EXHIBIT B: LOCAL AGENCY BENEFIT ASSESSMENT

I. OVERVIEW

This appendix describes the methodology for a Local Agency Benefit Assessment. Applicants must complete a Local Agency Benefit Assessment if they are requesting State cost sharing based on an Alternative State Cost Share rather than the Base State Cost Share. The purpose of the Local Agency Benefit Assessment is to estimate local flood damage reduction benefits from implementing the projects contained in the Applicant's Five-Year Plan. The Alternative State Cost Share is computed as one minus the ratio of the present value of estimated flood damage reduction benefits to the present value of the estimated costs of plan implementation. The Applicant may request an Alternative State Cost Share when this value is greater than the State Base Cost Share. For example, if the State Base Cost Share is 50 percent and the computed value is 70 percent, the Applicant could propose an Alternative State Cost Share of 70 percent (before cost-sharing enhancements).[1] Notwithstanding the results of the Local Agency Benefit Assessment, the Alternative State Cost Share cannot exceed 75 percent (before cost-sharing enhancements).

The Alternative State Cost Share is applicable to all projects contained in the Applicant's Five-Year Plan. Thus, the Applicant only needs to complete a Local Agency Benefit Assessment once. The Applicant may use the results of the Local Agency Benefit Assessment on all funding applications pertaining to projects contained in its Five-Year Plan. The final State cost share on individual projects contained in the Applicant's Five-Year Plan may also include cost-sharing enhancements (see Section V of the Guidelines) and therefore may exceed the Alternative State Cost Share derived from the Local Agency Benefit Assessment.

An example is used to illustrate the process just described. For simplicity, assume the Five-Year Plan contains just one proposed project. The project has a present value cost of $20 million. The Local Agency Benefit Assessment concludes the project would result in flood damage reduction benefits with a present value of $7 million. In this case, the Alternative State Cost Share (before cost-sharing enhancements) would equal 65 percent. If the State Base Cost Share is less than this value, the Applicant could request State cost sharing (before enhancements) at the higher level of 65 percent. Alternatively, suppose the same Five-Year Plan contained two projects rather than only one, and the Department determined that one of the projects qualified for a 5% cost-share enhancement. The project with no enhancement would qualify for a 65% State cost share and the project with the enhancement would qualify for a 70% State cost-share.

There are three possible outcomes of the Local Agency Benefit Assessment with regard to State cost sharing, as follows:

1. The calculated Alternative State Cost Share is less than or equal to the State Base Cost Share. In this case, the Applicant would use the State Base Cost Share.

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[1] Enhanced Cost Sharing is discussed in the Program Guidelines.

2. The calculated Alternative State Cost Share is greater than the State Base Cost Share and less than or equal to 75 percent. In this case, the Applicant would use the Alternative State Cost Share.

3. The calculated Alternative State Cost Share is greater than 75 percent. In this case, the Applicant would use 75 percent as the Alternative State Cost Share.

The purpose of the Local Agency Benefit Assessment is not an overall benefit-cost assessment, but rather an assessment of the benefits of the projects in the Five-Year Plan to the Applicant and its ratepayers. The Base or Alternative State Cost Share is intended to cover the costs of broader public benefits of the projects.

II. ESTIMATING FLOOD DAMAGE REDUCTION BENEFITS

A. Relationship to the Applicant's Five-Year Plan

Flood damage reduction benefits must be calculated in reference to the levee improvements and other flood risk mitigation actions specified in the Applicant's Five-Year Plan. The requirements for the Five-Year Plan are described in Exhibit A. This section discusses plan elements that pertain most directly to completion of a Local Agency Benefit Assessment. All discussion of benefits below refers only to the Local Agency benefits unless otherwise specified.

Information from the Five-Year Plan needed to complete the Local Agency Benefit Assessment includes the following:

- A quantitative assessment of the current and future level of flood protection provided by the levee system assuming the Five-Year Plan is not implemented;
- A quantitative assessment of the current and future level of flood protection provided by the levee system assuming the Five-Year Plan is implemented
- A description of the planned improvements, including estimates of when they will come on-line and their expected useful lives;
- A quantitative assessment of expected eligible costs of each planned improvement; and
- An inventory, valuation, and flood damage assessment of assessable structures and other property within the Applicant's service area.

A key aspect of determining flood damage reduction benefits is the specification of the *with-plan* and *without-plan conditions.*

> ***Without-plan condition*:** The without-plan condition is a forecast of conditions over the period of analysis that describes the risks of flooding if the levee improvements contained in the Five-Year Plan are not implemented. The characterization of the without-plan condition is one of the most important tasks of a flood risk management study. Specification of the *without-project* condition is described further in the USACE's *National Economic Development Manual for Flood Damage Reduction Studies*.[2]
>
> ***With-plan condition*:** The with-plan condition is a forecast of conditions over the analysis period that describes the risks of flooding if the levee improvements contained in the Five-Year Plan are implemented. The changes in future land use and development included in the without-plan condition should be reflected in the with-plan condition. However, no future development *induced by the improvements* should be reflected. The *with-plan* condition must also carefully consider how flood probabilities associated with hydrologic events would change *with* the projects in the Five-Year Plan compared to *without* them.

B. Dollar Base Year and Discount Rate

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[2] http://www.pmcl.com/nedprototype/index.asp

Express flood damages and eligible costs of the Five-Year Plan in current year dollars. In other words, if the Benefit Assessment is being conducted in, say, 2012, all benefits and costs shall be expressed in 2012 dollars. This will simplify the analysis and presentation of results. If dollar estimates are only available for prior years, these should be updated to current year dollars using an appropriate cost index. To update construction costs, appropriate indices include the US Bureau of Reclamation Construction Cost Indices[3], the Engineering News-Record Construction Cost Index[4], or the US Army Corps of Engineers' (USACE) Civil Works Construction Cost Index System.[5] To update building stock construction costs, Marshall & Swift (or a similar appraisal services company) comparative cost multipliers can be used.[6] Finally, a useful "all purpose" index is the Gross Domestic Product Implicit Price Deflator.[7] The analysis should identify which cost indices are used to convert prior-year benefit or cost estimates to current year dollars.

Discounting of future benefits and costs to present value should be done using a real discount rate of 6 percent. As described above, the dollar value of benefits and costs should be expressed in current year dollars prior to discounting.[8]

C. Categories of Flood Damage Reduction Benefits

Levee projects funded by the Special Projects Program provide local inundation reduction benefits. Inundation reduction benefits consist of avoided (1) physical damages or losses, (2) loss-of-function costs, and (3) emergency management costs. Each land use affected by a flood may experience losses in one or more of these areas. The following definitions of flood damages are from DWR's *Economic Analysis Guidelines: Flood Risk Management*.

