Delta Vision

Context Memorandum: Local and State Economics

This context memorandum provides critical information about Delta local and State economics to support policy making. As they are developed, the context memos will create a common understanding and language about the critical factors in establishing a Delta Vision.

This is an iterative process and this document represents the beginning of a dialogue with you about how best to understand Delta local and State economics and to inform recommendations by the Delta Vision Blue Ribbon Task Force. You have two weeks to submit comments that may be incorporated into the next iteration.

You may submit your comments in two ways: either online at dv_context@calwater.ca.gov or by mail. If you are using mail, please send your comments to: Delta Vision Context Memo: Economics, 650 Capitol Mall, 5th Floor, Sacramento, CA 95814.

Your attributed comment will be posted on the Delta Vision web site (http:www.deltavision.ca.gov). Please cite page and line number with specific comments; general comments may be keyed to sections.

Your participation in this iterative process is valuable and important and is greatly appreciated. Thank you for your comments.

Context Memorandum: Local and State Economics

Iteration 1: June 18, 2007

Section 1. Setting

This context memo discusses the economy of the Delta region. The relationship of specific Delta infrastructure and activities to the broader state economy is described. The economy is discussed in relation to a range of potential policies as well as the economy of the state as a whole.

The Delta economy includes a variety of persons who have economic relationships with the Delta. Some people work or do business in the Delta but live elsewhere, while others live in the Delta but work elsewhere. Many businesses have economic relationships with the Delta but are not located there, some businesses are located in the Delta but they do little business there. All of these people and businesses are part of the "Delta economy," but they are affected by policy actions in the Delta in profoundly different ways.

The wider state economy is influenced by a number of services provided by the Delta. These are described in further detail in other context memos, but are be described and summarized briefly in this document.

Economic measures. Economic measures are sales, employment, wages and salaries and other data that serve as indicators about the size of an economy. There are many economic measures specific to geographic regions, but there are none specific to the Delta region. Many economic measures are provided at the county level, but the Delta includes parts of six counties and all of no counties. This complicates measurement and description of the Delta economy, but some recent progress using GIS data is reported below. Economic benefits and costs are important economic measures which are not normally collected as economic data. Rather, they are estimated in relation to specific actions or policies.

Economic regions. The economic analysis includes some data for three different geographic areas, being:

1. The primary Delta. This is an area entirely within the legal delta where residential development outside of existing communities is discouraged. It does not include the secondary Delta which is also within the legal Delta.

2. All areas protected from a 100-year flood by levees within the legal Delta and Suisun Marsh (the Protected Region); also the area covered by the analysis zones in DRMS. Relative to the legal delta, this area includes additional parts of West Sacramento and Sacramento but it excludes some parts of the west and south Delta including Tracy, Pittsburg and Antioch.

3. The State of California

Table 1 provides a comparison of indicator statistics for these regions. There are few statistics compiled for the primary Delta or the Protected Region, so a range is provided.

Table 1.
Indicator Statistics for
California, the Primary Delta and the Delta Protected Region

Indicator	California	Primary Delta	Delta Protected Region
Households (2000)	11,500,000	3,000 to 4,000	100,000±
Employment (thousand persons)	19,626	3 to 6	205
Business Income (billion $)	$1,443	$0.5 to$1.0	$35
Agricultural Production (billion $)	$30	$0.5±	$0.7±

Note: California data is from DOF, IMPLAN (MIG 2006) and CDFA. Local employment and income from PBS&J GIS database, California agriculture data from DWR.

A map of the legal Delta, the primary Delta and the Protected Region is shown as Figure 1.

