EBERHARDT SCHOOL OF BUSINESS

Business Forecasting Center

Benefit – Cost Analysis of Delta Water Conveyance Tunnels

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Summary

This report updates an initial benefit-cost analysis of the water conveyance tunnels at the center of the Bay Delta Conservation Plan (BDCP). We find the tunnels are not economically justified, because the costs of the tunnels are roughly 2.5 times larger than their benefits. The economic benefits of the tunnels include water supply, water quality, and earthquake risk reduction to areas served by export water agencies. The economic costs include capital costs, operating and maintenance costs, and the costs to in-Delta and upstream water users.

Benefit-cost analysis is an essential and normal part of assessment and planning of large infrastructure projects such as the $13 billion water conveyance tunnel proposal, but has not been part of the BDCP. This report fills an important information gap for policy makers and water ratepayers who will ultimately bear the multi-billion dollar costs of the project.

This is a revision of an earlier white paper dated June 14, 2012. This version has been updated to reflect new project and economic information from BDCP, and some minor technical and editorial changes.

The principal author of this report is Dr. Jeffrey Michael, Director of the Business Forecasting Center (BFC) at the University of the Pacific. The BFC is among the most recognized economic research centers in California, and is known for its expertise on the Central Valley economy, growth resource issues facing the region. On water issues, the BFC is known for being the only academic or government entity to accurately assess employment impacts during the 2009 drought, and recently led the development of the Economic Sustainability Plan for the Delta Protection Commission. This report is part of the Center's mission of independent research and analysis of economic issues and trends in the state and region.

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Contents

Tables

Benefit – Cost Analysis of Delta Water Conveyance Tunnels

A pair of large water conveyance tunnels is being considered as the centerpiece of the Bay Delta Conservation Plan (BDCP). The tunnels would divert water from the Sacramento River and convey it around the Delta to state and federal water projects serving southern California rather than continuing to convey the fresh water through Delta channels. The construction cost of the tunnels is estimated at $13 billion. Essentially, the project is an updated version of the peripheral canal defeated by California voters in 1982.

This report updates an initial comprehensive economic benefit-cost analysis of the proposed tunnel with the latest information from the BDCP. Primarily using the results of the BDCP's own economic benefit and cost studies, we find benefit-cost ratios ranging from 0.3 to 0.5, meaning that there are between $1.90 and $3.36 of costs for every $1 in economic benefits. When these very low benefit-cost ratios are considered alongside the inconsistent and incomplete financial plans, it is clear that the Delta water conveyance tunnels proposed in the draft BDCP are not justified on an economic or financial basis.

The BDCP is considering a variety of sizes and operating criteria for the water conveyance tunnel. This analysis focuses on a scenario that is reported to be the preferred alternative emerging in BDCP negotiations.[1] Two large tunnels will be built to convey water below the Delta along with three intakes on the Sacramento river that can divert 9,000 cfs (cubic feet per second) from the river. The project would result in average annual water exports in a range between 4.3 maf (million acre feet) and 5.5 maf. The level of water exports through the tunnel depends on a 15-year decision-tree process based upon scientific studies of the effectiveness of the BDCP's habitat investments in recovering endangered fish populations. The studies and decision-tree process would be concurrent to the tunnel construction, so the water yield of the tunnels would not be known until after they are built.

This assessment examines a favorable water supply scenario for the water agencies that would finance the tunnels, average water exports of 5.3 maf, near the maximum level. This analysis looks only at the water conveyance proposal in the BDCP, and does not evaluate habitat creation proposals that provide their own benefits and would have several billion dollars in additional construction costs that would be primarily financed by the water bond recently moved to the 2014 ballot. As noted in a later section, this separate analysis of water conveyance infrastructure and habitat is consistent with Department of Water Resources' economic analysis guidelines.

This preliminary benefit-cost assessment can be updated with new information as it becomes available. Our intention is to motivate public agencies and others to conduct comprehensive benefit-cost analysis, and to provide appropriate economic justification of the project. Given the poor performance of the tunnel in this initial benefit-cost analysis with several assumptions favorable to tunnel construction, we believe it is highly unlikely that any subsequent benefit-cost analysis will find that the project is economically justified.

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[1] For example, see "Gov. Jerry Brown's delta fix is not much of a plan." *San Francisco Chronicle*, July 9, 2012, and presentations at the June 20, 2012 meeting of the Bay Delta Conservation Plan.