> ***Physical damages*:** This category (also known as direct flood damage) is typically the most straightforward to estimate. Structures, contents, infrastructure (transportation systems, utilities, schools, hospitals, etc.), landscaping, vehicles, equipment, and crops can be damaged by flood events. The monetary damage is the cost to repair or replace the damaged property. If direct damage estimates are not available, then depth/damage curves can be used to estimate damage, at least for structures and their contents.

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[3] www.usbr.gov/pmts/estimate/cost_trend.html

[4] www.enr.construction.com

[5] www.usace.army.mil/inet/usace-docs/eng- manuals/em1110-2-1304/entire.pdf

[6] http://www.marshallswift.com

[7] www.research.stlouisfed.org/fred2/series/GDPDEF/21

[8] The present value of D dollars received or spent n years in the future when the discount rate is i is given by the formula:

$$PV(D) = \frac{D}{(1+i)^n}$$

Structures that are potentially inundated with floodwater should be valued using depreciated replacement cost rather than full replacement costs.[9]

***Avoided loss-of-function costs*:** These costs (also known as indirect flood damage) occur when facilities are damaged thereby disrupting their normal functions. For example, occupants of residential, commercial, or public buildings may incur displacement costs for temporary quarters when flood damage makes buildings unsafe for occupation. Other costs include loss of business net income, loss of rental income, loss of wages, disruption time, and deterioration in the overall "quality of life." In addition, flooding of some types of critical facilities may have negative impacts on the community as a whole. These types of impacts would include the loss of public facilities (e.g., schools, hospitals, police/fire stations, nursing homes), transportation systems (e.g., highways, airports, ports) and utilities (e.g., water, sewer, electricity).

Emergency management costs: These costs include disaster response and recovery costs that may be incurred by a community during and immediately following a flood. Examples include avoided emergency operations costs (e.g., personnel and equipment mobilization, materials purchases), evacuation and rescue costs, debris removal/cleanup, temporary security costs, and emergency repairs to flood management systems (such as levees, floodwalls, etc.).

D. Steps to Determine Flood Damage Reduction Benefits

The steps for determining the flood damage reduction benefits for levee improvements contained in an Applicant's Five-Year Plan are outlined below.

1. Identify existing *without-plan* conditions:

i. Delineate the potential affected floodplain area;
ii. Determine floodplain characteristics (structures, infrastructure, etc.);
iii. Determine flood damages for existing floodplain conditions.

2. Identify future *without-plan* conditions:

i. Estimate future activities, structures, and land uses in the affected floodplain area;
ii. Estimate annual (*without-plan*) flood-proofing costs incurred by individuals within the floodplain;
iii. Estimate annual (*without-plan*) flood damages for each year of planned life of the levee improvements.

[9] FEMA's HAZUS model is one method by which structure depreciation can be estimated.

3. Identify future *with-plan* conditions:

i. Forecast future with-plan activities, structures, and land uses in the affected floodplain area (these will be the same as the future without plan);
ii. Estimate the change in annual flood-proofing costs (*with-plan)* incurred by individuals within the floodplain;
iii. Estimate future (*with-plan*) flood damages for each year of planned life of the levee improvements.

4. Calculate expected annual damages as described in Section F of this appendix.

5. Calculate the expected annual flood damage reduction benefit as described in Section G of this appendix.

Chapter 6 of DWR's "Economic Analysis Guidelines: Flood Risk Management" provides sample tables for compiling and presenting the data required to calculate flood damage reduction benefits.

E. Exclusion of Non-Assessed Assets

Only include assets belonging to property owners subject to assessment by the Applicant when estimating avoided physical damage, avoided loss-of-function costs, and avoided emergency response costs. Exclude non-assessable property and assets from the analysis. For example, damage and loss-of-function costs for a state highway or county road would be excluded from a tally of flood damages unless this property was subject to assessment by the Applicant. The purpose of the analysis is not an overall benefit-cost assessment, but rather an assessment of the benefits of the projects in the Five-Year Plan to the Applicant and its ratepayers. The Base or Alternative State Cost Share is intended to cover the costs of broader public benefits of the projects.

F. Calculating Expected Annual Damage

Expected annual flood damage (EAD) is the amount of annual flood damage estimated to occur *on average*. EAD should be calculated for the without-plan and the with-plan conditions.

EAD can be determined from three variables:

1. The probability of an event occurring that could result in flooding;
2. The probability that the levee system fails given the event's occurrence; and
3. The resulting damage if the levee system fails.

Table I-1 and Figure I-1 below provide an example of how these three variables are combined to estimate EAD for the without-plan and with-plan conditions. The table identifies five hydrologic events that could result in flooding. These events are described in terms of their probability of

occurrence, the probability of levee failure for each event, and the damage that would result if the levees failed.

The probability of an event resulting in flooding depends on the without- and with-plan level of protection. In the example table, there is a 25 percent chance a 10-Year event will result in flooding without the plan. With the plan, the flood risk for this event is zero.

Expected event damage equals the damage if the levees fail times the probability that the levees will fail for this event magnitude. In this example, expected event damage is greater for the without-plan condition than for the with-plan condition.

Frequency-damage curves are generated by plotting expected event damage against the corresponding event frequency, as in Figure II-1. The area under a frequency damage curve equals the expected annual damage (EAD) from flooding. In this example, EAD is greater for the without-plan condition than for the with-plan condition.

