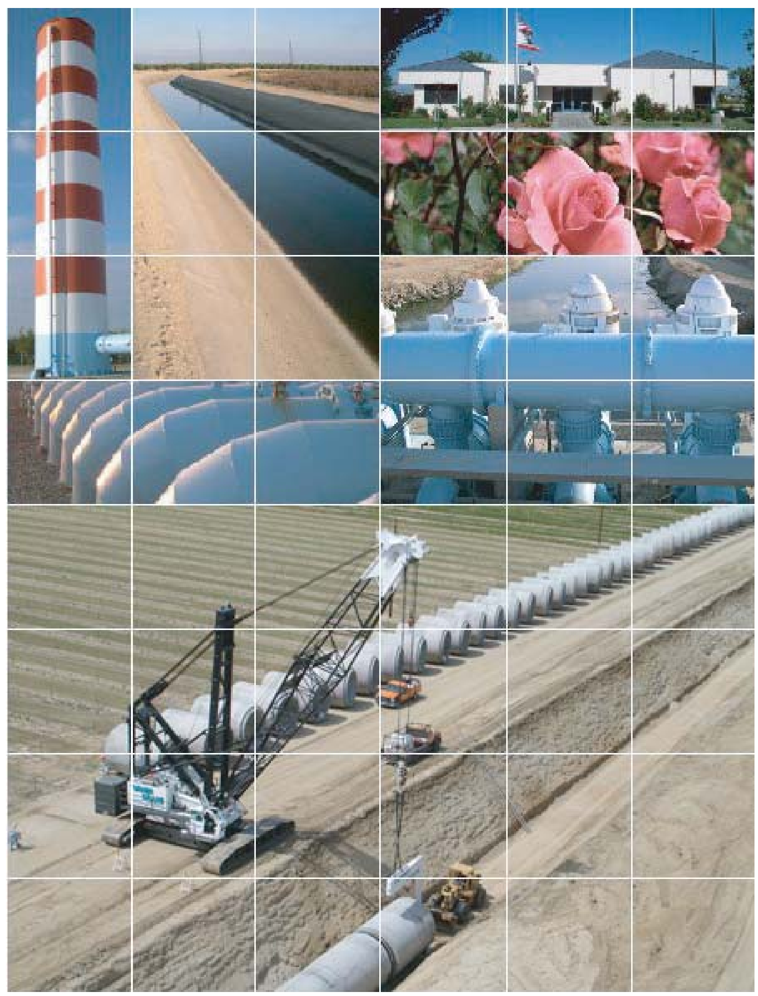
RECLAMATION

Managing Water in the West

Semitropic Stored Water Recovery Unit Special Study Report



U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

November 2007

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation’s natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitment to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Semitropic Stored Water Recovery Unit
Special Study Report

Prepared by:

Bureau of Reclamation

Mid-Pacific Region

U.S. Department of the Interior
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Abbreviations and Acronyms

CALFED	A unique collaboration among 25 Federal and State agencies that came together to improve both the water supplies in California and the health of the San Francisco Bay/Sacramento San-Joaquin River Delta.
Aqueduct	California Aqueduct
CEQA	California Environmental Quality Act
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
EA	Environmental Assessment
EIR	Final Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EWA	Environmental Water Account
FWS	U.S. Fish and Wildlife Service
HCP	Habitat Conservation Plan
KCWA	Kern County Water Agency
KWB	Kern Water Bank
MCL	maximum contaminant level
M&I	Municipal and Industrial
MOU	Memorandum of Understanding
MWD	Metropolitan Water District of Southern California
NED	National Economic Development
NEPA	National Environmental Policy Act
NWR	National Wildlife Refuge
O&M	Operation and Maintenance
P&G	Principles and Guidelines
Reclamation	U.S. Bureau of Reclamation
RED	Regional Economic Development
ROD	Record of Decision
RRA	Reclamation Reform Act
SCVWD	Santa Clara Valley Water District
Semitropic	Semitropic Water Storage District
Shafter-Wasco	Shafter Wasco Irrigation District
SWP	State Water Project
SWRU	Stored Water Recovery Unit
TDS	Total Dissolved Solids
UCCE	University of California Crop Extension
USDA	U.S. Department of Agriculture
WA	Wildlife Area
WAP	Water Acquisition Program

