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DATE: OCTOBER 14, 2008

FROM: MICHAEL TUERPE, LAFCO Analyst

TO: LOCAL AGENCY FORMATION COMMISSION

SUBJECT: State Water Project Delivery Reliability Report 2007

Attached for your information is the summary and text of the State Water Project Delivery Reliability Report 2007 published by the California Department of Water Resources on August 28, 2008.

This report and its findings are referenced in the municipal service reviews for the communities of Barstow and Hesperia.

California Department of Water Resources
Bay-Delta Office
August 28, 2008

Summary:
Final State Water Project Delivery Reliability Report, 2007

The final *State Water Project Delivery Reliability Report 2007* updates DWR's estimate of current (2007) and future (2027) SWP delivery reliability and expands the conditions under which reliability is quantified. The report is produce every two years as part of a settlement agreement signed in 2003. Public comments to the draft report were received in March 2008. The comments and DWR's responses are included in Appendix E of the final report.

The report shows that future SWP deliveries will be impacted by two significant factors. The first is climate change, which is altering hydrologic conditions in the State. The second is significant restrictions on SWP and Central Valley Project (CVP) pumping in accordance with a December 2007 federal court imposed interim rules to protect delta smelt. The 2007 report incorporates future impacts on water deliveries to communities due to these factors.

This report represents the state of water affairs if no actions for improvement are taken. It shows a continued eroding of SWP water delivery reliability under the current method of moving water through the Delta.

The analysis shows that annual SWP deliveries (Table A and Article 21 amounts) would decrease virtually every year in the future (93% of future years). These reductions would be amount to a 20% reduction from current levels about one-fourth of the time, and greater than 30% in one-sixth of future years.

The report discusses areas of significant uncertainty to SWP delivery reliability:

- the recent and significant decline in pelagic organisms in the Delta (open-water fish such as delta smelt and striped bass);
- climate change and sea level rise; and
- the vulnerability of Delta levees' to failure due to floods and earthquakes.

As in previous reports, estimates of SWP deliveries are based upon operation simulations with DWR's CalSim II model using an extended record of runoff patterns. These patterns have been adjusted to reflect the levels of development in the source areas and, for future conditions, possible impact due to climate change. Potential deliveries under current conditions are estimated at the 2007 level and assume current methods of conveyance across the Delta and the interim operating rules defined by the recent court order to protect delta smelt. Potential deliveries under future conditions are estimated at the 2027 level and are also based on the assumption that no changes will be made in either the way water is conveyed across the Delta or in the interim operating rules to protect delta smelt. The analysis of future conditions incorporates climate change scenarios which correspond to the scenarios contained in DWR's 2006 report, *Progress on Incorporating Climate Change into Management of California's Water Resources.*

Under current conditions, annual SWP Table A deliveries from the Delta average 63% of the maximum Table A amount of 4,133 thousand acre-feet (taf) per year. Over the 82-year simulation period, annual SWP Table A deliveries range from a minimum of 6% to 90% of the maximum amount. Over multiple-year dry periods, average annual Table A deliveries are 34 or 35% of the maximum Table A amount, while average annual Table A deliveries over multiple-year wet periods range from 66 to 73% of the maximum Table A

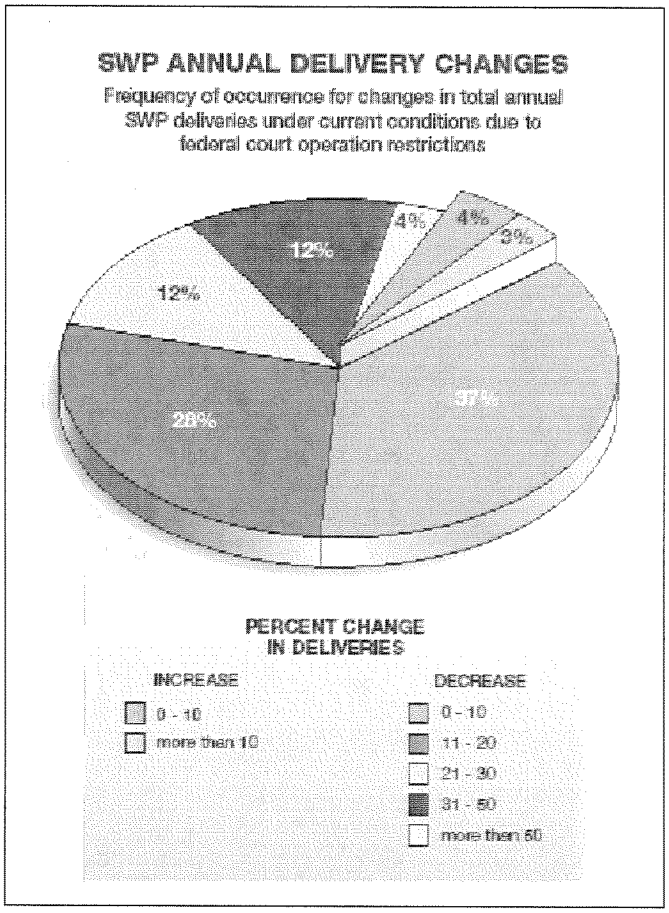
amount. Twenty-five percent of annual SWP Table A deliveries exceed 3,218 taf, 50 percent of deliveries exceed 2,976 taf and 75 percent exceed 2,168 taf.

Under current conditions, annual SWP Article 21 deliveries average 90 taf, ranging from 0 to 590 taf over the 82-year simulation period. Over the multiple-year wet period of 1978-1987, SWP Article 21 deliveries average 170 taf and range from 0 to 490 taf.

Due to the uncertainty of impacts by climate change on the availability of source water, SWP Table A and Article 21 deliveries under future conditions are expressed as a range in values. Under future conditions, annual SWP Table A deliveries from the Delta average from 66 to 69% of the maximum Table A amount. Although the estimated average annual amount of future SWP Table A deliveries increase when compared to current conditions, the amount of Article 21 deliveries decrease. Also, the amount of SWP Table A deliveries during multiple-dry periods in the future tend to decrease compared to current conditions. This decrease can be significant, depending upon the climate change scenario. This difference in future deliveries is reflected in lower SWP Table A delivery amounts associated with a 75% exceedence level (1,860 to 2,077 taf per year) than is for current conditions (2,168 taf per year).

Under future conditions, annual SWP Article 21 deliveries average 30 taf, ranging from 0 to 420 taf over the 82-year simulation period. Over the multiple-year wet period of 1978-1987, SWP article 21 deliveries average approximately 95 taf per year and range from 0 to 420 taf, depending upon the year and the climate change scenario.

The updated estimates of both current and future total annual SWP deliveries in the final *State Water Project Delivery Reliability Report, 2007* report are generally less than were estimated in the 2005 report, at times substantially so. As shown in the figure below, the current total annual SWP deliveries (Table A and Article 21 amounts) decrease in 93% of the years based on the historical data used in the analysis, when compared to the estimates in the 2005 report. Updated estimates for the current level of reliability show the total annual deliveries decrease over 20% in over one-quarter (28%) of the years analyzed and greater than 30% in one-sixth (16%) of the years, when compared to the estimates in the 2005 report. Water deliveries estimated for 20 years into the future show even greater decreases in a majority of years when compared to the estimates in the 2005 report.


SWP ANNUAL DELIVERY CHANGES
Frequency of occurrence for changes in total annual SWP deliveries under current conditions due to federal court operation restrictions
4%
4%
3%
12%
12%
37%
28%
PERCENT CHANGE IN DELIVERIES
INCREASE
0 - 10
more than 10
DECREASE
0 - 10
11 - 20
21 - 30
31 - 50
more than 50

State of California
The Resources Agency
Department of Water Resources

The State Water Project Delivery Reliability Report 2007

August 2008

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State of California

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The Resources Agency

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Foreword

The water delivery reliability of the State Water Project (SWP) is at a crossroads. Future water deliveries to millions of Californians throughout the state will be affected by many factors, including two significant changes: Delta pumping restrictions and climate change.

This report provides a glimpse of our current path if no action is taken to address these and other factors. The report also identifies many other factors that could be changed to positively affect our water future.

Estimating the delivery reliability of the SWP depends on many issues, including possible future regulatory standards in the Delta, population growth, water conservation and recycling efforts, and water transfers. The impact of climate change on hydrology, consumptive use of water, fisheries and sea level rise must also be considered. This report evaluates the impacts of potential changes in hydrology of climate change. These other factors, also need to be considered: the stability of Delta levees, and therefore, SWP water deliveries, are threatened by earthquakes, land subsidence and floods.

On the positive side, there are significant and promising processes under way that could take us to a much more reliable and sustainable Delta water conveyance system for the SWP.

In this report, a possible future for these factors is presented. However, to the extent that these factors can be and are changed by actions over the next few years, this estimate of water delivery reliability will also change.

In spring 2007, the state saw the first voluntary shutdown of the SWP pumps in the Delta to protect fish. Delta smelt and some other pelagic (open water) fishes have been in decline since the early 2000s for reasons that likely include the presence of invasive species, which have altered the basic food web in the Delta, and the impacts of toxics and water project operations. In 2007, water project operations changes in the Delta costing over 500,000 acre-feet were taken to help protect the endangered Delta smelt with the use of the Environmental Water Account. Unfortunately, these actions did not result in an increase in the abundance of Delta smelt in the fall of 2007 suggesting that more than just water project operational changes in the Delta are needed to increase Delta smelt abundance. In addition, another pelagic fish, the long-fin smelt, is now also being considered for listing under the State Endangered Species Act. Clearly, a more comprehensive approach to address the decline in pelagic fish is needed.

In December 2007, a federal court imposed interim rules that will significantly restrict the operations of both the SWP and the Central Valley Project while a new federal biological opinion for Delta smelt is written in 2008.

During 2007, new Delta planning efforts — including Delta Vision established by Gov. Arnold Schwarzenegger and the Bay-Delta Conservation Planning process — have reached important conclusions about the need to change the way water is conveyed across or around the Delta to better protect fish and provide a sustainable and reliable water supply for the state. Those efforts will continue into 2008.

This report on water delivery reliability of the SWP represents the current state of water affairs and future delivery scenarios if no action is taken. It shows a continued eroding of SWP water delivery reliability under the current method of moving water through the Delta and assumed near-term effects of climate change.

The estimates for current deliveries show that, when compared to the estimates in the *2005 State Water Project Delivery Reliability Report,* total annual SWP deliveries decrease in 93 percent of the years based on the historical data used in the analysis. Water deliveries estimated for 20 years into the future are also presented as a range of values to capture the variability in the results of the climate change studies.

When compared to the future estimates in the 2005 report, total annual deliveries for 2027 show even greater decreases in most of years if no action is taken to address the factors causing this decrease in water delivery reliability. That is why DWR is, and will continue to be, at the forefront of efforts to improve conditions in the Delta that will protect the ecosystem and water supply reliability for 25 million Californians.

Lester A. Snow
Director
California Department of Water Resources
December 2007

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Introduction

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The State Water Project (SWP) is primarily a water storage and delivery system intended to help close the gap in California between when and where precipitation primarily falls and when and where most water demands occur. Water from the SWP is a critical component of water supply for the 29 state water contractors, who may also receive water from other sources. While each of the water supply contracts defines the maximum amount of water to be delivered annually, the amount of water actually delivered may be less due to such factors as variable precipitation and runoff, physical and institutional limits on storage and conveyance, and contractors' variable water demands. For communities receiving SWP water, the reliability of SWP water deliveries is a key factor for local planners and government officials estimating their own water supply reliability.

Since the *2005 SWP Delivery Reliability Report*, DWR has updated its estimate of current (2007) and future (2027) SWP delivery reliability and has expanded the conditions under which reliability is quantified. The additional conditions are changes in hydrology due to potential climate change and restrictions on SWP and CVP pumping in accordance with the interim operation rules imposed by the December 2007 federal court order.

This report first briefly describes the SWP and the Sacramento-San Joaquin Delta (Delta), the hub of water deliveries in California. Next, it discusses the general topic of water delivery reliability and how DWR calculates delivery reliability for the SWP. Then it summarizes key planning activities that may affect future SWP delivery reliability. These activities are Delta Vision, the Bay Delta Conservation Plan, the Delta Risk Management Strategy, and the CALFED Ecosystem Restoration Program Conservation Strategy. The report presents three areas of significant uncertainty to SWP delivery reliability: the recent and significant decline in pelagic organisms in the Delta (open-water fish such as delta smelt and striped bass), climate change and sea level rise, and the vulnerability of Delta levees' to failure. Next, the report discusses the general approach to simulating SWP operations by CALSIM II for this report.

The report presents results of CALSIM II studies that assume future climate change scenarios and SWP operations under high and low flow restrictions in the Delta. The assumed flow restrictions are designed to estimate the operation restrictions to be put in place by the federal court to protect delta smelt for water year 2008 and until replaced by new federal biological opinions.

Finally, the report provides guidance on how to apply the delivery estimates to water management plans. Presented in appendixes are detailed CALSIM II simulation assumptions and results and recent SWP deliveries.

This report does not include analyses of how specific water agencies should integrate SWP water supply into their water supply equation. This topic requires extensive information about local facilities, local water resources, and local water use, which is beyond the scope of this report.

Moreover, such an analysis would require decisions about water supply and use that traditionally have been made locally. DWR believes that local officials should continue to fill this role.

Background

Purpose

This report on SWP delivery reliability is intended to help local agencies, cities, and counties that use SWP water while planning integrated water resources management to develop adequate and affordable water supplies for their communities. These activities are usually conducted in the course of preparing a water management plan such as the Urban Water Management Plans required by Water Code Section 10610. The information in this report can be used by local agencies in preparing or amending their water management plans and identifying the new facilities or programs that may be necessary to meet future water demands. Local agencies and governments will also find in this report useful information for conducting analyses mandated by laws requiring water retailers to demonstrate whether their water supplies are sufficient for certain proposed subdivisions and development projects subject to the California Environmental Quality Act.

This report can be used with published guidelines that explain how to integrate SWP supply information with supply information from other sources to develop an overall reliability assessment of each contractor's total water portfolio. DWR has published two documents addressing this topic. *Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001* (October 2003) includes suggestions on how local water suppliers can integrate supplies from various sources, such as the SWP, into their analyses. Another document is *Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan* (January 2005). Both documents can be found on DWR's Office of Water Use Efficiency home page at **http://www.owue.water.ca.gov**.

Reporting Requirements

As a result of a court-approved settlement agreement executed by the Planning and Conservation League, DWR, state water contractors and other entities in the wake of the 3rd Circuit Court of Appeal's ruling in the "Monterey Amendments" case in 2000, DWR has a legal duty to prepare State Water Project delivery reliability reports every two years. In that agreement, DWR committed to the following:

> Commencing in 2003, and every two years thereafter, the Department of Water Resources (DWR) shall prepare and deliver to all State Water Project (SWP) contractors, all city and county planning departments, and all regional and metropolitan planning departments within the project service area a report which accurately sets forth, under a range of hydrologic conditions, the then existing overall delivery capability of the project facilities and the allocation of that capacity to each contractor. The range of hydrologic conditions shall include the historic extended dry cycle and long-term average. The biennial report shall also disclose, for each of the ten years immediately preceding the report, the total amount of project water delivered and the amount of project water delivered to each contractor. The information presented in each report shall be presented in a manner readily understandable by the public. (Settlement Agreement Attachment B).

Previous Reports

The *2007 SWP Delivery Reliability Report* is the third report of this type. The previous reports in 2003 and 2005 defined and calculated delivery reliability the same manner as in this report with output from DWR's CALSIM II model. This report differs from those earlier reports because it includes estimates of reductions to SWP delivery reliability due to the pelagic organism decline (POD) and future climate changes. This report also discusses the risk of conveyance disruption due to Delta levee failure.

Context

The State Water Project

The SWP is a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants that extends for more than 600 miles. Its main purpose is to divert and store surplus water during wet periods and distribute it to areas in Northern California, the San Francisco Bay area, the San Joaquin Valley, the Central Coast, and Southern California. It is also used for recreation and to control floods, generate power, protect fish and wildlife, and manage water quality in the Sacramento-San Joaquin Delta.

The keystone of the SWP is Lake Oroville, which conserves water from the Feather River watershed. It is the SWP's largest storage facility with a capacity of about 3.5 million acre-feet. Releases from Lake Oroville flow down the Feather River into the Sacramento River, which drains the northern portion of California's Central Valley. The Sacramento River flows into the Sacramento-San Joaquin Delta, comprised of 738,000 acres of land interlaced with channels that receive runoff from about 40 percent of the state's land area. The SWP and the federal Central Valley Project (CVP) rely on Delta channels as a conduit to move water from the Sacramento River inflow to the points of diversion in the south Delta. Thus, the Delta is actually part of the SWP conveyance system, making the Delta a key component in SWP deliveries. The significance of the Delta to SWP deliveries is described in more detail below.

From the northern Delta, Barker Slough Pumping Plant diverts water for delivery to Napa and Solano counties through the North Bay Aqueduct. Near Byron in the southern Delta, the SWP diverts water into Clifton Court Forebay for delivery south of the Delta. Banks pumping plant lifts water from Clifton Court Forebay into the California Aqueduct, which channels the water to Bethany Reservoir. The water delivered to Bethany Reservoir from Banks Pumping Plant is either delivered into the South Bay Aqueduct for use in the San Francisco Bay Area or continues down the California Aqueduct to O'Neil Forebay, Gianelli Pumping-Generating Plant, and San Luis Reservoir.