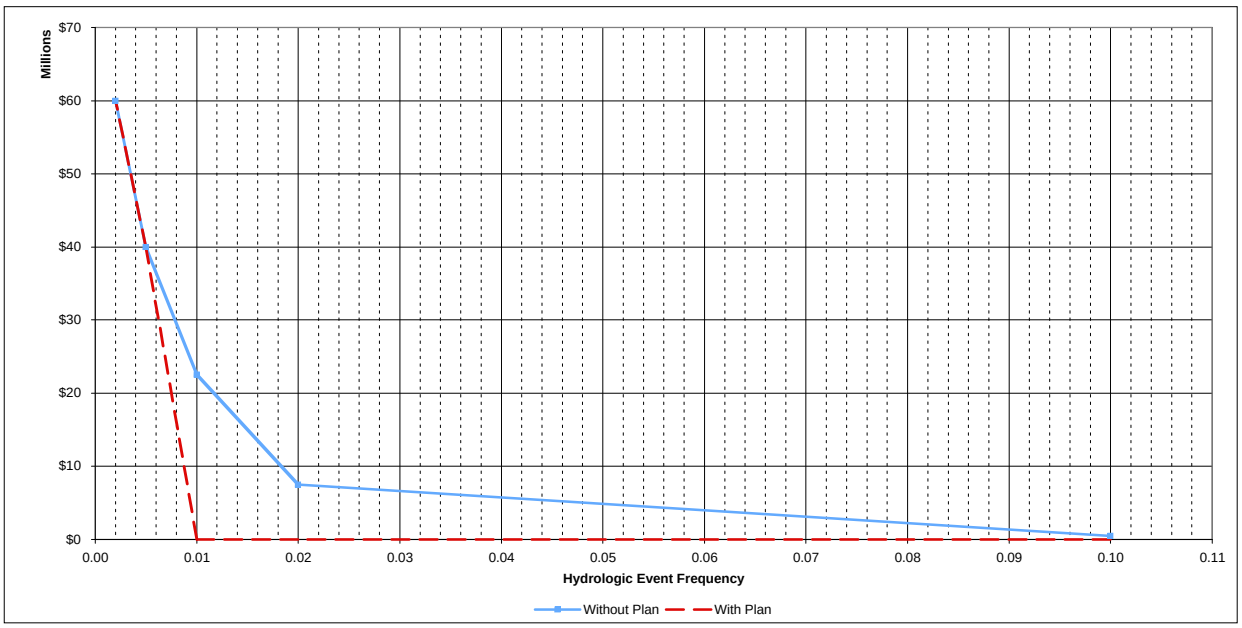
G. Calculating Expected Annual Benefit

The expected annual benefit (EAB) of the Five-Year Plan equals the difference between EAD without the plan and EAD with the plan. In the example in Table II-1, EAD without the plan is $0.9 million and with the plan is $0.37 million. Plan EAB is therefore $0.53 million.

Table I-1. Expected Annual Damage of Flood Events

Hydrologic Event	Event Frequency	Damage if Levees Fail (Million $)	Probability Levees Fail		Expected Event Damage (Million $)		Expected Event Benefit (Million $)
			Without Plan	With Plan	Without Plan	With Plan	
10-Year	0.100	$2.0	0.250	0.00	$0.5	$0.0	$0.50
50-Year	0.020	$15.0	0.500	0.00	$7.5	$0.0	$7.50
100-Year	0.010	$30.0	0.750	0.00	$22.5	$0.0	$22.50
200-Year	0.005	$40.0	1.000	1.00	$40.0	$40.0	$0.00
500-Year	0.002	$60.0	1.000	1.00	$60.0	$60.0	$0.00
Expected Annual Damage (EAD)					**$0.90**	**$0.37**	**EAB: $0.53**
Note: EAD and EAB are determined by integrating the areas under the curves shown in Figure II-1.							

Figure I-1. Frequency-Damage Curve



III. DETERMINING THE ALTERNATIVE STATE COST SHARE

Use the following steps to determine the Alternative State Cost Share:

1. Calculate the present value of 30 years of expected annual benefits by multiplying EAB (as determined in Section II.G) by 13.765.[10]

2. Divide Step 1's result by the present value cost of the levee improvements contained in the Five-Year Plan.

3. Subtract Step 2's result from one (1.0).[11]

4. If the value from Step 3 is less than 0.75, set the Alternative State Cost Share to this value. Otherwise, set the Alternative State Cost Share to 0.75.

Example: Taking EAB from Table II-1, Step 1 results in a value of $7.3 million ($0.53 x 13.765). Assume the present value cost of the plan is $24.0 million. The result of Step 2 is thus 0.304 ($7.3÷$24.0). Step 3 subtracts this value from 1.0, which equals 0.696, or 69.6%. Since this value is less than 0.75, the Alternative Cost Share in this example is 69.6%.

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[10] The present value of 30 years of a constant annual benefit is found by multiplying the annual benefit by the factor

$$\frac{(1+r)^{30}-1}{r(1+r)^{30}}$$

where r is the real discount rate. Setting r to 6% yields a factor equal to 13.765. While levee improvements may have useful lives longer than 30 years, a 30-year period is used to reflect the typical period for long-term debt financing.

[11] Note that in cases where local benefits exceed project costs, the result will be negative, implying an Alternative State Cost Share of 0 percent.

IV. TOOLS FOR ESTIMATING FLOOD DAMAGE REDUCTION BENEFITS

A. Manuals and Guidelines for Estimating Flood Damages

The USACE has prepared a new *NED Flood Damage Reduction Manual* that provides a detailed discussion on calculating non-farm flood damages and EAD.[12] Likewise, the U.S. Water Resources Council's *Principles & Guidelines* describe the procedures for estimating crop flood damage reduction benefits.[13] Additional guidance on the estimation of flood protection benefits is available from DWR's *Economic Analysis Guidelines: Flood Risk Management.* These manuals and guidelines should be consulted prior to estimating flood hazard reduction benefits of the proposed levee improvement projects in the Applicant's Five-Year Plan.

B. Data and Models for Estimating Flood Damages

Flood damage reduction benefits should be estimated using the best information available at the time the analysis is conducted. Many of the steps described for estimating physical damages of flooding can be implemented with data and models developed for the Delta Risk Management Strategy (DRMS), as discussed in the next section.[14] The U.S. Army Corps of Engineers and FEMA also have developed analytical software and data that can be used to compute flood hazard reduction benefits. These tools are described in Chapter 5 of DWR's *Economic Analysis Guidelines: Flood Risk Management*. Although tools such as these can facilitate the computation of flood protection benefits, use of them is not a requirement of the Special Projects Program.

C. DRMS Data and Models

DRMS developed a variety of data sets and models that can facilitate the calculation of avoided physical damages, loss-of-function costs, and emergency response costs of a levee improvement project. This section briefly describes these tools and data sets.

1. Flood Rapid Assessment Model (F-RAM)

F-RAM is an Excel-based spreadsheet model designed to calculate with- and without-project EAD and to assess the benefits and costs of flood protection projects. F-RAM was originally developed to determine levee rehabilitation priorities within the San Joaquin River Basin, but it is also suited to evaluating projects located throughout the Delta. The model and user documentation are available from DWR upon request.

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[12] http://www.pmcl.com/nedprototype/index.asp

[13] http://www.usace.army.mil/cw/cecw-cp/library/planlib.html.

