An Economic Valuation of the Benefits of the Cadiz Project

by

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Executive Summary

Cadiz Inc. retained *Stratecon Inc.* to provide an independent economic valuation of the water supply and related benefits of the Cadiz Valley Water Conservation, Recovery & Storage Project ("Cadiz Project") to project participants and to the public generally in urban Southern California. An initial draft of this report was prepared and commentary was solicited from water professionals and economists. After reviewing the comments, Stratecon revised and finalized this report.

Stratecon's valuation uses standard techniques of economic and financial analysis. To assess the economic value of supply reliability and water storage, Stratecon employs the same economic framework used by the Department of Water Resources to estimate the economic benefits of the Bay Delta Conservation Plan ("BDCP"). Moreover, unlike many project valuations, Stratecon's valuation incorporates a quantitative risk assessment that considers both the Cadiz Project expectation and sensitivity analysis of the impact of production cutbacks arising from regulatory conditions on the valuation. The valuation also addresses how the Cadiz Project benefits depend on whether the BDCP is implemented as planned.

The Cadiz Project generates significant benefits for Project participants and regional benefits for all urban water users in Southern California. Stratecon concludes that the economic value of the Cadiz Project's water supply benefits is $6.1 billion in 2013 dollars, based on a valuation date of January 1, 2018 (the anticipated start of project deliveries)—see Table E.1 next page.

The valuation reflects analysis of four significant water supply benefits offered by the Cadiz Project:

- ***Reliable water supply:*** offers customers a 50-year water supply independent of hydrologic risks and regulatory restrictions that confront Southern California's water supplies from the State Water Project and the Colorado River. The Cadiz Projecct would reduce Project Participant's dependence on unreliable State Water Project ("SWP") supplies of the Metropolitan Water District of Southern California ("MWD"). Additionally, all water users in the MWD service area would face less frequent and less severe water shortages as a result of the addition of the Cadiz Project into the region's water supply portfolio.
    - *Avoided water costs net of wheeling costs and reduced power costs for Project Participants:* $910 million
    - *Avoided economic costs of water shortages for Project Participants:* $628 million
    - *Total economic benefit for Project Participants:* $1.5 billion
    - *Avoided economic costs of water shortages for non-Project Participants*: $1.5 billion
    - *Total economic benefit of reliable Cadiz water supply*: $3.0 billion
- ***New Groundwater Storage***: The Cadiz Project offers a 1 million acre foot ("AF") storage facility with annual put and take capacity of 95,000 AF to store State Water Project ("SWP") water or other surplus water. The availability of stored water in the Cadiz Project could reduce future water shortages. Assuming water is available for storage when the yield of the SWP is greater than 50% (about two-in-ten years), the use of stored water in the Cadiz Project can avoid $631 million in economic losses from water shortages.

- *Total economic benefit of new groundwater storage*: $631 million

- ***Avoided Water Quality Damage*:** Groundwater at the Cadiz Project has low total dissolved solids, or salts. Introduction of this water into the Southern California water transportation system would reduce economic damages water users in Southern California suffer from high TDS water.
  - *Economic benefit of Cadiz Project water quality*: $240 million
- ***New Intentionally Created Storage Credits***: Groundwater from the Cadiz Project could help the MWD service area avoid economic losses from water shortages by allowing water agencies to store water in Lake Mead through the U.S. Bureau of Reclamation Intentionally Created Surplus ("ICS") program when water is delivered from Cadiz into Southern California. This also avoids the cost water agencies, such as MWD, would incur to create ICS credits from other sources.
  - *Total Economic Benefit of ICS credits created by the Cadiz Project*: $2.2 billion

Table E.1
Economic Value of Water Supply Benefits of the Cadiz Project
Valuation Date: January 1, 2018 (2013$)

Benefit	*Million*	*Comment*
Reliable Water Supply		
Cadiz Participants	$1,538	Existing MWD Wheeling Rates
Non-Cadiz Participants	$1,466	Reduced regional water shortages
Sub-Total	$3,004	
Water Storage	$631	Based on exchange of SWP water
Water Quality	$240	MWD customer benefit
ICS Credits	$2,207	MWD customer benefit
Project Total	$6,082	

Local Economic Benefits

The design and construction of the Cadiz Project will also generate economic benefits for the local San Bernardino County/Inland Empire economy. Construction will generate an annual average of 1,500 full-time equivalent jobs and $220 million of increased annual economic output during the design and construction period. The Cadiz Project is expected to generate $10 million in new local tax revenue annually during the design and construction period. The Cadiz Project will also permanently increase annual property tax revenue by $6 million in San Bernardino County.

Sensitivity Analysis

Similar to other water and infrastructure projects, the Cadiz Project has critics and faces legal challenges. In addition to a valuation based on the Company's expectation about project operations, this opinion also provides a quantitative risk assessment considering the impact of production cutbacks on the valuation.

In this alternative scenario, production cutbacks under the *Groundwater Management, Monitoring and Mitigation Plan for the Cadiz Valley Groundwater Conservation, Recovery & Storage Project* will occur when cumulative production of indigenous groundwater reaches a threshold (1.5 million acre feet), which is 40% below the project's planned production. When this threshold is reached, this scenario assumes that the project will suffer permanent cutbacks from 25% to 75% of annual native groundwater production.

Overall, in this alternative scenario, the economic benefits of the Cadiz Project fall by $816 million (see Table E.2). All components of value decline by a range of 11% to 19%, but one. In contrast, the value of Cadiz storage actually increases due to more frequent and severe water shortages. The Cadiz Project could suffer significant production cutbacks and still generate project benefits of $5.3 billion.

Table E.2
Impact of Production Cutbacks on Economic Value of Cadiz Project
Valuation Date: January 1, 2018 (2013$)

Valuation Component	*Cutback Threshold*		*Lost Benefit*	
	none	*1.5 (MAF)*	*Amount*	*Percent*
Water Supply				
Avoided Supply Costs				
Reduced Water Costs	$719	$593	($126)	-18%
Power Costs Savings	$191	$158	($33)	-17%
Sub-Total	$910	$751	($159)	-17%
Avoided Shortage Costs (Cadiz Customers)	$628	$523	($105)	-17%
Grand Total (Cadiz Customers)	$1,538	$1,274	($264)	-17%
Avoided Shortage Costs (other water users)	$1,466	$1,248	($218)	-15%
Sub-total Reliable Water Supply	$3,004	$2,522	($482)	-16%
Cadiz Water Storage	$631	$642	$11	2%
Water Quality	$240	$194	($46)	-19%
ICS Credits				
Avoided Shortage Costs	$1,364	$1,212	($152)	-11%
Avoided Acquisition Costs	$843	$696	($147)	-17%
Grand Total ICS Credits	$2,207	$1,908	($299)	-14%
Project Total	$6,082	$5,266	($816)	-13%

Impact of Bay Delta Conservation Plan

Finally, Stratecon examines how implementation of the BDCP impacts the economic benefits of the Cadiz Project. If implemented, the BDCP would start operations in 2025. In its analysis, Stratecon assumes that the BDCP would substitute for the 500,000 AF of new long-term supplies included in Stratecon's pre-Cadiz Project baseline. Under this scenario, implementation of the BDCP would reduce the economic benefits of the Cadiz project by about $1 billion (see Table E.3). Therefore, while successful implementation of the BDCP will reduce

water shortages in Southern California, the Cadiz Project still generates billions of economic benefits for Southern California.

Table E.3
Impact of Bay Delta Conservation Plan on Economic Value of Cadiz Project
Valuation Date: January 1, 2018 (2013$)

Valuation Component	*without BDCP*		*with BDCP*	
Cutback Threshold	*none*	*1.5 (MAF)*	*none*	*1.5 (MAF)*
Water Supply				
Avoided Supply Costs				
Reduced Water Costs	$719	$593	$719	$593
Power Costs Savings	$191	$158	$191	$158
Sub-Total	$910	$751	$910	$751
Avoided Shortage Costs (Cadiz Customers)	$628	$523	$431	$332
Grand Total (Cadiz Customers)	$1,538	$1,274	$1,341	$1,083
Avoided Shortage Costs (other water users)	$1,466	$1,248	$857	$689
Sub-total Reliable Water Supply	$3,004	$2,522	$2,194	$1,772
Cadiz Water Storage	$631	$642	$877	$897
Water Quality	$240	$194	$240	$194
ICS Credits				
Avoided Shortage Costs	$1,364	$1,212	$883	$859
Avoided Acquisition Costs	$843	$696	$843	$696
Grand Total ICS Credits	$2,207	$1,908	$1,726	$1,555
Project Total	$6,082	$5,266	$5,041	$4,418

Valuation Technique

Stratecon uses standard techniques of economic and financial analysis and the same economic framework used by the Department of Water Resources to estimate the economic benefits of the BDCP. Stratecon's valuation is conservative for two reasons:

- For projected growth in water demand and MWD water service in Southern California, Stratecon uses a compilation of MWD member agency projections that yield lower projected growth in water demand and greater growth in local supplies than used in MWD planning. Lower growth projections yield lower projected frequency, severity and economic cost of water shortages. As a result, these assumptions yield a smaller economic benefit of the Cadiz Project's supply reliability than an analysis based on higher demand projections.
- In addition, Stratecon includes in its pre-Cadiz Project "baseline" an assumption that MWD will develop approximately 500,000 AF of new annual supplies over the forecast period with supply reliability equal to the most senior water rights in the Central Valley Project. Stratecon's baseline reflects its opinion that a baseline

without any new water supplies yields water supply reliability so precarious that it threatens the viability of growth included in demand projections. If a pre-Cadiz project baseline included lower or even no new supplies, the economic cost of water shortages in Southern California would skyrocket. In a water supply unreliability environment implied by such an alternative pre-Cadiz project baseline, the economic value of the Cadiz Project's water supply reliability would be considerably greater than Stratecon's valuation opinion.

About Stratecon Inc.

Stratecon Inc. is a strategic planning and economics consulting firm specializing in water and other natural resources, providing advisory services (including due diligence on water projects and investments), proprietary research and testimony in legal proceedings. Stratecon combines a unique combination of disciplines with a proprietary database of water transactions throughout the western United States since the 1980s to provide cost-effective, timely and creative solutions to water resource management problems and legal disputes. For over 23 years, Stratecon published *Water Strategist*, a recognized monthly journal that provided analysis of water finance, legislation, litigation and water marketing. Stratecon launched is new web-based information service covering these issues in January 2014—www.JournalOfWater.com. The author of the report, Rodney T. Smith, Ph.D. is a renowned economist that has extensively studied, written and lectured on Western water issues and participated in major water transfers and projects throughout the western United States and Mexico.

An Economic Valuation of the Benefits of the Cadiz Project

Cadiz Inc.("Cadiz", the "Company") retained *Stratecon Inc.* to provide an independent economic valuation of the water supply and related benefits of the Cadiz Project. The Cadiz Project offers four significant water supply benefits:

- *Reliable water supply:* offers customers a 50-year annual water supply of 50,000 acre feet ("AF") independent of hydrologic risks and regulatory restrictions that confront Southern California's water supplies from the State Water Project and the Colorado River
- *Groundwater Storage*: a 1 million acre foot ("AF") underground storage facility with annual put and take capacity of almost 100,000 AF
- *Improved Water Quality*: Project groundwater has low total dissolved solids (TDS), or salts, and its use in Southern California can reduce economic damages currently suffered by the urban water users in Southern California suffer the use of high TDS water
- *Intentionally Created Storage Credits*: groundwater from the Cadiz Project is eligible for the creation of new storage credits Lake Mead benefitting Colorado River water users in urban Southern California

Stratecon's valuation uses standard techniques of economic and financial analysis. To assess the economic value of supply reliability and water storage, Stratecon employs the same economic framework used to estimate the economic benefits of the Bay Delta Conservation Plan. Unlike many project valuations, Stratecon expressly addresses project risks.

While there are many factors incorporated into Stratecon's valuation, they fall into two categories: (i) general analysis and (ii) project-specific analysis. The general analysis would apply to <u>any</u> source of a reliable water supply, storage, improvement of water quality and creation of ICS credits. As such, these factors have a general applicability for assessment of any water resource. The project-specific analysis involves the risk-assessment of whether the Cadiz groundwater resource can sustain proposed pumping. While this risk assessment involves the specific circumstance of the Cadiz Project, the principles and methods can assess other water resources and their project-specific circumstances.

The discussion proceeds as follows:

i. Cadiz Project description
ii. Market Value of Cadiz Water
iii. Southern California Water Shortage Model
iv. Economic cost of Water Shortages in urban Southern California
v. Stratecon Valuation Model and Risk Assessment
vi. Valuation of Cadiz Project's Benefits
vii. Economic Impact of Project Activities

The study presented below has the following limitations. First, the study estimates the economic value of benefits of the Cadiz Project, not the economic value of the Cadiz Project. The latter requires consideration of the Cadiz Project's capital, operating and environmental mitigation costs and adjustment of the valuation date of benefits to coincide with the valuation date of costs.[1] Second, the study does not opine on the terms and conditions of proposed

[1] This study's valuation date is January 1, 2018: the projected date of the start of water deliveries. The start date could be earlier depending on the resolution of several issues. A

agreements with Cadiz customers. This would require an analysis of the terms and conditions of proposed agreements with Cadiz Project's Participants and is beyond the scope of this report.