Benefit-Cost Analysis

Benefit-cost analysis of large infrastructure projects is common practice, and broadly considered to be an essential part of good public policy analysis of large capital projects. For example, high-speed rail, the other California mega-project in the news, has included multiple benefit-cost assessments as the plan has evolved. The most recent accompanied the revised business plan and found most scenarios had about $2 in expected benefits for every $1 in expected costs.[2] The benefit-cost ratio of high-speed rail is five times higher than the benefit-cost ratio we have calculated for the Delta water conveyance tunnel.

Benefit-cost analysis of the tunnel conveyance has been called for in numerous reports and reviews of the BDCP, but still has not been appropriately conducted by any state agencies or published in any independent academic studies before this report. The Department of Water Resources (DWR) has an Economic Analysis Guidebook that provides a comprehensive description of DWR's approach to benefit-cost analysis.[3]

The DWR Economic Analysis Guidebook states the importance of benefit-cost analysis well,

> Economic analysis is a critical element of the water resources planning processes because it not only evaluates the economic justification of alternative plans but it can assist in plan formulation. (p. 1)
>
> The economic analysis should answer questions such as, Should the project be built at all? Should it be built now?, Should it be built to a different configuration or size? Will the project have a net positive social value for Californians irrespective of to whom the costs and benefits accrue? (p. 5)
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> Benefit-cost analysis is the procedure where the different benefits and costs of proposed projects are identified and measured (usually in monetary terms) and then compared with each other to determine if the benefits of the project exceed its costs. Benefit-cost analysis is the primary method used to determine if a project is economically justified. A project is justified when:
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> - estimated total benefits exceed total estimated economic costs;
> - each separable purpose (for example, water supply, hydropower, flood damage reduction, ecosystem restoration, etc.) provides benefits at least equal to its costs;[4]
> - the scale of development provides maximum net benefits; and

[2] The April 2012 high-speed rail benefit-cost analysis can be downloaded from http://www.cahighspeedrail.ca.gov/assets/0/152/431/6515fa4a-a098-4b88-9f19-19f0e1475e19.pdf. The business plan and benefit-cost analysis of high-speed rail have been criticized for optimistic ridership projections, but this debate has strengthened the policy and planning process for the high-speed rail project. Many of the economic benefits of high-speed rail are health related such as reduced traffic fatalities and air pollution from reduced highway travel and the benefit-cost analysis attached monetary values to health and environmental benefits.

[3] The DWR Economic Analysis Guidebook is on the web at http://www.water.ca.gov/pubs/planning/economic_analysis_guidebook/econguidebook.pdf

[4] This bullet point is critically important to the BDCP which some argue can only be evaluated as a package of water conveyance and habitat improvement projects. The DWR economic analysis guidebook is correct in stating that water supply and habitat projects should be evaluated separately.

- there are no more-economical means of accomplishing the same purpose. (p. 13)

The benefits and costs of an investment occur at different points in time, and can extend for very long time horizons. Benefit-cost analysis examines a full stream of costs and benefits over the expected life of the project. For this analysis, we examined 50 years after the expected completion of the tunnels in 2025.

The long streams of benefits and costs are compared using a present discounted value in current dollars. A discount rate, comparable to an interest rate, is used to account for the time value of money or the opportunity costs of using funds for a public investment. Public investment has opportunity costs, because it competes with and crowds out funding for private consumption, investment or alternative public investments.

Benefit-cost results can be sensitive to the level of the discount rate, and the choice of discount rate is sometimes controversial in benefit cost analysis. Federal government guidelines recommend the use of a 7% discount rate.[5] The DWR Economic Analysis Guidebook endorses a 6% discount rate. Many economists recommend a lower discount rate, such as 3%, when looking at long-lived investments or regulations to combat long-run, global issues such as climate change. This analysis uses scenarios with a 3% and 6% discount rate.

Benefit-cost analysis is not just a pass/fail test to be taken after an investment proposal is finalized. It should be conducted and refined throughout a planning process as it yields valuable insights about a projects strengths, weaknesses, and overall merit. The absence of benefit-cost analysis throughout the BDCP process is a significant weakness that has left policy makers poorly informed to make a decision about a very costly investment with far ranging economic effects.

The objective of this report is to fill an important information void, and to challenge tunnel proponents to make their economic case using an accepted and established benefit-cost framework. Most of the values for benefits and costs in this report are taken directly or clearly derived from BDCP documents or reports sponsored or cited by tunnel proponents. Most assumptions required to derive values are made in ways that favor building the tunnel. The detailed sources and discussion of study assumptions are in the sections that follow.

Benefits of a Delta Water Supply Tunnel

The delta water supply tunnels would provide four types of potential benefits: higher export water supply, improved export water quality, earthquake risk reduction for water exports, and possible environmental benefits for endangered fish species. There is a trade-off between increasing water supply from the tunnels and their potential benefits for fish.