[14] http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/

2. Delta Asset Inventory and Damage Tables

Calculation of physical damages to infrastructure requires an inventory of existing and projected structures and infrastructure at risk for the with- and without-project conditions. The inventory should show the following: (1) number of existing and projected structures and other point and linear assets at risk, such as residential, commercial, industrial, public facilities, etc., for without- and with-project conditions; (2) value of inventoried assets; (3) value of structure contents. DRMS compiled structure and infrastructure inventories and flood damage tables by Delta Island and land tract. Damages were estimated for two levels of inundation: (1) 100-year flood event inundation and (2) Mean-Highest-High inundation.[15] These tables are contained in the DRMS document *Delta Risk Management Strategy: Impact to Infrastructure Technical Memorandum*.[16] Prior to using a DRMS asset inventory, it should be compared to actual on-the-ground conditions to verify the accuracy and completeness of the inventory. Note that it may be necessary to update or supplement the DRMS inventory with additional information.

3. Farmland Damage Tables

Scour and inundation can damage farmland and result in the destruction of permanent crops. DRMS estimated farmland damages by Delta island and land tract for 100-year and Mean-Highest-High flood events. The estimates are presented in farmland damage lookup tables. Each table includes several examples demonstrating how to use the tables to look up farmland damage estimates. The data, assumptions, and methodology are presented in the DRMS document *Delta Risk Management Strategy: Economic Consequences Technical Memorandum.*[17] These tables are available upon request from DWR.

4. Non-Farm Loss-of-Function Costs

Loss-of-function costs from a flood event include: lost use of residential structures; disruption of non-farm commercial enterprises; disruption of public services; and disruption of farm commercial enterprises. DRMS developed data and models to estimate loss-of-function costs by Delta island or land tract. Loss of function cost estimates by Delta island and land tract are presented in Appendix A of the DRMS document *Delta Risk Management Strategy: Economic Consequences Technical Memorandum.*

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[15] The 100-year flood level is the level of inundation that is expected to occur following a levee breach during 100-year storm event. The Mean-Highest-High flood level is the level of inundation expected to occur following a seismic event or some other "sunny day" cause of levee failure. For many interior Delta islands, the area and depth of inundation is the same for the two flood types because of their bowl-shaped topography.

[16] http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/Infrastructure_TM-updated07.pdf. This memorandum also documents the data, assumptions, and methodology used to construct the inventory and damage tables.

[17] http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/Economic_TM-updated07.pdf.

5. Farm Loss-of-Function Costs

Income losses for Farm Commercial Enterprises from a flood event depend on the time of year the flood event occurs, the time until the flooded area is dewatered, and the mix of crops affected. DRMS estimated farm income losses by Delta island and land tract for 100-year and Mean-Highest-High flood events. The estimates are presented in farm income loss lookup tables. Each table includes several examples demonstrating how to use the tables to estimate farm income losses. The data, assumptions, and methodology are presented in the DRMS document *Delta Risk Management Strategy: Economic Consequences Technical Memorandum.* The tables are available from DWR. These tables are available upon request from DWR.

6. Emergency Response Costs

Emergency costs include emergency sheltering and other public services, levee stabilization and repair, and island dewatering. DRMS estimated the costs of levee stabilization, repair, and dewatering by Delta island and land tract. These estimates are presented in the DRMS document *Delta Risk Management Strategy: Emergency Response & Repair Technical Memorandum.*[18]

[18] http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/ER&R_TM-updated07.pdf.

V. EXAMPLE LOCAL AGENCY BENEFIT ASSESSMENTS

This section provides an example that demonstrates the application of the foregoing methodology. The example considers a plan to upgrade Reclamation District No. 2029's (Empire Tract) levees to the PL84-99 standard.

RD 2029 EXAMPLE ANALYSIS

The RD 2029 example analysis consisted of applying the methodology for determining an Alternative State Cost Share for a hypothetical upgrade of RD 2029 existing levees to a 1-in-100 year level of protection consistent with the PL84-99 standard. The analysis of flood damage reduction benefits was based on existing land uses within RD 2029. No foreseeable changes in current land uses were identified, with or without the levee upgrade.

1. Overview of RD 2029 Land Uses

RD 2029, also known as Empire Tract, is located on the eastern side of the Delta close to the middle of the Delta's north-south axis (Figure V-1). Eight Mile Road bisects the district from east to west and terminates on the western edge of the island. The district comprises a total of 3,677 acres.

Most of this acreage is used for agricultural production (Figure V-2). Some acreage on the northern side of the district has been converted to hunting and wildlife habitat. A large parcel in the center of the island and just south of the existing hunting and wildlife acreage is being converted into a duck club (Figure V-2). There are currently no structures on this parcel and it is unknown whether this land will be used for commercial hunting purposes. It is also unclear whether this acreage will continue to be farmed as well. For the analysis of flood damage reduction benefits, it was assumed 50% of this acreage (about 260 acres) would remain in farming. About 350 acres of farmland on the southern side of Eight Mile Road has recently been planted to blueberries, a high-valued perennial crop (Figure V-2).[19] On the western edge of the district, adjacent to Eight Mile Road is a marina complex and ferry to Venice Island. There are few other structures within RD 2029 besides a small number of residences and farm buildings.

The marina complex on the district's western border is not subject to assessment by RD 2029, and therefore is excluded from the calculation of flood damage reduction benefits. Likewise, the county road bisecting the island is not subject to district assessment. Therefore, it also is excluded from the analysis.

The Delta Risk Management Strategy (DRMS) project identified six manufactured housing units (mobile homes) and three single-family residential structures. Table V-1 provides a summary of non-farm assets inventoried by DRMS. This inventory included the marina complex and county road, but did not include non-residential farm structures. Satellite imagery of RD 2029 shows what appear to be three farm-related structures. These structures were not included in the calculation of flood damage reduction benefits due to lack of information on their value.

Crop acreage for RD 2029 is shown in Table V-2. Field and grain crops account for approximately 85% of farmed acreage. Corn is the primary crop grown on the island. Higher valued truck crops and the new blueberry acreage account for about 15 percent of farmed acreage on the island.

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[19] Established blueberries can produce for 20 to 25 years.