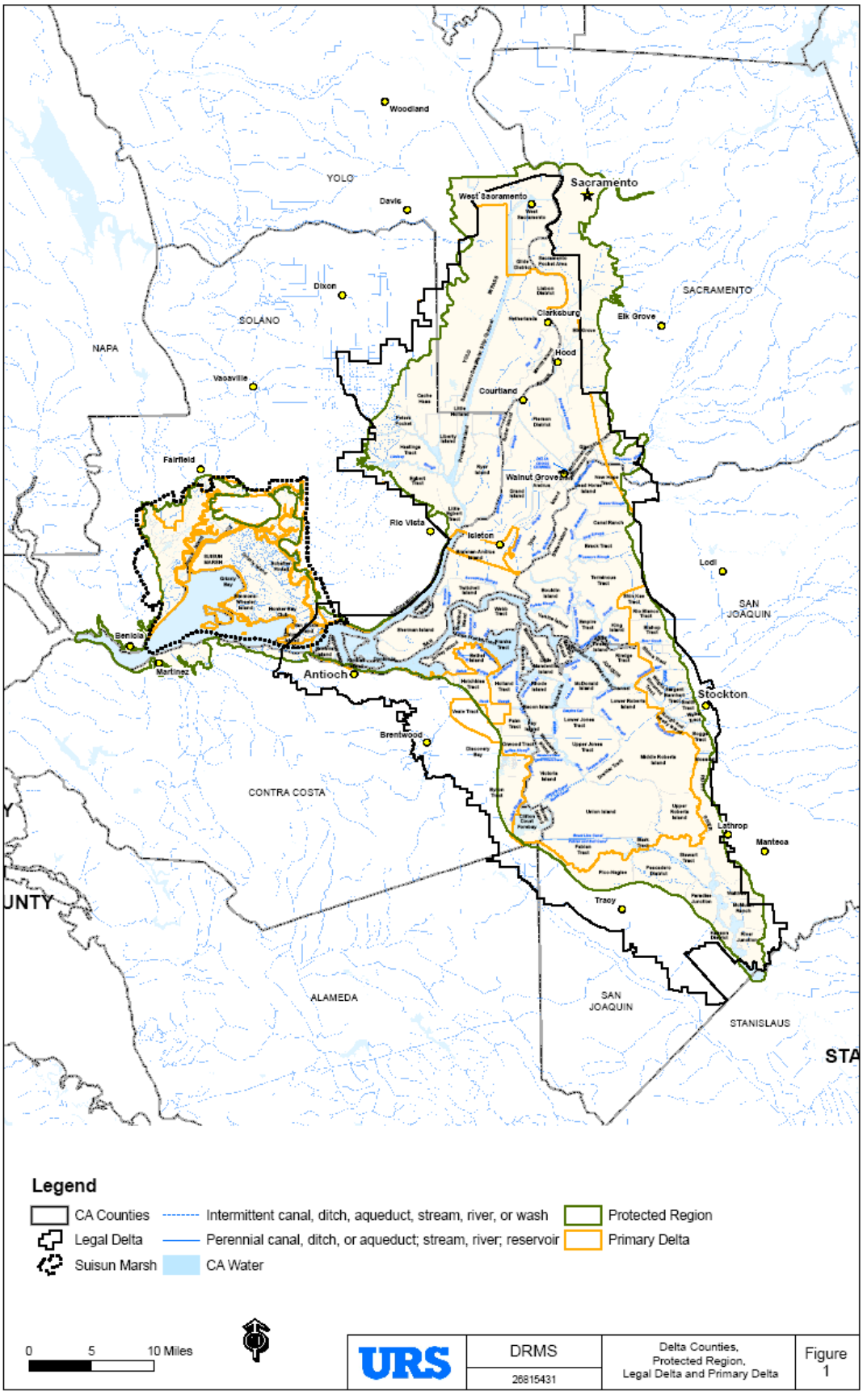
Economic significance of the Delta

The Delta is important as a place of business and residence. Relatively few businesses or persons reside within most of the primary Delta. The primary Delta includes about 1,000 business establishments with sales of about $500 million. However, many sales based on Delta assets are not recorded as sales to Delta businesses since the business offices are located outside of the Delta. The 2000 population of the primary Delta was probably about 8,000 persons in 3,400 households.

DWR used 1990 census data to estimate the population of named Delta islands in that year at about 22,300 persons (DWR, 1990). The 2000 census data summarized by DWR found that population of the same Delta Islands had increased to about 26,000 persons and 11,500 households. HAZUS data [1]for this same area shows 18,900 total residential housing buildings in the 100-year floodplain.

The Protected Region is the area protected from a 100-year event by levees located within the legal Delta and Suisun Marsh. This region was covered by the analysis zones in DRMS. There are about 116,000 residential structures in the Protected Region, or about ten times as many as are located on the Delta Islands. The area contains about 15,900 businesses that are counted by the ESRI (PBS&J) database.[2] These businesses have sales of about $35 billion annually and employ 205,000 people.

[1] HAZUS-MH is a risk assessment software program maintained by FEMA for use in analyzing potential losses from floods, hurricane winds and earthquakes.
[2] This GIS database includes business names, employment and approximate annual sales.


Woodland
YOLO
Davis
West Sacramento
Sacramento
Dixon
SOLANO
NAPA
Vacaville
Clarksburg
Elk Grove
SACRAMENTO
Hood
Courtland
Fairfield
Walnut Grove
Rio Vista
Isleton
Lodi
SAN JOAQUIN
Benicia
Martinez
Antioch
Stockton
Brentwood
CONTRA COSTA
Lathrop
Manteca
Tracy
ALAMEDA
SAN JOAQUIN
STANISLAUS
Legend
CA Counties
Legal Delta
Suisun Marsh
Intermittent canal, ditch, aqueduct, stream, river, or wash
Perennial canal, ditch, or aqueduct; stream, river; reservoir
CA Water
Protected Region
Primary Delta
0 5 10 Miles
URS
DRMS
26815431
Delta Counties, Protected Region, Legal Delta and Primary Delta
Figure 1

The Delta region is important to the State because it includes vital transportation and conveyance facilities. It contains highways, railroads and shipping routes, natural gas storage and transmission facilities, electric transmission pathways, and gasoline product distribution pipelines. All of these are important services for the state economy, and their loss would be costly.

Most importantly, the Delta is a key conduit of the state's water supplies for both urban and agricultural uses. Approximately two thirds of the state's population live and work in urban areas that receive at least some of their water supply from the Delta, and the Delta provides one quarter of the State's total urban water supply. Approximately 1.8 million people living in the Bay Area, served by Contra Costa Water District and East Bay Municipal Utility District, rely almost entirely on water supplies that are diverted from or delivered across the Delta.

The transportation, infrastructure and water supply uses of the Delta are described in separate framing memos.

The Delta is economically important for a variety of natural and mineral resources. Important production value is attributable to Delta agriculture, recreation, natural gas production and wastewater treatment. DWR estimates that the annual value of Delta agricultural production over the 1998 to 2004 period averaged $680 million in 2005 dollars. Average annual value of natural gas production in 2004 and 2005 was over $300 million. Recreation-related expenditures in the Delta were recently estimated to be over $500 million annually. A large share of recreation in the Delta is related to sport fishing. The Delta is an important rearing habitat for salmon. Resident sport fish include striped bass and freshwater bass species, and other wildlife provide important recreation and non-use values. Some communities around the Delta have wastewater treatment facilities within the region.

A summary of the estimates of economic benefits from services provided by the Delta and facilities in the Delta is provided in Table 2. These estimates are discussed in greater detail in Section 3 below. It should be noted that these estimates, while relying on best available studies, are not all of the same quality and some were estimated using different assumptions. Most were estimated in relation to flood events. Further investigation is warranted to refine these assumptions, particularly in areas of high benefit.

Important trends. DWR has provided forecasts for population and households of Delta islands for 2030. Population is projected to increase from about 26,000 to 67,000 and households will increase from 11,000 to 27,000. None of this growth is expected to be in the primary Delta, which is protected. A large share of this growth is associated with expansion of the Stockton metropolitan area and the Sacramento-Stockton corridor onto Bishop, Sargent Barnhart, Stewart and Shima Tracts. Figure 1 shows the legal

Delta and the primary Delta. The secondary Delta, the areas between these two, is currently available for development. Economic activity tied to residential development will increase dramatically by 2030 in these areas.

State population and households are both projected to increase by about 40 percent by 2030. Employment and earnings are projected to increase by 47 and 87 percent, respectively. Earnings increase faster than employment because of growth in real earnings per job.

Natural gas and agricultural production values will probably not increase significantly in the future. This continues recent trends.