A. Cadiz Project Description

The Cadiz Project proposes to extract and deliver 50,000 AF per year of indigenous groundwater to municipal customers in Southern California for a term of 50 years ("Conservation Component"). In a second phase, not yet permitted, the Cadiz Project would import and store water ("Imported Water Storage Project") at the Project area for later use when needed. Cadiz management anticipates an operational storage capacity of 1 million AF.

Cadiz management has planned for the following put and take capacities:

- Colorado River water: 95,000 AF/year
- State Project water: 30,000 AF/year (put) and 20,000 AF/year (take)

The Cadiz Project plans to commence operations of the Conservation Component in 2018.[2]

Groundwater extraction is subject to a Groundwater Management, Monitoring and Mitigation Plan ("Groundwater Plan").[3] The Groundwater Plan is designed to avoid significant adverse impacts and "undesirable results" to critical resources within the region, including:[4]

- Groundwater aquifers tapped by the project
- Local springs in the Fenner Watershed
- Brine resources of Bristol and Cadiz Dry Lakes
- Air quality in the Mojave Desert region
- Vegetation in the Mojave Desert region
- Adjacent areas, including the Colorado River and its tributary sources of water

The Groundwater Plan utilizes a network of monitoring facilities and data collection to track the impact of the Cadiz Project.[5]

Mitigation will occur if and when "action criteria" are triggered by deviations from baseline conditions and groundwater model predictions.[6] Review of triggering events will determine whether the Cadiz Project operations are "attributable or exacerbated" the conditions.[7]

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valuation of the Cadiz Project would have costs incurred years in advance. The valuation date of benefits would need to be adjusted to conform to the valuation date of the project. Project benefits in those earlier years would be zero. Project benefits for the earlier valuation date would, in effect, be reduced to account for the timing of benefits being later than the timing of the incurrence of costs.

[2] The planned start date was provided by Cadiz management and reflects their expectations about the timing and outcome of outstanding litigation, as well as required additional planning, engineering and construction.

[3] *Groundwater Management, Monitoring and Mitigation Plan for the Cadiz Valley Groundwater Conservation, Recovery & Storage Project,* Cadiz Inc., September 2012 (hereinafter cited "Groundwater Plan").

[4] *Ibid*, pp. 2-3.

[5] *Ibid.*

[6] *Ibid*, p. 77

[7] *Ibid.*

There are many different criteria for action in the Groundwater Plan: third party wells, land subsidence, induced flow of lower-quality water from Bristol and Cadiz Dry Lakes, brine resources underlying Bristol and Cadiz Dry Lakes, adjacent basins including the Colorado River and its tributary sources of water, springs, air quality, management of a groundwater floor, and project vegetation.[8]

The groundwater floor is a key criteria as it sets "a designated maximum drawdown elevation in the Project wellfield and helps assess trends and operate the Project in a manner that avoids Undesirable Results or other physical impacts."[9] The Groundwater Plan describes the floor as follows:[10]

> "The Project may drawdown the aquifer in the center of the Project wellfield area to a maximum drawdown level (the "floor") of elevation 530 feet (80 feet below baseline elevations). The floor will be calculated as an average groundwater elevation within a 2-mile radius from the center of the Project wellfield area. The rate of decline in groundwater elevation can be expected to vary, being higher initially and gradually stabilizing to a lower long-term rate. With the 80-foot floor, the projected rate of decline is approximately 1.6 feet per year averaged over the Project's 50-year lifespan. Once the floor is reached, and absent approval of a new floor by the County, pumping must be reduced to a quantity at or below the amount that will maintain water levels at or above the 80-foot floor. The floor is a management level, meaning annual, short-term incursions below the floor (3 consecutive years or less) are acceptable under the following conditions:
>
> (a) No management criteria or corrective actions under this Management Plan have been triggered as necessary to avoid the threat of Undesirable Results; and
>
> (b) Average groundwater levels must remain at or above the floor as measured on a 10-year average."

After 15 years of project operations, San Bernardino County may lower the groundwater floor to 100 feet under the following conditions:[11]

a) Sufficient operational data exists to support a decision to lower the floor and avoid Undesirable Results;
b) The urban water management plans for each of the municipal water agencies and purveyors receiving water from the Project have disclosed the 50-year limit on the Cadiz water supply;
c) Additional conservation benefits will be realized at the proposed floor;
d) Lowering the floor to 100 feet would not result in the triggering of either the action criteria or the corrective actions under this Management Plan as necessary to avoid the occurrence of Undesirable Results; and
e) There is no other threat of adverse environmental consequences that may arise due to changed or unforeseen circumstances.

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[8] *Ibid*, pp. 81-99.

[9] *Ibid*, p. 95. The "MOU" in the quote refers to the Memorandum of Understanding between the County of San Bernardino and Cadiz Inc.

[10] *Ibid*, pp. 95-96.

[11] *Ibid*, p. 97

The new 100-foot floor would operate as a new management level, meaning annual, short-term incursions below the floor would be acceptable under the conditions set forth above.

Corrective measures to manage or avoid elevations falling below 100-foot floor are the following:[12]

- Reduction in pumping from Project wells;
- Revision of pumping locations within the Project well field;
- Stoppage of groundwater extraction for a duration necessary to correct the predicted impact

Groundwater modeling conducted as part of the environmental review estimates that well elevations will fall with the Project's cumulative extraction of indigenous groundwater, but are unlikely to trigger production cutbacks.[13] Project opponents believe that environmental documents have overestimated recharge and, therefore, underestimated the Cadiz Project's impact on the groundwater basin. Given the structure of the Groundwater Plan, this controversy can be stated as two questions:

- At what threshold of cumulative extraction of indigenous groundwater, if any, will elevations fall to the trigger levels in the Groundwater Plan?
- If or when the trigger levels are reached, what would be the cutback in allowed production?

See the risk assessment discussion below regarding how Stratecon's valuation addresses these issues.

B. Market Value of Cadiz Water

Other than water supplies to Arizona California Railroad, the Cadiz Project's Participants are all located in MWD's service area and purchase water from MWD. MWD's water supplies are sourced primarily from the Colorado River and Northern California. These sources are generally acknowledged as potentially unreliable. Colorado River supplies face long-term shortages under existing policy. The State Water Project which originates in Northern California is undergoing sustained shortages on a regular basis. Therefore, there are two components to Stratecon's valuation of Cadiz water:

- Avoided water supply rates and charges net of wheeling costs
- Economic value of the superior reliability of Cadiz water in comparison to SWP supplies

B.1 Avoided Water Supply Rates and Charges

In 2004, Stratecon examined the history of MWD's rates for the period 1960 through 2002 when MWD restructured its rates.[14] As shown in the Table 1, MWD's water rates have

[12] *Ibid*, p. 98

[13] Private communication with Cadiz senior management

[14] *Financial Projections for 2004 Water System Project*, prepared by Rodney T. Smith, Stratecon Inc for Imperial Irrigation District, and included in Official Statement *Imperial*

consistently increased faster than inflation.[15] Real MWD rates (MWD rates adjusted for inflation) increased at an annual rate of more than 4% throughout the period.

Table 1
Annual Rate of Increases
Before MWD's Rate Restructuring

Time Period	*MWD Water Rates*	*Inflation*	*Real MWD Rates*
1960-2002	8.1%	3.9%	4.2%
1960-1980	9.4%	4.8%	4.5%
1981-2002	6.9%	2.7%	4.2%

This trend has continued in more recent years (see Table 2). Untreated and treated water rates and the Readiness-to-Serve ("RTS") charge have increased substantially faster than the rate of inflation (2.5%) over the period 2003 through 2012. For treated water rates and the RTS charge, the annual increase in MWD rates and charges adjusted for inflation since MWD's rate restructuring have grown at least as fast as MWD rates adjusted for inflation before rate restructuring. For more than a half of a century, MWD's real rates and charges have grown faster than 4% annually. While MWD's rates for 2013 and 2014 have grown a bit slower, they remain consistent with MWD's persistent history of rates and charges increasing faster than inflation.[16]

Table 2
Annual Rate of Increase
After MWD's Rate Restructuring

Period/	*Untreated Water*		*Treatment*	*Treated Water*		*RTS*
Rate Inc.	*Tier 1*	*Tier 2*	*Surcharge*	*Tier 1*	*Tier 2*	*Charge*
2003-2012						
Nominal	6.2%	6.0%	12.4%	7..7%	7.3%	6.9%
Real	3.7%	3.5%	9.9%	5.2%	4.8%	4.4%
2012-2014						
Nominal	2.9%	3.5%	12.7%	5.9%	5.9%	6.6%
Real	0.4%	1.0%	10.2%	3.4%	3.4%	4.1%

As part of its rate restructuring several components was created upon which MWD customers' rates would be based (see Table 3). The Cadiz Project Participants avoid paying the MWD base rate, or "Tier" rate for untreated service but must incur MWD's wheeling fee to transport Cadiz water within the MWD system. Under existing MWD policy, the wheeling fee equals the System Access Charge, the Stewardship Fee and the actual cost of power for wheeling

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Irrigation District, 2004 Taxable Revenue Certificates of Participation, April6, 2004 (hereinafter cited as "IID Financial Projections")

[15] *Ibid*, p. 6

[16] Rate increases for 2012-2014 adjusted by 2.5% expected inflation (see below).

(not the System Power Cost).[17] Therefore, the avoided water charge less MWD's wheeling rate equals the Tier water supply component of the Tier charge plus the difference between MWD's System Power Charge and the actual power cost of wheeling water on MWD facilities.[18]

Table 3
History of Components of Tier 1 and Tier 2 Untreated Rate

Item	*Tier 1 Water Supply*	*Tier 2 Water Supply*	*System Access Charge*	*Stewardship Fee*	*System Power*	*Tier 1 Untreated*	*Tier 2 Untreated*
2003	$73	$154	$141	$23	$89	$326	$407
2012	$164	$290	$217	$43	$136	$560	$686
2014	$148	$290	$243	$41	$161	$593	$735
Annual Increase							
Full Period	6.6%	5.9%	5.1%	5.4%	5.5%	5.6%	5.5%
2003-2012	9.4%	7.3%	4.9%	7.2%	4.8%	6.2%	6.0%
2012-2014	-5.0%	0.0%	5.8%	-2.4%	8.8%	2.9%	3.5%

MWD's Tier rate has two categories: Tier 1 and Tier 2. Tier 1 rates recover the cost of maintaining a reliable amount of supply, primarily MWD's imported Colorado River Aqueduct and SWP supplies. The Tier 2 rate recovers MWD's cost of developoing additional supply and aims to encourage efficient use of local resources.[19] For FY 2013-2014, the Tier 1 annual limits for MWD member agencies is 2,052,657 AF.[20] If MWD has sufficient water supplies to meet all Tier 1 demands, MWD customers should expect to pay the Tier 1 up to the Tier 1 limits. If customer demands exceed the Tier 1 limit, only then would the Tier 2 rate become applicable.

MWD's current expected supplies of Colorado River water and SWP water have expected annual yield of 1.576 million AF (see section C.4).[21] Therefore, MWD is short about 475,000 AF/year of water supplies to meet all Tier 1 demands. MWD can meet demands in the

[17] Section 4405, *The Administrative Code of the Metropolitan Water District of Southern California*.

[18] Note that the System Access Charge and Stewardship Fee are in both MWD's tier rate for water service and the wheeling fee. This leaves as the difference between avoided MWD rates and charges less wheeling costs the Tier water supply rate and the difference between the System Power Charge and the actual costs of wheeling.

[19] See MWD website, Adopted Water Rates & Charges, http://www.mwdw2o.com/mwdh20/pages/finance/finance_03.html.

[20] See *Rate Structure Administrative Procedures Handbook, FY 2013/14*, Metropolitan Water District of Southern California, Table 2, p. 6.

[21] The Department of Water Resources recently announced an initial allocation of 5% for the SWP in 2014. With this allocation, MWD's current supplies are 0.883 MAF.

near term by drawing down stored water supplies. At best, however, this is a short-run proposition.

Eventually, MWD must declare rationing, as it did in 2009 and 2010. MWD enforces its allocations through a penalty rate structure. For water use between 100% and 115% of a MWD allocation, the water price is the Tier 1 rate plus twice the Tier 2 rate.[22] For water use greater than 115% of a MWD allocation, the water price is the Tier 1 rate plus four times the Tier 2 rate.[23]

When penalty rates are applicable, therefore, the avoided cost of MWD water less MWD wheeling rates (before adjustment for difference between the System Power Charge and actual wheeling power costs) is $1,618/AF when water demand are below the Tier 1 limit.[24] Provided that the probability of MWD rationing is at least 10% (or once a decade), the expected value of the cost of MWD water at Tier 1 rates will exceed $290/AF, the Tier 2 water supply rate in 2014.[25]

Additionally, Stratecon considered the difference between the System Power Rate and the incremental power cost of wheeling Cadiz water on the Colorado River Aqueduct. This cost savings has an estimated range of $67/AF to $97/AF.[26]

Stratecon's conclusions regarding the avoided supply rates and charges for Cadiz customers are the following:

- Water rates: Tier 2 water supply rate ($290/AF in 2014)
- Power Cost Savings $77/AF in 2014

Since the Cadiz Project's first year of water delivery is in 2018 and has a term of 50 years, Stratecon's valuation assesses the potential growth in rates over the Project period. Based on MWD's history, it is reasonable to assume that there will be significant, long-term increases faster than inflation.