Figure V-1. Empire Tract (RD 2029)

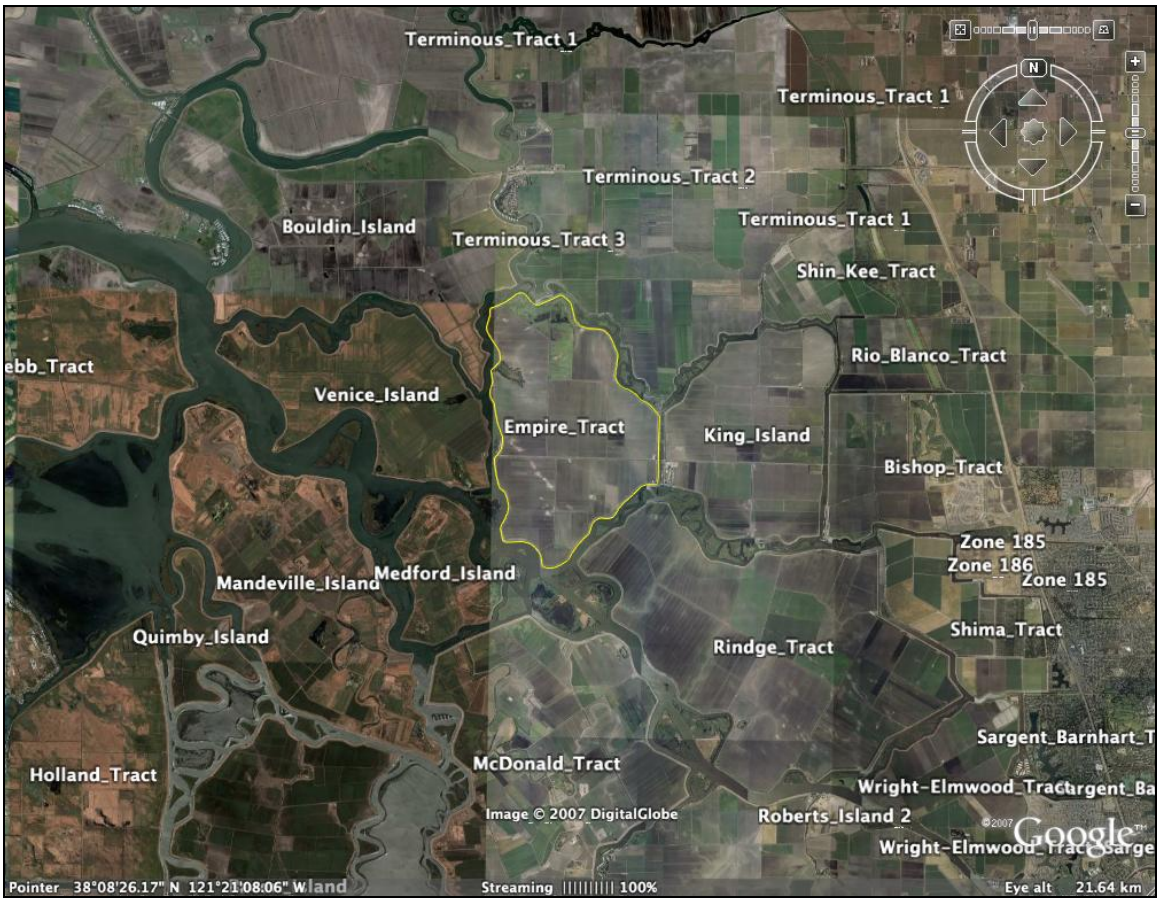


Table V-1. RD 2029 Non-Farm Asset Inventory

Asset Type	Unit	GIS Qty	Avg. Flood Depth	Total Asset Value (Thou. $)
Boat Launch, Marina*	Count	1	22	100
Delta Roads, PBSJ Minor Roads*	Length (ft)	44263	21	8853
PBSJ Gas-Oil Wells – non operational	Count	5	18	0
Residential - Manufactured Housing**	Count	6	21	326
Residential - Single Family Dwelling**	Count	3	21	512

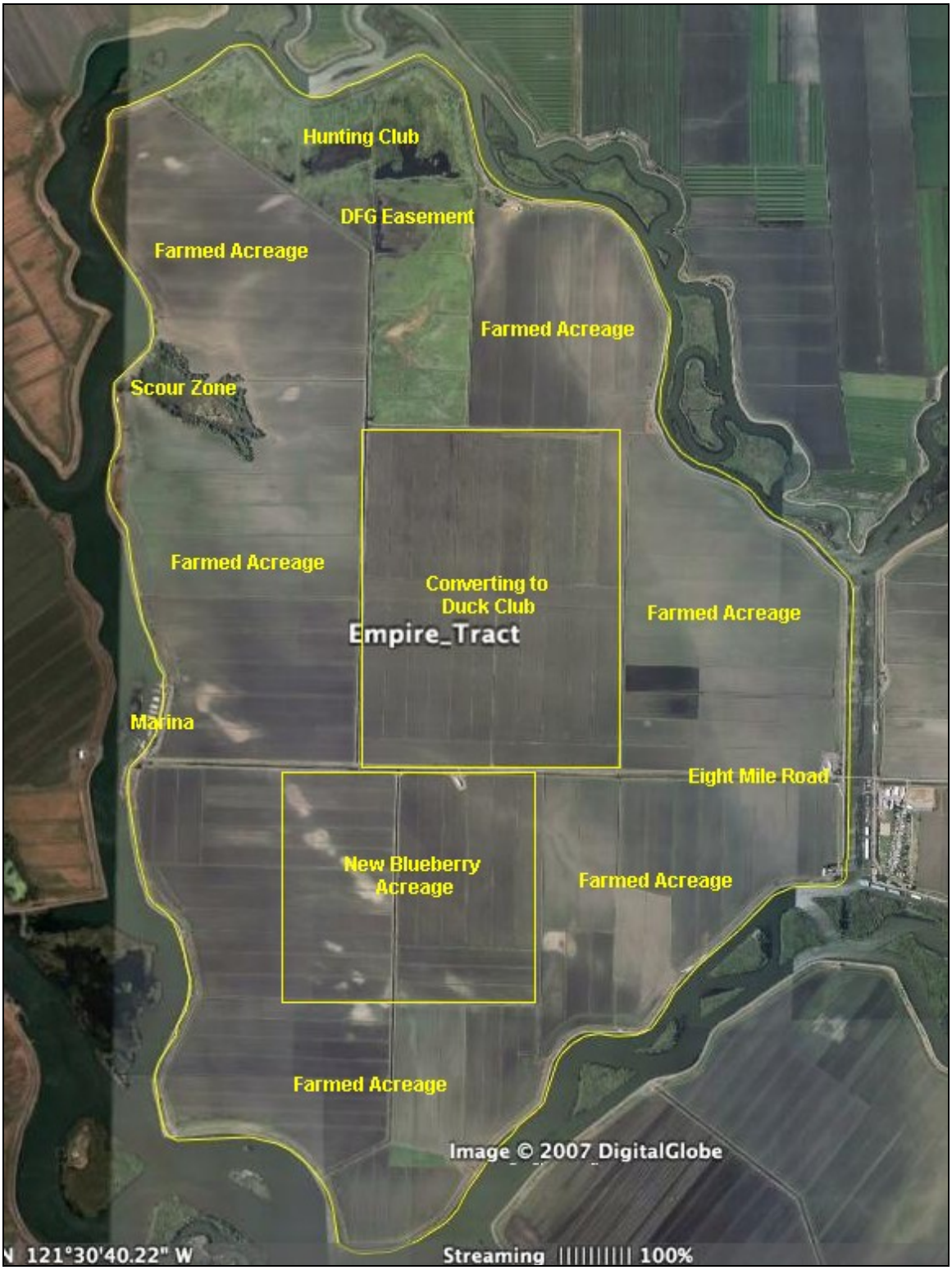
* These assets are not subject to district assessment and therefore are not included in the calculation of flood damage reduction benefits.
**Includes value of structure contents.
Source: Numbers in Table V-1 are from Tables 7-1a and 7-1b. Delta Risk Management Strategy (Phase 1), Technical Memorandum: Impact to Infrastructure, Draft 2, June 2007.