[5] See Office of Management and Budget, Circular No A-94. http://www.whitehouse.gov/omb/circulars_a094#7

The California Department of Water Resources has recently contracted with the Brattle Group to conduct an Economic Benefit Analysis of the BDCP led by Dr. David Sunding.[6] The quantification of economic benefits in this section follows the framework in the scope of work in the "Benefits Analysis," and the values used in this report are taken directly from the preliminary results presented by Dr. Sunding at the BDCP public meeting on June 20, 2012.[7] The benefits in the Brattle presentation are for the period of 2022 to 2050, whereas this analysis assumes the tunnels would open in 2025 and considers benefits from fifty years of operation, 2025 to 2074. To make the adjustment, we calculated the average annual benefit in the 29 years of the Brattle analysis, and assumed it was constant over the fifty year period from 2025 to 2074.[8]

The Brattle analysis is not a comprehensive statewide benefit-cost analysis, but has a more narrow purpose to "assess whether the benefits of BDCP are sufficient to justify the costs to the agencies receiving project water supplies." In addition to providing reliable, current estimates for several components of benefit-cost analysis, the Brattle "Benefits Analysis" raises some additional considerations for financial feasibility that are discussed later in this report.

Export Water Supply:

The Brattle group estimates the present value of water supply benefits from 2022 to 2050 at $1.898 billion for urban users and $1.138 billion for agricultural exporters using a 3% discount rate. This equates to average annual operating benefits of about $361 per acre foot, averaged across both agricultural and urban water exports. The average annual benefit of $136 million for urban agencies and $81 million for agricultural agencies creates a present value of export water supply benefits of $3.916 billion using a 3% discount rate and $1.700 billion using a 6% discount rate when this annual benefit of the tunnels is extended over the 50 year period beginning in 2025.

Export Water Quality Benefits:

Improved export water quality is a significant benefit of the proposed Delta tunnel. The Brattle group estimates the present value of water quality benefits from 2022 to 2050 at $1.802 billion

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[6] The Economic Benefit Scope of Work is available at http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Economics_Benefit_Scope_of_Work.sflb.ashx

[7] Dr. Sunding's presentation from the meeting is available on the BDCP website, http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/June_2012_Public_Meeting_Presentation_6-20-12.sflb.ashx. Some minor adjustments to the Brattle results have been made to reflect two differences in the scenario analyzed in this report. We assume the tunnel begins operation in 2025 as stated in BDCP documents, not the more optimistic 2022 used in the Brattle modeling. Also, we analyze benefits and costs out to 2075, 50 years of operation, rather than the 2050 end date in the Brattle analysis by assuming benefits continue at a constant annual rate beyond 2050. This assumption may understate total benefits somewhat, but by a much smaller amount than cutting the analysis off in 2050.

[8] This simplifying assumption may somewhat understate benefits since the benefits of the tunnel grow slowly over time and are likely to be somewhat higher in the post 2050 period than the pre-2050 period. However, it may also overstate benefits in the early years that are less affected by discounting. Overall, it has little effect on the results. An alternative option to ignore years after 2050 would result in much lower benefit estimates and significantly bias the analysis against the tunnels.

for all water exporters using a 3% discount rate. This equates to average annual benefits of $129 million after the tunnels are operating. If this annual benefit is extended over a 50 year period beginning in 2025, the present value of export water quality benefits are $2.328 billion using a 3% discount rate and $1.010 billion using a 6% discount rate.

When considering water quality benefits, it is important to note that the tunnel itself does not do anything to purify water supplies. It improves export water quality, because the tunnel moves Delta water exporters' diversion points to a stretch of the Sacramento River between Clarksburg and Courtland where water quality is better. The new intake would be upstream of the existing diversions of Sacramento River water by most Delta farmers, the Contra Costa Water District, and the cities of Stockton and Antioch, whereas the current intakes are downstream of these users. Thus, any water quality benefits received to the export projects will be at least partially offset by a degradation of water quality to those water users who will now be downstream of the massive intakes of the new tunnel. Many of these offsetting costs have not been thoroughly analyzed, but are at the root of much of the opposition to the proposed Delta tunnels. Some of these potential costs are included in the In-Delta and Upstream Impacts section in the cost assessment that follows.

Earthquake Risk Reduction:

A massive earthquake that floods Delta islands and disrupts water conveyance is frequently cited as the most important economic justification for an isolated water conveyance facility around the Delta. This is inaccurate. The Delta tunnels are often incorrectly portrayed as the only way to protect the economy from a catastrophic earthquake risk, and economic risks of water supply disruption are often inflated by including non-water supply economic losses. In this section, we first assess the economic benefit from the tunnels' earthquake protection assuming that there are no seismic upgrades to the Delta levee system. We use these values in the benefit-cost analysis. Second, we discuss alternative options for reducing seismic risk that protect against a broader set of economic risks at lower cost than the tunnels.