San Luis Reservoir is jointly operated by DWR and the Bureau of Reclamation and has a storage capacity of more than 2 million acre-feet (maf). DWR's share of gross storage in the reservoir is about 1.062 maf. Generally, water is pumped into San Luis Reservoir during late fall through early spring, and is temporarily stored for release back to the California Aqueduct to meet summertime peaking demands for SWP and CVP contractors.

SWP water not stored in San Luis Reservoir and water eventually released from San Luis continues to flow south through the San Luis Canal, a portion of the California Aqueduct jointly owned by DWR and the Bureau of Reclamation. As water flows through the San Joaquin Valley, deliveries of CVP water are made through numerous turnouts to farmlands in the service areas of the CVP. Near Kettleman City, the Coastal Branch Aqueduct splits from the California Aqueduct for water delivery to agricultural areas to the west and municipal and industrial water users in San Luis Obispo and Santa Barbara counties.

The remaining water conveyed by the California Aqueduct travels farther in the San Joaquin Valley to agriculture users such as Kern County Water Agency before reaching Edmonston Pumping Plant, which raises the water high enough to travel across the Tehachapi Mountains into Antelope Valley. In Antelope Valley, the Aqueduct divides into the East and West Branches. The East Branch carries water into Silverwood Lake and Lake Perris. Water in the West Branch flows to Quail Lake, Pyramid Lake, and Castaic Lake.

Twenty-nine state water contractors have signed long-term water supply contracts with DWR for 4.173 million acre-feet (maf) per year. Signed in the 1960s, all contracts are in effect to at least 2035 and are essentially uniform. Each contract contains a schedule of the maximum amount of water the contractor can receive annually. This schedule is contained in SWP Table A. The annual amount was designed to increase each year, with most contractors reaching their maximum amount in 1990. In most cases, SWP water is an important component of local water supplies. Five contractors use SWP water primarily for agricultural purposes and the remaining 24 contractors use SWP water primarily for municipal purposes. All available water is allocated annually in proportion to each contractor's annual SWP Table A amount. Appendix C contains additional information about SWP Table A.

The Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta is a network of natural and artificial channels and reclaimed islands at the confluence of the Sacramento and San Joaquin rivers. The Delta forms the eastern portion of the San Francisco estuary, receiving runoff from more than 40 percent of the state's land area. It is a low-lying region where over the years sediment from the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers mingled with organic matter deposited by marsh plants. Covering 738,000 acres interlaced with hundreds of miles of waterways, much of the land is below sea level and relies on more than 1,100 miles of rather fragile levees for protection against flooding.

Because the SWP and the CVP use Delta channels to convey water to the southern Delta for diversion, the Delta is the focal point for water distribution throughout the state. In fact, the Delta is one of the few estuaries in the world that is used as a major source of drinking water supply: about one-quarter of California's drinking water comes from the Delta; two-thirds of Californians get some portion of their drinking water from the Delta. The Delta also provides a unique estuarine habitat for many resident and migratory fish and birds, some of which are listed as threatened or endangered. Most of the native fish either migrate through the Delta or move into it for spawning. Resident native fish are mainly present in areas strongly influenced by the Sacramento River inflows.

The CVP pumps at Jones Pumping Plant have a capacity of 4,600 cubic feet per second (cfs) and divert water directly from Old River. The CVP has contracts to divert 3.3 maf annually from the Delta for primarily agricultural use south of the Delta. The SWP pumps at Banks Pumping Plant have a combined pumping capacity of 10,300 cfs; however, diversions into the buffering Clifton Court Forebay are restricted to 13,870 acre-feet (af) daily and 13,250 af per day over a three-day average. A rate of 13,250 af per day equates to an average pumping of 6,680 cfs.

CVP and SWP reservoir releases and Delta exports are coordinated according to the Coordinated Operating Agreement (COA), which sets guidelines for the sharing of supply and responsibility for meeting water quality standards in the Delta. Most of the water exported by the SWP depends on water rights derived from Lake Oroville storage; however, the SWP can also divert water considered in excess in the Delta. These excess conditions in the Delta usually result when there is sufficient inflow to meet all beneficial needs and the SWP is not required to make supporting releases from Lake Oroville. Diversions during excess Delta conditions are still governed by various determinations and rules.

In addition to the state and federal projects' diversions, irrigation water for use in the Delta is taken from channels and sloughs through approximately 1,800 diversions which can total more than 5,000 cfs in July and August.

Delta water quality is primarily governed by the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta (1995 Bay-Delta Plan). This plan established beneficial uses, associated water quality objectives, and an implementation program. The State Water Resources Control Board (SWRCB) in Water Rights Decision 1641 assigned primary responsibility for meeting many of the Delta water quality objectives to the SWP and CVP. Key factors in determining water quality in the western Delta are the quality of important Delta inflows and the intrusion of ocean-derived salts associated with daily tides. The extent of this intrusion is primarily determined by the magnitude of Delta inflows, export pumping rates, and operation of the Delta Cross Channel. Delta inflows are normally at least partially regulated by upstream reservoir operations.

The water flowing in Delta channels is constrained by an extensive levee system that protects Delta islands from flooding. This protection is critical because land subsidence in the Delta, primarily due to the consuming oxidation of aerated peat soils, has placed most of the land in the Delta below sea level. In fact, the elevation of Delta islands can be more than 20 feet below sea level. The resulting difference between the elevations of Delta lands and the water surface in adjacent channels makes Delta levees vulnerable to failure. Land subsidence in the Delta is expected to continue, which will increase the vulnerability of levees to failure and subsequent island flooding.

Water Delivery Reliability

2

As mentioned in the Introduction, estimates of SWP delivery reliability are intended to help local SWP water users assess their water supply reliability, a key measure of a system's ability to match water supplies with demand. Just how water delivery reliability is assessed is critical to whether it is a meaningful guide for such an analysis. This chapter presents DWR's method for calculating SWP delivery reliability, the factors affecting SWP delivery reliability, and the limitations to estimating future water delivery reliability.

Calculating SWP Delivery Reliability

For this report, "water delivery reliability" is defined as the annual amount of water that can be expected to be delivered with a certain numeric frequency. SWP delivery reliability is calculated using computer simulations based on 82 years of historical data. The annual amounts of SWP water deliveries are ranked from smallest to largest and a probability is calculated for each amount. These results are often displayed as a graph, commonly referred to as an exceedence plot. They can also be presented in a table.

Factors Affecting Water Delivery Reliability

The amount of the SWP water supply delivered to the state water contractors in a given year depends on the demand for the supply, amount of rainfall, snowpack, runoff, and water in storage, pumping capacity from the Delta, and legal constraints on SWP operation. Expressed in more general terms, water delivery reliability depends on three general factors: the availability of water at the source, the ability to convey water from the source to the desired point of delivery, and the magnitude of demand for the water.

Availability of Source Water

The availability of water at the source depends on the amount of rain and snow and water use in the source areas. For the SWP, the size of the April 1 snowpack in the Feather River watershed and the storage in Lake Oroville are key components of the annual estimation of the SWP's delivery capabilities from April through September.

Factors of Uncertainty The inherent yearly variable location, timing, amount, and form of precipitation in California introduce some uncertainty to the availability of future SWP source water and hence future SWP deliveries. The approach of analysis of SWP deliveries by simulating an 82-year sequence based on historical weather patterns restricts the subsequent simulation to no more extreme droughts or severe storms than have historically occurred. However, the 82-year sequence of weather patterns does produce a wide range of hydrologic events with which to evaluate the ability of the SWP to deliver water.

The second source of uncertainty in source water is due to climate change. Current literature suggests that global warming is likely to significantly affect the hydrologic cycle, changing California's precipitation pattern and amount from that shown by the record. In fact, there is evidence that some changes have already occurred, such as an earlier beginning of snowmelt in the Sierra, an increase in winter runoff as a fraction of the total runoff, and an increase in winter flooding frequency. More variability in rainfall, wetter at times and drier at other times, would place more stress on the reliability of existing flood management and water supply systems, such as the SWP.

Treating Availability of Source Water Issues in CalSim II Studies The State Water Project operation analyses contained in this report are based upon operation simulations under an extended record of historical precipitation and adjusted historical runoff. The 82-year record of 1922-2003 runoff patterns in the studies simulating 2007 and 2027 levels of development have been adjusted as needed to reflect the current and future levels of development in the source areas by analyzing land use patterns and projecting future land and water use. These series of data are then used to forecast the amount of water available to the SWP under Current and Future (2027) conditions.

Potential changes in climate patterns are becoming better defined and studies have been done on potential impacts to SWP deliveries due to associated changing hydrology. In a 2006 DWR report, *Progress on Incorporating Climate Change into Management of California's Water Resources*, broad-brush estimates are made of the potential impact upon the SWP around the year 2050 if no additional conveyance facilities or upstream reservoirs are built. These climate change studies adjusted the 73-year historical record (1922-1994) of rainfall and runoff according to four scenarios: weak temperature warming and weak precipitation increase in California under model PCM; modest warming and modest drying under model PCM; modest warming and modest drying under model GFDL v. 2.0; and weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0. These studies have been updated for this report by expanding the simulation period to 82 years (1922-2003).

DWR has estimated potential deliveries at the 2027 level. However, these estimates are based on the assumption that no changes will be made in either the way water is conveyance across the Delta or in the interim operating rules defined by the recent court order to protect delta smelt. These assumptions are not a prediction of the future but an assessment of the future if these factors do not change. In addition, these estimates must be viewed with caution given the uncertainty of the effects of climate change in the future and the simplifying assumptions required for the analyses.

Ability to Convey Source Water to the Desired Point of Delivery

The ability to convey source water to the desired point of delivery refers to the availability of facilities to capture and convey water and any institutional limitations placed upon the facilities. Uncertainty in SWP deliveries may be in part due to uncertainty in the ability to convey water. For the SWP, this uncertainty centers on the Delta.

Factors of Uncertainty In general, SWP operations are closely regulated by Delta water quality standards established by the State Water Resources Control Board (SWRCB) and set forth in Water Rights Decision 1641. Even in the times SWP operations are left to the discretion of DWR, actions often require consultation with federal and state fish and wildlife agencies under its Endangered Species Act provisions. The evolving response to the continuing unexplained decline in many pelagic fish species since the early 2000's, and the legal challenges to SWP operation and ongoing planning activities related to the Delta's future are sources of uncertainty for SWP delivery reliability related to water conveyance.

On May 25, 2007, a federal judge found that the 2005 USFWS Biological Opinion for delta smelt was not consistent with the requirements of the Federal Endangered Species Act and must be rewritten. On Aug. 31, 2007, the same judge established interim operating rules to protect delta smelt until USFWS rewrites the biological opinion. The interim operating rules set in-Delta flow targets in Old and Middle rivers from late December through June that will restrict CVP and SWP pumping in 2008 and until the delta smelt biological opinion is rewritten. In Chapter 4, this report discusses the process used to rewrite this biological opinion.

Another potential uncertainty for SWP water conveyance through the Delta is the risk of interruptions in SWP diversions from the Delta due to levee failure. SWP source water enters the Delta through the Sacramento River and is conveyed to Banks Pumping Plant via Delta channels lined with fragile levees. If a levee fails, depending on the location and the size of the adjacent island, the flow of water from nearby channels onto the affected island can draw saline water from Suisun and San Pablo bays into the central Delta. In such an incident, SWP pumping at Banks Pumping Plant may have to be curtailed or ceased for a period to prevent drawing saline water into the south Delta. Additional releases from Lake Oroville may also be necessary to flush the Delta of the saline water. As discussed in Chapter 4, the likelihood of levee failures in the future is expected to increase.

Finally, future sea level rise associated with climate change could increase the salinity in the Delta as higher ocean tides push saline water farther inland. If Delta water quality standards remain the same, SWP pumping could become more restricted, at least under some hydrologic conditions.

Treating SWP Conveyance Issues in CalSim II Simulations The 2007 base study in this report assumes current facilities and institutional limitations, which include Water Rights Decision 1641, export curtailments for the Vernalis Adaptive Management Plan (VAMP) as described in a 2004 new Operating Criteria and Plan (OCAP) developed by DWR and U.S. Bureau of Reclamation for the SWP and Central Valley Project, and court-ordered in-Delta flow targets in Old and Middle rivers to protect delta smelt. This report examines two levels of Old River and Middle River flow targets. Chapter 6 has a more detailed description of these assumptions. For comparison, the 2027 studies in this report assume the same institutional limitations as the 2007 simulations regarding Delta water quality requirements, fish protection, and Delta flows will be in place 20 years in the future; no facility improvements, expansions, or additions will be made to the SWP; and conveying water through the Sacramento-San Joaquin Delta will not be significantly interrupted by levee failures. These assumptions are not a prediction of the future but an assessment of the future if these conditions are not changed. As discussed in Chapter 3, there are several processes under way to further the discussion on the need for changes in water conveyance around the Delta to address many of the issues. The 2027 studies also incorporate assumptions about climate change, but do not account for sea level rise or the expected accompanying increase in Delta salinity because the tools to evaluate this impact of climate change have not yet been completed.

Also not included in this report are CALSIM II studies that reflect risk of levee failure. The impact on SWP deliveries due to a single or multiple levee failure is highly dependent on where the levees fail and the Delta conditions at the time. As the Draft DRMS Phase 1 Summary Report indicates, the effect on SWP deliveries can range from relatively minor to catastrophic for a large earthquake with extensive levee failures, depending on whether the earthquake occurs under dry or wet Delta conditions. However, the same report points out that if multiple Delta islands are left flooded with openings to adjacent channels after a large-scale levee failure, the volume of water that would move into and out of the Delta over a tidal cycle could actually increase, resulting in higher salinities in the west Delta. If Delta water quality standards remain unchanged, releases from Lake Oroville would then most likely need to increase above current levels to enable the same level of SWP pumping. The DRMS report also indicates that multiple levee failures and Delta island flooding due to flood flows may not significantly affect SWP deliveries due to the fresh water Delta-wide conditions that would exist at the time of flood flows. Chapter 4 addresses Delta levee vulnerability to failure in detail.

Demand for System Water

Water demand in the delivery service area is affected by such factors as the magnitude and types of water demands, the extent of water conservation measures, local weather patterns, and water costs. Supply from a water system may be sufficiently reliable at a low level of demand but become less reliable as the demand increases. In other cases, the reliability of a water supply system to meet a higher demand may be maintained at its past level because new facilities have been added or the operation of the system has been changed. In general, the higher and the more time-concentrated the water demands, the more need for storage and conveyance capacity to achieve the same delivery reliability. For example, if the demand occurs only three months in the summer, a water system with a sufficient annual supply but insufficient water storage may not be able to reliably meet the demand. If, however, the same total amount of demand is distributed over the year, the same system could more easily meet the demand because the need for water storage is reduced.

Demand levels for the SWP water users in this report are derived from historical data and information from the SWP contractors. Demand on the SWP is nearing the maximum contract amount (in other words, "Maximum SWP Table A amount"). Each SWP contract contains a SWP Table A, which states the maximum annual delivery amount over the period of the contract. These annual amounts usually increase over time. Most contractors' SWP Table A amounts reached a maximum in 1990. The total of all contractors' maximum SWP Table A amounts is 4.173 million acre-feet (maf) per year. SWP Table A is used to define each contractor's portion of the available water supply that DWR will allocate and deliver to that contractor. The SWP Table A amounts in any particular contract are not guarantees of annual delivery amounts but are used to allocate individual contractors' portion of the total delivery amount available. Estimates of each contractor's amount of water delivered are determined by the factors described in this report. (See Appendix C for additional explanation and listing of the maximum SWP Table A amounts).

Of the 29 SWP contractors, Yuba City, Butte County, and the Plumas County Flood Control and Water Conservation District are north of the Delta. Their total maximum SWP Table A amounts is 0.040 maf. The total maximum SWP Table A amounts for the remaining 26 contractors, who all receive their supply from the Delta, is 4.133 maf. This report focuses on SWP deliveries from the Delta because the amount of water pumped from the Delta by SWP facilities is the most significant component of the total amount of SWP deliveries. The results presented in this report in terms of estimated delivered water supplies as a percent of SWP Table A deliveries apply to contractors north of the Delta in the same manner as those contractors receiving supply from the Delta.

Factors of Uncertainty Estimating future demand for SWP water requires assumptions be made about population growth, water conservation, recycling efforts, other sources of supply available to the SWP contractors, and climate change. The estimates also depend on the cost to the SWP contractor for each of the components of their integrated water management plan. These factors are considered by the SWP contractors in the estimates of their current and future demands.

Treating Water Demand Issues in CalSim II Simulations SWP Table A and Article 21 demands in the 2007 studies were assumed the same as those in the 2005 study from the *2005 SWP Delivery Reliability Report*. SWP Table A and Article 21 demands in the 2027 studies were assumed the same as those in the 2025 study from the *2005 SWP Delivery Reliability Report*. The demand values are assumed to vary from year to year depending on the weather. Specific values used in the CalSim II studies are contained in Appendix A.

Limitations to Estimating Future Water Delivery Reliability

Studies Must Rely on Assumptions

Actual, historical water deliveries cannot always be used with a significant degree of certainty to predict future water deliveries. As discussed earlier, there are continual, significant changes over time in the determinants of water delivery for a specific water supply system. These changes include water storage and delivery facilities, water use in the source areas, water demand in the receiving areas, and the regulatory constraints on the operation of facilities for the delivery of water. Given the highly significant changes that have occurred for the SWP over the past 40 years, past deliveries are not a good predictor of SWP current deliveries, much less of future deliveries.