Table V-2. Empire Tract Crop Acreage

Crop	Acreage
Field crops (a)	1,981
Grain other than corn	666
Blueberries	350
Other Truck (b)	140
Total	3,138

Notes:
(a) Field crop acreage includes corn, the primary crop grown on Empire Tract.
(b) DWR/UC Davis acreage data for Empire Tract identified 490 acres of truck crop acreage. For the benefit assessment, we assume the new blueberry acreage came from this truck acreage.

Figure V-2. RD 2029 Current Land Uses



2. RD 2029 Flood Damage Estimation

a. Flood Depth

Flood damage to RD 2029 land, structures and improvements following a levee breach primarily depends on depth of inundation. Because of the island's bowl-shaped geography, depth of inundation will be the same regardless of whether a levee breach occurs during a sunny day event (e.g. a seismic event) or a flood event. All of RD 2029 is below sea level. DRMS estimated an average inundation depth of about 20 to 22 feet (Table V-1). At this level of inundation, all structures and improvements within the levees would be inundated and expected to incur significant flood damage.

b. Damage to Structures and Infrastructure

The DRMS analysis estimated the percent of damage to structures and infrastructure for each Delta tract following a flood event. The estimates for RD 2029 are shown in Table V-3. DRMS used the FEMA HAZUS method to calculate the cost of structure damages.[20] This method multiplies the percent of structure damage by the structure replacement cost. Damage estimates in Table V-3 include damages to structure contents, as well as cleanup costs. Estimation of structure contents and cleanup costs are discussed in subsequent sections.

Damages to the marina and county road are excluded from the calculation of the Alternative State Cost Share because they are not assessable properties. They are therefore not listed in Table V-3.

c. Damage to Structure Contents

Damage to structure contents is included in the DRMS structure damage estimates shown in Table V-3. DRMS used the FEMA HAZUS approach to calculating damages to structure contents. This method estimates structure contents as a percentage of the structural replacement value and multiplies this estimate by the percentage of structural damage based on HAZUS depth-damage relationships for different building types. HAZUS provides the following building content values as percentages of structural replacement values:

Residential	-	50%
Commercial	-	100%
Industrial	-	150%
Government	-	100%

[20] HAZUS is a flood damage estimation software package developed by FEMA. More information on HAZUS is available at http://www.fema.gov/plan/prevent/hazus/.

d. Debris Removal and Cleanup Costs

Debris removal and cleanup costs are included in the DRMS structure damage repair estimates shown in Table V-3. Debris removal costs are a substantial cost immediately following a flood event. After a review of the literature, DRMS concluded that these costs are highly variable, but typically constitute about 10% of total damages. In its analysis of flood damages, DRMS estimated debris removal and cleanup costs at 10% of structural and content damages.

Table V-3. DRMS Structure/Infrastructure Damage Estimates for Empire Tract

Asset Type	Inventory Unit	GIS Qty	% Damage	Total Asset Value (Thou. $)	Repair Costs (Thou. $)	Repair Time (months)
Levee Roads, Scour Damage (2)	Length (ft)	750	100	150	154	6
PBSJ Gas-Oil Wells – Non Operational	Count	5	NA	0	0	0
Residential - Manufactured Housing	Count	6	100	326	338	24
Residential - Single Family Dwelling	Count	3	100	512	544	24
Total (excludes marina and county road):				988	1,036	

Notes:
(1) County assessor's value for Boat Launch/Marina was used instead of DRMS estimate. Total asset value includes structure contents, estimated at 100% of the structure replacement value, per the HAZUS method.
(2) Assume road destroyed at breach site. Road repair cost estimate at breach site equals length of road damaged by scour divided by total road length times road asset value times 1.025 (cost escalator). Length of road damaged by scour equals breach width (500 ft) plus 50% of breach width (250 ft).
Source: Numbers in Table V-3 are from Tables 7-1a and 7-1b. Delta Risk Management Strategy (Phase 1), Technical Memorandum: Impact to Infrastructure, Draft 2, June 2007.

e. Damage Cost and Repair Time Scaling Factors

The damage and repair time estimates in Table V-3 are applicable for simultaneous flooding of up to five Delta islands. The cost and time required for repairs in the case of a larger number of simultaneous island failures is expected to be higher. DRMS used the cost and repair time scaling factors shown in Table V-4 to adjust damage cost estimates for flood events involving a large number of islands. The insurance industry refers to these scaling factors as "post event inflation" or "demand surge". The scaling factors apply to total flood damages (structure + contents + cleanup). To support the use of scaling factors, DRMS reviewed the literature from a variety of post-catastrophic events. The scaling factors shown in Table V-4 were used to estimate structure damages on RD 2029 in the case of a large number of simultaneous flood events.

Table V-4. DRMS Repair Cost and Time Scaling Factors

Number of Island Failures	Repair Cost Scaling Factors	Repair Time Scaling Factors
1 to 5	1.0	1.0

10	1.2	1.4
20	1.6	2.2
30	2.0	3.0

Source: Tables 7-7. Delta Risk Management Strategy (Phase 1), Technical Memorandum: Impact to Infrastructure, Draft 2, June 2007.

f. Residential and Commercial Displacement

A flood event would displace RD 2029 residents and businesses. Residents would need to secure temporary shelter during the period of dewatering and rebuilding. Businesses would likely be closed during the dewatering and repair period.[21] Like rebuilding costs, the period of displacement is a function of the number of structures damaged and requiring repair and the number of other islands and tracts flooded. DRMS used the FEMA HAZUS method for estimating residential displacement costs. This method assumes a one-time cost of $500 per flooded household, plus $500 per month per flooded household, plus a monthly cost based on local rental rates. DRMS estimated average monthly rental rates for typical housing of $747 for the Delta region. Residential displacement costs for a 1-to-5 flooded tract scenario are summarized in Table V-5.