The scope of work for the BDCP "Economic Benefit" analysis described a correct approach for an economic assessment of seismic risks, "After developing estimates of the probability of various outage scenarios, Contractor will calculate expected losses and characterize the risk inherent to the current system." In the June 20 presentation at the BDCP meeting, the Brattle analysis did not include probabilities of outage scenarios or calculate expected losses. It only showed losses from a scenario when a massive earthquake occurs on the first year the tunnels are operating. However, it is straight forward to use these results to derive the expected annual losses called for in the scope of work.

The length of seismic outages that are currently being discussed as likely, especially in light of recent and planned responses to the levee and emergency response system and the effect of freshwater flushing out the Delta, is on the order of 6 to 12 months. According to the June 20 presentation by the Brattle Group, the estimated present value cost of an outage occurring in 2022 as $722 million for 6 months, and $2.093 billion for a 12 month water supply outage. The effect of discounting needs to be eliminated to calculate an expected annual loss. The undiscounted cost of a 6 to 12 month outage in 2022 is $970 million to $2.812 billion.

To calculate an expected value, these undiscounted expected annual losses would be multiplied by an annual probability of such a seismic event and failure occurring. According to Figure 5 in the executive summary[9] of the Delta Risk Management Strategy Phase 1 report, the annual probability of 10+ islands failing from earthquake is about 3%, and the annual probability of 30 or more islands failing is about 1%. Many engineers feel that these failure probabilities are far too high[10], but we utilize them below in the absence of more current published probabilities.

Table 1 Expected annual urban losses from a Delta earthquake

Annual Probability	6 mos outage ($970m)	12 mos outage ($2,812m)
.03	$29.1 m	$84.4 m
.02	$19.4 m	$56.3 m
.01	$9.7 m	$28.1 m

The median value in the table is about a $29 million expected annual urban losses that could be avoided if the Delta water supply tunnels were built. The Brattle presentation did not calculate agricultural losses, but assuming that the urban to agriculture ratio of earthquake protection benefits is similar to the water supply benefits, the expected annual benefits from earthquake protection are $48 million annually for urban and agriculture combined. If this annual benefit is extended over a 50 year period beginning in 2025, the present value of earthquake protection benefits are $866 million using a 3% discount rate and $376 million using a 6% discount rate. Although we use these values in the benefit-cost analysis, they are likely to be far too high as the earthquake probabilities are lower, and, as explained below, there are less costly options that could lower the risk of seismic water export outages to near zero.

If a massive earthquake were to cause ten or more Delta islands to simultaneously flood, the human and economic losses that would result are much larger than the impact on water supplies. According to the Delta Risk Management Strategy (DRMS) reports, hundreds of people in the Delta would drown in such a catastrophic flood, possibly more. In addition, the DRMS reports found that interruptions of export water supply would be only 20% of the economic loss of such a catastrophe. Much larger economic losses would come from disruptions to natural gas systems, electricity transmission and generation, state highways, ports, railroads, and significant losses of in-Delta businesses, homes, and farmland. Given the scale of these potential losses to multiple types of economic infrastructure, it makes sense to consider seismic upgrades to the Delta levee system that protect all economic values in the Delta, including water exports. Unlike a tunnel, seismic levee upgrades could also save hundreds of lives and prevent environmental destruction of such a catastrophic flood.

Two reports by state agencies have identified seismic levee upgrades as a viable earthquake risk reduction strategy in the Delta.[11] The Delta Protection Commission Economic Sustainability

[9] http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/drms_execsum_ph1_final_low.pdf

[10] For example, Dr. Robert Pyke, a well-known geotechnical engineer states that the probability of an earthquake flooding ten or more islands is much lower than 1%.

[11] "Economic Sustainability Plan for the Sacramento-San Joaquin River Delta." Delta Protection Commission. January 2012. http://www.forecast.pacific.edu/desp.html. "Risks and Options to Reduce Risks to Fishery and Water Supply Uses of the Sacramento/San Joaquin Delta." Department of Water Resources and Department of

Plan estimated the cost of 300 to 600 miles of seismic levee upgrades at between $2 billion and $4 billion, including riparian habitat enhancements on the enlarged levees. The Department of Water Resources' January 2008 AB 1200 found an "Improved Levees" scenario with 100 miles of seismic upgrades to eight islands in the south Delta was the lowest cost of three promising risk reduction strategies, including a peripheral canal.[12] In addition, a 2007 PPIC report estimated the cost of a similar Dutch style, "Fortress Delta" strategy at $4 billion.[13] Seismic levee upgrades are 1/6 to 1/3 the cost of the proposed water conveyance tunnel, and provide a much larger and broader range of risk reduction benefits to the economy.