For example, the demand 30 years ago for water from the SWP was lower than it is now or expected to be in the future. Past lower demand for SWP water resulted in less water transported through the SWP during normal and wet times than could have been—or would have been if the demand for water had been higher. Less water was delivered then because less water was needed; the amount of source water and conveyance capabilities weren't limiting factors for deliveries. Conversely, the recent court-ordered restriction on SWP exports from the Delta is estimated to reduce annual deliveries from what has been delivered in the recent past. Analyses estimating future SWP deliveries must include assumptions about future (2027) conditions. Some assumptions are very important to the analyses and are key to understanding the resulting estimates of annual water deliveries. A discussion of the important assumptions for the studies in this report follows.

Studies Assume Repeating Historical Weather Patterns

One of the most significant assumptions for water planning in general is how wet, dry and variable the weather will be. Until recently, assuming the future weather pattern would be similar to the past was sufficient for many planning purposes. Given the evolving information on the potential effects of global climate change in the future, this approach is no longer adequate. Incorporating climate change into future projections is difficult because of the many ways the patterns of rain, snow and temperature could shift. A way to measure some of the uncertainty is to analyze many potential climate change scenarios in order to capture the range of water supply impacts.

This report contains estimates of future SWP deliveries under four future climate change scenarios. The scenarios are variations based upon the historical record of precipitation information for the Central Valley for the period 1922 through 2003. The amount and timing of rainfall and runoff is adjusted but the sequence of dry years or wet years is the same for all scenarios. Evaluating how water management systems will respond under severely dry periods is limited to assuming the worst droughts in the period of historical record. The worst multiyear drought on record is 1928 through 1934, although the brief drought from 1976 through 1977 was more acutely dry.

Other Important Assumptions

To identify the assumptions with the most effect on the estimates of SWP deliveries, DWR conducted a sensitivity analysis for assumptions in CalSim II model studies. In a sensitivity analysis, an assumption such as the amount of water used in the watershed above Lake Oroville is varied over several studies and the results for SWP deliveries are compared. This is done to assess how each assumption affects study results. The *2005 SWP Delivery Reliability Report* presents and discusses the results of DWR's study. The parameters having the largest net impact on SWP Delta deliveries are SWP Table

A demands and Banks Pumping Plant limits. The most elastic parameters (i.e., parameters causing the most percent change in SWP deliveries per percent change in value) are SWP Table A demands and Lake Oroville inflow. The estimates for the future inflow to Lake Oroville depend on what is assumed for climate change. Legal limitations are one of the factors defining the rules for operating Banks Pumping Plant. Therefore, the assumptions for climate change and the court-ordered restrictions directly affecting Banks Pumping Plant operations will significantly affect SWP delivery estimates.

Status of Planning Activities That May Affect SWP Delivery Reliability

3

As discussed earlier, the Sacramento-San Joaquin Delta is an essential part of the conveyance system for the SWP. SWP pumping at Banks Pumping Plant is largely regulated to protect the many uses of the Delta. However, there is a growing recognition that today's uses in the Delta are not sustainable over the long term under current management practices and regulatory requirements. Four major concurrent Delta planning efforts are under way with objectives related to providing a sustainable Delta. These plans may propose changes to SWP operations which in turn could affect SWP delivery reliability. These efforts are Delta Vision, Delta Risk Management Strategy, the CALFED Ecosystem Restoration Program Conservation Strategy, and the Bay Delta Conservation Plan. Each could affect SWP and CVP operations in the Delta.

Delta Vision

On Sept. 28, 2006, in conjunction with the signing of SB 1574, Gov. Schwarzenegger signed an executive order to initiate Delta Vision and establish an independent Blue Ribbon Task Force to develop a durable vision for sustainable management of the Sacramento-San Joaquin Bay Delta. The Delta Vision process is looking more broadly at the sustainability of the Delta. The Blue Ribbon Task Force has prepared its vision for sustainable management of the Delta at **http://www.deltavision.ca.gov**. A strategic plan to implement the vision will be the focus of the Task Force during 2008.

Key points from the Task Force's vision are:

- The water system and the ecosystem of the Delta are co-equal values.
- The Delta is a unique place that has value in its own right.
- Future management must work with nature to achieve desired goals for the Delta.
- Design for resiliency by encouraging regional self sufficiency and developing alternative ways to move water among areas of the state.
- Separate water for human uses from water for the ecosystem.
- New storage and improved conveyance must be constructed to capture water at times least damaging to the environment.
- Over time, reliance on levees should be reduced. However, levees remain critical to the future of the Delta and new policies should match levels of protection provided to uses allowed.
- Assess dual conveyance systems as the preferred direction, to understand the optimal combination of through-Delta and isolated facility improvements against listed performance standards.

The Task Force also identified near-term actions that must be taken. These focus on preparing for disasters in or around the Delta, protecting the Delta ecosystem and water supply system from urban encroachment, and quickly beginning work on short-term improvements to both the ecosystem and water supply system.

Delta Risk Management Strategy

The 2000 CALFED Record of Decision presented its Preferred Program Alternative describing actions, studies, and conditional decisions to help fix the Delta. Included in the Stage 1 implementation of the preferred alternative was the completion of a Delta Risk Management Strategy (DRMS) that would look at sustainability of the Delta and assess major risks to the Delta resources from floods, seepage, subsidence, and earthquakes. DRMS would also evaluate the consequences and develop recommendations to manage the risk.

In 2005, the Legislature passed and the governor signed AB 1200, which requires DWR to evaluate the potential impacts on water supply derived from the Delta based on 50-, 100-, and 200-year projections for possible impacts on the Delta due to subsidence, earthquakes, floods, climate change, and combinations of these. DWR and The Department of Fish and Game (DFG) must determine the principal options for the Delta. DWR must then evaluate each option for addressing those impacts for its ability to, among other things, prevent the disruption of water supplies derived from the Delta, improve the water quality of drinking water supplies from the Delta, and maintain Delta water quality for Delta users. DFG is to evaluate and comparatively rate each option for its ability to restore salmon and other fisheries that use the Delta. The study is to be completed by January 1, 2008. The DRMS Project was developed, in part, to address the provision in AB 1200 and is a major source of scientific and technical information on the Delta and Suisun Marsh levees for other major studies and initiatives including the Delta Vision initiative, the Bay Delta Conservation Plan, and the CALFED End of Stage 1 Assessment.

Prior to the initiation of the DRMS study, no other levee risk assessment had been as comprehensive and complex. Due to the relatively short time for the assessment, DRMS made the best estimates possible based on existing data and models. While data gaps exist, there were no opportunities to gather new data in the course of the DRMS effort. Results should be considered on a regional basis rather than for any individual island or levee reach. The results should be used for a gaining broad understanding of the condition in the entire Delta, and should not be used as a basis for design for any specific location.

The DRMS preliminary findings have been reviewed by a CALFED scientific panel. The review has lead to a reevaluation of some of the initial DRMS analyses. The results of the reevaluation will be incorporated into the final report and will be completed in April 2008. Delta Vision, the CALFED Ecosystem Restoration Program and the Bay-Delta Conservation Planning effort depend on the best available information from DRMS to support their own processes. The findings discussed in Chapter 4 should be viewed as a progress report that is subject to refinement. While specific numbers may change, the essence of the findings is expected to remain the same.

CALFED Ecosystem Restoration Program Conservation Strategy

The Ecosystem Restoration Program (ERP) implementing agencies are developing a Conservation Strategy to guide ecosystem restoration implementation based on evaluation of past actions, new information, and changing understanding of the ecosystem. The Conservation Strategy is non-regulatory and based on willing seller participation. To date, the effort has focused on the Delta due to the emphasis placed on the pelagic organism decline (POD) and other planning efforts. In future versions, comparable conservation strategies will be developed for the entire ERP focus area including the Sacramento and San Joaquin rivers' watersheds.

The Conservation Strategy is a biological view of where restoration of important habitat types could occur to restore ecosystem form and processes to the maximum extent. Areas have been identified in the Conservation Strategy with potential for various kinds of habitat restoration in the Delta-Suisun Marsh based upon existing elevations, habitat, and natural process requirements of pelagic organisms and other native fishes. Elevation and soil type are the drivers for this preliminary depiction, which does not consider the constraints of water conveyance options, infrastructure, or land use patterns and ownership. As noted in the BDCP discussion that follows, new conveyance focuses on new diversion(s) north of the Delta from the Sacramento River, which would divert water for export around the Delta, offers the greatest potential for meeting ecosystem restoration objectives. The Conservation Strategy is also incorporating information from other Delta-related planning efforts (e.g., Delta Risk Management Strategy, Suisun Marsh Implementation Plan, the ERP End of Stage 1 Assessment, and recovery plans for Federally-listed species) and technical and public input.

The draft of the strategy focuses on five broad habitat categories for restoration or management in the Delta. These categories include managed wetland and wildlife-friendly agriculture (primarily subsided islands), inter-tidal, floodplain, upland transition, and grassland/vernal pool transition corridor.

Information on ecosystem processes, such as hydrodynamics, temperature, salinity, residence times, and productivity is being developed. Details of restoration actions that address flow and river operations — the primary drivers of aquatic systems and habitats — will be incorporated once the Delta Regional Ecosystem Restoration Implementation Plan conceptual models (January 2008) and the anadromous fish recovery plans (Spring 2008) are completed and coordinated with the BDCP process.

Bay-Delta Conservation Plan

The Bay-Delta Conservation Plan (BDCP) has a different and more specific purpose than do DRMS and Delta Vision. BDCP is being developed consistent with the federal Habitat Conservation Plan (HCP) and State Natural Community Conservation Planning (NCCP). The purpose of BDCP is to develop a conservation plan that resolves the conflict between fishery protection under state and federal Endangered Species acts and water operations of the State Water Project (SWP), Central Valley Project (CVP), and Mirant Power facilities in the legal Delta. The goal of BDCP is to develop a plan that satisfies both the conservation and water supply goals of the Planning Agreement signed in October 2006. The BDCP Steering Committee is composed of 19 groups that represent the state and federal water agencies and export contractors, non-governmental organizations representing environmental and farming interests, and Mirant Power, with state and federal fishery agencies serving as ex-officio members. BDCP is ultimately focused on satisfying permitting requirements for the water supply system in the Delta. Among other things, the plan will:

- Provide for conservation and management of at-risk fish species affected by the covered activities.
- Preserve, restore, and conserve aquatic, riparian, and associated terrestrial habitats.
- Provide clear expectations and regulatory assurances for Delta water operations and facilities (CVP, SWP, and Mirant Corp.).

The steering committee for BDCP has been actively working since April 2007 to set the scope and focus of this planning. The committee initially developed 10 options. These options were narrowed to four options for conveyance and opportunities that provide for habitat restoration and enhancement.

• **Option 1: Existing Through-Delta Conveyance.** This option includes use of existing through-Delta conveyance with physical habitat restoration in the north and west Delta and Suisun Marsh (about 28 percent of BDCP planning area).

• **Option 2: Improved Through-Delta Conveyance.** This option includes improving through-Delta conveyance with operable barriers on some channels, separating water supply conveyance flows from the San Joaquin River, and providing habitat restoration in the north, west, central, and south Delta and Suisun Marsh (about 35 percent of the BDCP planning area).

• **Option 3: Dual Conveyance.** This option is similar to Option 2 with the addition of an isolated conveyance facility from the Sacramento River to the south Delta export facilities.

• **Option 4: Peripheral Aqueduct.** This option includes construction of a peripheral aqueduct from the Sacramento River to the south Delta export facilities, which would allow habitat restoration throughout the Delta and Suisun Marsh (about 75 percent of the BDCP planning area).

Table 3.1 shows a summary of how a BDCP Steering Committee consultant ranked the options during the evaluations.

The BDCP plans to finish a draft of the conservation plan by the end of 2008 and the associated draft Environmental Impact Report/ Environmental Impact Statement available for public review at the end of calendar year 2009.

Table 3.1 Overall comparison of BDCP options by criteria category (rank)[1]

Evaluation Criteria Category	Conservation Strategy Option			
	Option 1 *Existing Through Delta*	Option 2 *Improved Through Delta*	Option 3 *Dual Conveyance*	Option 4 *Peripheral Aqueduct*
Biological	★	★★	★★★	★★★★
Planning	★	★	★★★★	★★★★
Flexibility/Sustainability/Durability	★	★★	★★★	★★★★
Impacts on Other Resources	★★★★	★★★	★	★★

[1]/ Performance ranks are ★ (lowest-performing) to ★★★★ (best-performing). Some options receive equal rank.

Areas of Significant Uncertainty for SWP Delivery Reliability

4

Delta Vision's recognition that today's uses in the Delta are not sustainable in the long term is in large part based on three major growing concerns: the pelagic organism decline, possible impacts from climate change and sea level rise, and the vulnerability of Delta levees for failure. Each of these uncertainties for SWP delivery reliability is discussed below.

Pelagic Organism Decline

In late 2004 and early 2005, scientists became concerned about the numbers of many pelagic (open water) organisms including delta smelt that had been declining sharply since the early 2000s. Other pelagic fish with very low numbers in the Delta are striped bass, longfin smelt, and threadfin shad. By 2005, the decline was widely recognized as serious and became known as the Pelagic Organism Decline (POD). Hypothesized factors contributing individually or in concert to lower pelagic productivity are:

- toxic effects,
- exotic species effects, and
- water project effects.

Studies over the past three years are indicating that all these factors might be contributing to the decline in pelagic fishes, and their relative importance might vary depending on the year, season, and location in the Delta. Continued decline in the abundance of juvenile delta smelt led to a voluntary modification in 2007 in SWP and CVP operations to reduce the reversed flows in Middle and Old rivers — a modification made possible by the Environmental Water Account (discussed below). Subsequently on May 31, 2007, DWR ceased Delta pumping and the U.S. Bureau of Reclamation reduced pumping to the minimum operating level of 850 cubic feet per second (cfs). SWP pumping resumed on June 10 at a minimal level of 90 cfs and slowly ramped up to 5,000 cfs by July 1.

In 2007, the Pelagic Fish Action Plan (Resources Agency 2007), developed jointly by DWR and DFG, made several recommendations related to actions that could be taken to improve protection of pelagic fish, including delta smelt. These actions included ways to increase primary productivity in the Delta, reduce the effects of toxics, and possible changes in water project operations. The actions related to SWP and CVP operations guided the voluntary actions taken by DWR and USBR in 2007 as part of the Environmental Water Account.

Environmental Water Account and POD

The POD is occurring despite the operation since 2001 of the Environmental Water Account (EWA). This CALFED water management tool was created to provide added protection to at-risk fish species at no uncompensated costs to SWP and CVP water deliveries. The purpose of the EWA is to enable modifying water project operations in the Delta to provide protection for fish while also compensating for any water supply lost to SWP and CVP water users. Under EWA, fish protection is achieved by periodic curtailment of SWP and CVP water diversion from the Delta to water users south of the

Delta and later replacing any lost water supply. EWA achieves this through buying water from willing sellers or diverting surplus water when safe for fish, then banking, storing, transferring, and releasing the water as needed to protect fish and compensate water users. In its simplest terms, the EWA is aimed at adding flexibility to the state's water delivery system by providing water at critical times to meet environmental needs without reducing SWP and CVP water deliveries. Funding for the EWA is expected to continue through 2008. Without the compensation for the supply effects due to restricted pumping, SWP water supply reliability will be reduced. The studies in this report assume no EWA will be in place under the current and future scenarios.

Biological Assessment of the SWP and CVP Operating Criteria and Plan

In 2004, Reclamation and DWR developed a new Operating Criteria and Plan (OCAP) for the SWP and Central Valley Project (CVP). This plan documented many aspects of the SWP and CVP through: detailing project descriptions, explaining regulatory and legal requirements, listing changes in project operations since the last OCAP in 1992, and analyzing the present and proposed operations using computer simulations. OCAP provided the project descriptions required for a comprehensive biological assessment of SWP and CVP. The biological assessment analyzed existing and potential effects of SWP and CVP operations on listed species and led to Endangered Species Act (ESA) consultation with the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) to update biological opinions (BO) for delta smelt, winter-run salmon, and other species listed under the ESA. In 2004, USFWS issued a non-jeopardy BO with regards to impacts on delta smelt caused by revised operations of the CVP and SWP. This opinion was updated in 2005. USFWS concluded that any adverse effects from the CVP and SWP operations would be avoided or minimized by conservation and adaptive management measures included in the OCAP.

The USFWS's 2005 BO for delta smelt was challenged in U.S. District Court. This court ruled in May of 2007 that the OCAP BO for delta smelt was inconsistent with the Federal Endangered Species Act and needed to be rewritten. On Dec. 14, 2007, the court established interim operating rules to protect delta smelt while USFWS rewrites the BO. These interim operating rules are similar to the 2007 Pelagic Action Plan in that they include in-Delta flow limits in Old and Middle rivers that have the effect of restricting CVP and SWP pumping.

Assessment of Possible POD Impacts on SWP Delivery Reliability

As previously discussed in Chapter 2, a crucial impact of POD upon SWP delivery reliability is to cause additional restrictions on SWP operations. These constraints introduce uncertainty in the ability to convey SWP source water to the desired point of delivery. This uncertainty can be somewhat addressed in analyses by assuming two levels of restrictions. The 2007 and 2027 studies in this report assume constraints to Old and Middle rivers flow in accordance to the August 2007 court ruling on interim actions to protect delta smelt. These simulations are described in more detail in Chapter 6.