Commercial displacement costs are equal to the revenues net of variable expenses businesses forgo by having to shutdown during the dewatering and repair period. The DRMS estimates for non-agricultural commercial displacement costs for a Tract 1-to-5 flooded tract scenario are shown in Table V-5. While not explicitly stated in DRMS documents, it was assumed estimated business income losses pertained to the marina complex, which is the only commercial enterprise on the island other than farming. Since the marina is not subject to district assessment, its business losses were not included in the calculation of flood damage reduction benefits.

Table V-5. RD 2029 Residential and Commercial Displacement Costs (Thou. $)

Residential*	190
Businesses (other than agriculture)**	40
Total	230
Total, excluding marina losses	190

* Based on 1-to-5 flooded tracts. Residential lost use costs based on 24 month repair time for single family dwelling units.
** These assets are not subject to district assessment and therefore are not included in the calculation of flood damage reduction benefits.
Source: LostUseCost033007.xls; Delta Risk Management Strategy (Phase 1), Technical Memorandum: Economic Consequences, Draft 2, June 2007.

[21] The only non-agricultural commercial operations on the island are the marina and ferry. These facilities are not assessable by the reclamation district and therefore are not included in the benefit assessment.

g. Agricultural Disruption Costs

DRMS estimated agricultural disruption costs for each Delta island/tract. Total costs comprised four components: (1) destruction of or damage to permanent crops, (2) loss of productive land due to scour, (3) field cleanup costs, and (4) loss of crop revenue net of variable production expenses. Agricultural losses for RD 2029 are summarized in Table V-6. The original estimates prepared by DRMS have been updated to account for the new blueberry acreage. The costs in Table V-6 assume levee repair and dewatering would be completed within four months of the breach. In the event of a large scale disaster with multiple island failures, dewatering and repair could be substantially delayed and agricultural disruption costs would be higher than shown in Table V-6. The agricultural loss estimate also assumes a flood event would result in the total loss of the blueberry investment, valued at 1/2 of the establishment cost.[22] The blueberry acreage accounts for approximately 78% of the estimated agricultural losses.

Table V-6. Empire Tract Agricultural Disruption Costs (Thou. $)

	Perm Crops	Scour Damage	Field Cleanup	Income Losses	Total
Fall/Winter Flood	$2,868	$85	$600	$3,321	$6,874
Spring/Summer Flood	$2,868	$85	$600	$3,027	$6,580
Annual Average	$2,868	$85	$600	$3,174	$6,727

Sources: Delta_Flooded_Island_Ag_Impacts_MHH.xls; Delta Risk Management Strategy (Phase 1), Technical Memorandum: Economic Consequences, Draft 2, June 2007.
UC Cooperative Extension (2002). Sample Costs to Produce Fresh Market Blueberries, San Joaquin Valley, Tulare County.

h. Levee Repair and Dewatering Costs

DRMS estimated levee repair and dewatering costs for single breach events for each island/tract in the Delta. For RD 2029, DRMS estimated a cost of $3.4 million to repair a single levee breach and dewater the tract.[23] DRMS assumed the same cost scaling factors previously discussed would apply to levee repair and dewatering.

i. Summary of RD 2029 Flood Damages

Table V-7 summarizes the flood damage estimates. For purposes of this example analysis, it is assumed that the district or its landowners would incur the costs of levee repair and dewatering.

[22] The loss could occur at any time during the useful life of the blueberry bushes, so on average, the loss will occur at the midpoint of the useful life.

[23] The source of the repair cost estimate is Table 12-1 of the Delta Risk Management Strategy Phase 1 Draft Report, June 2007. Repair and dewatering time is from Table 5-4 of the DRMS Emergency Response and Repair Technical Memorandum, draft 2, June 2007. Repair costs assume a single, 500 ft wide breach with a 500 x 2000 square foot scour zone. Fill material is assumed to cost $55/ton; dewatering costs $35/AF pumped.

Table V-7. Empire Tract Flood Damage Costs (Million $)

Island Failures	Up to 5	Up to 10	Up to 20	Up to 30
Structures (1)	$1.04	$1.25	$1.66	$2.08
Res. & Comm. Displace. (2)	$0.19	$0.27	$0.42	$0.57
Ag. Disrupt. (3)	$6.73	$6.73	$10.30	$10.30
Levee Repair (1)	$3.40	$4.20	$5.44	$6.80
Total	$11.36	$12.45	$17.82	$19.75

Notes:
(1) Damage costs for more than 5 flooded islands based on cost scaling factors from Table V-4.
(2) Lost use costs for more than 5 flooded islands based on repair time scaling factors from Table V-4.
(3) Assumes one year of production is lost for 10 or fewer flooded islands; two years for more than 10 flooded islands. Field clean up cost for more than 10 flooded islands is multiplied by a scaling factor of 1.4. The second year of agricultural income loss is based on the value for a fall/winter flood event. The calculation is: 6.727+0.240+3.321 = 10.288, which is rounded to 10.3 in the table.

3. Expected Annual Flood Damage Without the Plan

Expected annual flood damage (EAD) is equal to the estimated damages from a flood event times the probability of occurrence. Estimated flood damages shown in Table V-7 are based on the number of islands and tracts flooded in an event. DRMS estimated the probabilities for simultaneous island flooding. These probabilities were used to estimate the average damage for an RD 2029 flood event. Sunny day and hydrologic events were considered.

Sunny day events can be divided into two categories: seismic and non-seismic. For non-seismic sunny day events, DRMS concluded that the probability of more than one simultaneous island/tract failure is negligible.[24] Therefore, the expected annual flood damage for a non-seismic sunny day event is equal to the probability of occurrence times the damage for 1 to 5 failures.[25] For RD 2029, DRMS estimated a 0.11% annual probability of a non-seismic sunny day failure, such as the Jones Tract failure in 2004.[26] This is approximately a 1-in-1000 year flood risk of a sunny day failure. The expected annual damage from a non-seismic sunny day event given current land uses is therefore approximately $12,500 (0.0011 x $11.36 million).

The same seismic risks were assumed with and without the hypothetical level improvement.[27] Thus, expected damages from sunny day seismic events would be the same with and without the plan and therefore do not need to be calculated.

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[24] Section 13.2.1, Delta Risk Management Strategy (Phase 1) Draft Report, June 2007.