Understanding the larger picture of earthquake risk is essential because benefit-cost analysis is based on "with and without" comparisons to the next best alternative. It is hard to envision that the state and federal governments would allow the seismic risk to human life and other economic assets in the Delta to remain unaddressed even if water exporters moved ahead with a Delta tunnel. Since necessary seismic upgrades to Delta levees could be completed by the time a Delta tunnel conveyance was constructed, a water supply tunnel would create no additional seismic protection for water exports. In this scenario, the earthquake risk reduction benefits of the water supply tunnel are zero.[14] Although we believe zero is a more appropriate value for benefit-cost analysis, we utilize the higher estimates that assume that alternative strategies to reduce seismic risk are not implemented, and thus the risks to the broader economy and public safety are ignored.

Environmental Benefits:

At equal levels of water exports, a water supply tunnel could have environmental benefits for endangered fish over the current diversion location in the south Delta that causes reverse flows in some Delta rivers and entrainment of endangered fish in the pumps. However, as water exports are increased beyond the no-tunnel estimate of 4.7 maf of average exports, the marginal environmental benefits of a tunnel diminish. The BDCP's most recent "effects analysis" found that an operating plan that includes 5.9 maf of average exports would harm many of the endangered species the BDCP intends to help. This benefit-cost analysis assumes an increase in water exports to a slightly lower level of 5.3 maf, near the top of the 4.3maf to 5.5maf range that is reported to be under current consideration. At higher levels of water exports, most if not all environmental benefits that could directly result from a tunnel are consumed or monetized in the form of higher water exports, and the environmental benefits of

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Fish and Game. January 2008.
http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/AB1200_Report_to_Legislature.pdf.

[12] The seismic upgrade of only 8 islands was found to reduce the cost of water export interruptions from the largest Delta earthquake by 2/3, and the strategy had the largest overall economic risk reduction because it also protected other economic assets from flood in the case of an earthquake.

[13] The PPIC ruled out a "fortress Delta" solution in 2007, because its $4 billion cost was seen as too high, and they assumed a peripheral canal cost only $3 billion. The PPIC also ignored or downplayed public safety and the risk to non-water supply infrastructure. See "Envisioning Futures for the Sacramento-San Joaquin Delta" Public Policy Institute of California, February 2007. http://www.ppic.org/main/publication.asp?i=671

[14] If the tunnel conveyance were implemented as part of a Delta policy package that prevented or delayed seismic levee upgrades in the Delta, it could be argued that that the net earthquake risk reduction benefits of a tunnel are negative compared to the next best alternative.

the BDCP would come from an extensive program of habitat restoration separately funded by state and federal taxpayers. If the tunnel did not result in increased water exports, there could be an increase in environmental benefits, but the water supply benefits would drop to zero. This trade-off between export water supplies and environmental benefits has been at the center of much of Delta discussions. Because increased water exports are essential to financing the tunnel by water contractors, we believe that a more environmentally beneficial scenario of tunnel conveyance that does not result in increases export water supplies is financially infeasible and irrelevant. Thus, we focus on the most realistic case of high water exports.

Costs of a Delta Water Supply Tunnel

Capital Costs:

We use the $12.7 billion construction cost estimate from Chapter 8 of the February 29, 2012 Draft Bay Delta Conservation Plan (BDCP).[15] There are news reports that tunnel cost estimates have risen to $14 billion[16] and possibly more. However, the proposed design change to a 9,000 cfs system with three intakes and large gravity fed tunnels may reduce construction costs. The elimination of two intakes and an intermediate pumping plant from the original 15,000 cfs design could reduce the cost estimate by about $2 billion. However, the gravity flow tunnels may have to be larger than originally estimated[17] which would increase costs. Since there are conflicting reports that costs have increased or decreased by roughly $2 billion, we stay with the original cost estimate. These figures are easy to revise once updated cost estimates are available. In addition, this construction cost estimate does not include costs for “avoidance and minimization” measures associated with construction of the tunnel conveyance, since no cost estimate for this component was included in the most recent draft of BDCP.

Chapter 8 of the BDCP describes a financing strategy for construction that would involve issuing a series of 4 revenue bonds with 40 year repayment terms. Debt servicing costs are estimated at $1.1 billion annually from 2021 through 2056, and the last of the bonds would be retired in 2061. Table 8-61 of BDCP Chapter 8 details the distribution of the $12.7 billion in construction costs over time. The present value of these construction costs are $10.777 billion using a 3% discount rate and $9.205 billion using a 6% discount rate.

