bay Area water supply reliability benefits. In the event that multiple providers receive reliability benefits from the project, the likely alternative supply for each of the providers would need to be evaluated.

Determination of the least-cost alternative supply comparable to expanding Los Vaqueros Reservoir should consider the location, cost, and relative reliability of the alternative supply. Bay Area water agencies have identified various potential sources of future water supplies in their urban water management plans, including increasing reliance on out-of-basin water transfers, groundwater, conservation, recycling, and desalination. Few opportunities exist to develop new surface water supplies within the Bay Area; surface water supplies developed outside the Bay Area (including surface storage and transfers) are subject to potential interruption due to earthquakes or other

events. Groundwater is a largely developed resource in the Bay Area; in addition, groundwater quality (due to saltwater intrusion and contamination) and groundwater overdraft are problematic. Most Bay Area water agencies already have aggressive conservation programs in the event of drought or water supply interruptions; it is unlikely that significant water savings can be made regionally through additional conservation. Similarly, recycling is limited in its ability to provide large supplies and can be very costly. Desalination of brackish water or seawater has been gradually gaining popularity in California; a Bay Area regional desalination study recently identified several potential desalination sites in the Bay Area. Desalination is not subject to the hydrologic uncertainty of other supplies, such as water transfers, surface supplies, and groundwater use.

Opportunities to develop new onstream or offstream surface water storage in the Bay Area are limited, and out-of-basin water transfers already are relied on in dry and critical years to meet current demands. Consequently, the next increment of supply reliability in the Bay Area would likely be obtained by higher-cost water transfers (either long-term or short-term,) or desalination of brackish or ocean water supplies.

Another benefit related to water supply reliability is the creation of emergency storage supplies in an expanded reservoir. These benefits would likely be measured as costs avoided in the event of emergencies that result in infrequent shortages or outages in water supply. This might include supply disruption caused by a levee failure in the Delta that causes water quality to degrade, or an earthquake that damages a major distribution or supply pipeline. For example, the existing Los Vaqueros Reservoir provides emergency water supply in the event that Delta water quality is significantly degraded by a levee failure. Estimation of costs avoided in emergencies and outages requires careful consideration of (1) the types of emergencies likely to occur, (2) their expected intensity and frequency, and (3) the expected economic costs for each level of intensity and frequency in the without-project and with-project conditions.

Bay Area Water Quality

Water quality benefits result from improvements in the quality of municipal water supplies. Several methods could potentially be used to estimate water quality benefits, including the following:

- **Least-cost alternative to achieve the same incremental improvement in water quality –** The cost to construct new water treatment facilities, modify existing treatment facilities, or construct other facilities to improve water quality could be used to value the benefits of improved water quality.
- **Direct consumer/user benefits of improved water quality –** Consumer cost savings may be applied when customer water quality costs incurred in the without-project condition are not incurred because of water quality improvements in the with-project conditions. Such savings may include residential costs for alternate supplies (such as bottled water), home treatments, and reduced life of household features.
- **Avoided cost of treatment –** Improvements in raw water quality, such as lower turbidity, total organic carbon (TOC), and bromides, can reduce municipal water treatment costs. This might include cost savings at treatment plants and lower groundwater management costs.

- **Contingent valuation –** The use of direct questioning or surveys can be used to elicit society's willingness to pay for improvements in water quality. However, these surveys can be difficult to obtain and results may be biased.

For the LVE, water quality benefits generally result from lower consumer costs, lower groundwater management costs, and lower water treatment costs when raw water of higher quality is delivered to municipal agencies receiving supplies from the project.

In previous studies of potential expansion of Los Vaqueros Reservoir, consumer-related water quality cost savings were estimated using methodologies developed by Sonnen (2002). This analysis considered the number of households receiving supplies from the project and calculated benefits related to reduced bottled water purchases; longer life of household appliances, plumbing, and fixtures; lower use of home water softeners; and reduced purchases of soaps and detergents. These benefits would accrue when water supplies with lower TDS and total hardness (TH) are delivered to households served by water treatment plants that receive water from the SBA. The economic benefit would then be estimated by subtracting the consumer costs for the without-project condition from the costs of the with-project condition.

Economic benefits from lower groundwater basin management costs could be estimated using the avoided cost approach. Groundwater is actively managed in the SBA service area to control saltwater intrusion and maintain the quality of these supplies for urban and agricultural use. Groundwater recharge occurs from two primary sources: active recharge via spreading basins, and passive recharge from outdoor irrigation of urban landscapes. Groundwater quality benefits would be realized if supplies with lower TDS were delivered from an expansion project. The economic benefit could be calculated as the avoided cost to achieve the same reduction in TDS, which would likely require desalination or another advanced treatment method prior to use.

Savings in water treatment plant operating costs might include the avoided cost of advanced treatment, reduced energy or chemical use, or other operating efficiencies. CCWD is currently developing a detailed water quality model that will estimate the water quality parameters of interest in this benefit category. This model is expected to be completed by the end of 2006 and available for use in subsequent LVE feasibility studies.