[25] Sunny day flood depths are determined by tidal level, and therefore damages for MHHW flood depths rather than hydrologic event flood depths are relevant.

[26] See Table 13-1, Delta Risk Management Strategy (Phase 1) Draft Report, June 2007.

[27] The hypothetical levee improvement did not include seismic upgrading to enable the levees to survive large seismic events

For flood events, DRMS estimated the probabilities of multiple island/tract failures shown in Table V-8. These probability estimates were combined with the damage estimates in Table V-7 to calculate the expected damage of a hydrologic flood event, as shown in Table V-9. The expected damage from a hydrologic flood event is $11.65 million.

Table V-8. DRMS Probability Estimates of Multiple Island/Tract Failures

Number of Island/Tract Failures	Probability of Exceedance
1	60.5%
3	28.1%
10	3.4%
20	0.9%
30	0.4%

Source: Table 13-5, Delta Risk Management Strategy (Phase 1) Draft Report, June 2007.

DRMS estimated a 4.41% annual probability (a 1-in-23 chance) of a flood-related failure under the *without plan condition*.[28] EAD for hydrologic events for the without plan condition is equal to the expected damages shown in Table V-9 times this probability, or approximately $514,000.

The total EAD for the *without plan condition* is equal to EAD for sunny day events and EAD for hydrologic events, which equals $526,500 ($514,000 + $12,500).

[28] Table 13-6. Delta Risk Management Strategy (Phase 1) Draft Report. June 2007.

Table V-9. RD 2029 Expected Flood Damage from Hydrologic Flood Events

(1)	(2)	(3)	(4)	(5)	(6)
Flooded Islands	DRMS Exceedance Probability [From Table V-8*]	Probability flooded islands less than or equal to Col. (1) [1-Col. (2)]	Probability flooded islands equals Col. (1) [Row n – Row n-1]	RD 2029 Damages (million $) [From Table V-7*]	[Col. (4) x Col. (5)]
1	**0.6050**	0.395	0.3950	**11.36**	4.487
2	*0.4430*	0.557	0.1620	**11.36**	1.840
3	**0.2810**	0.719	0.1620	**11.36**	1.840
4	*0.2457*	0.754	0.0353	**11.36**	0.401
5	*0.2104*	0.790	0.0353	**11.36**	0.401
6	*0.1751*	0.825	0.0353	*11.58*	0.409
7	*0.1399*	0.860	0.0353	*11.80*	0.416
8	*0.1046*	0.895	0.0353	*12.01*	0.424
9	*0.0693*	0.931	0.0353	*12.23*	0.432
10	**0.0340**	0.966	0.0353	**12.45**	0.439
11	*0.0315*	0.969	0.0025	*12.99*	0.032
12	*0.0290*	0.971	0.0025	*13.52*	0.034
13	*0.0265*	0.974	0.0025	*14.06*	0.035
14	*0.0240*	0.976	0.0025	*14.60*	0.036
15	*0.0215*	0.979	0.0025	*15.14*	0.038
16	*0.0190*	0.981	0.0025	*15.67*	0.039
17	*0.0165*	0.984	0.0025	*16.21*	0.041
18	*0.0140*	0.986	0.0025	*16.75*	0.042
19	*0.0115*	0.988	0.0025	*17.28*	0.043
20	**0.0090**	0.991	0.0025	**17.82**	0.045
21	*0.0085*	0.992	0.0005	*18.01*	0.009
22	*0.0080*	0.992	0.0005	*18.21*	0.009
23	*0.0075*	0.993	0.0005	*18.40*	0.009
24	*0.0070*	0.993	0.0005	*18.59*	0.009
25	*0.0065*	0.994	0.0005	*18.79*	0.009
26	*0.0060*	0.994	0.0005	*18.98*	0.009
27	*0.0055*	0.995	0.0005	*19.17*	0.010
28	*0.0050*	0.995	0.0005	*19.36*	0.010
29	*0.0045*	0.996	0.0005	*19.56*	0.010
30	**0.0040**	0.996	0.0005	**19.75**	0.010
31	*0.0036*	0.996	0.0004	**19.75**	0.008
32	*0.0032*	0.997	0.0004	**19.75**	0.008
33	*0.0028*	0.997	0.0004	**19.75**	0.008
34	*0.0024*	0.998	0.0004	**19.75**	0.008
35	*0.0020*	0.998	0.0004	**19.75**	0.008
36	*0.0016*	0.998	0.0004	**19.75**	0.008
37	*0.0012*	0.999	0.0004	**19.75**	0.008
38	*0.0008*	0.999	0.0004	**19.75**	0.008
39	*0.0004*	1.000	0.0004	**19.75**	0.008
40	*0.0000*	1.000	0.0004	**19.75**	0.008
				Expected Damages	**$11.648**

* Bold values are from Table V-7 or V-8. Italic values are linearly interpolated.

4. Expected Annual Flood Damage With the Plan

The hypothetical levee improvement would reduce the risk of levee failure from hydrologic events from 1-in-23 years to 1-in-100 years. The hypothetical improvement would not appreciably change the risk of non-seismic sunny day events. Therefore, EAD for the *with-plan condition* is equal to the previously calculated EAD for sunny day events and EAD for hydrologic events based on the lower flood risk. EAD for hydrologic events is equal to the expected damages shown in Table V-9 times the 1 percent probability of failure, or approximately $116,500.

The total EAD for the *with-plan condition* is equal to EAD for sunny day events and EAD for hydrologic events, which equals $129,000 ($116,500 + $12,500).

5. Expected Annual Benefit for RD 2029

The expected annual flood damage reduction benefit (EAB) of the plan is equal to the difference between EAD *without the plan* and EAD *with the plan*. This amount is $397,500. Multiplying this amount by 13.765 gives the present value of EAB.[29] This amount is approximately $5.5 million.

6. Determining the Alternative State Cost Share for RD 2029

DRMS estimated it would cost approximately $49 million to improve RD 2029's levees to meet PL84-99 standards and provide 1-in-100 year flood protection from hydrologic events.[30]

The ratio of the present value of EAB to the present value of the project cost ($5.5 million ÷ $49 million) is equal to 0.112. Subtracting this amount from 1 yields 0.888. Because this value is greater than 0.75, the Alternative State Cost Share (before cost sharing enhancements) would be 0.75 or 75%.

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[29] Based on a real discount rate of 6% over 30 years.

[30] DRMS did not provide a numeric estimate of the reduction in seismic risk from improving the levees to PL84-99 other than to indicate the risk reduction would be small to negligible.