Operating and Maintenance Costs:

The February 29, 2012 draft BDCP estimates operation and maintenance costs for the Delta tunnel at $85 million annually, including $17.8 million in electricity costs.[18] For the 50 year

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[15] http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/BDCP_Chapter_8_-_Implementation_Costs_and_Funding_Sources_2-29-12.sflb.ashx

[16] Weiser, M. *Sacramento Bee,* February 20, 2012. “Water Tunnels Would Be Huge Project—If They Clear Huge Obstacles.”

[17] Chapter 8 of the BDCP states that the tunnels would accommodate 7,000 cfs gravity feed, and DWR representatives at the June 20 meeting says that sizing had not been finalized but acknowledged that 9,000 cfs gravity feed tunnels may have to be larger than 15,000 cfs tunnels with an intermediate pumping plant.

[18] The electricity share of operating costs could decrease if tunnels are sized for gravity flows. Since electricity is a relatively small share of operating costs, we have not made an adjustment without further details of the impact.

period beginning in 2025, the present value of operating and maintenance costs are $1.533 billion using a 3% discount rate and $665 million using a 6% discount rate.

In-Delta and Upstream Costs:

The water supply tunnel will generate a variety of costs on in-Delta and upstream uses. As discussed before, the large new diversion on the Sacramento River will degrade water quality for those who divert Sacramento River downstream from the proposed intakes. These users include Delta farmers, the Contra Costa Water District, the Cities of Antioch and Stockton, industrial user such as power plants in eastern Contra Costa County, and the North Bay Aquaduct that serves Napa and Solano. In addition, the footprint of the tunnel facility will eliminate Delta farmland and property (although less than a surface canal), and three massive new water intakes will create substantial visual and noise pollution along a scenic, rural stretch of the Sacramento River, harming Delta residents and detracting from recreation and tourism in the area. Upstream users, such as the North State Water Alliance, are concerned that the tunnel operation could reduce upstream water supplies, and result in lower reservoir levels which could affect hydroelectric power generation and recreational use of reservoirs.

Economic values have not been estimated for most of these impacts. The Delta Protection Commission Economic Sustainability Plan estimated a water conveyance tunnel would result in an average of $65 million in annual losses for Delta agriculture; including about $50 million in losses from reduced water quality, and an additional $15 million in annual crop losses from roughly 8,000 acres of farmland lost to construction impacts and the physical footprint of the facilities.[19] It is possible that a tunnel with fewer intakes and operated for environmental benefits would be more protective of in-Delta water quality and result in lower impacts on Delta agriculture. Even if Delta agriculture impacts were lower than $65 million, the other impacts to in-Delta urban water intakes, Delta communities, and upstream water users would surely push the overall cost of in-Delta and upstream impacts higher. We use $65 million as a very conservative, preliminary estimate of the annual costs to in-Delta and upstream interests, and have not made any estimate of in-Delta costs associated with the construction activity itself. For the 50 year period beginning in 2025, the present value of estimated in-Delta and upstream costs are $1.173 billion using a 3% discount rate and $509 million using a 6% discount rate.

Benefit-Cost Ratio

Table 2 summarizes the benefits and costs detailed in the previous section. Using both a 3% and 6% discount rate, the economic benefits of the tunnels are about $7 billion less than the costs. Even without discounting, meaning that the time value or opportunity cost of money is ignored, the benefits are still $500 million lower than the cost through 2074. The benefit-cost ratio ranges from 0.3 to 0.5 depending on the discount rate used. Alternatively, costs are two to three times higher than the benefits.

[19] http://www.forecast.pacific.edu/desp.html

Table 2 Benefits and Costs of Delta Tunnels through 2074
Results are expressed as present discounted values calculated with 3% and 6% discount rates. Ending year of 2074 is fifty years after estimated completion of tunnels in 2025. (millions of current dollars)

Benefits ($ millions)	**3% Discount Rate**	**6% Discount Rate**
Export Water Supply at 5.3 maf of exports	3,916	1,670
Export Water Quality	2,328	1,010
Earthquake Risk Reduction	866	376
Environmental Benefits at 5.3maf of exports	0	0
Total Benefits ($ millions)	**7,110**	**3,056**
Costs ($ millions)		
Debt Service Capital Cost	10,777	9,205
Operation and Maintenance	1,533	666
In-Delta and Upstream Impacts	1,173	509
Total Costs ($ millions)	**13,484**	**10,380**
Net Benefits ($ millions)	**-6,374**	**-7,324**
Benefit-Cost Ratio	**0.527**	**0.297**
Cost-Benefit Ratio	**1.90**	**3.36**

