The Economics of Ending Delta Water Exports Versus the Peripheral Canal:

Checking the Data of the PPIC

October 23, 2008

Summary:
The issue of the peripheral canal has returned to the center of the debate about the future of the Delta. The case for building the peripheral canal has recently received a major boost from a report by the Public Policy Institute of California (PPIC) that endorses the peripheral canal as the best long-run solution for the Delta. The PPIC report considers alternative strategies, most notably ending Delta water exports. They find that ending Delta water exports is significantly better for the environment than a peripheral canal, but reject the strategy because it is too costly. However, the PPIC's cost estimates are exaggerated. They depend on inaccurate assumptions that utilize outdated, undocumented, or fabricated sources. When adjustments are made to their population growth and desalination cost assumptions to reflect the best, documented sources, the cost of ending Delta exports are likely to be similar to a peripheral canal. With similar costs, ending Delta exports is the best strategy due to its superior environmental benefits.

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The key unsupported assumptions that inflate PPIC cost estimates are:

- California population grows to 65 million in 2050.
- Desalination costs of $2,072 per acre foot of desalted water.

These assumptions are keys to assessing reduced Delta exports because they define the level of future urban water demand and the cost of alternative urban water supplies when Delta exports are curtailed. In both cases, the PPIC assumptions lie far beyond the highest estimates of credible sources. Their population projection assumes 5-10 million too many urban water users, and their desalination cost is double current estimates.

The next section provides details on the PPIC's assumptions, and documents more credible levels. This is followed by some calculations that illustrate the potential impact on the costs of reducing Delta exports. Finally, these adjusted cost estimates are compared to the peripheral canal, and the impact on the study's conclusion is discussed.

Unrealistic Assumptions and Inaccurate Data

Population Growth

The PPIC's population growth assumption is stated on page 4 of Technical Appendix F.

> "The results presented here simulate the level of development in the year 2050, with a projected population of 65 million (up from 39 million in 2008) (Medellin-Azuara et. al. 2008; Department of Finance, 2008). Urban water demands were based on the year 2020 per capita demands … scaled to the estimated 2050 population."

The first clue that there is a problem with the data is that the current population isn't even correct. The state's current population is about 37 million according to the U.S. Census and estimated at about 38 million by the California Department of Finance, not 39 million as stated above. By giving a pair of 2008 references, it appears that the PPIC report is using the latest data. However, the Department of Finance population reports they reference (the latest made in 2007 not 2008) estimate the 2050 population at 59.5 million, not the 65 million claimed. The second reference is another of the authors' papers (Medellin-Azuara et. al. 2008) and the true source is revealed in their *Climatic Change* article,

> "data from Landis and Reilly (2002) for a "high" estimate of year 2050 population (65 million) and resulting land use in California. This provided urban water demands and irrigated land areas for 2050."

This is rather stunning. The PPIC report never refers to their estimated future population as a high growth scenario like it is described in their references. Rather than update their model with the latest data, they use old high growth estimates from previous studies, drop the statement that it is a high growth scenario, and fabricate a reference to a reputable official source.

It is important to note that U.S. Census Bureau population figures are consistently below recent Department of Finance population estimates, which themselves are 5.5 million below the PPIC assumption. As Department of Finance estimates are eventually revised and benchmarked to the Census, it is highly likely that they will be revised lower in the future. For example, the latest Census estimate of California population is 36,553,215 on July 1, 2007. The Department of Finance estimate for the same date is 37,771,431, about 1.2 million people higher than Census figures that were released after PPIC released its estimates. In 2030, the Census projects the state population at 46,444,861, about 2.8 million lower than the Department of Finance projection of 49,240,891. The Census has not published 2050 numbers for California, but their earlier estimates project to 55 million for California in 2050. As a result, a much more defensible estimate of 2050 California population is 55-59 million, not the 65 million assumed in the PPIC report. The PPIC itself has a demographic research group that projects population in this range, and it isn't clear why the PPIC would assume population figures in this study that far exceed the estimates of their own in-house demographers.