Stratecon's valuation is based on real increases in MWD's rates and charges of 3.5% in 2015 declining to 1.5% by 2020 and thereafter. This projection starts at more than 50 basis points below MWD's long-term real increase but assumes that the growth in MWD's real rates slows down by 2020 to only 1.5%, **which is about one-third of MWD's performance for more than 50 years.** As such, Stratecon believes that its valuation is conservative.

B.2 Economic Value of Superior Supply Reliability of Cadiz Water

The Cadiz water supply is independent of hydrologic risks and regulatory restrictions that confront Southern California's water supplies from the State Water Project and the Colorado River. Therefore, Cadiz Projecct water has superior supply reliability relative to MWD water service. Therefore, the valuation of Cadiz water should include a premium for that superior

[22] See *The Regional Urban Water Management Plan,* Metropolitan Water District of Southern California, November 2010, p. A.4-12.

[23] *Ibid*

[24] The Tier 1 water supply rate ($148/AF) plus twice the untreated Tier 2 water rate ($1,470 = 2x$735/AF)

[25] Expected Cost of MWD Water: $1,618/AF p + $148/AF (1-p), where p is the probability of MWD rationing. The value of "p" where the Expected Cost of MWD water equals the Tier 2 water supply rate ($290/AF) is approximately 0.097.

[26] Private communication with Gordon Hess, who examined this issue two years ago.

reliability (see discussion in sections D and E regarding potential discounts in the valuation for Cadiz Project risks).

The value of superior supply reliability is the economic losses suffered from water shortages avoided by the superior supply reliability. This framework is the methodology used by the economic analysis of the Bay-Delta Conservation Plan.[27] The economic loss per acre-foot of a water shortage depends on the following factors:

- Retail water price—higher price, greater losses from shortages
- Incremental water cost (differs from retail price due to fixed costs of water systems)—higher incremental water cost, lower losses from shortages
- Elasticity of demand (measure of the responsiveness of water demand to water price)—more responsive demand is to price, lower losses from shortages

Using data from the BDCP's Appendix 9.A for Southern California, the economic loss of municipal water users increases rapidly with the size of water shortage (see Figure 1).[28]

In economics, there are two important cost concepts: average cost and marginal cost. Average cost expresses the economic losses of a defined shortage per AF of the water shortage. The marginal cost expresses the increase in economic losses for an additional acre-foot of water shortages. Using a retail price of $875/AF for a 5% shortage, for example, the economic loss expressed per acre-foot of the water shortage, or average cost is $708 (2013$)/AF. For a 5% shortage, the economic losses from an additional acre-foot of water shortage, or its marginal cost, is $812 (2013$)/AF.

Greater water shortages translate into higher average and marginal costs of shortages. Given the $875/AF retail price used in the examples, the economic losses from water shortages are 100% to 300% of retail prices (compare marginal cost of shortages to retail price).

To value the superior reliability of Cadiz water, one must compare the economic losses from shortages with and without the Cadiz Project. Stratecon developed a Southern California Water Shortage Model for this purpose.

C. Southern California Water Shortage Model

Water shortages result from an imbalance between water demands at current water pricing and available water supplies. The discussion below presents the various components of Stratecon's Southern California Water Shortage Model.

[27] Appendix 9..A *Economic Benefits of the BDCP and Take Alternatives*, The Brattle Group, David Sunding lead author, May 2013, pp 24-28.

[28] Retail price $875/AF (2013$): based on DWR chart showing today's retail water prices in MWD's service area are $1.50/1,000 gallons in 1990$. Use Bureau of Labor Statistics Inflation Calculator to adjust to 2013 dollars (1.79) and convert from 1,000 gallons to acre feet

Incremental cost of water: $250/AF per DWR assumption (equals 28.5% of retail price)

Elasticity of Demand: -.25 (mid-range reported in DWR materials)

C.1. Structure of Model

In any year, projected water demands are compared to projected available water supplies. Available water supplies in Southern California include local sources, Colorado River water, State Water Project ("SWP") water and water withdrawn from local storage. If water demands are at or below available water supplies, there is no water shortage. The excess water supplies (the amount available water supplies exceed demand) will be locally stored if there is available storage capacity. Water shortages occur only when projected water demand exceeds available water supplies (including water withdrawn from storage).

C.2. Projected Regional Water Demand

Stratecon uses the projections from MWD member agency 2010 Urban Water Management Plans and Local Water Supply Development Plans as compiled by Gordon Hess and Associates, Inc. (see Table 4).[29] As discussed in that report, the member agency plans project a lower regional demand for MWD water than projected by MWD.[30] These are the lowest publically-available water demand projections of which Stratecon is aware.

Table 4
Projected Regional Water Demand in MWD Service Area

Year	2015	2020	2025	2030	2035
Average	3,770,925	3,872,771	4,020,960	4,142,052	4,236,290
Single Dry	3,870,219	3,991,279	4,143,475	4,272,701	4,372,231
Multiple Dry	3,868,322	3,990,985	4,147,406	4,289,295	4,391,796

Stratecon interpolates total water demands between forecast years by using the implied annual rate of growth in total water demands between the years stated in Table 4.[31] Stratecon uses the annual growth rate from the year 2030 through 2035 to forecast demand growth after 2035. Water demand in single or multiple dry years is about three percent higher than average years.

[29] "Comparison of MWD Demand Projections, Member Agency UWMP and Local Supply Development Plans, Gordon Hess and Associates, Inc., prepared for the San Diego County Water Authority, December 2011, p. 112 (hereinafter cited as "Hess Demand Study").

[30] *Ibid,* pp. 20-25.

[31] Annual growth rate between years 2015 and 2020 is 0.53%, between years 2020 and 2025 is 0.75%, between years 2025 and 2030 is 0.60% and between years 2030 and 2035 is 0.45%. Projected regional water demand before 2015 based on 3,631,490 AF in 2012 (see Metropolitan Water District of Southern California, Annual Report 2012, p. 14 Table 1-4) increasing to 3,770,925 AF by 2015).

C.3. Local Water Supply Sources

Table 5 presents the projected local water supplies in the MWD Service Area.[32] The yields of local supplies are lower in single and multiple dry years relative to average years. Stratecon interpolates local supplies between forecast years by using the implied annual rate of growth between the years stated in Table 5. Stratecon uses the annual growth rate from the year 2030 through 2035 to forecast growth in local water supplies after 2035.

Table 5
Projected Local Water Supplies in MWD Service Area

Year	2015	2020	2025	2030	2035
Average	2,053,760	2,311,019	2,408,534	2,451,200	2,485,955
Single Dry	1,750,569	2,043,501	2,137,037	2,176,143	2,215,385
Multiple Dry	1,937,316	2,084,795	2,212,105	2,298,135	2,365,792
Single Dry/Ave	85%	88%	89%	89%	89%
Multiple Dry/Ave	94%	90%	92%	94%	95%

The demand for MWD water in average years is projected to rise to 2015 and then fall through 2020 (see Figure 2) remaining slightly above 1.5 million AF. Thereafter, the growth in regional water demand exceeds the growth in local supplies. The annual demand for MWD water during average years will not reach 2 million AF until the year 2054. Dry year demands are assumed to be 20% higher than average year demands. They will exceed 2 million AF per year by 2030.

Table 6 provides the historical record of the frequency of water year types based on the Sacramento River Index.[33] Dry and Critical years occur about one-third of the time. Therefore, the dry year demands will occur about one-third of the time.[34]

[32] Hess Demand Study, calculated as difference between Regional Water Demand and MWD Firm Demand, p. 112. The study treats the Colorado River water secured by San Diego County Water Authority under an agreement with the Imperial Irrigation District and related agreements under the Quantification Settlement Agreement as a local supply. MWD often includes these water supplies in their reports of water delivered by MWD.

[33] Department of Water Resources, California Data Exchange Center, Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices. Table 6 records the manual counts from the data table provided by DWR.

[34] As discussed below, SWP allocations are projected to be less than 35% about one-third the time. Therefore, the model uses the higher demand for water in dry/critical years when SWP allocations fall below 35%.

Table 6
Historical Record of Frequency of Water Year Types in California

Year Type	*1906-1960*	*1961-2012*	*1906-2012*
Wet	30.9%	38.0%	34.3%
Above Normal	14.5%	14.0%	14.3%
Below Normal	21.8%	16.0%	19.0%
Dry	21.8%	16.0%	19.0%
Critical	10.9%	16.0%	13.3%
Dry/Critical	32.7%	32.0%	32.4%

C.4: Regional Water Sources

MWD has two basic sources of water supplies—Colorado River and the State Water Project. Table 7 shows MWD's Colorado River supplies for 2011.[35]

Table 7
MWD's Colorado River Water Supplies

Source	Acre Feet
Priority 4	550,000
PVID	122,216
IID	99,940
Lining	16,000
Total	788,156

MWD also has 1.9 million AF of Table A entitlement in the State Water Project. The supply reliability challenges of the SWP are legendary. As part of its analysis of the Bay Delta Conservation Plan, DWR has completed an updated analysis of the deliverability of the SWP project. Table 8 shows the results for the existing conveyance—High Delta Outflow Scenario.[36] Ninety-nine percent of the time, the SWP allocation will exceed 12%. About half the time, the SWP Allocation will exceed 41%. The minimum allocation is 7.2% and the maximum allocation is 91%.

[35] Metropolitan Water District Annual Report, 2012, p. 34.

[36] See Appendix 9.A Economic Benefits of the BDCP and Take Alternatives, May 2013, p. 9.A-12. The data are readings from the figure titled "Total SWP Deliveries (Probability of Exceedance).

Table 8
SWP Allocation and Probability of Exceedance

SWP Allocation	Probability of Exceedance
12%	99%
29%	86%
34%	74%
36%	62%
41%	49%
43%	37%
48%	25%
53%	12%
91%	0%

The expected allocation for the statistical distribution in Table 8 is 41.5%.[37] Therefore, the expected annual yield of MWD's SWP Table A entitlement is 0.788 million AF. By happenstance, this equals MWD's Colorado River water supplies in 2011. Therefore, MWD's expected supplies total 1.576 million AF, which is approximately the same as current demand for MWD water. Given the variability in imported supplies as well as forecasted demand growth, there are two final components to Southern California's water situation: storage and new supplies.

C.5 Regional Storage

With the variability in SWP supplies, storage is a critical component of supply reliability. Table 9 presents the capacity and water stored in MWD water storage programs.[38] In 2011, for example, regional water demand was 3,631,940 AF and MWD water demand was 1,560,439 AF. With 788,156 AF from the Colorado River, the demand for SWP water was 782,283 AF (which is equivalent to a 41% SWP allocation). Therefore, when the SWP allocation exceeds 41%, MWD can place the extra water in storage up to available capacity. When the SWP allocation falls below 41%, MWD can withdraw water from storage to reduce, if not eliminate water shortages.

Table 9
MWD Water Storage Programs, 2011

Program	*Capacity*	*Storage*	*Take Limit*
Semitropic	350,000	263,525	223,000
Arvin-Edison	350,000	171,450	75,000

[37] Based on Monte Carlo analysis of 1,000 iterations of random draws from the statistical distribution in Table 8.

[38] Metropolitan Water District Annual Report, 2012, pp. 30-33, 38-39.

Program	*Capacity*	*Storage*	*Take Limit*
Kern Delta	250,000	135,907	50,000
Local Conjunctive Use	211,889	55,884	50,000
Total	1,161,889	626,766	398,000

MWD also has storage capacity on the Colorado River in Lake Mead under a 2007 agreement among the federal government and agencies of the lower basin states[39]. MWD may store as "Intentionally Created Surplus" Colorado River water made available from extraordinary conservation, tributary conservation, system efficiency improvements and importation of non-Colorado River water.[40] Under this agreement, MWD has a storage capacity right of 1.5 million AF. Under the terms of the program, 5% of the amount of water stored is contributed to system storage and the storage amounts are subject to a 3% annual decline for evaporation.[41] MWD's current storage account stands at 580,000 AF.[42] Stratecon assumes that the ICS credit agreement will be extended beyond the end of its current term of 2027.

C.6 New MWD Supplies

As shown by Figure 2, MWD faces declining demand in the immediate future (reflecting increases in local water supply projects). But by 2020, MWD water demands are expected to return to their levels in 2012. Given MWD's supply of Colorado River water, the demand for SWP water will equal the expected yield of SWP Table A entitlement.[43]

As an economic matter, Southern California's economy needs reliable water supplies. As such, the Cadiz Project will not only face competition simply from existing supplies, but also from future projects. Assuming that no future projects will occur is an extreme assumption. Stratecon's analysis assumes that new water sources will start coming on line in 2025 whose scale will be 75% of the cumulative growth in demand from 2025.[44]

Figure 3 shows the projected water supply sources for MWD under these assumptions. MWD's Colorado River water supply sources (see Table 7) are assumed firm over the forecast period. The assumed new supply sources limit how growth translates into MWD reliance on the SWP project. The assumed new supplies reach almost 0.5 million AF by the end of the forecast

[39] *Lower Colorado River Intentionally Created Surplus Forbearance Agreement*, December 13, 2007 (hereinafter cited as "ICS Agreement").