Table 3 Estimated Annual Benefits and Costs in 2030

Benefits ($ millions)	**2030 Benefits/Costs**
Export Water Supply at 5.3 maf of exports	217
Export Water Quality	129
Earthquake Risk Reduction	47
Environmental Benefits at 5.3maf of exports	0
Total Annual Benefits ($ millions)	393
Costs ($ millions)	
Debt Service Capital Cost	1,100
Operation and Maintenance	85
In-Delta and Upstream Impacts	65
Total Annual Costs ($ millions)	**1,250**

Although we have been careful to use the most recent reliable values from the BDCP and reports of other state agencies, there is uncertainty surrounding any assessment of this kind. The uncertainties and any omitted values are balanced between items that help and harm the economic case for the tunnels. For example, the in-delta and upstream costs are almost certainly underestimated, and include no in-Delta impacts from the construction process, in-Delta municipal water supply and quality impacts, and a host of potential upstream impacts on water supplies from the Sacramento Valley to the east side of the San Joaquin Valley. As discussed in a previous section, the earthquake risk reduction benefit is likely overstated since it ignores the alternative of seismic upgrades to the Delta levee system. The water supply benefits and capital costs may also prove to be too optimistic, further weakening the case for the tunnels. On the other hand, the tunnels would facilitate water transfers from areas north of the Delta, benefits that have not been valued in this analysis. In addition, the initial Brattle results did not include urban benefits to Santa Clara which receives some of their water supplies from the Delta. The cost of the tunnels may also be reduced if an alternative with fewer intakes is selected. Overall the uncertainties and omissions are balanced and it seems very unlikely that any of them could be large enough to change the conclusion given the size of the gap between costs and benefits.

Some socio-economic considerations are also not included in the analysis. Most notably, the values of agricultural water do not include multiplier effects to capture the broader regional economic benefits created by water supplies. There are legitimate reasons why these indirect impacts are generally excluded from benefit-cost analysis, but the special role of agriculture in supporting the economic base of the Central Valley should be acknowledged. If these socio-economic values of agricultural production were included, the benefits would increase by about $100 million per year, a roughly 25% increase in total benefits. However, it is important to note that these socio-economic impacts are present for both areas that benefit from water exports from the tunnels, and for the in-Delta and upstream areas that are potentially harmed. Incorporating socio-economic impacts would increase both the benefits and the costs of the tunnels.

Financial Feasibility and Ratepayer Impacts

Benefit-cost analysis is sometimes confused with financial analysis and ratepayer impacts. Benefit-cost analysis does not estimate rate increases as these depend upon a number of financing assumptions, the amount of public investment, cost recovery principles, and business considerations of individual utilities. Benefit-cost analysis is a tool for policy analysis and decision making that informs whether a project is economically justified and should be built.

In contrast, financial feasibility analysis simply investigates whether a project can be financed and paid for, whether or not it is economically desirable or the most cost-effective way to meet a given objective. Financial feasibility must be demonstrated for certain regulatory requirements, and also must be proven to investors who are needed to buy bonds to finance construction. Financial feasibility is clearly linked to estimating ratepayer impacts since increased water rate revenue will be required to finance the bonds.

Despite the differences, the benefit-cost calculations raise serious questions about financial feasibility. If only the benefits and costs to water exporters in Table 2 are considered, the total benefits of the tunnels are still about $6 billion shy of the total costs that would be paid by the water agencies. However, there could be additional benefits to water agencies that are not accounted for in Table 2, such as the value of regulatory assurances that would be part of the BDCP. Financial feasibility also raises concerns about how the costs would be distributed across the state and federal water projects and urban and agricultural agencies.

Regulatory Assurance under the Endangered Species Act:

The tunnels are proposed as part of the BDCP, a habitat conservation plan (HCP) that may reduce regulatory risk to the exporting water agencies from further cuts in Delta water exports due to Endangered Species Act protections for endangered fish. This regulatory assurance would have tremendous value to the water agencies.

Despite its value to water agencies, we did not include regulatory assurance in the comprehensive benefit-cost analysis because the assurance does not create any value from a comprehensive, statewide perspective. Regulatory assurance transfers the risk of a negative environmental outcome from the export water agencies to the environment, taxpayers, and in-Delta and upstream resource users who might have to pay in place of water agencies if the tunnels turn out to be negative for endangered fish. If the value of the fisheries and the Delta environment are as high as the Brattle Group and BDCP estimate, then shifting this risk away from water exporters could actually be a net negative from a statewide perspective.