Climate Change and Sea Level Rise

Climate change is identified in the 2005 update of the *California Water Plan (Bulletin 160-05)* as a key consideration in planning for the state's future water management. This is because climate change may seriously affect the state's water resources, particularly the SWP's ability to deliver water. In fact, the 2005 report by the University of California, Berkeley, for the California Energy Commission, *Climate Change and Water Supply Reliability*, asserts that climate change in California "is likely to affect water users primarily through its impact on supply reliability and uncertainty" (p. 4).

For the SWP, climate change has the potential to simultaneously affect the availability of source water, the ability to convey water, and users' demands for water. These potential changes are described below.

Three climate warming scenarios prepared by the California Climate Change Center predict slightly warmer winters with less winter snowpack. Some changes in hydrology due to climate change may already be noticeable, such as an earlier beginning of snowmelt in the Sierra, an increase in winter runoff as a fraction of the total runoff, and an increase in winter flooding frequency. Also, spring and summer runoff in the Sacramento River and San Joaquin River watersheds may be declining due to reduced snowpack.

In the future, average winter flood flows to the Delta are likely to become larger due to more intense storms with more precipitation occurring as rain instead of snow. This shift from snow to rain, particularly in the northern Sierra Nevada, is expected to shift the timing of the peak runoff toward the winter. This in turn may require adjustments to reservoir flood control operations — water managers may be forced to make changes in reservoir operations and flood-control rule curves — resulting in less spring and summer Delta inflows and an increase in Delta salinity.

Climate change experts believe that the timing and quantity of available water supplies in the coming decades may be less predictable due to changing climatic conditions (DWR's 2006 report, *Progress on Incorporating Climate Change into Management of California's Water Resources*). This may exacerbate the existing mismatch in California between where and when precipitation occurs and where and when people use water.

The sea level has been rising at an average rate of 0.08 inches per year and is now about 0.6 feet higher at the Golden Gate than it was in 1920. The Intergovernmental Panel on Climate Change estimates that sea level will rise by about 0.6 to 1.9 feet over the next 100 years (Intergovernmental Panel on Climate Change 2007). Even if Delta levees are fully upgraded, sea level rise could negatively affect water supply reliability through increased salinity intrusion in the Delta. A further tightening of drinking water quality standards or increases in salinity or other constituents could significantly increase the cost of treating Delta water for municipal use. Increased salinity in the Delta reduces the opportunity for exporters to blend the less saline Delta water with other sources higher in salinity. If current in-Delta water quality standards are maintained, re-operation of upstream reservoirs would be needed to provide more water for controlling the seasonal salinity intrusion in the Delta. This would likely result in generally lower reservoir levels, perhaps reducing the ability to meet water supply and water quality needs during dry periods.

Assessment of Possible Climate Change Impacts on SWP Delivery Reliability

As previously discussed in Chapter 2, climate change can potentially affect SWP delivery reliability by altering the timing and amount of source water. In 2006, DWR released a report on climate change and its potential impact on California's water resources. Entitled *Progress on Incorporating Climate Change into Management of California's Water Resources*, the report summarizes recent research into changes in precipitation, air temperatures, snow levels, and rainfall and snowmelt runoff. The report also evaluates possible future impact on California water supply through CalSim II simulations with hydrologic sequences, which reflect different scenarios of climate change. In order to account for the uncertainty in future climate change, four scenarios are examined:

1. weak temperature warming and weak precipitation increase in California under model PCM;
2. modest warming and modest drying under model PCM;
3. modest warming and modest drying under model GFDL v. 2.0; and
4. weak temperature warming and weak precipitation increase in California under model GFDL v. 2.0.

Some of the main results of the 2006 climate change report related to estimated impacts on the SWP and Delta around the year 2050 are:

- Estimated changes in annual average SWP south-of-Delta SWP Table A deliveries range from a slight increase of about 1 percent for a wetter scenario to about a 10 percent reduction for one of the drier climate change scenarios.
- Estimated increased winter runoff and lower SWP Table A allocations result in slightly higher annual average Article 21[1] deliveries in the three drier climate change scenarios. However, the boosts in Article 21 do not offset losses to SWP Table A. The wetter scenario with higher SWP Table A allocations result in fewer Article 21 delivery opportunities and slightly lower annual average Article 21 deliveries.
- Estimated SWP carryover storage is reduced in the drier climate change scenarios and is somewhat increased in the wetter climate change scenario.

Sea level rise effects on water project operations to repulse a greater salt water intrusion under these conditions were not examined due to lack of existing tools for that type of analysis.

For this report, the Calsim II simulations were updated to incorporate an extension of the hydrologic simulation sequence to 2003 and operation of the SWP to meet the interim operating rules of the August 31, 2007, court order related to delta smelt. The same four scenarios of future climate change were simulated. It should be noted that these scenarios assume greenhouse emissions for 2050, not at the 2027 level assumed for Future Conditions. This report estimates climate change impact to SWP deliveries by interpolating between future studies that assume no climate change and studies that assume 2050 emissions. This approach is detailed in Appendix B. These studies are the best available estimates for future SWP water deliveries. Chapter 6 describes these simulations along with all other simulations presented in this report.

[1] Article 21 water is interruptible water allocated under certain conditions: SWP's share of San Luis Reservoir is full or projected to fill in the near term; other SWP reservoirs are full or at their storage targets, or conveyance capacity to fill these reservoirs is maximized; releases from upstream reservoirs plus unregulated inflow exceed the water supply needed to meet Sacramento Valley in-basin uses; SWP Table A deliveries are being fully met; and Banks Pumping Plant has spare capacity.

Vulnerability of Delta Levees for Failure

Delta levees provide constant protection from flooding because most lands in the Delta are below sea level. Most of the Delta's levees, however, do not meet modern engineering standards and are highly susceptible to failure. Levees are subject to failure at times of high flood flows, but also at any time of the year due to seepage or the piping of water through the levee, slippage or sloughing of levee material, or sudden failure due to an earthquake. According to the URS Corp./Jack R. Benjamin & Associates report, *Draft Summary Report, Phase 1: Risk Analysis, Delta Risk Management Strategy (DRMS)*, June 2007, the risk of levee failure in the Delta is significant, as shown by the fact that virtually all levees in the Delta have failed at least once over the past 100 years, with about half failing at least twice. Since 1900, there have been 166 levee failures.

A breach of one or more levees and island flooding will affect Delta water quality and water operations. Depending on the hydrology and the size and locations of the breaches and flooded islands, a significant amount of saline water may be drawn into the interior Delta from Suisun and San Pablo bays. At the time of island flooding, exports may be drastically reduced or ceased to evaluate the salinity distribution in the Delta and to avoid drawing higher saline water toward the pumps. The introduced salinity then could become dispersed and degrade Delta water quality for a prolonged period because of complex relationships between Delta inflows, tidal mixing, and the time taken to repair the breaches.

A large earthquake in the Delta causing significant levee failures and island flooding could lead to multiyear disruptions in water supply, significant water quality degradation, as well as permanent flooding of several islands. Such permanent multi-island flooding would probably lead to increased salt water intrusion into the Delta during seasonal low inflows. Maintaining Delta water quality when several islands are flooded and breaches are open would require additional Delta inflow because the volume of water coming into the Delta on the flood tide would increase, requiring more fresh water from the rivers to prevent the saline water from extending into the Delta. When SWP and CVP pumping is restarted, Delta inflow would need to increase again beyond the pumping amount in order to prevent water quality degradation in the Delta. This chain of events would significantly affect water supply reliability by limiting pumping and requiring additional reservoir releases to generate the needed higher Delta inflows. A worst case scenario for water supply impacts would be a moderate or large earthquake causing extensive levee failure in the late summer or fall of a dry year.

The levee break on Middle River and subsequent flooding of Upper Jones Tract in 2004 is a small-scale example of this phenomenon. Following the break, Delta pumping was curtailed for several days to prevent seawater intrusion. Water shipments down the California Aqueduct were continued through unscheduled releases from San Luis Reservoir. Also, Shasta and Oroville reservoir releases were increased to provide for salinity control in the Delta.

A growing concern about the long-term viability of the Delta's levee system led to the initiation of the Delta Risk Management Strategy (DRMS).

Delta Risk Management Strategy

The 2000 CALFED Record of Decision presented its Preferred Program Alternative to help fix the Delta that described actions, studies, and decisions contingent upon subsequent environmental and engineering analyses. Included in the Stage 1 implementation of the preferred alternative was the completion of a Delta Risk Management Strategy (DRMS) that would look at sustainability of the Delta and assess major risks to the Delta resources from floods, seepage, subsidence, and earthquakes. DRMS would also evaluate the consequences and develop recommendations to manage the risk.

Assembly Bill 1200, passed in 2005, directs DWR to evaluate the potential effects of subsidence, earthquakes, floods, and climate change to Delta-based water supply. After determining principal options for the Delta, DWR must then evaluate each option according to its ability to prevent the disruption of water supplies from the Delta, improve the water quality of drinking water supplies from the Delta, and maintain Delta water quality for Delta users. By providing important information on levees in the Delta and Suisun Marsh, the DRMS Project is intended to support other major studies and initiatives including the Delta Vision initiative, the Bay Delta Conservation Plan, and the CALFED End of Stage 1 Assessment.

DWR defined Phase 1 of DRMS as the risk analysis of levee failures and associated potential economic, environmental, and public health and safety impacts and Phase 2 as the development and evaluation of strategies to reduce risks from levee failures. Risk analysis includes the likely occurrence of earthquakes of varying magnitudes in the region, future rates of subsidence given continued farming practices, the likely magnitude and frequency of storms, and the potential effects associated with global climate change (sea level rise, climate change, temperature change). Estimated risks to the Delta were made for 50-, 100-, and 200-year projections since risk can be expected to increase with time.

One reason for conducting a risk analysis is to quantitatively consider the uncertainties that relate to the performance of levees. Sources of uncertainty that affect any analysis can be fundamentally different. Events in nature such as precipitation are inherently random and this uncertainty cannot be reduced by simply collecting more information; rather, this uncertainty can be predicted in terms of probability.

The Draft DRMS Phase 1 Report looked at several hazards to levees: seismic events that cause levee failures, flood flows that can overtop levees or cause levee failure by increased pressure and seepage, undetected problems during non-flood flow periods, and erosion due to high wind waves. The level of risk of failure of Delta levees was determined by considering: the frequency of different magnitudes of hazards that can challenge the integrity of Delta levees, how vulnerable different levee reaches are to hazards, how hazards and levee vulnerabilities combine to produce levee failure, and the economic and ecosystem impacts due to levee failure. The analysis assumes that existing regulatory and management practices will continue.

Potential Interruption/Disruption of SWP Deliveries Due to Earthquakes A strong earthquake affecting the Delta could cause simultaneous levee failures on several islands, and there is a real possibility of several simultaneous island flooding. DRMS considered scenarios that consisted of different combinations of flooded islands, ranging from one island to 30 islands flooded. **Table 4.1** summarizes impacts of various scenarios of island flooding associated with a single seismic event as presented in the URS/Jack R. Benjamin & Associates report, *Draft Summary Report, Phase 1: Risk Analysis, Delta Risk Management Strategy (DRMS)*, June 2007.

Preliminary analysis indicates that some water may not be treatable by municipal agencies for many months beyond those listed in **Table 4.1** due to high organic carbon concentrations. This would extend the period that Delta water supply would be unavailable for urban users.

Key findings of the Draft Phase 1 DRMS report on possible impacts on SWP deliveries due to earthquakes are:

- When the probability of all seismic levee breaches under existing conditions is considered, about 115 levee failures can be expected during 100 years.
- There is about a 28 percent chance of 30 or more islands simultaneously failing during a major earthquake in the next 25 years.
- A moderate to large earthquake capable of causing multiple levee failures could happen in the next 25 years. Under such an earthquake, extensive levee failure would most likely occur in the west and central Delta. Levee repairs could take up to 6.5 years and exports from the Delta could be disrupted for up to two years with a loss of up to 9.3 maf of water.
- By 2050, the frequency of island flooding from seismic events is expected to increase by 12 percent over 2005 conditions, if a seismic event has not occurred.

The Draft DRMS Phase 1 report is being reviewed as recommended by the CALFED Independent Science Board evaluation of the draft report. Based on the review conducted to date the specific numbers in the Draft Phase 1 report may change but the overall conclusions of the report are not likely to change.

Table 4.1 Expected impact on Delta exports due to salinity intrusion from various seismic events

Seismic Case	Flooded islands	Months to repair levees	Months without pumping	Water not exported (maf)
1	1	up to 20	up to 2	up to 0.7
2	3	19	1 to 3	0.1 to 1.0
3	3	23	1 to 4	0.1 to 1.2
4	10	45	2 to 10	0.7 to 2.5
5	20	62	11 to 21	6.3 to 6.5
6	30	81	16 to 23	6.5 to 9.3

Potential Interruption/Disruption of SWP Deliveries Due to Floods During an average year, about 85 percent and 10 percent of the total Delta inflow comes from the Sacramento and San Joaquin rivers respectively. The remaining Delta inflow primarily comes from three eastside tributaries. Inflow from the Sacramento and San Joaquin rivers depends on reservoir releases, precipitation, and snowmelt. Over the long-term, many different combinations of high flood flows in the Sacramento and San Joaquin rivers are possible because of the large geographical extent of the two rivers' watersheds and the variability in storm paths. DRMS considered magnitude and frequency of flooding in different parts of the Delta from different sources to evaluate the probability of these high flows. This approach allows the inclusion in the risk analysis of floods that, while possible, are larger than have been historically recorded. The DRMS report views an analysis which relies only on historical data as likely to underestimate risk.

Potential disruption of Delta exports due to floods and levee failures would depend on the number of flooded islands, the timing and size of the flood flows, and the water quality in the Delta and Suisun Bay at the time of the flood. However, during such high flows, there would normally be little or no impact on water quality on the exports due to levee failures and DRMS assumes no significant effect on Delta exports.

Key findings of the Draft Phase 1 DRMS report on possible impacts on SWP deliveries due to flood flows are:

- By 2050, Delta flood hazard is expected to increase 200 percent due to sea level rise and more frequent high flows.
- By 2050, the frequency of island flooding from floods is expected to increase over 2005 conditions.
- By 2050, flood fragility of levees is expected to increase 10 percent due to subsidence, and overall Delta island flood frequency is expected to increase 230 percent.
- By 2050, the frequency of floods is expected to increase by 50 percent and levees are expected to become 20 percent more vulnerable to flooding due to increased seepage and stability problems associated with more subsidence and sea level rise.
- By 2050, the combined effects of increased levee vulnerability and flood flows indicates an 80 percent expected increase in island flooding from flood flows.

The Draft DRMS Phase 1 report is being reviewed as recommended by the CALFED Independent Science Board evaluation of the draft report. Based on the review conducted to date the specific numbers in the Draft Phase 1 report may change but the overall conclusions of the report are not likely to change.

Potential Interruption/Disruption of SWP Deliveries Due to "Sunny Day" Event A "sunny day" levee failure is a failure that occurs during non-flood times and is not caused by an earthquake. Possible causes of levee failure include wave action, animal activity, and seepage. DRMS reports that, on average, there will be about 5.4 sunny-day breaches with 50 years of exposure in the Delta. These types of levee failures are not expected to involve the potential of simultaneous multilevee events as could happen with high flood flows and a large earthquake.

Combined Potential Interruption/Disruption of SWP Deliveries DRMS evaluated combined risk of levee failure due to earthquakes, floods, and "sunny day events" as well as how risks may change in the future. Key findings by DRMS are:

- Taking into account the probability of all levee breaches from all hazards under 2005 conditions, the number of levee failures in the Delta can be expected to about double over the next 100 years.
- Levee hazards are expected to grow in the future due to such factors as sea level rise and more frequent flood flows that will put more pressure on the levees.

- The overall likelihood of a major Delta event causing extensive levee failure is increasing as is the magnitude of the consequences from a given event.

- There is a possible range of sea level rise of from 0.7 to 4.6 feet over the next 100 years, depending on the assumed future greenhouse gas emissions and the forecast model used. Current estimates by the Intergovernmental Panel on Climate Change indicate that sea level will rise from 0.6 to 1.9 feet over the next 100 years. The CALFED Independent Science Board (ISB) has recommended that planning that incorporates sea level rise, should use the full range of variability of 20-55 inches.

The Draft DRMS Phase 1 report is being reviewed as recommended by the CALFED Independent Science Board evaluation of the draft report. Based on the review conducted to date the specific numbers in the Draft Phase 1 report may change but the overall conclusions of the report are not likely to change.

Emergency Operations Plan

As part of its efforts to reduce impacts to the SWP should a levee failure occur, DWR has initiated the development of an Emergency Operations Plan (EOP). This plan will provide procedures for emergency preparedness and incident management typically necessary for a jurisdiction or organization with emergency response roles and responsibilities. While DWR has current general procedures for emergency response, the EOP will ultimately enhance the state's ability to prepare for, respond to, and recover from a Delta levee failure disaster and will provide DWR with a plan focused specifically on a catastrophic levee failure disaster. The EOP will be a blueprint for coordinating the protection of life and property with its local, state, and federal partners in taking the steps necessary to protect the state's water system.