[40] *Ibid*, p. 4

[41] *Ibid, pp. 6-7.*

[42] *Southern California's Response to a Dwindling Colorado River,* Drought Response Workshop, Bill Hasencamp, Metropolitan Water District, October 8, 2013, p. 9.

[43] Projected MWD demand in 2020 is 1.571 million AF in Figure 2. With a 0.788 million AF supply of Colorado River (Table 7), the demand for SWP water equals 0.783 million AF. With a Table A SWP entitlement of 1.9 million AF, the SWP allocation to meet MWD demand for SWP water is 41.2% (0.783/1.9), the expected yield of a SWP Table A contract (see text discussion of Table 7).

[44] The development of significant supply sources in California requires long lead-times. For example, the Bay Delta Conservation Plan contemplates a new conveyance facility for the California's state and federal water projects. Assuming that approvals are secured by 2015, that project is not projected to start operations until 2025.

period. [45] With 1.9 million AF Table A SWP contract, Stratecon assumes that, when combined with storage, MWD demand for SWP water can be at a 52% yield of a SWP allocation long-term.[46] If there were no new water supplies developed, then MWD would need to rely on a much higher yield from the SWP to meet its projected water demands. For example, no new water supplies would mean that MWD would need a 77% SWP allocation to meet its water demands.[47] As we shall see, even with an assumed development of an additional 500,000 AF of water supplies long-term, Southern California faces significant future water shortages that generate significant and growing economic losses.

C.7 Operational Rules and Analytic Method

The Southern California Water Shortage Model combines the elements discussed above to project the frequency and magnitude of water shortages without and with the Cadiz Project. The key driver involves the variability in the SWP. If the SWP allocation is not sufficient to meet MWD's demand for SWP water, MWD takes water from storage. If the SWP allocation exceeds MWD's demand for SWP water, then the excess water is placed into storage, subject to available storage capacity.[48]

The variability in SWP allocation is generated by a Monte Carlo study. A Monte Carlo study takes reported random samples from the statistical distribution of SWP Allocations in Table 8. A random sequence of draws from the distribution yields a sequence of SWP Allocation for the years 2014 through 2072. For that sequence of SWP allocations, one computes withdrawals and additions to storage and, if any, the size of water shortage in each year. The statistical distribution for water storage and water shortages is computed by running 1,000 random sequences.[49]

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[45] Stratecon assumes that these water supplies are not 100% reliable. Using the senior Sacramento River Settlement Contractors and Exchange Contractors as a benchmark, the new supplies suffer a 25% cutback during suitably dry hydrologic conditions. The model assumes that these cutbacks occur when the SWP Allocation falls below 25%. Given the probability distribution for SWP Allocations in Table 8, this occurs in about one-in-eight years (the historical frequency that the Sacramento and Exchange Contractors are cut back by 25%).

[46] 52% = 0.985/1.9.

[47] 77% ≈ (0.985 + 0.487)/1.9

[48] The model assumes that MWD uses the 250,000 AF portion of Diamond Valley dedicated for dry-year yield first, then MWD storage programs in Table 9 and ICS credits last. MWD storage activities are limited by put and take limits stated in MWD's annual report. The use of ICS credits are limited by the lessor of the 400,000 AF limit stated in the 2007 Agreement and available capacity on the Colorado River Aqueduct. Concerning the latter, available capacity less 1.2 million AF, less MWD's Colorado River water supplies, less the San Diego County Water Authority Colorado River water supplies from its long-term agreement with the Imperial Irrigation District and lining of the All American and Coachella Canals.

[49] The Southern California Water Shortage Model is developed in Microsoft Excel. The Monte Carlo study is conducted by using the add-in @Risk model. The "Latincube" sampling method is used to generate the sequence of SWP Allocation; this is a technical method to assure that the statistical distribution of draws for SWP Allocations conforms with the distribution in Table 8. To assure that the results of Monte Carlo analyses ran under different scenarios

D. Economic Cost of Water Shortages in the MWD Service Area without the Cadiz Project

Water users in the MWD service area face the prospect of significant water shortages without the Cadiz Project. Even with the assumed 500,000 AF of new MWD annual supplies over the forecast period, water users face rising risk of water shortages.

The probability of a water shortage has three periods (see Figure 4). In the short-term, the demand for MWD water will increase until 2015, then decline through 2020 and start increasing again (see Figure 2). In the first period, MWD has enough water in storage that can be drawn down to moderate the increased risk of water shortages with rising water demands in the face of the unreliability of the SWP. Also during this period, the amount of water in MWD's local storage and conjunctive use programs falls below 225,000 AF and MWD draws down its ICS credits in Lake Mead to an expected level of about 225,000 AF. The frequency of water shortages increase from about one-in-five years to one-in-three years.

During the second period, when demand for MWD water is declining, the risk of water shortages decline and the amount of water in MWD storage recovers. Once the demand for MWD starts increasing in 2020, the risk of water shortages starts steadily increasing.

By 2025, the probability of a water shortage breaks through 40%. MWD continues to draw down water from storage and uses ICS credits to combat the economic losses from water shortages. The slow draw down in ICS credits represents the fact that available capacity in the Colorado River Aqueduct declines long-term with the ramp-up in the volume of conserved water moving under the Imperial Irrigation District-San Diego County Water Agency agreement.

Figure 5 presents the size of projected water shortages in the MWD service area. The conditional average (the average size of water shortages when they occur) is small over the next couple of years. Thereafter, the conditional average of water shortages drifts up towards 10%. The maximum water shortage jumps from below 15% to 25% with the short-term increase in demand for MWD water. With the turnaround in the demand for MWD water after 2020, the maximum amount of water shortages drifts upward towards 30% by the end of the forecast period.

The expected economic losses from water shortages grow steadily over the forecast period (see Figure 6). They reach $100 million (2013$) by 2015 and increase by $100 million (2013$) every ten years.[50]

The present value of expected economic losses from water shortages in the MWD service area is $8.2 billion (see Table 10).[51] Cadiz customers experience expected economic losses of $1.4 million. Other water users in the MWD service area experience expected economic losses of $6.8 billion.

(without the Cadiz Project and different scenarios about the Cadiz Project), the Monte Carlo studies sample from the distribution in Table 8 with the "fixed seed" method. This option uses the same 1,000 sequences of random draws from the distribution in Table 8 under the alternative scenarios.

[50] The Expected Economic Losses in Figure 6 ("EL") grows steadily with years ("t") as reflected in the following linear regression: EL = 40.705 + 10.177 t, R^2 .98. That is, Expected Economic Losses increase by $10 million (2013$) per year. This model explains 98% of the annual variation in Expected Economic Losses.

[51] The valuation uses the time period of the Cadiz Project: 2018 through 2067.

Table 10
Present Value of Economic Loss from Water Shortages in MWD Service Area without Cadiz Project (2018-2067) millions 2013$

Water Users	Mean	Minimum	Percentile					Maximum
			10%	25%	Median	75%	90%	
Total	$8,192	$1,517	$5,160	$6,514	$8,059	$9,689	$11,482	$15,964
Cadiz	$1,431	$266	$887	$1,129	$1,401	$1,705	$2,028	$2,872
Others	$6,761	$1,251	$4,278	$5,391	$6,664	$7,987	$9,453	$13,091

Millions 2013$. Valuation Date: January 1, 2018

Reflecting the variability in SWP allocations, there is considerable variability in projected economic losses from water shortages. Comparing the 10% and 90% percentiles, 10% of the distribution of present value of economic losses is less than $5.2 billion for the MWD service area and 10% of the distribution is greater than $11.5 billion.[52]

E. Stratecon Valuation Model and Risk Assessment

The valuation of the project benefits of the Cadiz Project is based on the present value of expected benefits from the water resource elements of the Cadiz Project:

- Water supply reliability
- Water Storage
- Water quality
- ICS Credits

The valuation date is the anticipated start of deliveries: January 1, 2018. The term of the valuation is the anticipated 50-year project life.

E.1. Interest Rate Assumption

The financial projections of benefits are presented in inflation adjusted dollars (2013$). As a result, the relevant interest rate is a benchmark interest rate adjusted by anticipated inflation. In the valuation, I use an interest rate of 2.5%. This assumption reflects a long-term, risk-free real interest rate of 2% and a 0.5% default risk premium.

A real interest rate of 2% is consistent with the pre-financial crisis, market conditions for Treasury Inflation Adjusted Securities ("TIPS").[53] While TIPS currently trade at 0.60% for the

[52] The percentile measures the portion of a distribution with a value below a stated value. So, the 90% percentile is the value where 90% of the distribution is below $11.5 billion. Therefore, 10% of the distribution is above ("exceeds") $11.5 billion.

[53] See "Project Evaluation II: Thoughts About Interest Risk", Rodney T. Smith. *Hydrowonk Blog*, http://hydrowonk.com/blog/2013/01/11/project-evaluation-ii-thoughts-about-interest-rates/. (hereinafter cited as "Thoughts About Interest Rates").

week ending January 17, 2014,[54] these historically low rates reflect current disruptions in the international capital markets. Valuation of a long-term project starting in 2018 should proceed with a more conservative assumption that the currently low interest rates will not continue into the future.[55]

The 0.5% default risk premium represents the annual probability of early termination.[56] Apart from the hydrologic risk of the Cadiz Project (discussed below), this implies there is a one-in-five chance of early termination some time before the last year (year 50) of the project.[57]

E.2 Project Hydrologic Risk Assessment

The Company believes that the Cadiz Project can extract 50,000 AF/year of indigenous groundwater without a material risk of triggering cutbacks under the Groundwater Plan. This belief was the basis for the project description that was analyzed in the Environmental Impact Statement that was analyzed in the Environmental Impact Report that was certified for the Cadiz Project. This assumption forms the baseline for valuation (called "Base Case"). Given the criticisms raised by Project opponents regarding the groundwater resource, Stratecon provides a sensitivity analysis of the Cadiz Project benefits under an alternative assumption that production cutbacks may be triggered.

As discussed in Section A, there are two key points about the project's hydrology as it related to the project's hydrologic risk:

- At what threshold of cumulative extraction of indigenous groundwater, if any, will elevations fall to the trigger levels in the Groundwater Plan?

- If or when the trigger levels are reached, what would be the cutback in allowed production?

Figure 7 plots the Project's time profile of cumulative production under alternative assumptions about the threshold where cumulative production triggers cutbacks and, when cutbacks occur, production is reduced by 50%. For a threshold of 1.5 million AF, cutbacks are triggered in project year 30. Before year 30, annual production of indigenous groundwater will be 50,000 AF/year. After year 30, annual production falls to 25,000 AF/year. Cumulative production over the Project life is 1.875 million AF, or 625,000 AF less than planned.

Stratecon reviewed publicly available data on the Project's hydrology. The debate over the project's viability did not provide sufficient information to quantify a probability distribution

[54] Federal Reserve Board, http://www.federalreserve.gov/releases/h15/current/ yield on 10-year TIPS.

[55] For more discussion, see Thoughts About Interest Rates.

[56] For discussion of risk premium, see "Project Evaluation III: Risk Premium and Risk Assessment," Rodney T. Smith, *Hydrowonk Blog*, http://hydrowonk.com/blog/2013/01/19/project-evaluation-iii-risk-premium-and-risk-assessment/

[57] With an annual probability of early termination ("d'), the probability of surviving to the 50th year equals (1-d)^49. For d = .005, the probability of surviving (1-.006%)^49 = .782. Therefore, the probability of early termination equals 21.8% (100% - 78.2%).

concerning the relative likelihood of the alternative scenarios in Figure 7. Therefore, Stratecon lacked the information to include the project's hydrologic risk in its Monte Carlo analysis.[58]

Stratecon does provide information about project risk by providing a sensitivity analysis concerning the project's hydrology. Production cutbacks are initiated when cumulative production of indigenous groundwater reaches a threshold of 1.5 million AF. When they occur, cutbacks may be 25%, 50% or 75%. Lacking information about the relative likelihood of these cutbacks, the analysis assumes that these cutbacks are equally likely. This situation is termed the "Alternative Case."

E.3 Bay Delta Conservation Plan

California Department of Water Resources is proposing the BDCP as a project to increase the amount of water available from Northern California for use in Southern California. Table 11 shows the deliverability of the SWP pre and post BDCP under High Delta Outflow Scenario.[59] The expected yield of the SWP increases from 41.5% to 60.6%.[60] The increased expected yield from the BDCP comes from higher water supplies in normal and wet years (where the cumulative descending probability is low), not in drought years (where the cumulative descending probability is high).[61] With a 1.9 million acre foot Table A contract, the BDCP would increase the expected annual yield of MWD's SWP contract from 0.789 million AF pre-BDCP to 1.151 million AF post BDCP, or an increase of 0.362 million AF.