Desalination Costs

The PPIC's desalination cost figures are also described on page 4 of Technical Appendix F.

> "Urban coastal areas were assumed to have access to desalted seawater at a cost of $1,400 per acre-foot (in 1995 dollars, or $2,072 per acre-foot in 2008 dollars)"

A few sentences earlier, the PPIC explains their approach to getting current cost figures.

> "economic data are in 1995 dollars, but for this report all costs have been updated to 2008 dollars using the Engineering News-Record multiplier of 1.48."

They provide no references for their cost estimates. Rather than gathering the most recent cost estimates based on the latest technology and experience, the PPIC study uses 1995 estimates and inflates them based on a generalized construction cost index. This is an inaccurate approach even with constant technology, but is especially problematic in this case due to significant cost decreases as desalination technology has improved in recent years.

In May 2008, the National Research Council of the National Academy of Sciences published an assessment of current desalination technology in the United States from a panel of a dozen leading experts. The report generally cites desalination costs of approximately $1000 per acre foot. Similarly, the California Coastal Commission (2004) notes the significant declines in desalination costs, estimating average costs for several proposed southern California plants in an approximate range of $800-$1000 per acre-foot with costs rising to about $1200 per acre-foot with high electricity costs. In general, the PPIC estimates appear to be about double current estimates. Over time, desalination costs are likely to decrease further as technology develops further, so a cost of $1000 per acre foot should be viewed as a conservative figure for 2050 projections.

Other Assumptions

Other PPIC assumptions could further inflate the estimated costs of restricting exports, but likely have a lesser role and are not considered in the next section. These include their assumed water recycling cost of $1,480 per acre foot which may also be too high since the PPIC estimated it in the same manner as desalination costs. For example, the National Academy Press desalination book cites the San Diego Water Authority estimate of these costs as similar to desalination or about $1,000 per acre foot. Another is their assumption that the composition of the economy is fixed over time, while the reality is that the industrial share of the economy has declined since they fixed the proportions and is likely to continue in the future. The PPIC produces a forecast of the structure of the state economy, and these could be used to more accurately estimate future demand. Future developments to water conservation technology and implementation are likely to further decrease demand. Finally, there is uncertainty about the costs of constructing the peripheral canal itself. The estimates are extremely uncertain. The PPIC assumes the costs are less than $10 billion, but the Delta Vision report cites estimates as high as $26 billion.

Estimating the Impact on the Cost of Ending Delta Exports

What would be the impact of lower population levels and desalination costs on the PPIC estimates? Using the tables and figures from the PPIC report, a rough estimate shows that the cost of eliminating Delta exports decreases from a range of $1.5-$2.5 billion per year to about $0.8 billion per year.

The costs of reduced exports come from two sources: scarcity costs and operating costs of the water system. When Delta water exports are eliminated, southern water users either bear the scarcity costs of doing without the water (e.g. decreased agricultural profits, reduced benefits from urban water uses) or bear the cost of replacing Delta water from higher cost sources (e.g. recycling wastewater, desalination).

The PPIC study estimates these costs with the CALVIN model developed at UC-Davis. Table F.3 in the PPIC report (displayed below) details how these costs break down at different levels of water restrictions. BC is the base case, and represents current Delta exports of 5.9 million acre-feet (maf) annually. 50%R is a 50% reduction in pumping capacity, which translates into a 1 maf (18%) reduction in water delivery. 75%R is a 75% reduction in pumping capacity, which leads to a 3.4 maf (58%) reduction in delivery. NE is the no export case, a 5.9 maf (100%) reduction in water deliveries. RT represents restricted transfers, a special case of no exports that causes increased costs on urban users by limiting their ability to purchase water from agricultural users

Table F.3. reprinted from PPIC report.