With more liberal trade rules, imports from Asian countries including China and India are increasing. This is increasing the volume of freight at west coast ports and related railways and highways. Increasing international trade is an important trend affecting the region. With more liberal trade rules, imports from the Pacific rim, China, India and elsewhere are increasing as these nations adjust to their comparative advantages. California agriculture and other California industries are also facing economic adjustments as production relocates to these and other nations such as Mexico. Increasing international demands for raw materials and supplies has changed the composition of imports and exports from the State.

The value of recreation in the Delta will be closely related to the quality of sport fishing and boating. Changing tastes and technology in recreation will be important. For example, wakeboarding, kite boarding and windsurfing have all increased in recent years. Increased opportunities for wildlife viewing have increased participation; for example, in the Yolo Bypass Wildlife Area.

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Table 2.
Economic Values for Delta Services, circa 2000 Conditions

Type of Value	Economic Measure (Benefit unless noted)	Value
As a place		
Primary Delta Residential	Mil $ per event[1]	$2.14
	plus Mil $/day of use	$0.24
Primary Delta Business [1, 2]	Mil $ per event	$0.88
	plus Mil $/day of use	$0.05
Protected Area Residential	Mil $ per event	$33.00
	plus Mil $/day of use	$3.40
Protected Area Business [2]	Mil $ per event	$15.93
	plus Mil $/day of use	$1.22
Primary Delta Public Offices	Employment (jobs)	153
Protected Area Public Offices	Employment (jobs)	38,946
As transportation/conveyance		
Urban water supply [3]	Mil $/year of alternative cost	$2,000 to $5,000
	% of State economic activity supported	30.0%
Agricultural water supply [3]	Mil $/year revenue minus variable costs	$840
Interstate Highways (5, 80, 680, 205)	Mil $/year of use	$1,100 to $1,825 per road. Long duration or multiple closures not likely
State Highways (4, 12 or 160)	Mil $/year of use	$36 to $180 per road, minimum of $336 for all
Local Roads		Unknown
Railroads, BNSF or UPRR to Sac	Mil $/year of use	$290
Railroad UPRR to Stockton	Mil $/year of use	$73
Ports (Sacramento & Stockton)	Mil $/year of use	$5
Natural Gas Storage & Trans	Mil $/year of use	$1,400, winter only
Gas and jet fuel [5]	Mil $/year of use	$9,125 not comparable
Electricity [6]	Mil $/year of use	$440
Natural and Mineral Resources		
Urban water quality	Mil $/year/mg/l TDS at Delta [7]	$1.0
	Mil $/year/mg/l TOC at Delta [7]	$10.0
Delta Agriculture [3]	Mil $/year revenue minus variable costs	$220
Delta Agricultural Water Quality	Mil $/year/mg/l TDS, range 500 to 2500	$5.7
Recreation [8]	Mil $/year of use	$628
Natural Gas Production [9]	Mil $/year net revenue	$784
Wastewater Treatment [10]	Mil $/year of use	$3,650

1. An event is any action which forces residents or businesses to leave. Primary Delta approximated by Mean higher high water
2. Business losses assume 5% profit rate and substitution by other CA businesses
3. Daily values depend on season and increase substantially as duration of lost use increases.
5. Assumes no trucking capacity to carry fuels available. Actual would be less.
6. Summer only. Three lines, $0.4 M each
7. Urban water benefit if water quality improved by 1 mg/l for 1 year
8. Lower bound based only on fishing and boating, not other recreation occurring independently of fishing or boating (e.g. hunting, wildlife viewing, sightseeing). Does not include Suisun Marsh, other values, see text.
9. Value of production net of 10% O&M, most would be recovered later
10. Stockton and Ironhorse SD. Based on daily value. Closure for 1 year would result in development of alternative facilities at less cost

2

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Section 2. Value of Assets in the Delta

An important part of the economic risk associated with the Delta is the value of assets in place. DRMS estimated the value of assets and repair costs for assets at risk in the Delta within the Mean Higher High Water (MHHW) lines and the 100-year flood[3]. A summary is provided in Table 3 below. The total value of assets at risk is about $4.5 billion within the MHHW area and $35.4 billion within the 100-year flood area. More detail is provided in the infrastructure framing memo.

Section 3. Services Provided by the Delta

This section summarizes the more important Delta services and, where possible, provides estimates of their economic value. The values were summarized in Table 2. It should be stressed that the estimates presented here are based on numbers that were

[3] The area flooded at the height of the average of the highest water heights for each tidal day observed over a long period, usually 19 years. The 100-year flood area is that flooded by a storm with a 1 in 100 year probability.

not originally developed for this purpose. The values are primarily costs per day of losing the services and were often developed from specific scenarios that included the costs and availability of alternatives. Some estimates have been "stretched" in an attempt to provide more information than is readily available. These estimates only give a rough approximation of the value of services provided.

Table 3
Total Estimated Asset Value and Repair Costs in the Protected Area for MHHW and 100-Year Flood Events

Estimated Asset Value & Repair Costs[b]	Mean Higher High Water (MHHW)	100-Year Flood
Total Value of Delta Assets [a,c]	$4.5 billion (within MHHW limits)	$35.4 billion (within 100-year flood plain limits[d])
Total Cost of Repair[a,e]	$1.1 billion	$13.6 billion
Asset Repair Cost (without scour)/ Asset Value	24%	38%

[a] Median value estimates.

[b] Assuming all islands and tracts are flooded (maximum in-Delta losses).

[c] The value of Delta assets is estimated at replacement cost.

[d] Flood plain limits were developed from FEMA Flood Insurance Rate Maps

[e] Total repair cost is without the scour component. Scour damages would increase total cost and cost as a share of value.

Residential, Business and Public Offices. The residential use value counts dislocation costs and alternative costs for people living in the Delta at the time of a flood event. The economic methodology is based on FEMA (2005). Economic costs include the average dislocation cost per household per event and the average cost per day of lost use.

Flooded businesses incur costs and impacts beyond the costs of repair and replacement of facilities and inventory. The FEMA methodology (2005) allows for a one-time cost when flooded plus monthly costs based in part on costs for rented space. The economic cost of business lost sales assumes that sales stop for the duration of lost use and that these businesses do not pay rental costs. A portion of these lost sales will be made up by California businesses located outside the Delta providing similar goods and services. The data in Table 2 account for this substitution effect and only report the net reduction in sales, which is the appropriate measure for considering the economic impact to all of California.