Table 11
SWP Allocations Pre and Post BDCP

Post-BDCP	*Pre-BDCP*	*Cumulative Descending*
12%	12%	99%
29%	29%	86%
36%	34%	74%
51%	36%	62%
68%	41%	49%
73%	43%	37%

[58] Use of probability distributions and Monte Carlo analysis are recommended to incorporate uncertainty into analysis of water projects. See *Principles and Guidelines for Evaluating Federal Water Projects: U.S. Army Corps of Engineers Planning and the Use of Benefit Cost Analysis*. A Report for the Congressional Research Service, August 2009, pp. 46-49

[59] Pre-BDCP from Table 8. Post-BDCP from Appendix 9.A Economic Benefits of the BDCP and Take Alternatives, May 2013, p. 9.A-12, The data are readings from the figure titled "Total SWP Deliveries (Probability of Exceedance).

[60] Based on Monte Carlo analysis of 1,000 iterations of random draws from the statistical distributions in Table 10.

[61] A cumulative descending probability, such as 99% means that 1% of the time the SWP yield is below 12%. A cumulative descending probability, such as 12%, means that 88% of the time the SWP yield is below 53% pre-BDCP and 92% post-BDCP.

Post-BDCP	*Pre-BDCP*	*Cumulative Descending*
85%	48%	25%
92%	53%	12%
100%	91%	0%

Stratecon assumes that the BDCP would substitute for the 500,000 AF of new long-term supplies included in Stratecon's pre-Cadiz Project baseline

F. Valuation of Cadiz Project's Benefits

Stratecon's valuation opinion is based on projections of the avoided supply rates and charges for Cadiz Project Participants, the reduction in the economic losses from water shortages for Cadiz Project Participants and other water users in MWD's service area, the further reductions in economic losses from a Cadiz storage program and creation of ICS credits, MWD's avoided cost of developing ICS credits from an alternative water supply and the economic value of the project's low TDS water.

F.1 Avoided Water Supply Rates and Charges

Table 12 shows the present value of expected avoided costs of supply rates and charges for Cadiz Project Participants.[62] Under the Base Case, expected avoided costs for Cadiz customers are $910 million. Under the Alternative Case, expected avoided MWD rates and charges are $751 million. Due to the production losses being incurred in the later years of the agreement, the 25% reduction in cumulative production yields a smaller, 17.5% reduction in the valuation.[63]

Table 12
Expected Avoided Costs of MWD Rates and Charges
for Cadiz Customers (million 2013$)

Item	*Base Case*	*Alternative Case*
MWD Water Price	$719	$593
Power Cost Savings	$191	$158
Total	$910	$751

Valuation Date: January 1, 2018

F.2 Value of Cadiz supply reliability

Both Cadiz Project Participants and other water users in the MWD service area benefit from the supply reliability of Cadiz water (see Table 13). Without the Project, Cadiz customers

[62] See discussion in Section B.1 for assumptions.

[63] Percent reduction in cumulative production: 0.625/2.5 = 25%. Percent reduction in valuation: ($910 - $751)/$910 = 17.5%

and other water users in the MWD service area suffer expected economic losses from water shortages of $1.4 billion and $6.8 billion, respectively. All water users in the MWD service area benefit from the Cadiz water supply because it reduces annual demand on the unreliable SWP by 50,000 AF per year. For Cadiz Project Participants, they also benefit from not having to endure any cutbacks in Cadiz Project water. Under either case, both Cadiz Project Participants and other water users benefit from the Cadiz water supply. Expected economic losses from water shortages for Cadiz customers are reduced by about 44% under the Base Case and 37% under the Alternative Case. The expected economic losses from water shortages for other water users in the MWD service area are cut by 22% under the Base Case and 18% under the Alternative Case.

Table 13
Expected Economic Losses from Water Shortages
with and without the Cadiz Water Supply

Project Scenario	*Cadiz Project Participants*	*Other Water Users*	*Total*
Base Case	$803	$5,295	$6.098
Alternative Case	$908	$5,513	$6,421
Pre-Project	$1,431	$6,761	$8,192

Valuation Date: January 1, 2018

The value of Cadiz water supply reliability is measured by the reduction in the expected economic cost of water shortages (see Table 14). Under either case, the total value of Cadiz's supply reliability is about $1.1 to $2.1 billion. Cadiz customers enjoy about 30% of this value. Other water users in the MWD service area enjoy 70% of the benefit.

Table 14
Value of Cadiz Water Supply Reliability
(millions 2013$)

Project Scenario	*Cadiz Project Participants*	*Other Water Users*	*Total*
Base Case	$628	$1,466	$2,094
Alternative Case	$523	$1,248	$1,094
Difference	$105	$218	$323

Valuation Date: January 1, 2018

F.3 Value of Cadiz Storage

The Cadiz Project also has groundwater storage capacity. Stratecon's valuation assumes that additional SWP water is available for storage in Cadiz whenever the SWP Allocation

exceeds 50%.[64] Stratecon assumes that water is taken from Cadiz storage after MWD's takes from its storage program and ICS credits. Cadiz storage reduces the economic losses from water shortages further below the levels in Table 10.

The value of Cadiz storage is $631 million under the Base Case (see Table 15). The value of Cadiz storage is greater under the Alternative Case because more frequent and severe water shortages increase the value of storage.

Table 15
Value of Cadiz Groundwater Storage Capacity (millions 2013$)

Project Scenario	*Cadiz Project Participants*	*Other Water Users*	*Total*
Base Case	$83	$548	$631
Alternative Case	$91	$551	$642
Difference	($8)	($3)	$(11)

Valuation Date: January 1, 2018

F.4 Value of ICS Credits

Cadiz indigenous groundwater is non-Colorado River water imported into the MWD service area. The company believes that the use of this water will create ICS credits for MWD. Some commentators questioned the availability of these credits. However, the ICS regulations suggest that with an agreement with MWD, the credits would be available. Moreover, former high-ranking Bureau of Reclamation and Department of Interior officials confirm the likely viability of ICS credits provided that there is a suitable agreement with MWD.

The generation and subsequent use of ICS credits benefits all water users in MWD's service area by further reducing water shortages. The value of this further reduction in the economic losses of water shortages is from $1.2 billion to $1.4 billion (see Table 16). Cadiz Project Participants capture around 13% of the total benefits.

Table 16
Value of Created ICS Credits (millions 2013$)

Project Scenario	*Cadiz Project Participants*	*Other Water Users*	*Total*
Base Case	$182	$1,182	$1,364
Alternative Case	$170	$1,042	$1,212
Difference	$12	$140	$152

Valuation Date: January 1, 2018

[64] This occurs about 20% of the time for the statistical distribution for SWP Allocation given in Table 7.

The ICS Credits generated by the Cadiz Project avoid transactions that would otherwise be needed to create credits. MWD has entered into three agreements to create ICS Credits. The cost of water in these agreements was from a low of $287/AF (All American Canal Drop 2 project), $340/AF (emergency land fallowing in the Palo Verde Irrigation District) and $490/AF (Yuma Desalter), with a weighted average of $340/AF.[65]

MWD also earned ICS credits involving the acquisition of water previously stored for Mexico at a price of $50/AF. This transaction, however, is part of a complex, bi-national negotiation of a treaty minute where Mexico made water previously stored in Lake Mead available to US water users in exchange for other valuable considerations, including a right of Mexico to store water in Lake Mead. The unique circumstance of that transaction is not likely to be replicated.

Stratecon's Valuation of the avoided cost of ICS Credits is based on the $340/AF price paid Palo Verde. Assuming that this price (adjusted for inflation) increases at the same pace as MWD rates and charges, the present value of MWD's benefit is $843 million for the Base Case and $696 million for the Alternative Case.

We now turn the discussion to an assessment of how the Cadiz Project can change the dynamics of water shortages in the MWD service area.

F.5 Water Shortages in the MWD Service Area with the Cadiz Project

The significant valuations for the reliability benefits of Cadiz's supply reliability, storage and creation of ICS credits reflects the impact of the Cadiz Project on the risk of water shortages. Figure 8 shows the probability of water shortages in the MWD service area under four scenarios for the Base Case:

- No Cadiz Project (red line)
- Cadiz Project I: production of indigenous groundwater only (green line)
- Cadiz Project II: Cadiz Project I plus groundwater storage (blue line)
- Cadiz Project III: Cadiz Project II plus creation of ICS credits (purple line)

Without the Cadiz Project, the probability of water shortages in MWD's service area jump past 30% by 2016 and steadily increase thereafter to 75% by the end of the forecast period. Under Cadiz Project I, II or III, the probability of a water shortage does not pass 30% until the mid-2020's, early 2030's and early 2040's, respectively. With the termination of the Project in 2067 (Project Year 50), the probability of water shortages drifts up towards the no Cadiz Project scenario. The return is not immediate due to the fact that MWD will have more water in storage and ICS credits due to the Cadiz Project (see below).

With initiation of operations, the Cadiz Project reduces the expected annual economic costs of water shortages—see Figure 9. Without the Project, expected annual cost of water shortages steadily increases to about $650 million (2013$) by the end of the forecast period. Under Cadiz Project I, II or III, expected annual economic losses from water shortages increase

[65] *Overview of the Intentionally Created Surplus and Intentionally Created Mexican Allocation Programs for the Lower Basin States and Mexico and Preliminary Evaluation of the Value the Cadiz Project Could Bring to the Metropolitan Water District*, Gordon Hess, GHA Water Inc, September 2013.

to only about $520 million (2013$), $480 million (2013$) or $390 million (2013$), respectively, by the end of the Cadiz Project.

The final critical aspect of the Cadiz Project involves the interaction with MWD water in storage and ICS credits (see Figure 10). As discussed in Section D, MWD will draw down water in local storage and ICS credits to fight water shortages without the Cadiz Project. The indigenous groundwater supplied by the Project will reduce the demand on MWD's unreliable SWP Table A Contract. With lower demand on its SWP supply, MWD can place more water in storage when SWP Allocations are high and must take less water out of storage to combat water shortages when SWP Allocations are low.

Cadiz groundwater storage does not contribute to increased MWD storage and ICS credits. This is a result of the "priority" assumed in Stratecon's model where Cadiz water is taken out only after MWD has withdrawn all its water and there is still a water shortage. This assumption results in a conservative valuation of Cadiz storage capacity.

The creation of ICS credits by the Cadiz Project will have a large impact on MWD water storage. Under the Cadiz Project III scenario, the amount of water in storage (in MWD storage programs or in Lake Mead) will peak at 0.7 million AF by the mid-2030s. This asset will be drawn down thereafter as part of MWD's efforts to combat long-term water shortages. With the termination of the Cadiz Project after Project Year 50, MWD will be drawing down storage significantly in its fight against water shortages.

F.6 Value of Cadiz Low TDS Water

Cadiz's indigenous groundwater is low TDS water. The introduction of Cadiz water into Southern California's water network will reduce the TDS in water used by all of the region's water users.[66] High TDS results in economic losses, such as treatment costs and infrastructure erosion and damages. Use of Cadiz indigenous groundwater reduces economic damages from TDS concentrations by $7.89 million (2012$).[67] The economic value of these benefits ranges from $194 million to $240 million (see Table 17).

Table 17
Value of Cadiz Project Water Quality Benefits (millions 2013$)

Project Scenario	*Total*
Base Case	$240
Alternative Case	$194
Difference	$46

Valuation Date: January 1, 2018

[66] *Potential Economic Benefits of Water Quality Improvements for Water Delivered by the Colorado River Aqueduct*, prepared for Cadiz Inc by CH2MHILL Engineers, August 16, 2013.

[67] *Ibid*, p.4.

G. Impact of the Bay Delta Conservation Plan

The BDCP will increase the yield of MWD's SWP contract. As a result, there will be less frequent and smaller water shortages. Stratecon examines how implementation of the BDCP impacts the economic benefits of the Cadiz Project. If implemented, the BDCP would start operations in 2025. In its analysis, Stratecon assumes that the BDCP would substitute for the 500,000 AF of new long-term supplies included in Stratecon's pre-Cadiz Project baseline.

Under this scenario, implementation of the BDCP would reduce the economic benefits of the Cadiz project by about $1 billion (see Table 18). Therefore, while successful implementation of the BDCP will reduce water shortages in Southern California, the Cadiz Project still generates billions of economic benefits for Southern California.

Table 18
Impact of Bay Delta Conservation Plan on Economic Value of Cadiz Project
Valuation Date: January 1, 2018 (2013$)

Valuation Component	*without BDCP*		*with BDCP*	
Cutback Threshold	*none*	*1.5 (MAF)*	*none*	*1.5 (MAF)*
Water Supply				
Avoided Supply Costs				
Reduced Water Costs	$719	$593	$719	$593
Power Costs Savings	$191	$158	$191	$158
Sub-Total	$910	$751	$910	$751
Avoided Shortage Costs (Cadiz Participants)	$628	$523	$431	$332
Grand Total (Cadiz Participants)	$1,538	$1,274	$1,341	$1,083
Avoided Shortage Costs (other water users)	$1,466	$1,248	$857	$689
Sub-total Reliable Water Supply	$3,004	$2,522	$2,194	$1,772
Cadiz Water Storage	$631	$642	$877	$897
Water Quality	$240	$194	$240	$194
ICS Credits				
Avoided Shortage Costs	$1,364	$1,212	$883	$859
Avoided Acquisition Costs	$843	$696	$843	$696
Grand Total ICS Credits	$2,207	$1,908	$1,726	$1,555
Project Total	$6,082	$5,266	$5,041	$4,418

There are two different impacts of implementation of the BDCP on the value of the economic benefits of storage. With the BDCP, water shortages are less frequent and severe. Therefore, while the Cadiz Project still has supply reliability benefits, they are smaller. For example, with no production cutbacks, Cadiz Project Participants avoid water shortages costing $628 million without the BDCP, but avoid water shortages costing $431 with the BDCP. For other water users in the MWD service area, the Cadiz Project reduces their economic losses from

water shortages by $1.5 billion without the BDCP, but avoid water shortages costing $857 million with the BDCP.