Table F.3 - Annual average statewide net operating costs with export restrictions

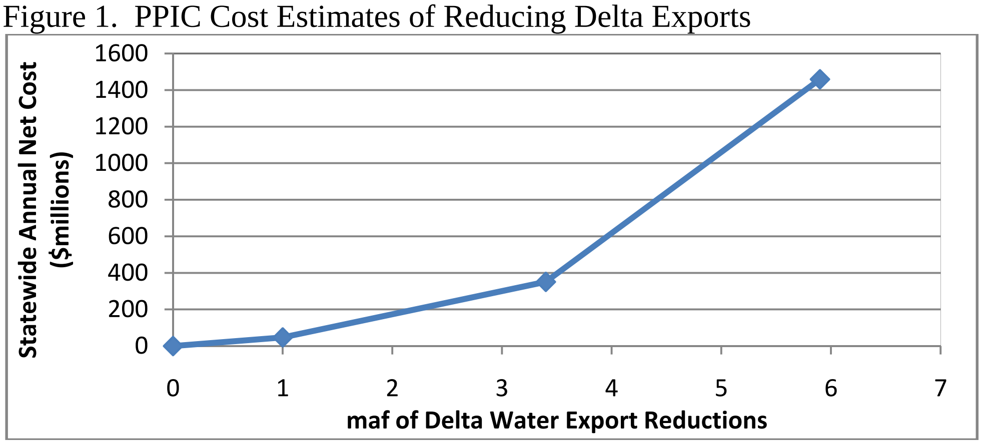
	Statewide Annual Average Costs ($M/year)				
	RT	NE	75%R	50%R	BC
Groundwater	771	736	773	806	818
Surface Water Treatment	1143	1492	2044	2060	2061
Desalination	1933	541	55	55	55
Recycled Water	1446	1452	354	348	347
Surface Water Pumping	449	981	1669	1784	1832
Hydropower Benefits	2476	2605	2746	2745	2749
Total Net Operating Costs[a]	3266	2596	2151	2308	2365
Statewide Scarcity Cost	1573	1540	877	416	312
Total Statewide Net Costs[a]	4839	4136	3028	2724	2677

[a] Totals may not sum due to rounding, RT is no exports with restricted transfers, NE is no exports, 75%R is 75% reduction in export pumping capacity, 25%R is 25% reduction in export pumping capacity, and BC is base case (2050 demands).

The PPIC cost estimate of $1.5-$2.5 billion annually is calculated directly from Table F.3. The cost of each level of water restriction is found by subtracting the total costs for that scenario from the cost of the base case. Thus, the total cost of the restricting all exports is $4,136,000,000 - $2,677,000,000 = $1,459,000,000. This is how they arrive at the $1.5 billion lower bound cost of reducing Delta exports. The upper bound figure of $2.5 billion is calculated by looking at the difference between the RT (restricted transfer) case and the base case, then arbitrarily adding another $300 million for assumed inefficiencies in the system ($4,839,000,000 - $2,677,000,000 + $300,000,000 = $2,462,000,000).

For this analysis, the most important implication of Table F.3 is that the cost of the last 2.5 maf of water taken out of the system (moving from 75%R to NE) is much higher than the first 3.4 maf of export reductions (the difference between 75%R and BC). Figure 1 shows the cost of reducing Delta water exports at different levels. It's only in this final step that the reductions effect higher value urban users and force expensive investments in wastewater recycling and desalination. These costs are reduced dramatically if urban water demand and desalination costs are lower.

Figure 1. PPIC Cost Estimates of Reducing Delta Exports



What would be the impact of changing these two assumptions (population growth and desalination costs) to more current and justifiable levels? Given the urban water demands assumed in the PPIC study, reducing 2050 population estimates by 6-10 million would decrease statewide water demand by approximately 1.5 - 2.5 maf in 2050. Assuming that about two-thirds of that urban demand reduction occurs in areas south of the Delta implies a reduction of 1 – 2 maf of demand from the region served by Delta exports.