Data on public offices from PBS&J include the number of employees. These data are reported as a proxy for their economic value.

Transportation and Conveyance Services

Urban Water Supply. Urban areas obtain water either directly from Delta diversions (CCWD and industrial diversions), from the Delta export projects (CVP and SWP) or, in the case of East Bay Municipal Utility District (EBMUD) from pipelines that cross the Delta. To give an understanding of the importance of the water supplies conveyed through the Delta, Table 4 summarizes estimates of the influence of those Delta water supplies on state populations and economic activity.

The bulk of the urban population dependent on water supplies from the Delta are found in just nine counties in the state, but these are among the state's most populous.[4] The table lists the populations for the counties that use Delta water, and includes an estimate of "other" water users – that is, the urban populations that use Delta water, but are resident in counties other than the nine chosen for analysis. The table reports that 25 million people are resident in counties that obtain water from the Delta. The table then reports the 2005 value added in each of the nine counties. This is provided as a measure of economic activity in those counties. Value added is wages and salaries, proprietor's incomes, rents and dividends, and indirect business taxes. It measures the region's contribution to the total value of economic output the region has some hand in producing.

Next, the table reports an estimate of the percentage of the county urban water supplies that are obtained from the Delta. This number is not readily available, and was inferred from the population of agencies within each county that received Delta water, and the percentage of supplies from the Delta that were reported by those agencies in their Urban Water Management Plans. Finally, the share of water supply from the Delta was used to develop people-equivalents of the Delta share of water supply, and similar value added equivalents.

These numbers show that without the Delta water supplies, additional municipal water or equivalent conservation would need to be found for almost a third of the state's population. The Value Added Delta Share reports the level of economic activity supported by the provision of Delta water, about $500 billion dollars annually.

[4] This analysis has ignored water urban water supplies taken from the Delta through the North Bay Aqueduct. Because this diversion takes water directly from the flows of the Sacramento River, it is assumed that the communities using water from this source will be able to continue to divert water from the Delta regardless of the salinity situation of Delta water in general. If a particular change in the management of Delta salinity is under consideration, then the validity of this assumption should be checked.

However, this should not be taken to mean that a loss of Delta water would lead to a cut in the state's economic activity by this level. If Delta water supplies were cut, alternative, albeit more expensive water supplies would be found. LCPSIM, a water supply model of the south coast, includes about 500,000 acre-feet of water transfer opportunities, plus one million acre-feet of urban water conservation, desalination and recycling as south coast water supply options, plus about 70,000 AF of additional supply options for the Bay Area. Depending on the availability of water transfers from San Joaquin Valley agriculture, and assuming Sacramento Valley water is not available, the cost for replacement and conservation of about 1.9 million acre-feet per year of urban supplies from the Delta might be on the order of $2 billion to $5 billion annually.[5] It should be stressed that this number is not the result of an extensive analysis. Rather, it is an educated guess to provide guidance to the Vision Process. This supply alternative would also likely require major expansion of electric generation (to power recycling and desalination plants) which would seriously undermine the state's greenhouse gas emission goals. Also, the cost of these additional water supplies might cause some industries to relocate, but these would likely be activities that have higher than average water use per dollar of output.

As an additional alternative, the lost urban water supplies might be provided from the Sacramento Valley using an isolated facility. The up-front cost of such a facility would probably be on the order of $3 to $5 billion in one-time costs, or in annualized terms, about $200 to $350 million per year with O&M costs.[6] This would primarily address Delta supply risks associated with current operations of the State and federal pumping facilities in the Delta, but would not necessarily resolve risks to the large portions of the Bay Area served by East Bay Municipal Utility District and Contra Costa Water District.

The influence of the Mokelumne Aqueduct is shown separately in Table 4, because different policy options may need consideration of the Aqueduct supplies versus other Delta-associated urban water supplies.

Agricultural Water Supply: In-Delta. Agricultural land within the Delta is irrigated by water pumped from the Delta. DWR estimates there were an average of 405,899 acres of harvested or grazed, irrigated crop acres in the Delta during the 1998 – 2004 period (DWR 2006). The annual value of Delta agricultural production over this period averaged $680 million of which 87% was associated with crop production and 13% or

[5] Low end estimate is 500,000 AFY of transfers at $300 per AFY in San Joaquin Valley, 1 MAFY of conservation, reclamation and desalination at $1000 per AFY, and 400,000 AFY of ocean desalination at $2000 per AFY. High end is 300,000 AF of transfers at $400 per AF, 1.2 MAFY at $2,500 per AFY, and 400,000 AFY at $5,000 per AFY.
[6] Annualized at 50 years, 6 percent real interest.

$88 million represents value of livestock production. After accounting for variable costs, the annual net value of crop production is about $220 million.

Agricultural losses following flood could be by inundation, by inability to use saline surface water, or by irrigation with saline water. The amount of net income lost per day following a levee failure would depend on the time of year that the failure occurred, the duration of the outage and the quality of the water taken for irrigation, among other factors.

Agricultural Water Supply: South of Delta. South of Delta farming areas that are supplied in part by water from the Delta had gross expected revenues from agricultural production of $7.5 billion in 2006 of which $3.0 billion was in excess of variable costs. Approximately 40 percent of these revenues were produced in areas that obtained at least half of their irrigation water from the Delta. Over the entire region about 28 percent of water supplies were Delta exports. Therefore, about $2.1 billion of output and $840 million of net income over variable costs was produced with Delta water. Agricultural losses could be by lack of water

Table 4
The Influence of Delta Water Supplies

County	County Population Estimates 2005	2004 County Value Added $ Million	Delta % Of Co. Water Supply	People-Equivalent Delta Share	2004 Value Added Delta Share $Million
Alameda	1,515,000	75,489	24%	363,600	18,117
Contra Costa	996,823	45,518	47%	468,507	21,393
Los Angeles	10,205,568	428,942	39%	4,184,283	175,866
Orange	3,078,200	166,529	36%	1,169,716	63,281
Riverside	1,753,932	47,022	20%	368,326	9,875
San Bernardino	1,855,900	50,871	21%	408,298	11,192
San Diego	2,966,000	138,678	44%	1,394,020	65,179
Santa Clara	1,750,000	121,157	50%	875,000	60,579
Ventura	658,346	31,049	47%	342,340	16,145
Other	654,043			252,701	11,656
Total	**25,433,812**			**9,826,790**	**453,283**
Mokelumne Aqueduct					
Alameda	849,000		51%	772,650	38,263
Contra Costa	489,000		43%	428,634	19,664
Subtotal	1,338,000			1,204,200	57,927
Total Delta Influence	**25,433,812**			**11,030,990**	**511,210**
State	**36,810,000**	**1,556,255**		**30.0%**	**32.8%**

supply or by irrigation with saline water. Economic losses from loss of water supply would be less since marginal, not average cropland would be affected and, in the short run, some groundwater could be used.