DWR has completed the first of two phases of engineering design work intended to enhance the state's ability to respond to large-scale levee failures or floods in the Delta. In the first phase, DWR conducted a discovery process to analyze previously developed plans and procedures and to identify current DWR capabilities for response to emergencies and disasters in the Delta. This phase included: developing plans to determine the quantity and gradation of rock needed to repair several levee breaches and block certain river channels to minimize salinity intrusion into the interior of the Delta, securing strategic joint stockpile-transfer facilities, completing design requirements and contracting for the construction of a new belt conveyor system, and establishing new procurement contracts for rock to be placed at the stockpile-transfer facilities. Through this process, DWR has categorized response actions that can be taken to reduce the impact of a Delta levee failure disaster. The first phase, now complete, has resulted in a DWR report, *Delta Emergency Operations Plan Concept Paper April 2007*. This report can be accessed at **http://www.dfm.water.ca.gov/er/**.

In the second phase, DWR will engage its partners in local, state, and federal government, and in the private sector, to develop a detailed EOP for responding to levee failure events, stabilizing the system, and facilitating recovery. The EOP will be consistent with and in compliance with California's Standardized Emergency Management System (SEMS)[2] and with the National Incident Management System (NIMS)[2]. By developing the EOP, DWR will improve preparedness capabilities for response and recovery.

[2]/ SEMS is an emergency management system required by California Government Code Section 8607(a) for managing incidents involving multiple jurisdictions and agencies. NIMS is a nationwide, federal emergency management approach, for managing incidents with all levels of government, private-sector, and nongovernmental organizations working together. For more SEMS/NIMS information, please visit: www.oes.ca.gov.

General Approach for Assessing SWP Delivery Reliability

5

CalSim II, a computer model jointly developed by DWR and U.S. Bureau of Reclamation, simulates much of the water resources infrastructure in the Central Valley and Delta region of California. CalSim II models all areas that contribute flow to the Delta. The geographical coverage includes the Sacramento River Valley, the San Joaquin River Valley, the Sacramento-San Joaquin Delta, the Upper Trinity River, and the CVP and SWP service areas. CalSim II simulates operation of the CVP-SWP system using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period.

General Solution Techniques and Incorporating Operational Constraints

CalSim II routes water through a CVP-SWP system network representation. The network includes more than 300 nodes and over 900 arcs, representing 24 surface reservoirs and the interconnected flow system. The physical description of the system is expressed through a user interface with tables outlining the system characteristics. CalSim II uses logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses runoff forecast information, which incorporates uncertainty and standardized rule curves (i.e., Water Supply Index versus Demand Index Curve). The rule curves relate forecasted water supplies to deliverable demand, and then use deliverable demand to assign subsequent delivery levels to estimate the water available for delivery and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta SWP delivery is determined based on water supply parameters and operational constraints. The CVP system-wide delivery and south-of-Delta delivery are also determined using water supply parameters and operational constraints with specific consideration for export constraints.

Hydrology

The historical flow record is adjusted for the influence of land-use change and upstream flow regulation in order to represent the possible range of water supply conditions. The hydrology used by CalSim II was developed jointly by DWR and U.S. Bureau of Reclamation. Water diversion requirements (demands), stream accretions and depletions, rim basin inflows, irrigation efficiency, return flows, non-recoverable losses, and groundwater operation are components that make up the hydrology used by CalSim II. Sacramento Valley and tributary basin hydrologies are developed using a process designed to adjust the historical sequence of monthly stream flows to represent a sequence of flows at a future level of development. Adjustments to historical water supplies are determined by imposing future level land use on historical meteorological and hydrologic conditions. San Joaquin River basin hydrology is developed using fixed annual demands and regression analysis to develop flow accretions and depletions. The resulting hydrology represents the water supply available from Central Valley streams to the CVP and SWP at a future level of development. Groundwater has only limited representation in CalSim II. This resource is modeled as a series of interconnected lumped-parameter basins. Groundwater pumping, recharge from irrigation, stream-aquifer interaction and interbasin flow are calculated dynamically by the model.

Demands

SWP demands are preprocessed independent of CalSim II and vary according to the specified scenario (e.g., 2007, 2027) and according to hydrologic conditions. Agricultural land-use-based demands are calculated from an assumed cropping pattern and a soil moisture budget. Urban demands are typically set to contract amount, but with reductions in wet years based on recent historical data. Both land-use-based demands and estimated contract amounts serve as upper bounds on deliveries. Environmental demands such as minimum reservoir storage requirements, minimum in-stream flows and deliveries to national wildlife refuges, and wildlife management areas are as stipulated in current regulatory requirements and discretionary interagency agreements.

Meeting Delta Water Quality Standards

CalSim II uses DWR's Artificial Neural Network (ANN) model to simulate the flow-salinity relationships for the Delta. The ANN model correlates DSM2 model-generated salinity at key locations in the Delta with Delta inflows, Delta exports, and Delta Cross Channel operations. The ANN flow-salinity model estimates electrical conductivity at the following four locations for modeling Delta water quality standards: Old River at Rock Slough, San Joaquin River at Jersey Point, Sacramento River at Emmaton, and Sacramento River at Collinsville. In its estimates, the ANN model considers antecedent conditions up to 148 days, and considers a "carriage-water" type of effect associated with Delta exports.

CalSim II Priorities in Water Deliveries

CalSim II allocates water according to the four priorities shown in **Table 5.1**. Highest priority is given to prior-right water users, minimum in-stream flow requirements and water quality requirements. While CVP and SWP contractor deliveries take precedence over next year's storage, a balance between the two is struck in the allocation decision to ensure that enough water is left in storage at the end of the year in case of impending drought.

SWP Table A and Article 21 Deliveries

The CalSim II simulations in this report estimate SWP delivery amounts for SWP Table A and Article 21. As mentioned in Chapter 2, SWP Table A is the contractual method for allocating available supply, and the total of all maximum SWP Table A amounts for deliveries from the Delta is 4.133 million acre-feet (maf) per year. Article 21 refers to a provision in the contract for delivering water that is available in addition to SWP Table A amounts. (See Appendices A and B for more discussion.) Article 21

Table 5.1 CalSim II water use prioritization

1	Prior-right water users, minimum in-stream flow requirements, water quality requirements
2	SWP Table A contractors, CVP contractors
3	Reservoir storage for the next year (carryover)
4	SWP Article 21 deliveries

of SWP contracts allows contractors to receive additional water deliveries only under specific conditions. These conditions are:

1. The water is available only when it does not interfere with SWP Table A allocations and SWP operations;
2. The water is available only when excess water is available in the Delta;
3. The water is available only when conveyance capacity is not being used for SWP purposes or scheduled SWP deliveries; and
4. The water cannot be stored in the SWP system. In other words, the contractors must be able to use the Article 21 water directly or be able to store it in their own system.

Water supply under Article 21 becomes available only during wet months of the year, generally December through March. Because an SWP contractor must have an immediate use for Article 21 supply or a place to store it outside of the SWP, not all SWP contractors can take advantage of this additional supply.

The importance of Article 21 water to local water supply is tied to how each contractor uses its SWP supply. For those SWP contractors who are able to store their wet weather supplies, Article 21 supply can be stored by being put directly into a reservoir or by offsetting other water that would have been withdrawn from storage, such as local groundwater. In the absence of storage, Article 21 water is not likely to contribute significantly to local water supply reliability. Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts, and level of water supply reliability required. This report presents information on Article 21 water separately so local agencies can determine whether it is appropriate to incorporate this supply into their analyses.

CalSim II Performance

Some of the comments to the *Draft 2003 SWP Delivery Reliability Report* expressed concern about the accuracy of CalSim II and the credibility of conclusions about SWP delivery reliability that are based on CalSim II simulations. In order to respond to these concerns, DWR conducted several CalSim II studies. In one study, results from a CalSim II simulation using historical input from 1975 to 1998 were compared to historical operations. This study is documented in the report, *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report, November 2003* and was provided in Appendix E of the *2005 SWP Delivery Reliability Report*. In a second study, a sensitivity analysis was performed to quantify the effects of various inputs on CalSim II results. Two performance measures were used, a Sensitivity Index and Elasticity Index, to quantify the sensitivity of 12 model output responses to 12 different model input parameters. This sensitivity study was also provided in Appendix E of the *2005 SWP Delivery Reliability Report*.

In a follow-up study, DWR staff conducted a more detailed analysis of the sensitivity results, focusing on the delivery reliability of SWP system. The results of this analysis are documented in an internal memorandum report, dated April 30, 2007. The purpose of this analysis was to assist SWP contractors and other interested parties in evaluating the impact of model input parameters on SWP deliveries (SWP Delta deliveries, SWP north-of-Delta deliveries, and SWP deliveries under Article 21) with respect to a selected subset of input parameters. This memorandum report is available via the internet at **http://baydeltaoffice.water.ca.gov/** by clicking on the announcement of the *Draft 2007 SWP Delivery Reliability Report* under "Items of Interest."

Recent Improvements to CalSim II Simulations

The SWP operation simulations in this report use the CalSim II model developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP) that was then modified specifically for these studies. In addition to the modifications needed for the 2007 U.S. District Court Judge Oliver Wanger's decision, the 2004 OCAP version was modified to include the improvements listed below. A complete list of model assumptions is included in Appendix A. The new enhancements to CalSim II are:

- **Improved representation of the San Joaquin River Basin** The previous San Joaquin River Basin representation was replaced by the San Joaquin River Water Quality Module version 1.00 (SJRWQM) developed by U.S. Bureau of Reclamation Mid-Pacific Region. The SJRWQM is an update to previous versions that has gone through extensive agency review and a formal peer review.

- **Improved modeling of flow-salinity relationships in the Delta** The previous Artificial Neural Network (ANN) used to estimate flow-salinity relationships has been replaced with a newer more accurate version. The new ANN and its accompanying implementation to the CalSim II model produces salinities that match more closely the Delta Simulation Model 2 (DSM2) salinities.

- **An extended hydrologic sequence** The Hydrologic sequence of 74 simulated years has been extended to 82 years, from water years 1922 through 1994 to water years 1922 through 2003.

Assessment of Present and Future SWP Delivery Reliability

6

CalSim II simulations were conducted to evaluate current (2007) SWP delivery reliability and incorporate actions to protect delta smelt defined by the 2007 federal court ruling. Simulations to evaluate future (2027) SWP delivery reliability incorporate the current interim court-ordered operating rules related to delta smelt and a range of possible climate change impacts to hydrology in the Central Valley. The interim operating rules for delta smelt are simulated at both a more-restricted level and a less-restricted level for Delta exports to provide a range of estimated water deliveries. Therefore, for 2007, two studies are conducted. For 2027, 10 simulations are used to reflect the four assumed scenarios for climate change and the two levels of operation rules. By using these interim court-ordered operating rules in the studies, DWR is not making an assumption about the results of the ongoing discussions to revise the delta smelt Biological Opinion. The studies are simply an indication of the near-term impacts of these interim operating rules. An update of this report for 2009 will be done using operating rules defined by the revised delta smelt Biological Opinion.

Results of these updated CalSim II simulations are presented alongside results from the *2005 SWP Delivery Reliability Report* to help identify and explain impacts to delivery reliability due to actions to protect delta smelt and future climate change. At the end of the chapter, the information is presented in a way to easily compare the estimated SWP deliveries under Current (2007) Conditions to those under Future (2027) Conditions.

This chapter contains tables summarizing the updated estimated delivery amounts of the studies for the entire study period (1922-2003), dry years, and wet years and presents information on the estimated probability of SWP Table A delivery amounts currently and 20 years in the future. While two CalSim II simulations were made to estimate current delivery reliability (bookends for delta smelt protection) and 10 simulations were made to estimate future delivery reliability (combinations of flow constraints and climate change scenarios), simulation results in this chapter for Future (2027) Conditions are presented in terms of ranges in values for ease of analysis. The annual values for SWP deliveries estimated by all the CalSim II simulations are listed in tables in Appendix B. These tables also show the annual SWP Table A demands assumed for each study.

The results indicate potentially significant differences between the updated studies and studies done for the 2005 report under both current and future conditions for estimated deliveries during multiple-year dry periods. In general, updated estimates of both current and future SWP Table A deliveries are less than the deliveries presented in the 2005 report, particularly during multiple dry years. For a given probability of exceedence, current and future SWP Table A deliveries are also less than were presented in the 2005 report. For future conditions, the probability of an annual SWP Table A delivery exceeding 1.7 maf is substantially less than was presented in the 2005 report. The updated studies show generally higher SWP Table A deliveries under Future (2027)

Conditions compared to Current (2007) Conditions, but decreases in deliveries in the future are possible during multiple dry year periods, depending on which climate change scenario is assumed. In comparison, the 2005 report showed more frequent and greater increases in future deliveries.

Assessment of SWP Delivery Reliability under Current (2007) Conditions

Current Conditions refer to those conditions believed in effect in 2007. These conditions, described below, include Old River and Middle River flow targets from the current court-ordered interim operating rules. Results from CalSim II simulations for the *2005 SWP Delivery Reliability Report* under the 2005 study are presented throughout this section for comparison. Appendix A presents a detailed list of the study assumptions for this report.

Availability of Source Water

The 2005 level of development (level of water use in the source areas) is assumed representative of 2007. The hydrologic sequence of simulated years is based on historical precipitation and runoff patterns and is from water years 1922 through 2003. The hydrologic sequence for the 2005 report is shorter, from water years 1922 through 1994. For comparison purposes, these differences are not significant.

Demand for Delta Water

The SWP Table A demands for deliveries from the Delta assumed for 2007 are shown in **Table 6.1**. The assumed demands for the studies were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with DWR's 2007 document, *Draft Environmental Impact Report: Monterey Amendment to the State Water Project Contracts (Including Kern Water Bank Transfer) and Associated Actions as Part of a Settlement Agreement (Monterey Plus)*. A range in SWP Table A demands is shown because the demand is assumed to vary each year with the weather. **Table 6.1** presents key demand values. Differences between the values in updated studies and the 2005 study in the 2005 report are due to the longer simulation period for the current report. SWP Article 21 demands for water are the same as assumed in the *2005 SWP Delivery Reliability Report* and are shown in **Table 6.2**.

Ability to Convey Source Water to the Desired Point of Delivery

The CalSim II simulations assume that current Delta water quality regulations (contained in the

Table 6.1 SWP Table A demands from the Delta under Current Conditions

Study of Current Conditions	Average Demand		Maximum Demand		Minimum Demand	
	taf /year	maximum SWP Table A[1]	taf /year	maximum SWP Table A[1]	taf /year	maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2005	3290	80%	3862	93%	2321	56%
Updated Studies (2007)	3308	80%	3864	94%	2323	56%

1/ 4,133 taf /year.

Table 6.2 Article 21 demands from the Delta under Current Conditions

Study of Current Conditions	Average Article 21 demand (taf)		Total (taf/year)
	December - March	April - November	
2005 SWP Delivery Reliability Report, Study 2005	704	607	1311
Updated Studies (2007)	699	598	1297

State Water Resources Control Board's Decision 1641) are in place for the 2007 studies. The simulations also incorporate flow restrictions of the recent court-ordered interim operating rules related to delta smelt. Two CalSim II simulations were run to evaluate a lower level and a higher level of flow restrictions to give a range of potential SWP water delivery estimates. The specific rules for these flows are contained in **Table 6.3**. The lower- and higher-level restrictions are the same for Dec. 25 through Feb. 20 and April 15 through May 15. They are significantly different during Feb. 21 through April 14 and May 16 through June 30. Additional information on the characterization of the potential court decision in the model is found in Appendix A. The amount of exports allowed while achieving the Old River and Middle River flow targets are assumed shared equally between the CVP and the SWP. Combined CVP and SWP exports also are assumed constrained according to the June 30, 2004, Long-Term Central Valley Project Operations Criteria and Plan during April 15 to May 15. This operation is part of the Vernalis Adaptive Management Plan. The specific rules for this restriction are included in Appendix A.

The simulation of Current Conditions in the 2005 report also assumed D-1641 Delta standards and combined SWP and CVP pumping restrictions according to the 2004 Long-Term Central Valley Project Operations Criteria and Plan. However, the 2005 report assumed no Old River and Middle River flow targets.

Presentation of CalSim II Results

For the purpose of describing SWP deliveries under Current (2007) Conditions in this chapter, the annual deliveries from the two CalSim II simulations, which assumed a higher and a lower level of Old River and Middle River flow targets, are averaged. The annual SWP Table A and Article 21 deliveries for the two 2007 simulations are presented in Appendix B.

SWP Table A Deliveries under Different Hydrologic Scenarios

Table 6.4 contains the average, maximum, and minimum estimates of SWP Table A deliveries from the Delta under Current Conditions from the *2005 SWP Delivery Reliability Report* and under 2007 assumptions that include Old River and Middle River flow targets. As previously mentioned, SWP deliveries under 2007 conditions are the result of averaging annual deliveries from two scenarios of Old River and Middle River flow targets. The estimated probabilities for a given amount of annual SWP delivery under Current (2007) Conditions are presented in **Figure 6.1**.