Despite the lack of statewide value, there is no denying that regulatory assurance is valuable to water exporters and contributes to their financial feasibility. But what is it worth? Preliminary modeling from the Brattle Group presented at the June 20, 2012 BDCP meeting suggests the value of regulatory assurance could be as high as $11 billion. That would exceed the $6-7 billion shortfall suggested by the benefit-cost analysis. However, this issue begs another important question.

Does regulatory assurance and a valid HCP granting incidental take permits for the water agencies require the peripheral tunnels? According to this analysis, the water agencies could pay up to $6 billion in habitat improvements for an HCP on the current through Delta conveyance system, and still come out economically ahead of paying for the $13 billion tunnels. It seems logical that the necessary investments for an HCP and regulatory assurance on a no-tunnel alternative would be no more expensive than the $4 billion expense of habitat creation in the current BDCP proposal. Taxpayers would benefit greatly from this approach since a water bond that further burdens the state's beleaguered general fund would be unnecessary to finance Delta habitat upgrades.

Will Costs Be Allocated Proportional to Water Supply, Economic Benefits, or Population?

Although the BDCP has yet to release a detailed financial plan with cost allocations between Delta export water agencies, the agencies have said that the cost of the tunnel would be paid in proportion to the water received through the tunnel. For example, Metropolitan Water District, has said it expects its ratepayers to pay for 28% of the cost of the tunnel, equivalent to their share of Delta water exports. However, the high cost of the Delta project raises serious affordability questions for the agricultural users who receive the majority of water exported from the Delta. The cost of irrigating with water exported through the tunnels would exceed the profits of many crops grown in the Central Valley.

A proportional financing plan is simple to implement, prevents cross-subsidies between urban and agricultural users and is consistent with California Proposition 218. However, financial feasibility for a proportional financing plan requires the benefits to exceed the cost for every water agency, a much tougher standard than assessing whether the collective benefits to the agencies exceed the collective costs to the agencies. As discussed above, a proportional cost allocation means the tunnels are clearly financially infeasible for agricultural water agencies who receive the majority of water exported from the Delta under proportional cost allocation.

The most recent draft of the BDCP suggests a non-proportional financing approach, and compares the cost of the tunnel to urban rather than agricultural water supply projects. In fact, the draft BDCP financial analysis states the project is feasible because its per capita cost is smaller than some urban water projects financed by local urban water agencies. But the per capita financial feasibility analysis in the draft BDCP is inconsistent with the statements water contractors have made about proportional financing for the past five years. At the June 26, 2012 board meeting of the Metropolitan Water District (MWD), directors clearly expressed disapproval of the per capita financing suggested in the latest draft BDCP and MWD staff concurred.

Despite the fact that proportional cost allocation will clearly not work for financing the tunnels, water agencies have not put forward any other approach with their boards or ratepayers. The facts are that the tunnels are financially marginal for water agencies collectively, and that urban water use produces 2/3 of the benefit with 1/3 the water, and agricultural water use is 1/3 the benefit with 2/3 of the water. Financing the tunnels will either require a subsidy for agricultural users from urban ratepayers or taxpayers, or significant sales of water from agricultural to urban water agencies that will lead to fallowed fields in the Central Valley but more funds for bond repayment. But urban agencies and the government are adamant that there will be no ratepayer or taxpayer subsidies for farmers. And farmers insist that they have no intention of selling their water supplies to urban areas.

The result is that mere days from the Governor's expected announcement that the state is building the tunnels, water agencies still can't provide details on how much it will really cost their ratepayers or explain how they would generate the nearly $1.2 billion per year necessary for debt service and operating costs. There has been some informal discussion about pricing strategies that would yield more revenue for debt service such as differential pricing by reliability or allocating costs proportional to economic benefits instead of water quantity. However, it is unclear if such new pricing schemes are practical, supported by ratepayers or consistent with Proposition 218.

Of course, the main reason that financing the tunnels is so challenging is that the project does not provide economic benefits that exceed its cost. The recent recession is a powerful reminder that no amount of financial engineering can change the fundamental economics of an investment from bad to good.

Conclusion

This report updates an initial benefit-cost analysis of the water conveyance tunnels at the center of the Bay Delta Conservation Plan (BDCP). Primarily using the results of the BDCP's own economic benefit and cost studies, we find a benefit-cost ratios ranging from 0.3 to 0.5, meaning that there are between $1.90 and $3.36 of costs for every $1 in economic benefits. To put this in perspective, this benefit-cost ratio is 80% lower than those estimated for the State's high-speed rail project.

When these very low benefit-cost ratios are considered alongside the inconsistent and incomplete financial plans, it is clear that the Delta water conveyance tunnels proposed in the draft BDCP are not justified on an economic or financial basis.