Roads and Highways. The Delta road system includes local, state and interstate highways, bridges and causeways, automobile ferries, and related infrastructure. The transportation framing memo provides additional detail about this road network. The following important roads and highways traverse the Delta:

- Interstates 5, 205, 680 and 80. The interstates go around the primary Delta but they cross areas where flooding could damage roadways and cause outages
- State Highways 160, 84, 12 and 4. These roads have at least one segment that crosses the primary Delta
- County roads J2, J11, E9 and E13 are important local roads and could be important alternate routes if a highway is closed.

Estimated values of services or economic costs per day of outage are shown in Table 5.

Table 5.
Economic Value of Services or Costs From Delta Road Closures ($Millions per Day)

4	12	160	205	County J-11	I-5	All
0.5	0.3	0.12	4.0	0.1	3.0	24.0

Note: Costs not additive because single highway failures are reduced by the presence of other highways. Estimates were not developed for I-680 or I-80 or other county roads; Highway 84 is generally the same as 160.

Railroads. Railroads are described in more detail in the transportation framing memo. Three major railroads carry freight and provide passenger service across the Delta:

- The Union Pacific Railroad from Oakland to Sacramento
- The Union Pacific Railroad from Fremont to Stockton
- The Burlington Northern Santa Fe Railroad to Stockton

Estimated values of economic services are shown in Table 6.

Table 6.
Economic Value of Services or Costs From Delta Railroad Closures ($Millions per Day)

UPRR Oakland to Sacramento	UPRR Fremont to Stockton	BNSF Oakland to Stockton	Total
0.8	0.2	0.8	1.8

Deepwater Shipping Channels and Ports. Commercial boat traffic includes freight traffic through the Ports of Stockton and Sacramento, ferries which are used to carry vehicle traffic across Delta channels, and a variety of boat traffic for local commercial and public purposes. The two commercial shipping channels, Sacramento Deep Water Channel and Stockton Deep Water Ship Channel, provide important routes for freight transportation. Lost use costs per day for the Sacramento and Stockton ports areestimated to be $2,000 and $10,000 per day, respectively. These daily costs could be increased if any Delta railroads were also closed.

Petroleum products pipelines. The petroleum product pipelines crossing the Delta connect the Bay Area refineries to terminals located in Sacramento, Chico, Reno, Stockton and Fresno. These five pipelines provide gasoline, diesel and aviation fuel to interior Northern California and Nevada. During summer months these pipelines are operating near capacity, so a single pipeline failure could not be offset by increased transmission through other pipelines. For the DRMS analysis, California Energy Commission (CEC) staff estimated the consequences of two of the more important of these pipelines failing (CEC 2007). The study estimated that these pipelines provide the following proportions of Northern California demand, by segment:

- Gasoline – 25 percent
- Diesel Fuel – 33 percent
- Military Jet Fuel – 67 percent
- Commercial Jet Fuel – 2 percent.

The military jet fuel is provided to Travis Air Force and to Fallon Naval Air Station in Nevada, so these pipelines have important national security value as well as their economic value. Much of the diesel fuel is delivered to farmers in the Central Valley, so shortages of this fuel could limit agricultural production.

Some of the fuel normally delivered through these pipelines could be delivered by tanker truck, assuming that sufficent trucks, and drivers could be found, and that Delta roads were operational. However, the CEC believes that there is insufficient truck loading capacity at Bay Area refineries to allow for complete maintenance of supply. Assuming no trucks were available, the CEC estimates that failure of these pipelines could cost Northern California consumers nearly $25 million per day (Schremp, 2007).

Natural Gas Storage and Transmission. Pacific Gas and Electric (PG&E) owns a large natural gas storage facility on and under MacDonald Island, and natural gas transmission and distribution pipelines across the Delta. The most important of these pipelines ties the storage field to the rest of the state, so PG&E is building redundant pipeline capacity to minimize the risk of being unable to withdraw natural gas from

storage when it is needed. The state imports most of its natural gas from out of state sources over a network of pipelines. Under most conditions, the capacity of these pipelines provides sufficient gas to meet the state's needs. However, under cold winter conditions PG&E relies on withdrawals from the MacDonald Island storage field to meet its share of the state's requirements. PG&E estimates that during cold winter periods the MacDonald Island storage can be required to meet up to 25 percent of the region's natural gas needs. The storage field provides benefits at other times of the year, allowing PG&E to buy gas when prices are low, and reduce purchases when prices spike, but the major benefit of the storage field and associated pipelines is to meet cold winter needs. PG&E estimates that during an extremely cold winter, the benefits of the pipelines and storage could be up to $1 billion, but that on average the benefits per winter's day are $3.8 million (PG&E 2005).

Natural and Mineral Resources

Recreation. The Delta provides a wide range of recreational opportunities, including fishing, hunting, boating, camping, picnicking, and nature viewing. For boaters, the Delta offers a mix of broad, open channels suitable for water skiing, wakeboarding and pleasure cruising, and smaller meandering channels, cloaked in riparian vegetation, ideally suited to house boating, swimming, and secluded picnics. The Delta provides world-renowned hunting, fishing, and nature viewing opportunities.

Delta Recreation is economically important to the State in many ways. It is valuable to residents who use it for recreation. Table 7 provides the DRMS estimate of average economic value of recreation services per day. Average value per day for weekend days or summer days is much more than the average. More detail is provided in the recreation context memo.