Implementation of the BDCP increases the economic value of Cadiz groundwater storage, from $631 million to $877 million if there are no production cutbacks in the Cadiz Project. The BDCP generates its largest increase in available supply in normal and wet years. Therefore, the extra storage provided to the region by the Cadiz Project can better manage the available supplies from the BDCP. Store the extra water in wet years and release it years with low SWP allocations to avoid water shortages.

H. Economic Impact of Project Activities

Operation of the Cadiz Project will generate significant economic benefits for San Bernardino County and economy. [68] During the four-year period of project design and construction, the project will create 1,497 full-time job and generate economic activity of $880 million and $38 million in state and local taxes. There would be a permanent increase in annual property tax revenue of $6 million over the Project term of 50 years.

I. Conclusion

The MWD service area faces a future of increasingly frequent and severe water shortages. A new water supply, independent of hydrologic risks and regulatory restrictions that confront Southern California's water supplies from the State Water Project and the Colorado River is a valuable resource. It reduces the demand on unreliable SWP water. This benefits Cadiz Project Participants directly and all other water users in MWD's service area indirectly.

The development of the Cadiz Project has a long history. Opponents have expressed reservations about utilizing groundwater resource for this Project. However, over the past few years, the Company has invested in significant studies to demonstrate the viability of their groundwater resource. The Project will be regulated by the Groundwater Plan, which established procedures to monitor the Project's impact on groundwater elevations and other resources. If thresholds in the Groundwater Plan are reached, the Cadiz Project faces cutbacks.

Stratecon's extensive research on the Cadiz Project does not provide a factual basis for conducting a quantitative risk assessment of the Cadiz Project (see Section E). Instead, Stratecon prepares its valuation based on the Company's expectations (Base Case) and a sensitivity analysis based on the assumption that production cutbacks are triggered with cumulative production of groundwater reaches a threshold 40% below planned operations (Alternative Case).

As shown in Table 19, the economic benefits under the Base Case and Alternative Case are substantial (all benefits measured in 2013$). Cadiz Project Participants enjoy benefits of more than $1 billion under the Base Case, Alternative Case, with or without the BDCP. The Cadiz Project reduces the economic losses suffered by other urban water users in the MWD service area by hundreds of millions if not more than $1 billion, depending on whether the BDCP is implemented as proposed. The Cadiz Project has underground storage capacity worth

[68] *Economic Impact of the Proposed Cadiz Valley Groundwater Conservation, Recovery, and Imported Water Storage Project* John E. Husing, Ph.D., Economics & Politics, Inc. April 18, 2011.

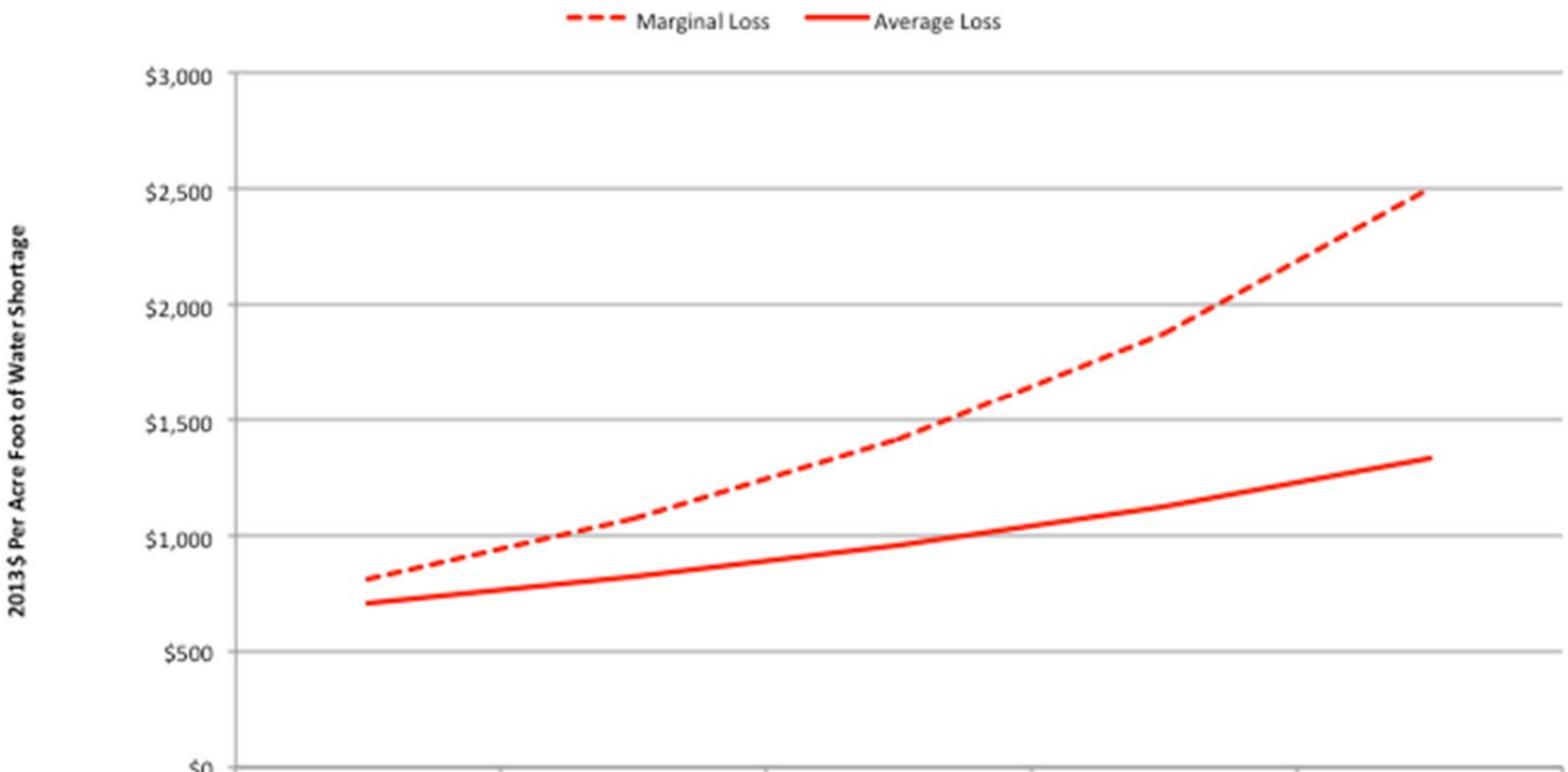
hundreds of millions of dollars in terms of reduced economic losses from water shortages. The generation of ICS credits is worth $1.5 billion to $2.0 billion.

Table 19
Summary of Economic Benefits of Cadiz Project
(millions 2013$)

Valuation Component	*without BDCP*		*with BDCP*	
Cutback Threshold	*none*	*1.5 (MAF)*	*none*	*1.5 (MAF)*
Water Supply				
Cadiz Project Participants	$1,538	$1,274	$1,341	$1,083
Avoided Shortage Costs (other water users)	$1,466	$1,248	$857	$689
Sub-total Reliable Water Supply	$3,004	$2,522	$2,194	$1,772
Cadiz Water Storage	$631	$642	$877	$897
Water Quality	$240	$194	$240	$194
ICS Credits	$2,207	$1,908	$1,726	$1,555
Project Total	$6,082	$5,266	$5,041	$4,418

Valuation Date: January 1, 2018

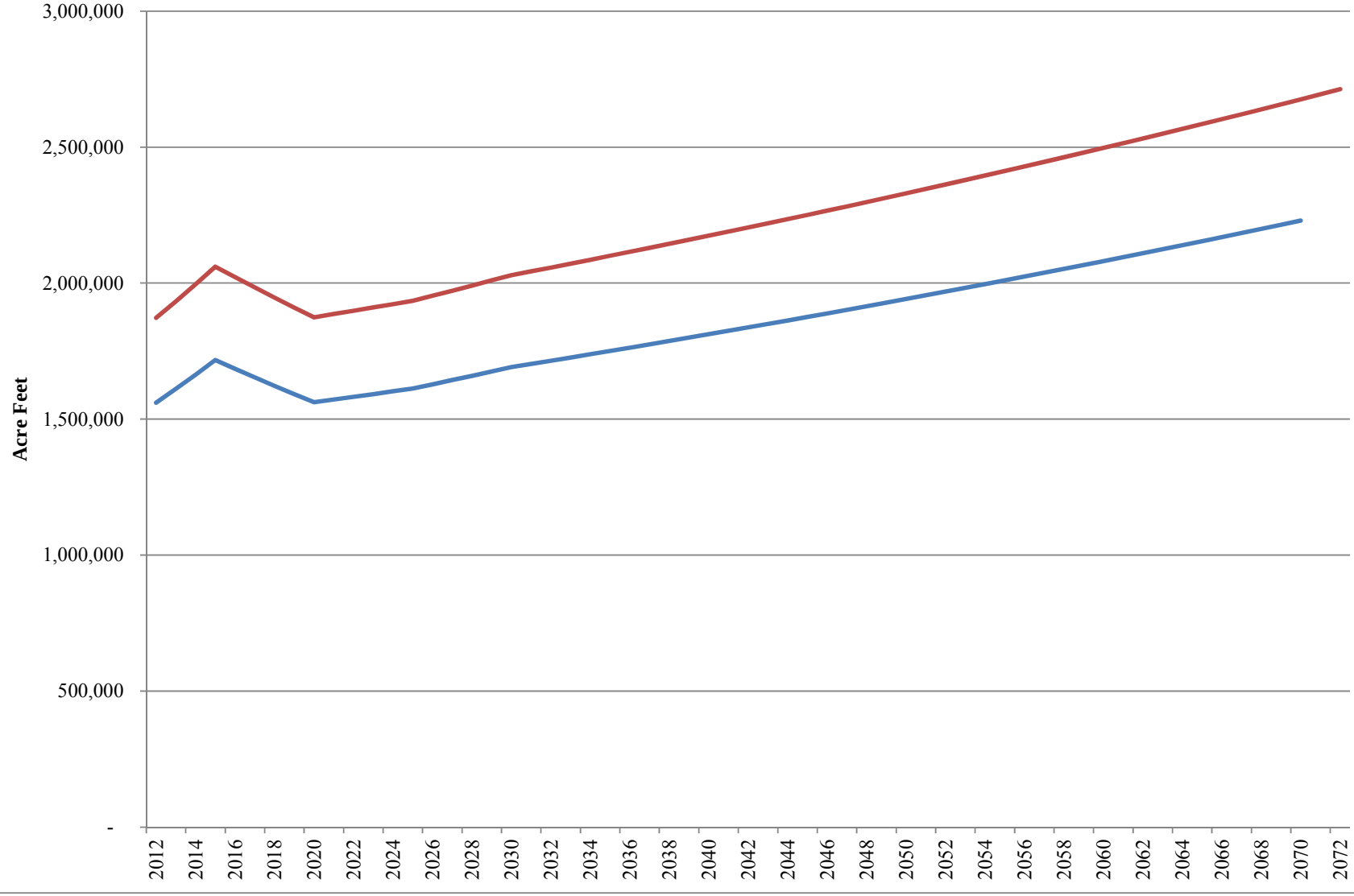
Figure 1
Economic Cost of Municipal Water Supply Shortages



	5%	10%	15%	20%	25%
Marginal Loss	$812	$1,072	$1,414	$1,874	$2,504
Average Loss	$708	$822	$960	$1,128	$1,337