This 1 – 2 maf reduction in demand essentially replaces some of the lost Delta water. A 1.25 maf reduction in urban water consumption would move the costs of the no export (NE) case halfway between the original NE and 75%R cases, dramatically lowering the cost of the NE case. The reduction in urban water consumption would also reduce base case (BC). Table 1 adjusts the values in Table F.3 so that NE (no export) values are between the current NE and 75%R values (due to lower population levels), and cuts desalination costs in half ($1,036 per acre foot rather than $2,072). The BC (base case) adjusts also, but the change is small because it is a flat segment of the cost curve. The BC cost is reduced by ½ the change between BC and 50%R which assumes a constant slope to this curve around the original base case level.

Table 1. PPIC table F.3 adjusted for lower population and desalination costs.

	RT new	NE new	BC new
Groundwater	772	754.5	824
Surface Water Treatment	1594	1768	2061.5
Desalination	497	149	27.5
Recycled Water	900	903	346.5
Surface Water Pumping	1059	1325	1856
Hydropower Benefits	2611	2675.5	2751
Total Net Operating Costs	2211	2224	2364.5
Statewide Scarcity Costs	1225	1208.5	260
Total Statewide Net Costs	3436	3432.5	2624.5

Under these adjusted calculations, the cost of ending Delta exports changes from $1.5 billion to $0.8 billion for the NE case. For the highest cost ($2.5 billion) RT case, the scarcity and operating costs also decrease to $0.8 billion. If a range of urban water demand reductions of 1-2 maf annually (the table assumes a 1.25 maf reduction) is considered, the cost range of ending Delta exports is approximately $0.4-$1.0 billion.

In the PPIC's RT case, the extremely high costs were primarily driven by forcing large amounts of desalination in urban areas. The adjusted RT case greatly reduces the amount of desalination plants required due to lower urban demand, and cuts the cost of supplying desalted water in half as well. Thus, over $1.4 billion in cost savings are realized from the desalination adjustments alone. The PPIC's arbitrary addition of $300 million due to inefficiencies should also be eliminated, because it is inappropriate for this type of cost-benefit analysis, and inconsistent with the estimation of costs in other areas of the report. As a result, the difference in cost between the RT and NE cases disappears. It should be noted that a rhetorical argument can be made against considering the RT case, even before recalculating costs. The extra cost from restricting transfers is essentially a water subsidy for agricultural users at the expense of urban users (if imposed by the government) or a decision by farmers to forego the economic benefit of selling water to urban areas (if voluntary). In either case, it is not a cost required by reducing Delta exports, but results from separate decisions to allocate water inefficiently.

Surprisingly, the PPIC report does not cite the recently completed doctoral dissertation (Tanaka 2007) of Appendix F's lead author, Stacy Tanaka. In her dissertation, Tanaka estimates the cost of eliminating Delta exports with more realistic desalination ($1,400 per acre foot) and water recycling ($1,000 per acre foot) costs, while still assuming the inflated 65 million population figure. Under these assumptions, Tanaka finds the cost of ending Delta exports is $977 million annually, a decrease of about 1/3 compared to the PPIC report. A more realistic estimate of future population would decrease this estimate by substantially more. The Tanaka estimates confirm that altering these assumptions would have large impacts on the PPIC results and conclusion.

The criticism above does not take issue with the general approach or model used in the PPIC study. The problem is the inaccurate and outdated data input into an otherwise sound model. Thus, the best way to calculate the impact is to reestimate the UC-Davis CALVIN model with the lower parameter values. The UC-Davis research team does not have any examples of their model solutions with lower population numbers, all of their published studies with statewide modeling utilize the high 65 million population estimate.

Impact on the PPIC Decision Analysis

The headline news about the PPIC report is that a group of independent academics concluded after an extensive study that the peripheral canal is the best strategy for the Delta. This is unfortunate, because there is no objective way of reaching this conclusion with their data. The PPIC report finds that ending Delta exports has higher environmental benefits (including direct economic benefits to fisheries and recreation they do not calculate) that they do not attempt to value in economic terms, whereas the peripheral canal has lower economic costs in terms of its water supply costs and benefits. To reach their conclusion, the authors must impose their own subjective value judgment that the environmental benefits of ending Delta exports is not worth the additional costs on the water supply system. However, it is quite plausible that these environmental benefits could have values in excess of $1 billion per year, and the burden is on the PPIC team to argue that the benefits are less. The report makes no attempt to justify this critical assumption about environmental values that is required to objectively reach their conclusion. It is astonishing that a group of reputable academics would make such a value-laden conclusion in a research report rather than simply identify the trade-offs.