Table 7.
Average Value of Recreation Services per Day

Delta Recreation Region	Value of Service Per Day in Million $, Annual Average
North	0.16
Northwest	0.06
Central	0.34
West	0.61
East	0.39
South	0.16
Total	1.72

Delta recreation also supports roughly 200 recreation-related businesses in the Delta such as marinas, resorts and boat services. Recreation-related expenditures in the Delta were recently estimated to be over $500 million annually. Without Delta recreation,

recreation facilities elsewhere in the State would be more crowded. The Delta provides rearing habitat for salmon and other fish caught in the open ocean and the San Francisco Bay. These values are not included in Table 7.

Urban Water Quality. The key water quality issues on the State Water Project are total organic carbon (TOC), bromides and salinity. Bromides and salinity result from greater incursions of seawater into the Delta, and TOC results in large part from erosion and drainage of the peat soils of Delta islands. Levee failures can cause sudden increases in these contaminants, potentially sufficient to close Delta pumps.

A 1999 report by Metropolitan Water District and the U.S. Bureau of Reclamation (MWD 1999) reports that the MWD service territory would experience annual benefits of $95 million if imported water salinity were to be reduced by 100 mg/L. After adjustments such as inflating this to today's dollars, and expanding to include all Delta urban water users, this could be used to arrive at an estimated benefit of around $100 million per year from reducing salinity in the Delta, or $1 million per mg/l. Of course, these results are only valid for small movements in Delta salinity levels. At some level, the water in the Delta would become too saline for municipal uses, and water diversions and exports would need to cease.

Increased levels of TOC will result in increased treatment costs for urban supplies. For short term changes in TOC, or for smaller increases, this additional treatment could be provided through changes to operations and maintenance practices to provide enhanced coagulation. Background concentrations for Delta water are typically around 3 mg/L, but may be higher during winter storm events. The Metropolitan Water District of Southern California estimates that a doubling of organic carbon concentrations in the Delta would increase its water treatment costs by about $18 per acre-foot (URS 2007). Assuming annual urban water deliveries from the Delta of around 1.8 million AF, this would result in additional costs of around $32 million per year or $10 million per mg/l. Once again, it should be noted that this estimate is only valid for small movements in TOC. Were Delta water TOC content to increase significantly, or for extended periods of time, Delta water would not be able to be used for municipal services without additional investment in more expensive water treatment options.

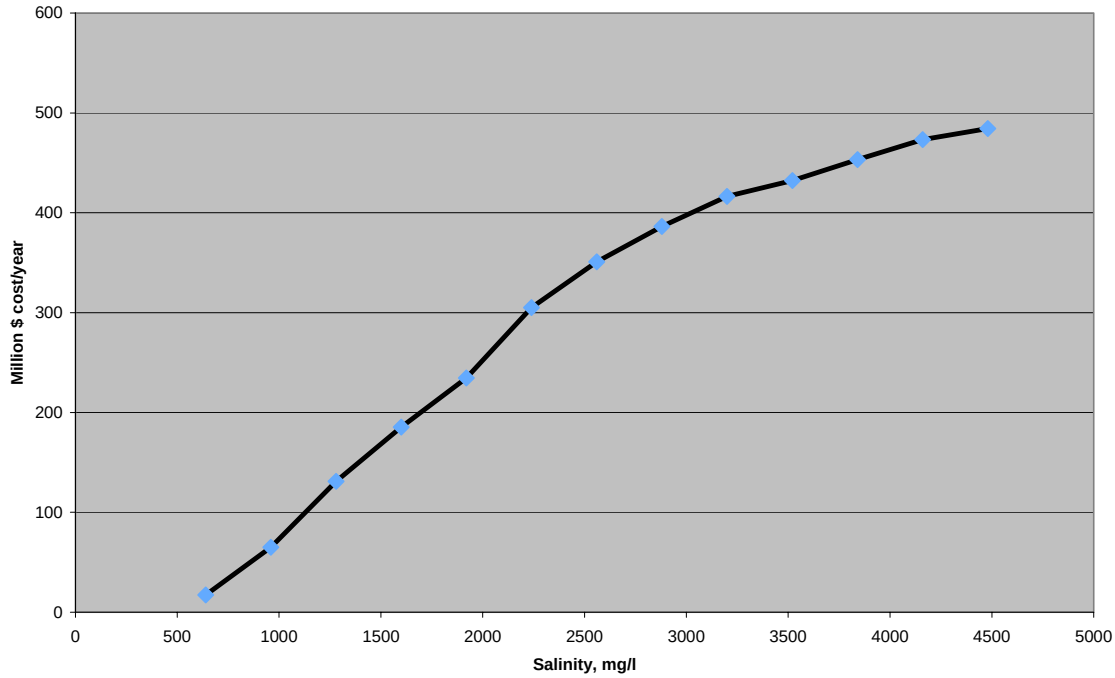
Irrigation Water Quality. If the Delta were to become more brackish, the level of both salinity and chlorides in Delta water applied to irrigated cropland would increase. The cropland using this water would become less productive, with the loss in revenues varying by crop type and level of increased salinity. Figure 2 shows the estimated losses in agricultural revenue in the Delta at varying levels of salinity and chloride. This is based on analysis developed for DRMS, and uses average annual salinity levels. More refined estimates would take into account the geographic and temporal variations

in salinity, adjustments to leeching fractions, and changes in soil structure. The DRMS study developed models that could provide a framework for these estimates.

The results in Figure 2 can be summarized in this way. Each unit of ds/M is about 640 units of tds in parts per thousand. Between a tds in mg/l of about 500 and 2,060 mg/l the economic loss is about $5.7 million dollars per mg/l per year. The rate of loss falls off after that, but by then most crops would probably be abandoned.

Wastewater. City of Stockton wastewater treatment facilities are located on Analysis Zone 159 and Roberts Island in the 100-year floodplain. Protection is by the San Joaquin River levees; there are no additional levees around the facilities. About 280,000 people are served by these facilities of which about 10,000 live in Zone 159. If Zone 159 were lost, then the value per day of lost service would be $9.0 million. If Zone 159 was lost permanently, then Stockton would have to build new primary and secondary treatment facilities. If Roberts Island were lost, especially in an event not

Figure 2. Economic Cost of Salinity to Delta Agriculture



related to high river flows, the release of secondary treated effluent to the San Joaquin River may impair the ability to use Delta water for other purposes.