Table 6.4 shows that under updated Current (2007) Conditions, average SWP delivery amounts may decrease 5 percent of maximum SWP Table A when compared to the earlier estimate, from 68 percent to 63 percent. Since SWP Table A demands are the same between the earlier and updated studies, this decrease in deliveries is primarily due to the Old River and Middle River flow targets to

Table 6.3 Old and Middle River flow target scenarios assumed in CalSim II studies

Period	Combined Average Old River and Middle River flow[1]	
	Less Restrictive	More Restrictive
Dec 25 - Jan 3	Less than 2,000 cfs flow upstream	Less than 2,000 cfs flow upstream
Jan 4 - Feb 20	Less than 5,000 cfs flow upstream	Less than 5,000 cfs flow upstream
Feb 21 - April 14	Less than 5,000 cfs flow upstream	Less than 750 cfs flow upstream
Apr 15 - May 15	No Old and Middle River flow constraint; VAMP controls exports	No Old and Middle River flow constraint; VAMP controls exports
May 16 - May 31	Less than 5,000 cfs flow upstream	Less than 750 cfs flow upstream
Jun 1 - Jun 30	Less than 5,000 cfs flow upstream	Less than 750 cfs flow upstream

[1]/ Where: OMR flow = (0.58 * flow at Vernalis) - (0.913 * total export)

protect delta smelt reducing the amount of Delta water available for export by the SWP. The maximum delivery of 93 percent for the 2005 study is reduced to 90 percent for the updated study. The estimate of minimum SWP Table A delivery actually increases slightly. This is primarily due to the larger amount of storage available in Lake Oroville at the beginning of the year. The higher amount of storage is due to the fish-protection restrictions on SWP Delta pumping for the previous year reducing the need to release water from Lake Oroville.

Table 6.5 includes estimates of SWP Table A deliveries for Current (2007) Conditions under an assumed repetition of historical drought periods. The years are identified as dry by the Eight River Index, a good indicator of the relative amount of water supply available to the SWP. The Eight River Index is the sum of the unimpaired runoff from the four rivers in the Sacramento Basin used to define water conditions in the basin plus the four rivers in the San Joaquin Basin, which correspondingly define water conditions in that basin. The eight rivers are the Sacramento, Feather, Yuba, American, Stanislaus, Tuolumne, Merced, and San Joaquin. **Table 6.5** also includes the average deliveries for comparison purposes. Once again, deliveries under Current (2007) Conditions are the result of averaging annual deliveries from two scenarios of Old River and Middle River flow targets.

Table 6.5 shows that estimates of updated SWP deliveries under Current (2007) Conditions during dry periods are less than were earlier estimated. SWP deliveries may be reduced to 34 percent of maximum SWP Table A during the two-year drought of 1976-1977. The six-year drought of 1987-1992 is estimated to provide 35 percent of maximum SWP Table A, a reduction of 289 taf/year when compared to the 2005 estimate. The four-year drought of 1931-1934 is an exception with SWP deliveries estimated to increase 3 percent of maximum SWP Table A, from 32 percent to 35 percent.

Table 6.6 summarizes SWP Table A deliveries under an assumed repetition of historical wet periods under Current (2007) Conditions. As with drought years, the Eight River Index is used to identify wet years. **Table 6.6** shows that estimates of SWP

Table 6.4 SWP Table A delivery from the Delta under Current Conditions

Study of Current Conditions	Average Delivery[2]		Maximum Delivery[2]		Minimum Delivery[2]	
	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2005	2818	68%	3848	93%	159	4%
Updated Studies (2007)[3]	2595	63%	3711	90%	243	6%

[1]/ 4,133 taf /year
[2]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[3]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3.

Table 6.5 Average and dry period SWP Table A deliveries from the Delta under Current Conditions

Study of Current Conditions	SWP Table A delivery from the Delta (in percent of maximum SWP Table A[1])					
	Long-term Average[2]	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005 SWP Delivery Reliability Report, Study 2005	68%	4%	41%	32%	42%	37%
Updated Studies (2007)[3]	63%	6%	34%	35%	35%	34%

[1]/ 4,133 taf /year
[2]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[3]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

deliveries under updated Current (2007) Conditions do not significantly change from earlier estimates during wet years. Decreases in SWP deliveries for these wet periods generally range from 0 to 2 percent of maximum SWP Table A (0 to 83 taf/year).

Article 21 Deliveries under Different Hydrologic Scenarios

State Water Project water delivery is a combination of both SWP Table A deliveries and the use of Article 21 by some contractors to store water locally at times when extra water and capacity is available beyond that needed by normal SWP operations. **Table 6.7** contains the average, maximum, and minimum SWP Article 21 deliveries over the 1922-1994 period for the earlier study and the 1922-2003 period for the updated simulations. Comparing the estimates of SWP Article 21 deliveries, the updated estimates show significantly less delivery amounts on average and for maximum delivery over the simulation period. Estimated average Article 21 deliveries are 175 taf less under the updated Current (2007) Conditions than was estimated in the 2005 report. Estimated maximum Article 21 delivery is reduced 520 taf. These reductions are primarily due to the storage in San Luis Reservoir being lower in the 2007 studies. The reservoir is lower because Delta pumping is restricted by the court-ordered operation rules for delta smelt. To assure SWP Table A deliveries for the coming year are not reduced, the SWP portion of San Luis Reservoir must be very close to full, if not completely full, before Article 21 deliveries are made.

As noted above, water available for Article 21 occurs only in wet periods and it is difficult to evaluate impacts except to look at specific years. **Table 6.8** shows the updated and earlier estimates of Article 21 deliveries by year during dry periods. Under the updated current (2007) conditions, Article 21 deliveries are estimated to be significantly reduced during the dry periods 1929-1934, 1976-1977, and 1987-1992.

Table 6.9 shows the updated and earlier estimates of Article 21 deliveries by year during the 1978-1987 wet period. Under Current (2007) Conditions, updated estimated Article 21 delivery can decrease up to 550 taf in an individual year, compared to earlier estimates. In only one year, 1980, does the estimated Article 21 deliveries increase when compared to earlier estimates.

Table 6.6 Average and wet years SWP Table A delivery from the Delta under Current Conditions

Study of Current Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[1]	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
2005 SWP Delivery Reliability Report, Study 2005	68%	60%	65%	69%	75%	72%
Updated Studies (2007)[2]	63%	60%	66%	68%	73%	71%

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

Table 6.7 Annual SWP Article 21 delivery from the Delta under Current Conditions

Study of Current Conditions	Average delivery[1] (taf)	Maximum delivery[1] (taf)	Minimum delivery[1] (taf)
2005 SWP Delivery Reliability Report, Study 2005	260	1110	0
Updated Studies (2007)[2]	85	590	0

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for Current (2007) Conditions in **Figure 6.1**. Results from the *2005 SWP Delivery Reliability Report* and updated estimates for 2007 are shown. Updated estimates of probability for Current (2007) Conditions are shown as a single line which results from ranking the averaged deliveries from the two scenarios of Old River and Middle

Table 6.8 Average and dry year SWP Article 21 delivery under Current Conditions (taf per year)

Year	2005 SWP *Reliability Report*, Study 2005	Updated Studies (2007)[2]
1929	0	0
1930	120	0
1931	0	0
1932	240	0
1933	510	40
1934	210	0
1976	190	5
1977	0	0
1987	550	0
1988	0	0
1989	0	0
1990	0	0
1991	0	0
1992	0	0
Long-term average[1]	260	85

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

Table 6.9 Average and wet year SWP Article 21 delivery under Current Conditions (taf per year)

Year	2005 SWP *Reliability Report*, Study 2005	Updated Studies (2007)[2]
1978	300	100
1979	160	0
1980	140	190
1981	550	0
1982	800	490
1983	400	400
1984	550	460
1985	0	0
1986	120	30
1987	550	0
1978-87 Average	360	170
Long-term Average[1]	260	85

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2007)
[2]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3

River flow targets. Probability values for each of these two scenarios are presented in Appendix B. To use **Figure 6.1**, one would first locate the percent exceedence of interest along the horizontal axis (x-axis) of the graph, move vertically upward to the curve, then horizontally to the vertical axis (y-axis) and read the annual delivery. For example, for an 80 percent exceedence, corresponding annual SWP Delta deliveries would be 2,277 taf from previous estimates and 1,990 taf for the updated estimates. The numerical data for this figure is included in Appendix B and should be referenced for specific values corresponding to specific exceedences.

Figure 6.1 shows that under Current (2007) Conditions, for probabilities of exceedence above 40 percent, updated annual SWP Table A deliveries can be 250 taf to 500 taf less than the earlier estimates. Annual SWP Table A deliveries associated with exceedences below 40 percent are much less different than the 2005 study. **Table 6.10** contains the values for SWP Delta deliveries corresponding to 25 percent, 50 percent, and 75 percent exceedence. The information in **Table 6.10** can be stated as follows: For any given year,

- There is a 25 percent chance that SWP deliveries will be at or above 3,218 taf.
- There is an equal chance that SWP deliveries will be above or below 2,976 taf.
- There is 75 percent chance that SWP deliveries will be above 2,168 taf. Another way to state this is that there is a 25 percent chance that deliveries will be below this value.

Impact on Total SWP Deliveries under Current (2007) Conditions Due to Flow Restrictions to Protect Delta Smelt

As previously discussed, the updated estimates of current SWP deliveries in this report incorporate

Figure 6.1 Average and wet years SWP Table A delivery from the Delta under Current Conditions

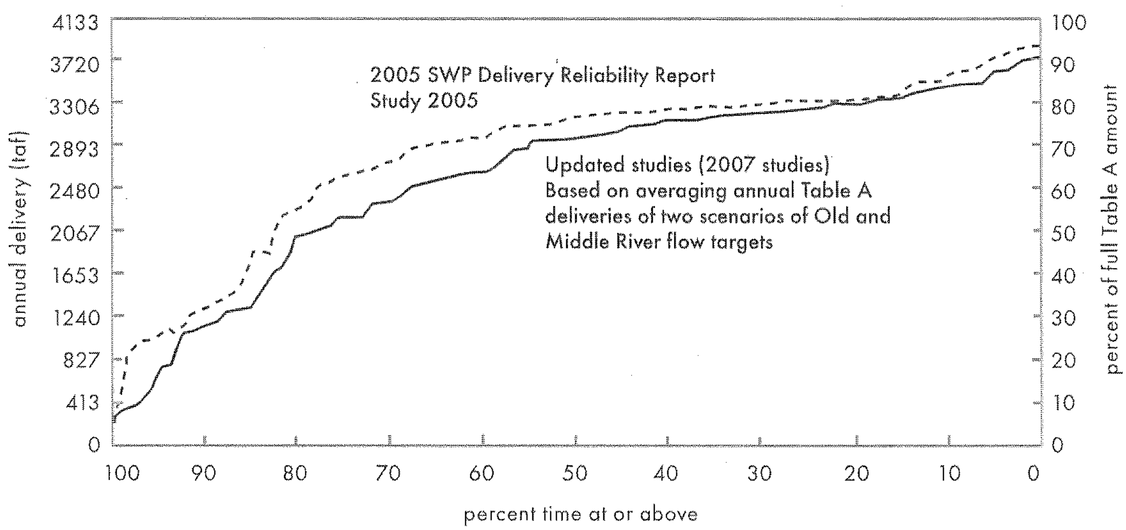


Table 6.10 Highlighted SWP Table A delivery percent exceedence values under Current Conditions

Exceedence	Annual SWP Table A Delivery (taf)		Reduction in delivery compared to 2005 report (taf)
	2005 SWP Reliability Report, Study 2005	Updated Studies (2007)[1]	
25%	3323	3218	105 (3%)
50%	3173	2976	197 (6%)
75%	2588	2168	420 (16%)

[1]/ Values reflect averaging annual deliveries from the two scenarios of Old and Middle River flow targets described in Table 6.3.

effects on SWP deliveries caused by new restrictions in Old River and Middle River flows ordered by the federal court in December 2007. **Tables 6.4, 6.5, 6.7, and 6.8** indicate that both SWP Table A and Article 21 deliveries under the updated studies tend to be less overall and in particular during dry periods compared to the results presented in the previous 2005 report. This section further characterizes the change in combined SWP Table A and Article 21 SWP deliveries due to the federal court order.

For the updated delivery estimates, CalSim II simulations were run assuming a lower level and a higher level of flow restrictions to give a range of potential SWP water delivery estimates. The lower- and higher-level restrictions are significantly different during Feb. 21 through April

Figure 6.2 Distribution of changes in total annual SWP deliveries under Current Conditions due to implementation of flow restrictions to protect delta smelt

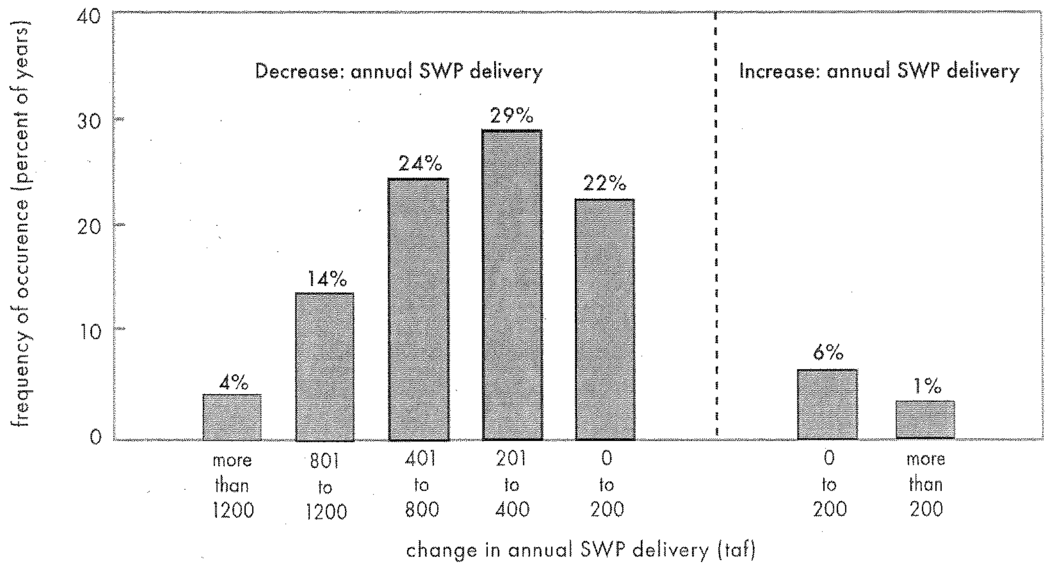
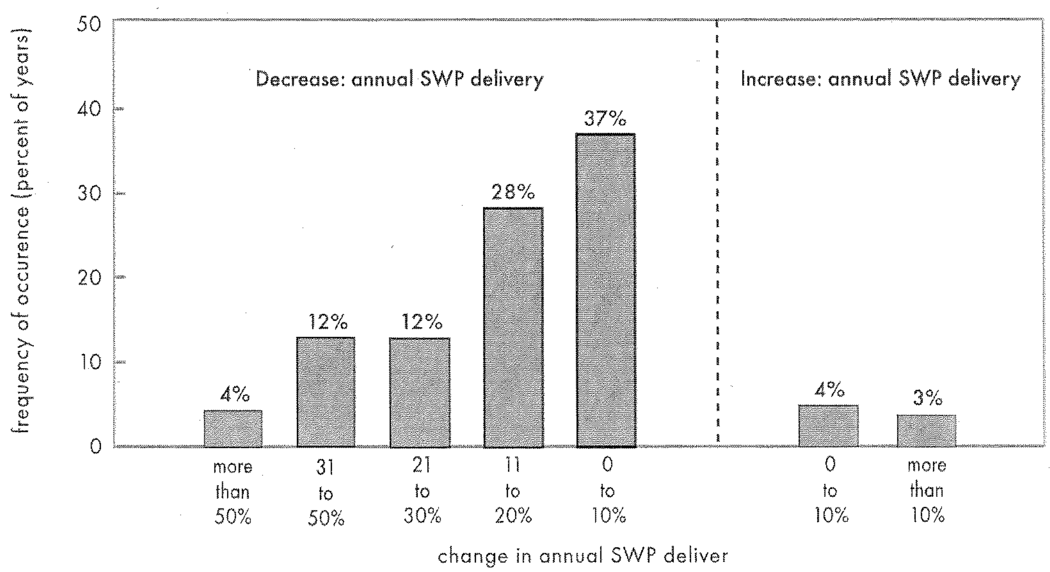


Figure 6.3 Distribution of percent changes in total annual SWP deliveries under Current Conditions due to implementation of flow restrictions to protect delta smelt



14 and May 16 through June 30. The specific rules for these flows are contained in **Table 6.3**. For presentation of combined SWP deliveries, annual SWP Table A and Article 21 deliveries from the two simulations are averaged.

Figures 6.2 and 6.3 show the distribution of changes in total annual SWP deliveries between updated estimates and estimates from the 2005 report over the common 1922 through 1994 simulation period. **Figure 6.2** shows the distribution of changes in total annual delivery in terms of thousand acre-feet and frequency of occurrence while **Figure 6.3** shows the distribution of changes in terms of percent change from the 2005 report estimates and frequency of occurrence. Any differences in SWP deliveries are nearly entirely due to the new flow restrictions for delta smelt in the updated studies. The total annual SWP deliveries which are used to generate **Figures 6.2 and 6.3** are presented in **Table B.22**.

Figures 6.2 and 6.3 show that out of the 73 years of simulation (1922-1994), total annual SWP deliveries decrease 93 percent of the time under the updated estimates. Annual deliveries decrease from 0 to 400 taf over 50 percent of the time and from 401 taf to 1,200 taf 38 percent of the time. In terms of percent decrease in deliveries, total annual SWP deliveries decrease more than 30 percent 16 percent of the time.