Magnitude of Water Shortages

Figure 2
Projected Demand for MWD Water



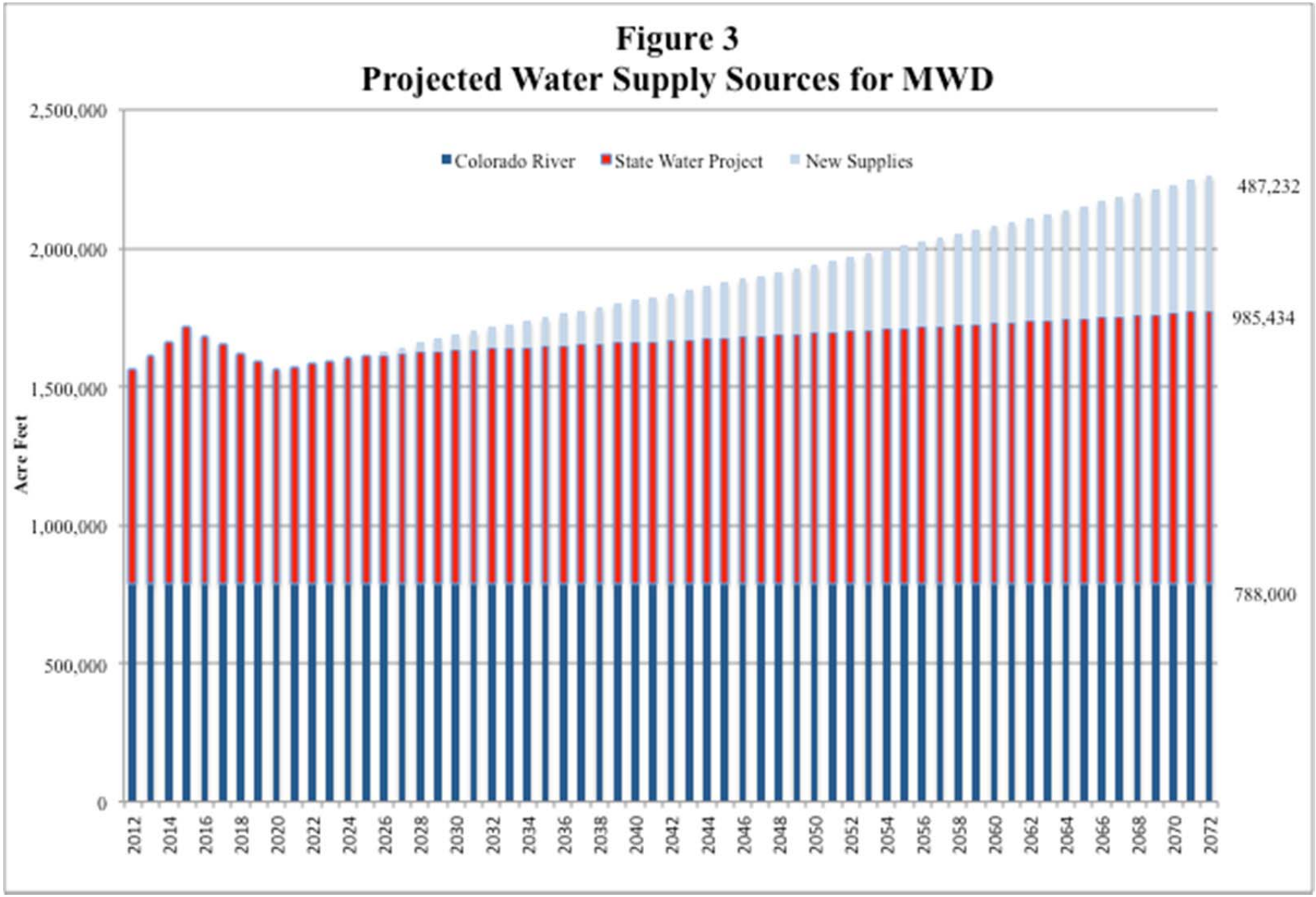


Figure 3
Projected Water Supply Sources for MWD
Colorado River
State Water Project
New Supplies
Acre Feet
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
487,232
985,434
788,000
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
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2068
2070
2072

Figure 4
Probability of Projected Water Shortages in MWD Service Area without Cadiz Project

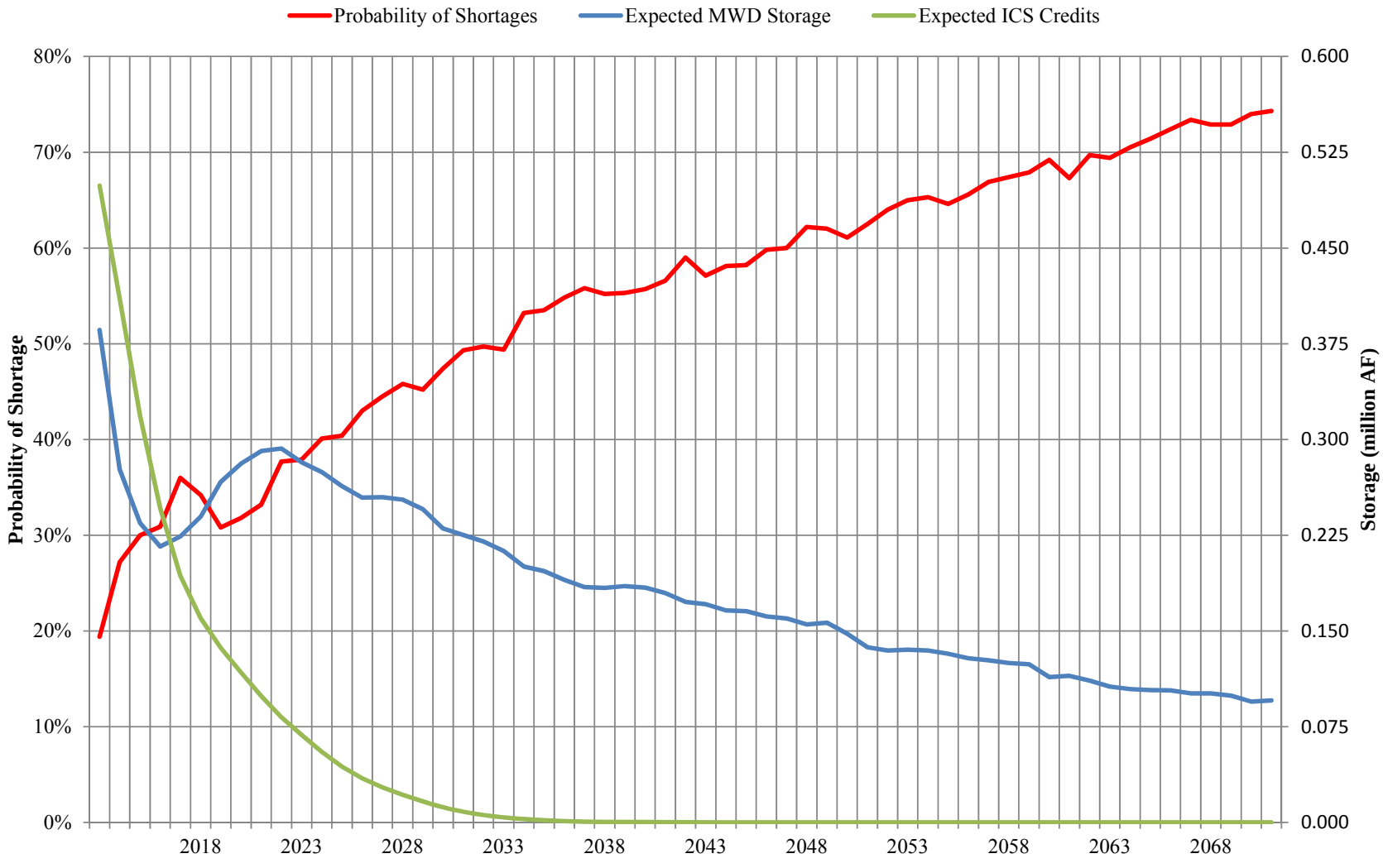

Figure 5
Size of Projected Water Shortages in MWD Service Area without Cadiz Project

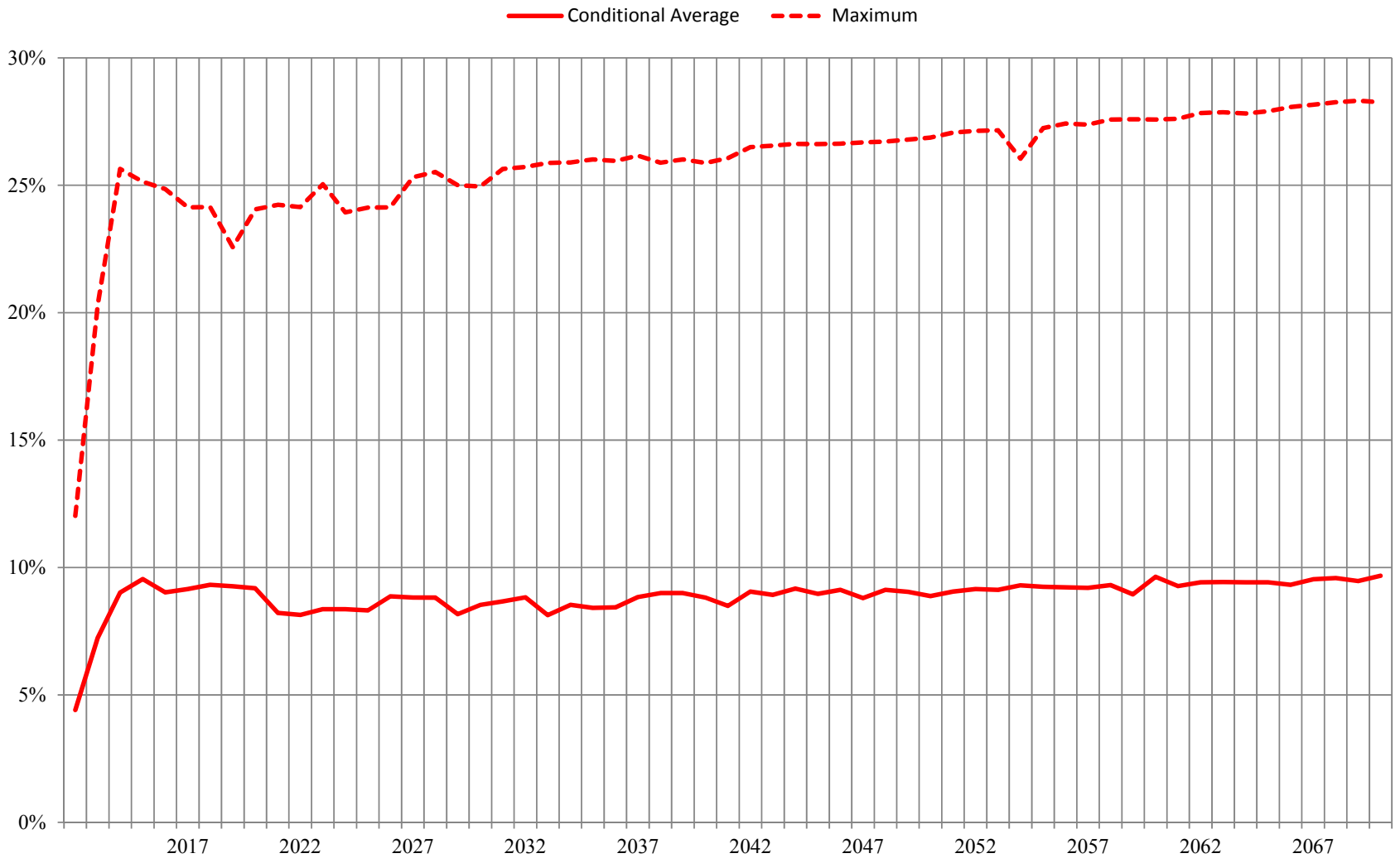

Figure 6
Expected Economic Losses from Water Shortages in MWD Service Area without the Cadiz Project