Ironhouse Sanitation District owns about 95% of Jersey Island which is used for wastewater disposal. If Jersey island floods for more than a week (wet conditions), or more than a month (dry conditions) then 30,000 people would lose wastewater service at a value of $0.9 million per day. If service were lost permanently, then new tertiary treatment facilities to serve this population would be required.

Natural Gas Production. Natural gas production is an important economic activity within the Delta. Most natural gas production is not covered in the business sales analysis because most of the companies that own the gas wells are not located within the Protected Region. In a flood event, owners of the gas wells will shut them off if possible. Wells that cannot be shut off may be permanently lost. About 240 wells in the Protected Region were producing in 2004 and 2005. Daily value of production from all of the wells is about $870,000. Production from these wells and others in the Sacramento Valley is less than two percent of the state's natural gas annual requirements (CPUC 2006).

Electric Transmission Pathways. A number of electric transmission lines cross the Delta. Many of the lower voltage transmission lines provide electric services within the region. However, the three 500kV lines provide benefits to the state as a whole by allowing for efficient electric interchange between California and the Pacific Northwest. California's electricity needs peak in summer, while the Pacific Northwest systems peak in winter. During summer peaks the 500 kV lines allow the California System Operator to purchase power from more-efficient generation in the Pacific Northwest. The three 500 kV lines are operated to import a maximum of 4000 mW, but on occasion can bring up to 4800 mW into the state (Mirzadeh 2006). This is approximately 10 percent of the state's estimated peak load for 2007 of 47,847 mW (CAISO 2007). A study PG&E conducted for the DRMS analysis estimated that these lines provide benefits to California of $0.4 million per line (for 3 lines, or $1.2 million total) per summer's day (Chen, 2007).

Section 4. Institutions, Policies, Economics and Financing

In summary, the key policy issues identified in this memo are:

- Current water operations in the Delta have a goal of keeping the water in the Delta sufficiently low in salinity to allow its use for export and diversion for agricultural and urban users in the Delta and to the south of the Delta. The current water quality standards may be revised to enhance environmental benefits in the Delta. Changing the water operations to encourage a more brackish Delta, or a Delta with more variable salinity could have economic effects on the water supply uses of the Delta and could change the economics of alternative concepts for routing water south of the Delta.

- Research for DRMS indicates that the size of economic costs of a Delta levee failure event depends on where the levee failure occurs. For some islands there

is little economic risk. The economic cost of any flood of urbanized areas or major highways is substantial, but some areas are well-protected. The economic costs from some supply disruptions; water, natural gas, and railroads, depend largely on the duration of the outage, and this duration also depends on location of failures. For Delta levees, one size does not fit all.

- Urbanization and other development in the Delta region are occurring. There is an ongoing opportunity to reduce future State costs by ensuring that high standards for flood protection are researched, developed and enforced.

- Private incentives to internalize risk may be distorted by public policies that pay for costs of flooding. The key permitting authority is held by local government agencies that have little economic responsibility for flood protection. State and federal agencies bear a large responsibility for flood damages but have little input into local land use decisions.

- Future land use and investment decisions related to the Delta will need to recognize the complex interrelationships between Delta activities and the broader state. Some of the benefits to the state may be large relative to the expected value of the benefit to the Delta economy.

- Some multi-purpose projects, especially storage and conveyance facilities, that address Delta issues have other purposes and benefits that are largely unrelated to the flood risks. The State needs to consider all of the potential benefits regardless of their relationship to the Delta.

Economic Factors Related to Flood Policies. The existing uses of the Delta result from a long history of development, some as a result of public policies which encouraged more intensive land use. Reclamation laws encouraged the development of the Delta for agriculture, and public policies have at times encouraged continued agricultural land use. Much land use within the Delta is now related to agriculture.

The types of costs and benefits that could occur in the region vary among policies. For flooding, some of this variety is caused by the different nature of the events, and some is caused by differences in the economic values at risk on different land areas. For example, rainfall events could result in flooding of up-Delta developed areas near Sacramento or Stockton. Flooding of developed areas results in an immediate large cost and on-going lost use costs. Seismic events could result in flooding of islands in the western Delta. Flood damages to land and improvements would be relatively small, but daily water supply costs could be large and increasing over time. This variety of circumstances suggests that different strategies might be best for different islands and protected areas.

Some of the Delta policies that interact most closely with flood control economics are 1) policies that affect the assets in place at the time of an event, 2) policies that affect the frequency, depth and duration of flooding, and 3) the programs and policies in place to cover costs of flooding and assist with reconstruction.

Assets in Place at Time of Flood. Most of the immediate costs of a flood typically involve residential areas. Direct damages are certainly a cost from the national perspective. From the State perspective, some of the costs are compensated by insurance and disaster aid. Some of the direct cost is caused by flooding of uninsured homes. The owners do not have any funds for rebuilding and may become homeless. Uninsured flood losses occur because some people in the floodplain are not insured and some occurs because some floods occur in areas outside of the floodplain where insurance participation rates are low.

Most flood insurance is provided by the National Flood Insurance Program (NFIP). Private policies generally do not cover flooding. Federal lending laws prohibit banks from making federally insured loans in a flood hazard area unless the property has flood insurance. Typically, the flood hazard area is a 100 year floodplain. Insured homeowners can often obtain federal disaster aid for construction costs in excess of their insurance payment. Federal flood insurance is also available for any property located in a community participating in the NFIP.

Development in the primary Delta is generally not allowed by local land use plans.[7] Development in the secondary Delta and in other areas protected by Delta levees is occurring, and economic pressure to allow development in the primary Delta will increase.

On Stewart Tract, a tract not in the primary Delta, the proposed River Islands project would depend on a levee up to 300 feet wide for protection of about 11,000 new homes. The project has received a notice from FEMA stating that it could be designated as outside of the 100-year flood hazard zone; the actual level of protection could be as high as 1 in 200.