Table 6.7 shows that, on average, Article 21 delivery is about 175 taf less under the 2007 study than under the 2005 study. When this is combined with the difference in average SWP Table A delivery projections presented in **Table 6.4**, the difference in total average SWP delivery is about 400 taf, for an overall decrease of about 13 percent in delivery capability from the 2005 to the 2007 study

Assessment of SWP Delivery Reliability under Future (2027) conditions

Future Conditions refer to conditions that are assumed in effect in the year 2027. These conditions as described below include effects of climate change and the same Old River and Middle River flow targets that are assumed under Current (2007) Conditions. Results from the CalSim II simulation for the *2005 SWP Delivery Reliability Report* under 2025 future scenario (Study 2025) are presented throughout this section for comparison purposes. A detailed list of the study assumptions for this report is presented in Appendix A.

Availability of Source Water

DWR's 2006 report, *Progress on Incorporating Climate Change into Management of California's Water Resources*, evaluates possible future impact on California water supply through CalSim II simulations with hydrologic sequences that reflect different scenarios of climate change. The four climate change scenarios consist of two greenhouse gas emissions scenarios, A2 and B1, and two global climate models, the Geophysical Fluid Dynamic Lab model (GFDL) and the Parallel Climate model (PCM). The A2 emissions scenario assumes high growth in population, regional based economic growth, and slow technological changes, which collectively result in significantly higher greenhouse gas emissions. The B1 scenario represents low growth in population, global based economic growth, and sustainable development all of which results in a low increase in greenhouse gas emissions. Both the GFDL model and PCM predict future warming although the GFDL model indicates a greater warming trend than does the PCM. These four scenarios are assumed for the analysis in this report in order to generate the 82-year hydrologic sequence. It should be noted that these scenarios, although focusing on potential water supply conditions in 2050, include the assumption that water use in the water supply basins is at a 2020 level of development, not a 2050 level of development. In this respect, the studies span assumed temporal points of reference. They are, however, the best available estimates for future SWP water deliveries.

Demand for Delta Water

The SWP contractors' SWP Table A demands for deliveries from the Delta assumed for 2027 are shown in **Table 6.11**. The assumed demands for the studies were developed through discussions with SWP water contractors and stakeholders involved in the development of DWR's *Draft Environmental Impact Report (Draft EIR) for the Monterey Amendment to the State Water Project Contracts, including the Kern Water Bank Transfer and associated actions as part of a Settlement Agreement (Monterey Plus).* Maximum and minimum SWP Table A demand is shown because the demand is assumed to vary each year with the weather. SWP Article 21 demands for water are the same as assumed in the 2005 SWP Delivery Reliability Report and are shown in **Table 6.12**.

Ability to Convey Source Water to the Desired Point of Delivery

One of the most significant assumptions regarding SWP conveyance is that the rules and facilities related to Delta conveyance will remain at the status quo. That is, no new facilities are assumed to be in place to convey water through, around, or through and around the Delta. As noted in Chapter 3, there are several processes under way to identify modifications to the existing method of conveying water through the Delta to reduce the conflict between fishery concerns and water supply reliability. However, these programs are not at a stage where such changes can be used in this report. The CalSim II simulations for 2027 scenarios assume the current Delta water quality regulations (contained in the State Water Resources Control Board's Decision 1641) are in place as well as the flow restrictions for Old River and Middle rivers set forth in the federal court-ordered interim action related to delta smelt. The studies evaluate a lower level and a higher level of flow restrictions to give a range of potential SWP water delivery estimates. The specific rules for these flows are contained in **Table 6.3**. The exports resulting from meeting Old River and Middle River flow targets related to delta smelt are again assumed shared equally between the CVP and the SWP.

The simulation of Future Conditions in the 2005 report (Study 2025) also assumed D-1641 Delta water quality requirements and combined SWP and CVP pumping restrictions according to the 2004 Long-Term Central Valley Project Operations Criteria and Plan. It did not assume the flow restrictions for Old River and Middle Rivers were in place.

To simulate the assumed 2027 conditions, 10 CalSim II simulations are needed: the two levels of flow restrictions combined with four climate change scenarios and a scenario assuming no climate change. SWP deliveries derived from these 10 simulations were modified as explained below before

Table 6.11 SWP Table A demands from the Delta under Future Conditions

Study of Future Conditions	Average Demand		Maximum Demand		Minimum Demand	
	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2025	4110	99%	4133	100%	3898	94%
Updated Studies (2027)	4111	99%	4133	100%	3935	95%

[1]/ 4,133 taf /year.

Table 6.12 Article 21 demands from the Delta under Future Conditions

Study of Future Conditions	Average Article 21 demand (taf)		Total (taf)
	December - March	April - November	
2005 SWP Delivery Reliability Report, Study 2025	704	607	1311
Updated Studies (2027)	699	598	1297

being used to describe Future (2027) Conditions.

Presentation of CalSim II Results

For the purpose of describing SWP deliveries under Future Conditions in this chapter, the annual deliveries under the four scenarios of climate change simulated by CalSim II were adjusted to better estimate deliveries reflecting 2027 conditions. As previously mentioned, the climate change scenarios for Future Conditions assume projections of climate and hydrology for 2050. Currently, 2027 climate change projections are not available. In order to estimate SWP deliveries 20 years in the future with potential changes in climate, annual SWP deliveries were interpolated between deliveries from a CalSim II simulation of a particular climate change scenario under the low or high operation restrictions for Old River and Middle River flows and deliveries from the corresponding CalSim II simulation which assumes no climate change. All CalSim II simulations for Future Conditions assume a 2027 SWP demand level.

Each climate change scenario then consists of two sequences of modified (interpolated) SWP deliveries, one sequence for each of the two levels of Old River and Middle River flow targets. For each climate change scenario, these two sequences of annual deliveries were then averaged to yield a single sequence designed to reflect a climate change projection to 2027 with an averaged Old River and Middle River flow target operation. The following tables and graph of SWP Table A delivery probability are based on these four sequences of annual SWP deliveries.

The annual SWP Table A and Article 21 deliveries for the 10 simulations on which the information in this section is based are presented in Appendix B.

SWP Table A Deliveries under Different Hydrologic Scenarios

Table 6.13 contains the average, maximum, and minimum estimates of SWP Table A deliveries from the Delta under Future Conditions from Study 2025 from the *2005 SWP Delivery Reliability Report* and under updated 2027 assumptions. The deliveries under 2027 conditions are shown as a range to account for the four climate change scenarios. The estimated probabilities for a given amount of annual SWP delivery under Future (2027) Conditions are presented in **Figure 6.4.**

Table 6.13 shows that under the updated Future (2027) Conditions, average SWP delivery amounts may decrease from 8 to 11 percent of maximum SWP Table A amounts compared to earlier estimates. Since SWP Table A demands are the same in the earlier and updated studies, this decrease in deliveries is primarily due to the incorporation of the Old River and Middle River flow targets related to delta smelt reducing the amount of Delta water available for export by SWP and the assumed hydrologic changes associated with climate change. The estimate of minimum annual SWP Table A delivery for the updated study ranges from 6 to 7 percent of maximum SWP Table A amounts.

Table 6.14 includes estimates of SWP Table A deliveries for a single-year and multiyear droughts. It also includes the average of the SWP Table A

Table 6.13 SWP Table A delivery from the Delta under Future Conditions

Study of Future Conditions	Average Delivery[2]		Maximum Delivery[2]		Minimum Delivery[2]	
	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]	taf / year	% of maximum SWP Table A[1]
2005 SWP Delivery Reliability Report, Study 2025	3178	77%	4133	100%	187	5%
Updated Studies (2027)[3]	2724-2850	66 - 69%	4133	100%	255-293	6 - 7%

1/ 4,133 taf /year
2/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
3/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

deliveries for comparison purposes. Estimates of updated SWP deliveries under Future (2027) Conditions during dry periods can range 5 percent of maximum SWP Table A (32 percent to 37 percent for 1931-1934). This is a range of almost 210 taf/year. With the period 1931-1934 being the exception, all other multiyear droughts show reduced deliveries. The reductions range from 2 percent to 13 percent of maximum SWP Table A amounts, or from 83 taf/yr to 540 taf/yr.

Table 6.15 summarizes SWP Table A deliveries under an assumed repetition of historical wet periods under Future Conditions. As with drought years, the Eight River Index is used to identify wet years. The estimated deliveries for the updated future (2027) condition during wet periods do not generally range as much as those for the dry periods. The maximum range is 3 percent of maximum SWP Table A for the six-year and 10-year wet periods. This equates to a range of 120 taf/yr. Reductions in delivery amounts are significant for the four-, six-, and 10-year wet periods. For example, average annual SWP Table A deliveries decrease to a range of 86 to 87 percent of maximum SWP Table A for the 1980-1983 period. The estimate for the 2025 study for this period is 93 percent. This corresponds to a reduction of 250 taf/yr to 290 taf/yr.

Article 21 Deliveries under Different Hydrologic Scenarios

Table 6.16 contains the average, maximum, and minimum SWP Article 21 deliveries over the

Table 6.14 Average and dry period SWP Table A deliveries from the Delta under Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[1]	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005 SWP Delivery Reliability Report, Study 2025	77%	5%	40%	33%	42%	38%
Updated Studies (2027)[2]	66 - 69%	7%	26 - 27%	32 - 37%	33 - 35%	33 - 36%

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.15 Average and wet period SWP Table A deliveries from the Delta under Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[1]	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
2005 SWP Delivery Reliability Report, Study 2025	77%	95%	97%	93%	93%	89%
Updated Studies (2027)[2]	66 - 69%	94%	97%	86 - 87%	84 - 87%	80 - 83%

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.16 Annual SWP Article 21 delivery from the Delta under Future Conditions

Study of Current Conditions	Average delivery[1] (taf)	Maximum delivery[1] (taf)	Minimum delivery[1] (taf)
2005 SWP Delivery Reliability Report, Study 2025	120	550	0
Updated Studies (2027)[2]	30	410 - 420	0

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

1922-1994 period for earlier studies and the 1922-2003 period for the updated simulations of Future (2027) Conditions. Comparing the estimates of SWP Article 21 deliveries, the updated estimates show less delivery amounts on average and for the maximum annual delivery over the simulation period. Estimated average Article 21 deliveries are 90 taf less under updated Future (2027) Conditions than was estimated in the *2005 SWP Delivery Reliability Report*. Estimated maximum

Table 6.17 Average and dry year SWP Article 21 delivery under Future Conditions (taf per year)

Year	2005 SWP Reliability Report, Study 2025	Updated Studies (2007)[2]
1929	0	0
1930	140	0
1931	0	0
1932	110	0 - 40
1933	550	20 - 90
1934	240	0 - 10
1976	0	0
1977	0	0 - 10
1987	180	0
1988	0	0
1989	90	0
1990	0	0
1991	0	0
1992	100	0
Long-term Average[1]	120	30

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.18 Average and wet year SWP Article 21 delivery under Future Conditions (taf per year)

Year	*2005 SWP Reliability Report*, Study 2025	Updated Studies (2027)[2]
1978	300	40 - 150
1979	140	0
1980	90	90 - 130
1981	70	0
1982	170	0
1983	360	270 - 290
1984	490	410 - 420
1985	0	0
1986	80	0 - 10
1987	180	0
1978-87 Average	190	90 - 100
Long-term Average[1]	120	30

[1]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Article 21 delivery is reduced 120 to 130 taf.

Table 6.17 contains the estimates for Article 21 deliveries during historical dry periods. No Article 21 delivery is estimated for the lower range of the updated Future (2027) Conditions for any of the years. For the higher range, some Article 21 deliveries are shown for 1932 through 1934 and 1977. The availability of Article 21 deliveries during dry periods is greatly reduced in the analysis of the updated future (2027) condition.

Table 6.18 shows updated and earlier estimates of Article 21 deliveries by year during the 1978-1987 wet period. The availability of Article 21 deliveries is also reduced for this wet period. The average Article 21 delivery for the 1978 - 1987 period under Future (2027) Conditions ranges from 90 taf/yr to 100 taf/yr, compared to 190 taf/yr for the 2025 study.

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for Future (2027) Conditions in **Figure 6.4.** Results from both the 2025 study from the *2005 SWP Delivery Reliability Report* and the updated 2027 studies are shown. Probabilities for 2027 conditions are shown as a shaded area to reflect the range in SWP Table A deliveries resulting from the four climate change scenarios analyzed.

Figure 6.4 shows that under Future (2027) Conditions, for probabilities of exceedence under 80 percent, updated annual SWP Table A deliveries can be significantly less than the earlier estimates. For example, given a 60 percent time at or above, an earlier estimate of about 3,400 taf annually decreases to about 2,670 taf to 2,890 taf annually for the updated estimates. Displaying delivery

Figure 6.4 *SWP Table A delivery probability under future conditions*

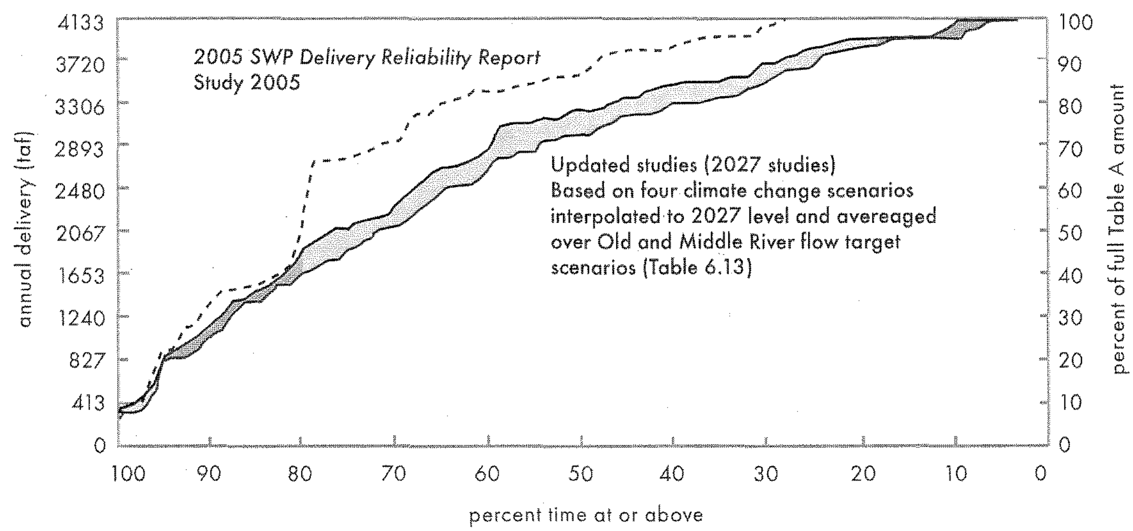


Table 6.19 Highlighted SWP Table A delivery percent exceedence values under Future Conditions

Exceedence	Annual SWP Table A Delivery (taf)		Reduction in delivery in updated studies compared to 2005 report (taf)
	2005 SWP Delivery Reliability Report, Study 2025	Updated Studies (2027)[1]	
25%	4133	3687 - 3815	318 - 446 (8 - 11%)
50%	3565	2967 - 3205	360 - 598 (10 - 17%)
75%	2738	1860 - 2077	661 - 878 (24 - 32%)

1/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets probabilities as a shaded area on **Figure 6.4** shows the impact of uncertainty on probabilities associated with a given future SWP Table A delivery. The information on which **Figure 6.4** is based is contained in **Tables B.12 through B.15** in Appendix B.

Table 6.19 presents the SWP Table A annual deliveries associated with 25, 50, and 75 percent exceedence from **Figure 6.4**. The information in this table can be stated as follows: For any given year,

- There is 1 chance in 4 that SWP deliveries will be at or above the range of 3,687 taf to 3,815 taf.
- There is an equal chance that SWP deliveries will be above or below the range of 2,967 taf to 3,205 taf.
- There is 75 percent chance that SWP deliveries will be above the range of 1,860 taf to 2,077 taf. Another way to state this is that there is a 25 percent chance that deliveries will be below this range.

Comparing Current and Future SWP Delivery Reliability

CalSim II simulation-based results presented earlier in this chapter compare updated delivery projections with those contained in the *2005 SWP Delivery Reliability Report* and generally show that deliveries are projected to be less than projected in the 2005 report due to adding flow restrictions for Old River and Middle rivers set forth in the recent federal court-ordered interim action related to delta smelt and potential climate change scenarios. This section presents the same CalSim II simulation-based results in a way to facilitate comparing current reliability to future reliability. Results from the *2005 SWP Delivery Reliability Report* are presented as a reference.

SWP Table A Deliveries under Different Hydrologic Scenarios

Tables 6.20, 6.21, and 6.22 contain summaries and highlights of estimated SWP Table A deliveries from the Delta under current and Future (2027) Conditions from the *2005 SWP Delivery Reliability Report* and as derived from updated CalSim II simulations for this report. In the 2005 report, future SWP deliveries on average tended to increase over current deliveries. The updated estimates of future SWP deliveries also tend to increase compared to updated estimated current deliveries. An exception is for dry periods. The 2005 report indicated that future SWP Table A deliveries for dry periods would be approximately the same as for current dry periods. The updated estimates indicate that future SWP Table A deliveries under a two-year drought condition (1976-1977) could be lower by as much as 8 percent of maximum SWP Table A than under Current (2007) Conditions (**Table 6.21**).