Other Direct Benefits

Other direct benefits are those plan effects that are incidental to project purposes. For the LVE, these would be project benefits not directly associated with increased water supply reliability and quality or EWA replacement supplies. Potential other direct benefits relevant to the LVE might include reduced impacts to Delta aquatic resources and recreation, as described below.

- **Reduced impacts to Delta aquatic resources -** Delta aquatic resources would be affected by changes in the location, timing, and amount of diversions as a result of the project. However, estimation of these benefits may be very difficult because of complexities associated with the relationship between Delta fisheries and export operations. Alternately, reduced impacts to Delta aquatic resources may be appropriate for inclusion in the EQ account, rather than the NED account.

Water delivered to the SBA from Los Vaqueros Reservoir would be diverted from the Delta through modern, state-of-the-art fish screens similar to the existing fish screens at CCWD's Old River intake and pumping station. Currently, water delivered to the SBA passes through Clifton Court Forebay, which does not have modern, positive-barrier fish screens. The economic benefit of diverting water through a screened intake versus an unscreened intake could be valued in several ways. One potential method would be to estimate the avoided cost of equivalent fish screens at Clifton Court Forebay. Another potential valuation method might use the fish and wildlife restoration fund charge for CVP contractors; the charge of $16 per acre-foot for CVP M&I contractors was established in the Central Valley Project Improvement Act (CVPIA) to help pay for fishery restoration and other environmental projects.

- **Recreation -** Economic benefits associated with an expansion of Los Vaqueros Reservoir include increased recreational opportunities for Bay Area residents. Existing recreational uses at Los Vaqueros Reservoir include boating, fishing, hiking, sightseeing, and related outdoor activities (water contact sports are prohibited). Recreation was not included as an objective of the LVE because a need for additional recreation opportunities in the Bay Area, such as those that could be provided by reservoir expansion, could not be specifically established. Potential estimation methods identified in the P&G include (1) unit day values, (2) travel cost method, or (3) contingent valuation. Should recreation benefits be included in future economic analyses for the LVE, they are not likely to account for a significant portion of total project benefits.

Future studies should assess the appropriateness of including these or other direct benefits in the economic analysis for the LVE.

ECONOMIC ANALYSIS PARAMETERS

Economic parameters and future without-project conditions that form the basis for the economic analysis presented in this report are summarized below.

Economic Parameters

Economic analysis assumptions outlined in the P&G include those related to full employment, risk neutrality, and others. Parameters specific to the LVE include period of analysis and discount rate, summarized briefly below.

- **Period of analysis -** The period of analysis is the anticipated period over which project benefits or effects are likely to accumulate. The P&G allow for a period of analysis for up to 100 years based on anticipated project life. A 100-year period of analysis is believed appropriate for LVE due to the anticipated longevity of a dam and reservoir project. The economic benefits of the project would begin to accrue the year construction is completed.
- **Discount rate -** Benefits and costs are worth more if they are experienced sooner. The discount rate is the rate at which society as a whole is willing to trade off present for future benefits. NED benefits and costs are compared at a common point in time in average annual equivalent terms. This is accomplished by discounting the benefit stream, deferred installation costs, and operation, maintenance, and replacement costs to the beginning of the period of analysis using

an established Federal discount rate. Installation costs (including construction costs) are brought forward to the end of the installation period by charging compound interest from the date costs are incurred (interest during construction (IDC)). The Federal discount rate for plan formulation and evaluation is established annually by the Secretary of the Treasury pursuant to 42 United States Code 1962d-1. The Federal discount rate of 5-1/8 percent will be used in this initial economic analysis.

Future Without-Project Conditions

An important aspect of any economic analysis is establishing appropriate future conditions, both with and without the proposed action. Project benefits are measured as the difference between two alternative futures: the without-project condition (future without any action) and with-project condition. The following summarizes important conditions that are assumed to exist in the future without the LVE (see also discussion of Project Baselines in **Chapter 2**):

- The EWA or a similar program continues to purchase water to support pumping curtailments and other actions that promote protection and recovery of at-risk Delta fisheries. The program continues to be funded by both the Federal and State governments and operates/functions similar to the existing program. The program is assumed to use the EWA asset acquisition and management resources identified in the EWA Operating Principles Agreement (CALFED, 2000c), as may be amended, including the following:
    - Storage in existing CVP/SWP reservoirs (as available)
    - Dedicated pumping capacity of 500 cfs (July through September) at Banks Pumping Plant
    - SWP annual carryover debt in San Luis Reservoir of 100,000 acre-feet, when available
    - Existing water purchase mechanisms (primarily spot market purchases and short-term transfer agreements)
- The CCWD AIP is constructed and operating with a capacity of 250 cfs (high lift pump station) on Victoria Canal.
- The EBMUD Mokelumne Aqueduct Intertie with the CCWD Los Vaqueros Pipeline is constructed.
- The South Bay Aqueduct Improvements and Enlargement Project is constructed, increasing the capacity of the SBA to 430 cfs.
- Allowable pumping capacity at Banks Pumping Plant is increased to 8,500 cfs, per the SDIP.