The designation of flood-prone areas can change and such changes can result in large public and private costs. Recently, FEMA redrew flood hazard area maps to include the Natomas area near Sacramento. Previously, only 11 to 13 percent of homeowners in the area had flood insurance at an annual cost of about $317 per $250,000 of coverage. The new flood hazard maps will result in flood insurance costs of

[7] The Land Use and Resource Management Plan for the Primary Zone of the Delta states that “New non-agricultural residential development, if needed, shall be located within the existing Primary Zone communities where support infrastructure and flood protection are already provided” (DPC, 1995)

about $1,000 per $250,000 of coverage, and all homes with FDIC insured loans will be required to carry it. The cost of levee work to attain the 100-year protection level was estimated to be $300 million (Kobely, 2007).

Urbanization has other interactions with Delta policies. The costs of water control structures such as a San Joaquin River bypass or an isolated facility will be increased by development in their paths. Stewart Tract had been discussed as a possible location for a bypass and as a location where an intentional levee breach might relieve pressure on other levees.

The assets in place at the time of a flood include all assets that might be used to reduce the extent and duration of flooding and the severity and duration of water quality impacts. Metropolitan Water District of Southern California (MWDSC) board members recently approved a strategy which would stockpile repair and fill materials at strategic spots around the Delta. Following an event the material could be used to repair levees and change Delta hydraulics to route more fresh water toward the export facilities (Breitler, 2007).

Inconsistent Responsibilities. The 2003 “Paterno” decision found that when the State operated a flood control system built by someone else, it accepted liability as if it had planned and built it. However, local governments have the permitting responsibilities for development in flood-prone areas, and the NFIP provides the flood insurance. By agreeing to operate a flood control system to a 100-year standard, the State apparently must accept liability for flooding of development in the floodplain. This development is permitted by local governments and insured by the federal government.

This apparent disconnect between State liability and local land use planning is being considered in the State Assembly. Assembly Bill 5, for example, proposes local plans for flood protection, a State plan for flood protection in the Central Valley, and new development in "high-risk, flood prone" areas would require appropriate levels of flood protection. Still, the level of protection may decline with subsidence, upstream development and climate change, and levees must be maintained to continue their designed level of protection.

Water supply policies and infrastructure. The economic analysis suggested that water supply costs of some events are closely related to their duration. For water supply, costs of an event of one to three months would often be minimal; most water users have alternative supplies they can draw on for short durations. Strategies that reduce the duration of an outage or increase the availability of local supplies south-of-Delta may be

economical. Additional connections and emergency exchange agreements among south-of-Delta water users could be important.

An isolated facility would allow fresh water to be routed around the Delta following an event. The multiple benefits of such a facility, including the associated changes in normal water management, might be very large compared to the benefits related to levee failures. The facility might have a Contra Costa connector which would provide multiple benefits to that water user as well.

Additional upstream storage like North of Delta Offstream Storage (NODOS) might allow for quicker salinity repulsion. As with other multi-purpose facilities, the expected benefit from this use is probably small compared to other expected benefits.

Policies from Land Use and Resource Management Plan for the Primary Zone of the Delta. The Delta Protection Commission has established a number of policy goals for the Delta based on economics. New policies could interact with the existing policies in many ways. For example:

- The existing commercial shipping channels should be maintained, and if determined to be environmentally and economically appropriate, deepened to meet modern shipping needs.

- Acquisition of farmed land, and subsequent retirement of that land, affects the economic base for farm support industries; the economic base for community business that rely on patronage from citizens working in farm or farm support industries; the tax and assessment base for special districts, county, and State; and existing wildlife use patterns which have adapted to agricultural land use patterns.

- Local governments shall support long-term viability of commercial agriculture in the Delta because of its economic and environmental importance to the State and local communities.

Section 5. Evaluation Tools and Criteria

Need for benefit-cost analysis from State and national perspective. The economic criteria most often used for evaluation of water supply and flood control invests is net economic benefit. Benefits and costs are compared and policies with more benefits than costs are deemed economically justified. For Delta policies that may include a significant federal cost share, cost and benefits analyses from the State and federal perspective are advisable. Federal agencies have very specific guidelines and criteria for counting economic benefits that may need to be followed.

Available models and tools

Overview of economic tools used for DRMS. Any economic analysis of flood damages must depend on information from physical models about the physical effects of flooding. The economic analysis takes results from this component as input. The economic model then uses information on markets, prices and economic linkages and relationships to estimate the effects of flooding on the economic measures. The physical models should provide information about many types of physical effects of flooding; physical damages from flooding or salinity, the extent of repairs or replacements, and the duration of lost use being examples.

The economic models of lost use used for DRMS are shown in Table 8 following the text.

Ideally, the economic analysis of flood damages would use a general equilibrium model of the local, state and national economy to estimate how the economic measures change following a disruption like a flood event. The general equilibrium model would include supply and demand functions for affected goods and services so that price and quantity changes could be used to estimate changes in all of the economic models. There is no much model available to use, so the economic analysis uses several sector-specific and simplified models to complete an analysis.

The available tools include CVPM, a general equilibrium model of central valley agriculture, LCPSIM, a model of local water use and value for the Bay area and south coast, and IMPLAN, a database of county-level data and a tool for input-output (IO) analysis. IO analysis considers how changes in expenditures by directly affected businesses and households affect other businesses and households in a region. For CVPM, there are a number of similar models and derivations available. CALVIN, a modeling tool developed by UCD, considers hydrology, urban economics and agricultural economics simultaneously.

Limitations of current tools. Katrina demonstrated that a major flood event could affect prices at the local, State and even national level. National prices of some materials used for reconstruction have remained high as suppliers have struggled to keep up with demand. There is currently no modeling tool to show how an event in the Delta might change prices of affected commodities.

Additional tools, data or analyses needed. A number of potential improvements for economic modeling of alternative policies for the Delta have been identified

- Estimation of economic costs of large, permanent water supply reductions is needed.
- Better modeling of resident, business and labor mobility and costs is needed.
- Price response functions for water, for reconstruction goods and services, and for housing and business space markets would be a useful addition to residential values
- Better value functions for public services would be helpful. The modeling currently uses an estimate of operating costs as a proxy for value.
- Additional modeling of highway flooding, damages and use is needed
- Further investigation of water supply and associated economics would help clarify economic value estimates

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