Article 21 Deliveries under Different Hydrologic Scenarios

Tables 6.23, 6.24, and 6.25 contain summaries and highlights of estimated SWP Article 21 deliveries

Table 6.20 SWP Table A delivery from the Delta under current and Future Conditions

Study of Future Conditions	Average Delivery[2]		Maximum Delivery[2]		Minimum Delivery[2]	
	taf /year	SWP Table A[1] maximum	taf /year	SWP Table A[1] maximum	taf /year	SWP Table A[1] maximum
2005 SWP Delivery Reliability Report Current (2005) Future (2025)	 2818 3178	 68% 77%	 3848 4133	 93% 100%	 159 187	 4% 5%
Update Studies Current (2007) Future (2027)[3]	 2595 2724-2850	 63% 66 - 69%	 3711 4133	 90% 100%	 243 255 - 293	 6% 6 - 7%

[1]/ 4,133 taf /year

from the Delta under current and Future Conditions from the *2005 SWP Delivery Reliability Report* and as derived from updated CalSim II simulations for this report. Overall, the CalSim II simulations from the 2005 report and the updated simulations for 2007 and 2027 conditions tend to show less Article 21 deliveries in the future. Depending on the climate change scenario, updated estimates of future SWP Article 21 deliveries may increase over updated current values for specific years; however, the long-

Table 6.21 Average and dry period SWP Table A deliveries from the Delta under current and Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[2]	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005 SWP Delivery Reliability Report						
Current (2005)	68%	4%	41%	32%	42%	37%
Future (2025)	77%	5%	40%	33%	42%	38%
Update studies						
Current (2007)	63%	6%	34%	35%	35%	34%
Future (2027)[3]	66 - 69%	7%	26 - 27%	32 - 37%	33 - 35%	33 - 36%

Table 6.22 Average and wet period SWP Table A deliveries from the Delta under current and Future Conditions

Study of Future Conditions	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Long-term Average[2]	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
2005 SWP Delivery Reliability Report						
Current (2005)	68%	60%	65%	69%	75%	72%
Future (2025)	77%	95%	97%	93%	93%	89%
Update studies						
Current (2007)	63%	60%	66%	68%	73%	71%
Future (2027)[3]	66 - 69%	94%	97%	86 - 87%	84 - 87%	80 - 83%

Table 6.23 Annual SWP Article 21 delivery from the Delta under current and Future Conditions

Study of Current Conditions	Average delivery[2] (taf)	Maximum delivery[1] (taf)	Minimum delivery[1] (taf)
2005 SWP Delivery Reliability Report			
Current (2005)	260	1110	0
Future (2025)	120	550	0
Update studies			
Current (2007)	90	590	0
Future (2027)[3]	30	410 - 420	0

For Tables 6.20 - 6.23:
[2]/ 1922-1994 for 2005 *SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[3]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.24 Average and dry year SWP Article 21 delivery under current and Future Conditions (taf per year)

Year	*2005 SWP Delivery Reliability Report*		Updated Studies	
	Current (2005)	Future (2025)	Current (2007)	Current (2027)[2]
1929	0	0	0	0
1930	120	140	0	0
1931	0	0	0	0
1932	240	110	0	0 - 40
1933	510	550	40	20 - 90
1934	210	240	0	0 - 10
1976	190	0	5	0
1977	0	0	0	0 - 10
1987	550	180	0	0
1988	0	0	0	0
1989	0	90	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	100	0	0
Long-term Average[1]	260	120	85	30

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Table 6.25 Average and wet year SWP Article 21 delivery under Current and Future Conditions (taf per year)

Year	*2005 SWP Delivery Reliability Report*		Updated Studies	
	Current (2005)	Future (2025)	Current (2007)	Current (2027)[2]
1978	300	300	100	40 - 150
1979	160	140	0	0
1980	140	90	190	90 - 130
1981	550	70	0	0
1982	800	170	490	0
1983	400	360	400	270 - 290
1984	550	490	460	410 - 420
1985	0	0	0	0
1986	120	80	30	0 - 10
1987	550	180	0	0
1978-87 Average	360	190	170	90 - 100
Long-term Average[1]	260	120	85	30

[1]/ 1922-1994 for *2005 SWP Delivery Reliability Report*; 1922-2003 for Updated Studies (2027)
[2]/ Range in values reflects four modified scenarios of climate change: annual *Table A* deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

term average future Article 21 delivery is less than half of the estimate for the current (2007) scenario.

SWP Table A Delivery Probability

The current and future probability that a given level of SWP Table A amount will be delivered from the Delta is shown in **Figure 6.5** from the *2005 SWP Delivery Reliability Report* and in **Figure 6.6** for update studies for this report. In the 2005 report, future SWP Table A deliveries exceeded current deliveries at the 80 percent exceedence level. Under the updated simulations for this report, future SWP Table A deliveries exceed current deliveries at approximately the 60 percent exceedence level. Above this exceedence, future deliveries are larger than current deliveries,

Figure 6.5 Current and future *SWP Table A* delivery probability from the *2005 SWP Delivery Reliability Report*

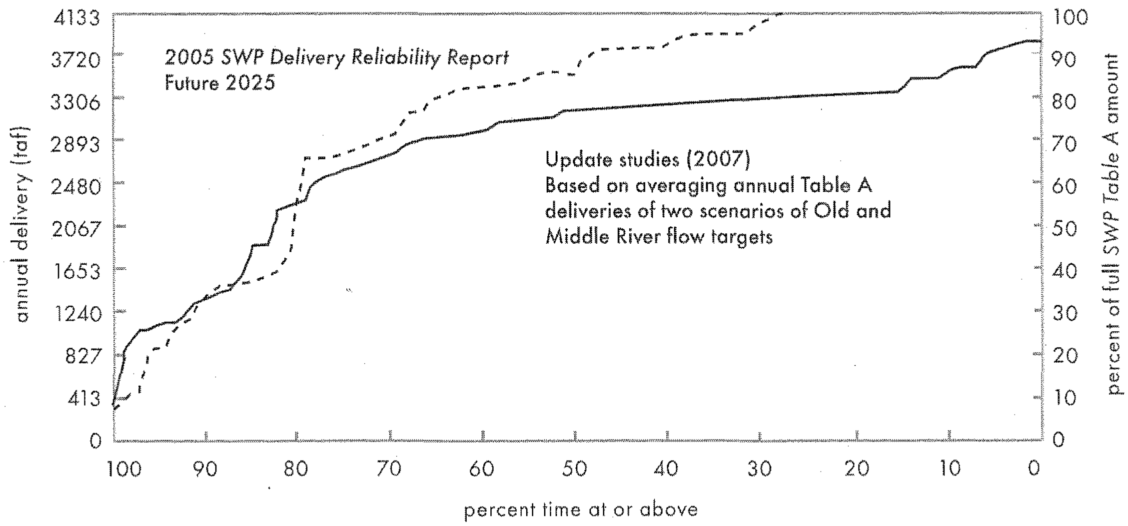
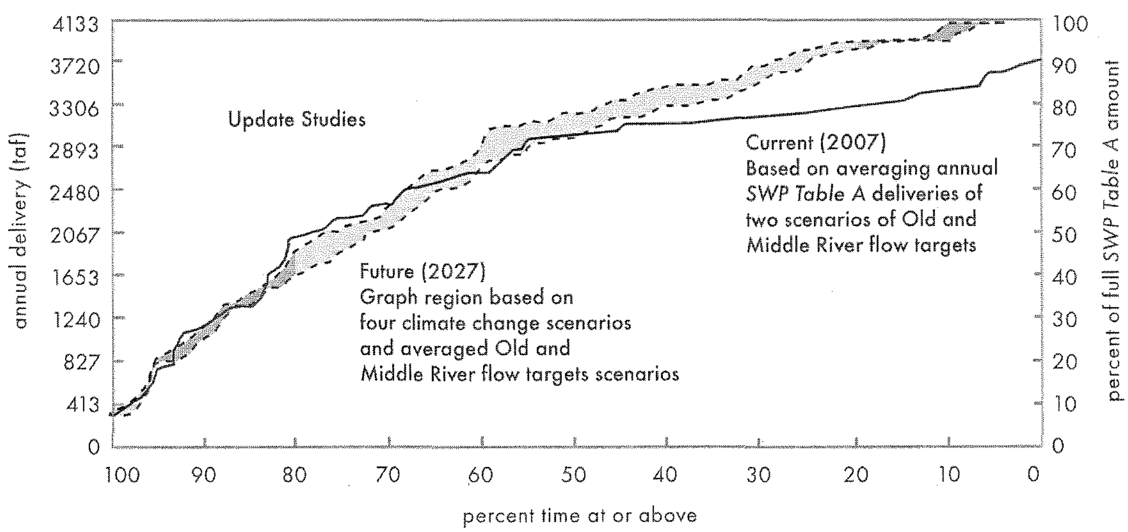


Figure 6.6 Updated current and future *SWP Table A* delivery probability



with the difference in delivery amount depending upon which climate change scenario is assumed.

Table 6.26 presents SWP Table A delivery values which correspond to 25, 50, and 75 percent exceedence for Current and Future Conditions. Previously in the 2005 report, future annual SWP deliveries were estimated to be larger than current deliveries by approximately 900 taf, 400 taf, and 150 taf for 25 percent, 50 percent, and 75 percent exceedences respectively. For the updated studies, future SWP Table A deliveries associated with a given percent exceedence may also be higher than for the deliveries at the current level (2007), but this difference is significantly less. In fact, future deliveries associated with an exceedence level of above 50 percent may be less than under Current (2007) Conditions for certain climate change scenarios.

Table 6.26 Highlighted SWP Table A delivery percent exceedence values under Current and Future Conditions

Exceedence	Annual SWP Table A Delivery (taf)			
	2005 SWP Delivery Reliability Report		Updated Studies	
	Current (2005)	Future (2025)	Current (2007)	Future (2027)[1]
25%	3323	4133	3218	3687 - 3815
50%	3173	3565	2976	2967 - 3205
75%	2588	2738	2168	1860 - 2077

[1] Range in values reflects four modified scenarios of climate change: annual SWP Table A deliveries were first interpolated between full 2050 level and no climate change scenarios, then averaged over the two scenarios of Old and Middle River flow targets.

Interpreting and Applying the Results for Local Planning Use

7

Chapter 6 presents a single set of estimates for current-level deliveries and a range of results for deliveries 20 years in the future. Chapter 6 and Appendix B explain how these estimates are developed. This chapter provides guidance on how to apply the delivery estimates to water management plans.

All results in this report are presented as percentages of the maximum SWP Table A amount for SWP deliveries from the Delta of 4.133 maf/yr. Estimates of deliveries for a specific SWP contractor can be converted to acre-feet/year by multiplying the percentages by that contractor's maximum SWP Table A amount. It is possible that the SWP Table A amount for a specific contractor may not be at the ultimate maximum value, but it should be very close to it. The Delta SWP Table A value for 2007 is 4.127 maf/yr, 99.9 percent of the maximum Delta SWP Table A value of 4.133 maf/yr. Therefore, for almost all purposes, this approach should be sufficient for these analyses. In addition, the percentages may also be used to estimate the SWP Table A deliveries to SWP contractors in Butte and Plumas counties and Yuba City. The deliveries to these contractors would be calculated using the same method.

The following two examples are taken from Chapter 6 of the *2005 State Water Project Delivery Reliability Report* and updated with the data from this report. These examples are developed for a hypothetical SWP contractor with a maximum SWP Table A amount of 100,000 acre-feet per year. Hypothetical examples illustrating applications of the delivery probability curves and adjustments to the data for a SWP contractor that cannot convey its maximum SWP Table A amount are provided in *The State Water Project Delivery Reliability Report 2002*. Questions regarding the use of the information contained in these reports may be directed to the Department of Water Resources' Bay-Delta Office at (916) 653-1099.

Example 1

This example uses data directly from **Table 6.21** for updated current and future estimates of SWP Table A deliveries during dry periods and employs allocation methods that provide a simple means of estimating supplies to each contractor. The analysis includes high and low estimates of the range of values for year 2027. In order to estimate deliveries between current (2007) and Future (2027) Conditions, the data in the table is interpolated for five-year increments and contained in **Table 7.1**. **Table 7.1** shows the average percentage of maximum Delta SWP Table A deliveries for average, single-dry year, and two-, four- and six-year multiple dry year scenarios from 2007 to 2027 in five-year increments.

The maximum SWP Table A amounts of each contractor are listed in Appendix C. SWP Table A amounts can be amended and a contractor's SWP Table A amount over the next 20 years may be less than its maximum over some or all of this period. In this case, the contractor should use the amended SWP Table A amounts for the corresponding years during this period. To use dry years other than those presented in **Table 7.1**, or to show year-to-year supplies instead of averages over a multiple-dry year period, see Example 2.

How to Calculate Supplies

In order to estimate delivery amount for the average and drought periods for each five-year increment from 2007 to 2027, multiply the contractor's SWP Table A amount for a particular year by the corresponding delivery percentages for that year from **Table 7.1**.

Tables 7.2 through 7.4 show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum SWP Table A amount of 100,000 af, on average and for the various drought periods. For this example, the supplies shown for the multiple-dry year period are average supplies over the four-year drought from 1931-1934. Data from other year types, although not required in an urban water management plan, could also be presented this way.

Example 2

This example is similar to Example 1 but allows a contractor to select alternative single-year or multiple-dry year sequences other than those presented in **Table 7.1**. This option might be selected if analyzing different hydrologic year(s) makes more sense given a contractor's other supply sources, or given the locally acceptable risk level for water delivery shortages.

This example can also be used to identify supplies projected to be available in each year of a multiple-dry year period. While the Water Code does not specifically require this, the *Urban Water Management Plan Guidebook* suggests showing year-to-year supplies (see the *UWMP Guidebook*, Section 7, Step 3).

Where to Find the Data

Choose a single-year or multiple-year sequences from **Tables B.3 and B.12 through B.15** to represent single-dry year and multiple-dry year scenarios. **Table B.3** contains the percent of maximum SWP Table A deliveries under all 82 hydrologic years in the updated model study for 2007. **Tables B.12 through B.15** contains the percent of maximum SWP Table A deliveries under all 82 hydrologic years in the updated model studies for 2027.

How to Calculate Supplies

Multiply the contractor's SWP Table A amount for a particular year by the percent of maximum SWP Table A deliveries for the selected years, to get an estimated delivery amount for the years selected, for 2007 and 2027. Values for years between 2007 and 2027 can be linearly interpolated.

Tables 7.5 through 7.8 show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum SWP Table A amount of 100,000 af, in a single dry year and year-to-year over a multiple dry-year period. For this example, the single dry year selected is for 1988 conditions, and the multiple dry-year period selected is the three-year period from 1990-1992. In showing year-to-year supplies for the multiple-dry year period, these year-to-year supplies should be shown for each five-year increment during the 20-year projection period.

Table 7.1 SWP average and dry year SWP Table A delivery from the Delta in five-year intervals for studies 2007 and 2027

Year	Percent of maximum (4,133 taf /year) SWP Table A delivery from the Delta					
	Average 1922-2003	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2007	63%	6%	34%	35%	35%	34%
2012	64 - 65%	6%	32%	34 - 36%	35%	34 - 35%
2017	65 - 66%	7%	30 - 31%	34 - 36%	34 - 35%	34 - 35%
2022	66 - 68%	7%	28 - 29%	33 - 37%	34 - 35%	33 - 36%
2027	66 - 69%	7%	26 - 27%	32 - 37%	33 - 35%	33 - 36%

Table 7.2 Average annual SWP deliveries assuming a maximum SWP Table A amount of 100,000 acre-feet (acre-feet)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	63,000	64,000 - 65,000	64,000 - 66,000	65,000 - 68,000	66,000 - 69,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1]/ Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 4.

Table 7.3 Single dry year SWP delivery (1977 conditions) assuming a maximum SWP Table A amount of 100,000 acre-feet (acre-feet)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	6,000	6,000	7,000	7,000	7,000
State Water Project (Article 21)[1]	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1]/ Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 4.

Table 7.4 Average SWP Delivery over a multiple dry year period assuming a maximum SWP Table A amount of 100,000 acre-feet 1931-1934 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	35,000	34,000 - 36,000	34,000 - 36,000	33,000 - 37,000	32,000 - 37,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1]/ Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 4.

Table 7.5 Annual SWP delivery over single dry year (1988 conditions),
assuming a maximum Table A amount of 100,000 acre-feet (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	11,540	11,490 - 12,000	11,440 - 12,460	11,370 - 12,920	11,320 - 13,380
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Table 7.6 Annual SWP delivery over multiple dry year period 1990-1992,
assuming a maximum Table A amount of 100,000 acre-feet 1990 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	8,710	8,080 - 8,590	7,450 - 8,470	6,800 - 8,320	6,170 - 8,200
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Table 7.7 Annual SWP delivery over multiple dry year period 1990-1992,
assuming a maximum SWP Table A amount of 100,000 acre-feet 1991 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	17,640	17,980 - 18,485	18,290 - 19,360	18,630 - 20,200	18,950 - 21,050
State Water Project (Article 21)[1]	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Table 7.8 Annual SWP delivery over multiple dry year period 1990-1992, assuming a maximum SWP Table A amount of 100,000 acre-feet 1992 conditions (acre-feet per year)

Water Supply Source	2007	2012	2017	2022	2027
State Water Project (Table A)	26,300	26,180 – 26,880	26,030 – 27,460	25,910 – 28,040	25,770 – 28,620
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					