This paper finds that the PPIC report cost estimates are highly inflated by inaccurate, unsupported assumptions about the data they input into their models. The previous section demonstrates that the annual cost of reducing Delta exports is more likely $0.4-1.0 billion, very comparable to the PPIC's estimated cost of a peripheral canal. If the net costs to water supply are similar, then the best societal decision is ending Delta exports, the option with the highest environmental benefits. Table 2 demonstrates the point. It reproduces the key information from the PPIC study summary table, and adds a row with recalculated costs.

Table 2. Annual Costs and Fish Population Viability

Alternative	Average Cost ($ billion/year)	Delta Smelt Population Viability	Chinook Salmon Fishery Viability
Peripheral Canal (PPIC study)	0.25-0.85	10-40%	20-50%
No Delta Exports (PPIC study – high pop. growth and desalination costs)	1.50-2.50	30-60%	40-80%
No Delta Exports (Actual pop. growth and costs)	0.4-1.0	30-60%	40-80%

Conclusion

This paper finds that a gradual end to ending Delta water exports is superior solution to constructing a peripheral canal on economic and environmental grounds. This is the opposite conclusion of the PPIC report upon which these calculations are based. The PPIC-UC Davis models and approach are generally sound, but their calculations are grounded in unrealistic and undocumented population and cost assumptions that greatly exaggerate the costs of ending Delta water exports. It can be argued that other assumptions should change in ways that tilt the analysis even further in favor of ending Delta exports. For example, water recycling costs are likely to be lower, technology for desalination, water conservation and recycling are all likely to improve between now and 2050. On the other side of the cost equation, estimates of peripheral canal construction costs are rising with some estimates cited by the Delta Vision report in excess of $20 billion, when the high-end of the PPIC study range is under $10 billion.

The decision to construct a peripheral canal will have long lasting impacts for the state. The project will impose significant financial and environmental costs. The primary benefits of the peripheral canal (avoiding the costs of reducing and ending Delta water exports) are likely to be much less than claimed by the PPIC and other canal proponents. Statements such as “Without water conveyed through the Delta … California’s economy will run dry,” (Delta Vision Strategic Plan Executive Summary, page ES-1) are less credible than previous predictions that the nation’s economy would collapse with gas at $3 per gallon. The cost of ending Delta exports is less than 0.1% of the current state economy, and is similar to the costs of building a peripheral canal. Similar to reducing our dependence on cheap fossil fuels, reducing our dependence on cheap water conveyed through the Delta will generate increased efficiency, stimulate alternative supplies as technology increases, and leave future generations with a healthier environment.

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Dr. Jeffrey Michael is Director of the Business Forecasting Center and Associate Professor in the Eberhardt School of Business at the University of the Pacific. His research forecasting regional economic performance includes work assessing the long-range economic impacts of various aspects of climate change. Other work has examined the effect of environmental regulations and policy on property markets and land use decisions. He has received several grants, published in scholarly journals such as *Energy Policy, Journal of Law and Economics,* and *Ecological Economics*, and his work has been covered extensively in the press including the *Wall Street Journal, New York Times Magazine, Washington Post, Sacramento Bee* and the on-line magazine *Slate.* Before coming to Pacific, Dr. Michael spent nearly nine years at Towson University in Maryland where he was an award-winning teacher while serving as faculty, Associate Dean, and Director of the Center for Applied Business and Economic Research. Jeff received his Ph.D. from North Carolina State University, M.S. from the University of Maine, and B.A. from Hamilton College (NY).