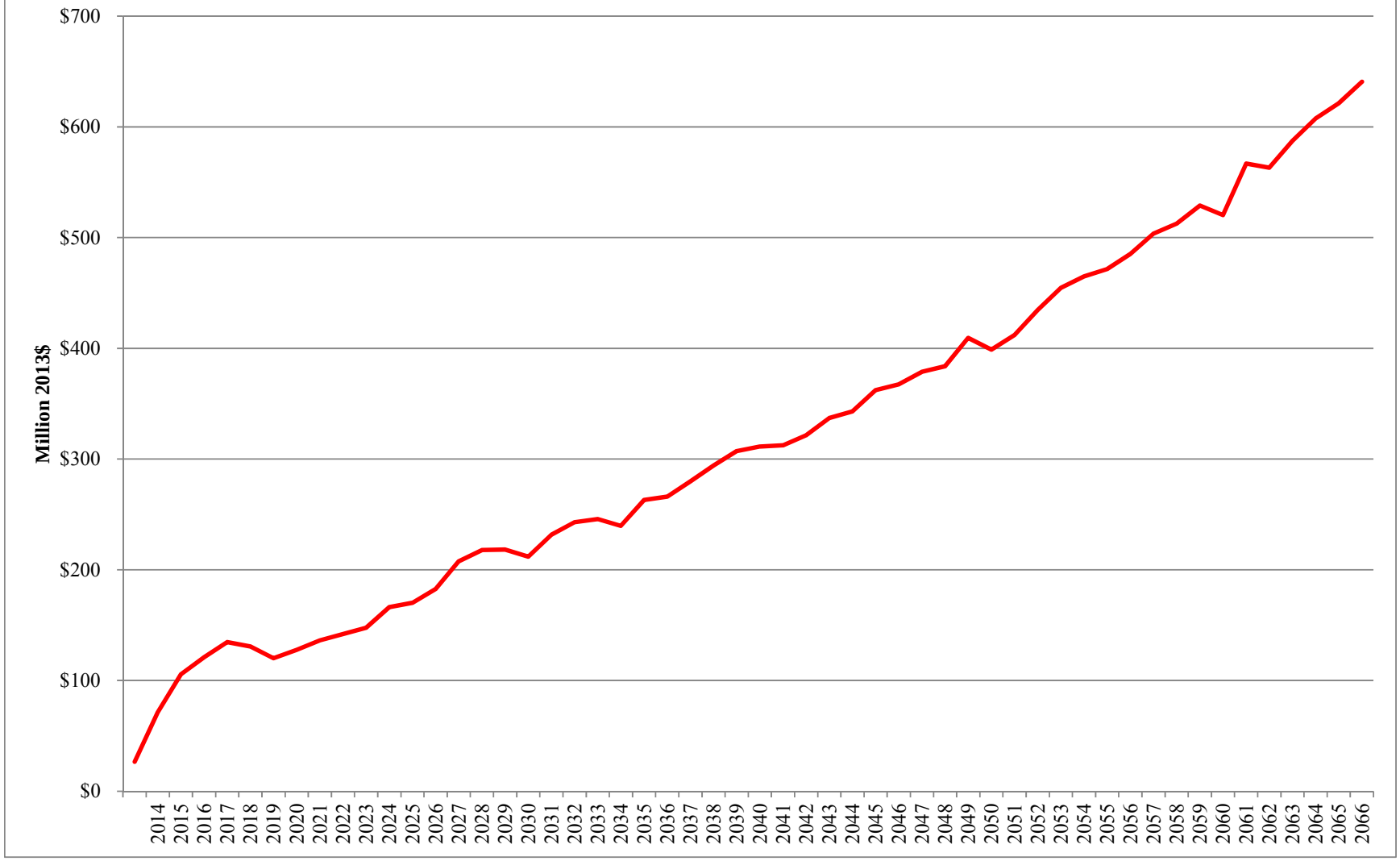

Figure 7
Cumulative Production by Trigger of Production Restrictions

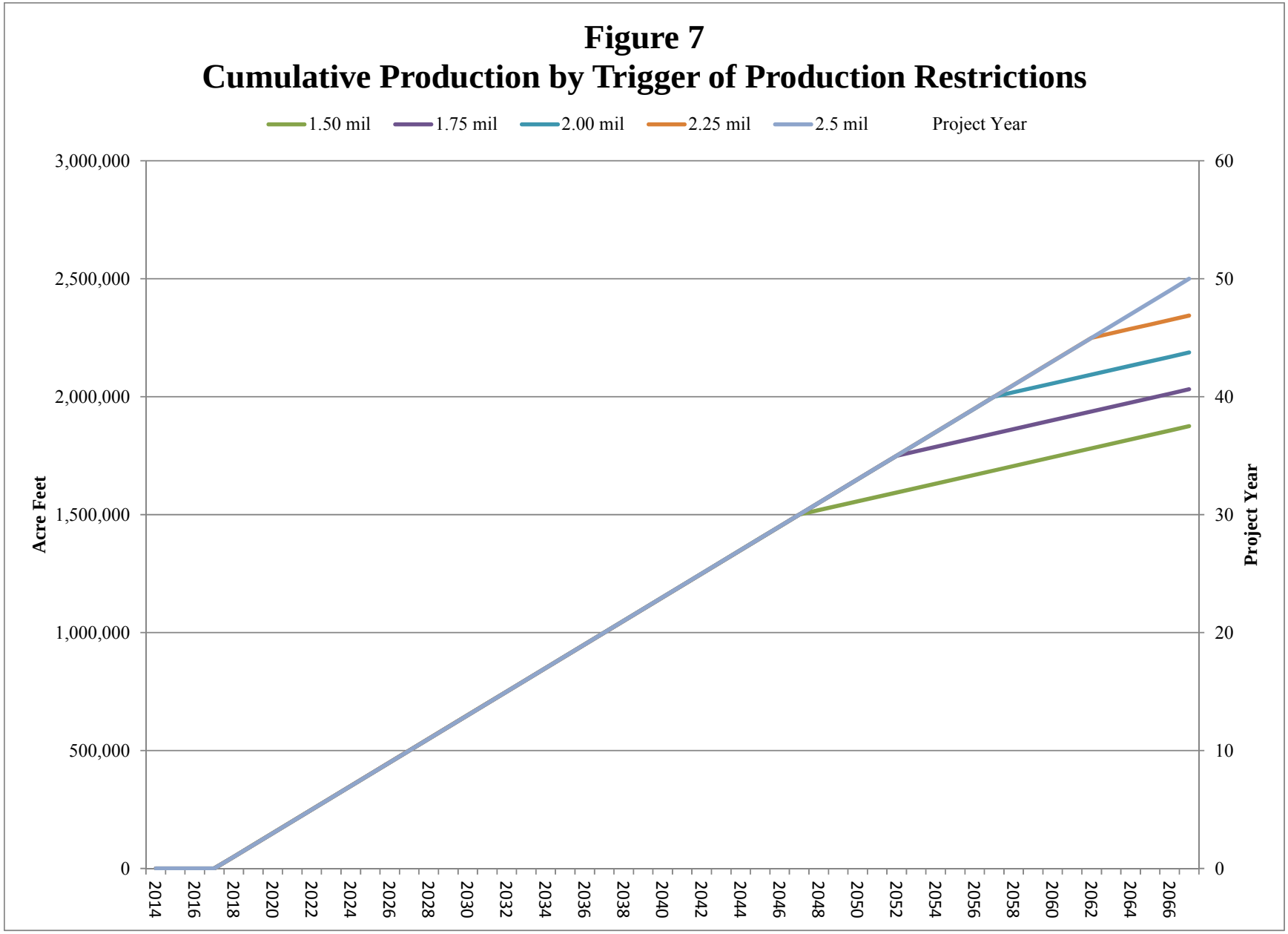

Figure 8
Cadiz Project Reduces Probability of Water Shortages in MWD Service Area

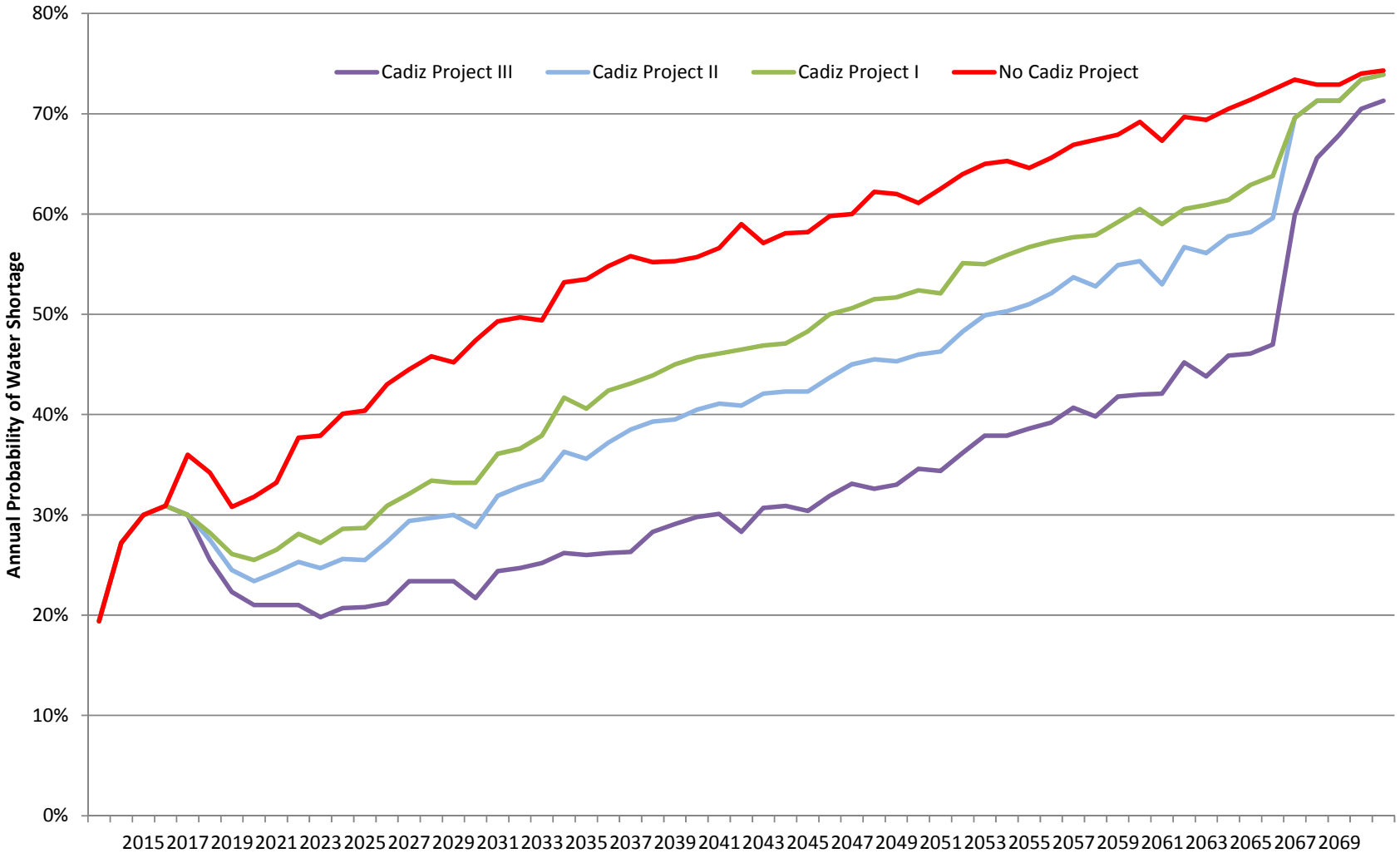

Figure 9
Cadiz Project Reduces Expected Economic Losses from Water Shortages in MWD Service Area

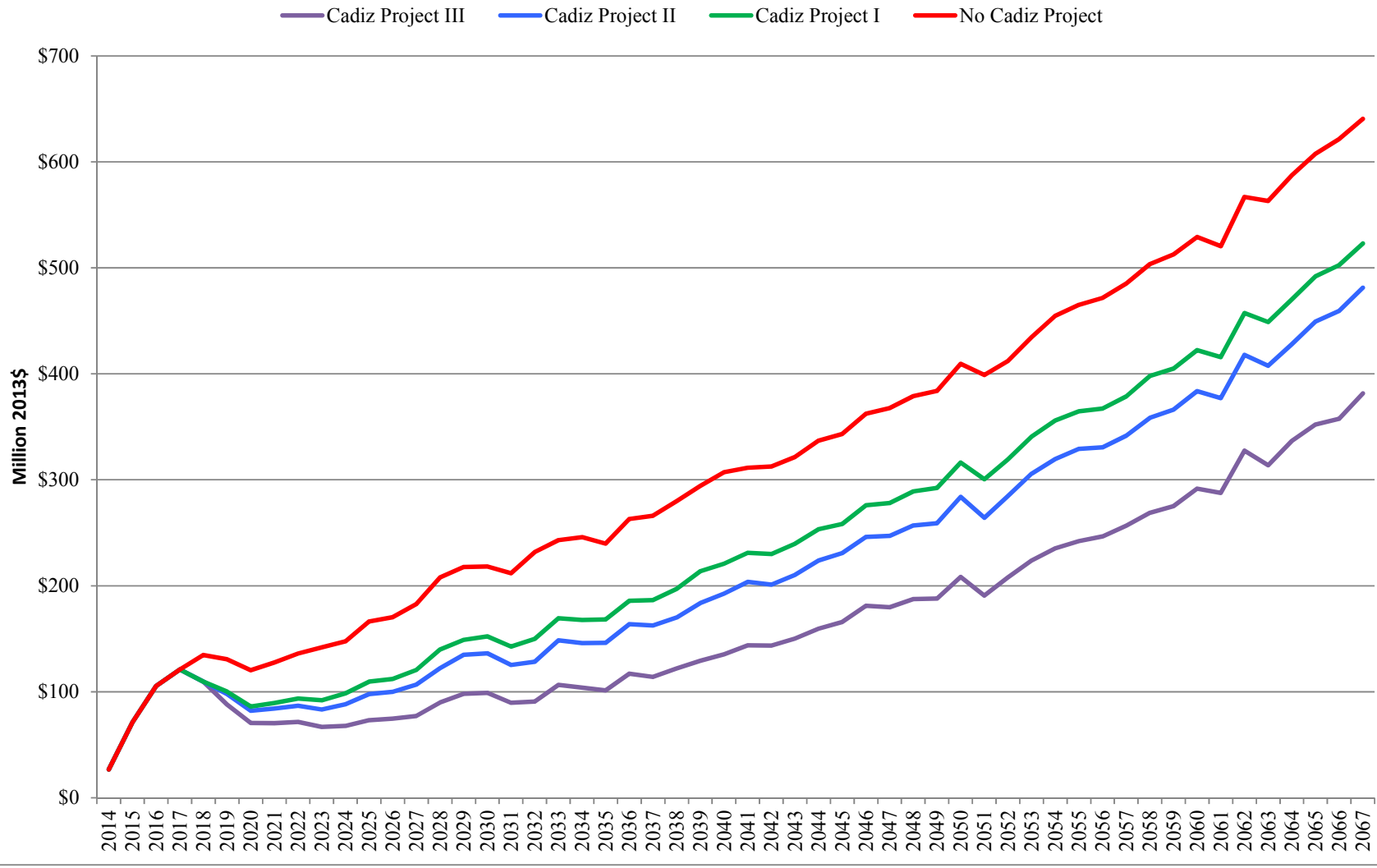

Figure 10
Cadiz Project Increases MWD Water Storage and ICS Credits