Units of Measure

af	acre-feet
cfs	cubic feet per second
gpd/ft	gallons per day per foot
mg/L	milligrams per liter
ppb	parts per billion
ppm	parts per million

Executive Summary

Introduction

The United States Department of the Interior, Bureau of Reclamation (Reclamation) has prepared this report to present the results of a Special Study to determine if a potential Federal interest exists in participating in the Stored Water Recovery Unit (SWRU) project of the Semitropic Water Storage District (Semitropic), in Kern County, California. This Special Study was prepared using information provided by Semitropic for compliance with the California Environmental Quality Act (CEQA). This Special Study is being accomplished by Reclamation as directed by Congress in the Conference Report (H. Rpt 109-275 for H.R. 2419) for the Energy and Water Development Appropriations Act of 2006 (P.L. 109-103 November 19, 2005). As detailed below, this Study finds that there are several areas of potential Federal interest in the SWRU that may warrant further evaluation because additional information is needed to fully determine the advantages and disadvantages of the SWRU to the Central Valley Project (CVP). This report is not a decision document, but rather an assessment and synthesis of available information together with an economic analysis of potential Federal participation in the SWRU.

Semitropic has sought Reclamation's participation in the SWRU to help meet its objectives of improving surface water availability and groundwater reliability to support agricultural production, environmental protection, and the longevity of the underlying aquifer within Semitropic.

Reclamation’s potential participation in the SRWU may possibly assist in providing CVP contractors with added water supply reliability and could provide the CVP with additional water storage options for a variety of Reclamation water delivery obligations in California. These obligations include agricultural, municipal and industrial (M&I), and various environmental water demands.

The primary study area for the Special Study is Semitropic. A secondary study area includes all current Semitropic banking partners and regional water supply programs that could be affected by Federal participation in the SWRU. This secondary area extends from San Francisco Bay to southern San Diego County. Figure ES-1 shows the primary study area and current banking partners.

Study Approach

A process was developed to formulate alternative ways for Reclamation to participate in the SWRU to achieve its planning objectives. The first step was to specify planning objectives as the basis to determine the potential type and extent of Federal interest. Alternative management measures were then identified to address problems, take advantage of opportunities, and achieve the planning objectives.

The management measures were then evaluated to determine how well each measure achieves the Federal planning criteria: completeness, effectiveness, efficiency, and acceptability. The evaluation included the following steps:

- Evaluate how well each management measure performs related to each planning objective and other criteria;
- Develop rating scales to allow even application of performance measures to each management measure; and
- Compile the evaluation results into a matrix to understand results.

Lastly, a scenario of the management measures was developed and evaluated to determine the potential type and extent of Federal interest.

Planning Objectives

Reclamation’s planning objectives for potential Federal participation in the SWRU include the storage of CVP water to improve operational reliability and flexibility. Specifically these objectives include:

- Improve CVP water supply reliability for use during drought periods.
- Provide environmental water supply reliability for refuges and other environmental programs in the San Joaquin Valley.
- Provide additional water supply and storage to lessen the region's reliance on Millerton Reservoir and the Friant-Kern System.

Management Measures

A management measure is a potential project feature or component, policy, or program that could help achieve the planning objectives. If Reclamation funds a portion of the SWRU, it could participate in the banking project with storage and pump-back benefits for a variety of different sectors. With Reclamation’s participation in the SWRU, the following management measures were identified:

- Provide dry-year supplies for agricultural and municipal and industrial users.
- Provide water for the Kern National Wildlife Refuge;
- Store water for environmental purposes similar to the Environmental Water Account (EWA); and
- Use the intertie between Semitropic and the Shafter-Wasco Irrigation District (Shafter-Wasco) to reduce demand on the Friant-Kern System (and provide water for environmental use).

According to the Federal planning criteria, all of these measures perform well.

Figure ES-1
Semitropic Stored Water Recovery Unit Study Area

Scenario for Potential Federal Participation in the SWRU Project

An example scenario was developed that combined the following two management measures: drought water supply reliability to CVP contractors and environmental water to the San Joaquin River by exchanging banked water for Shafter-Wasco contract deliveries on the Friant-Kern System.

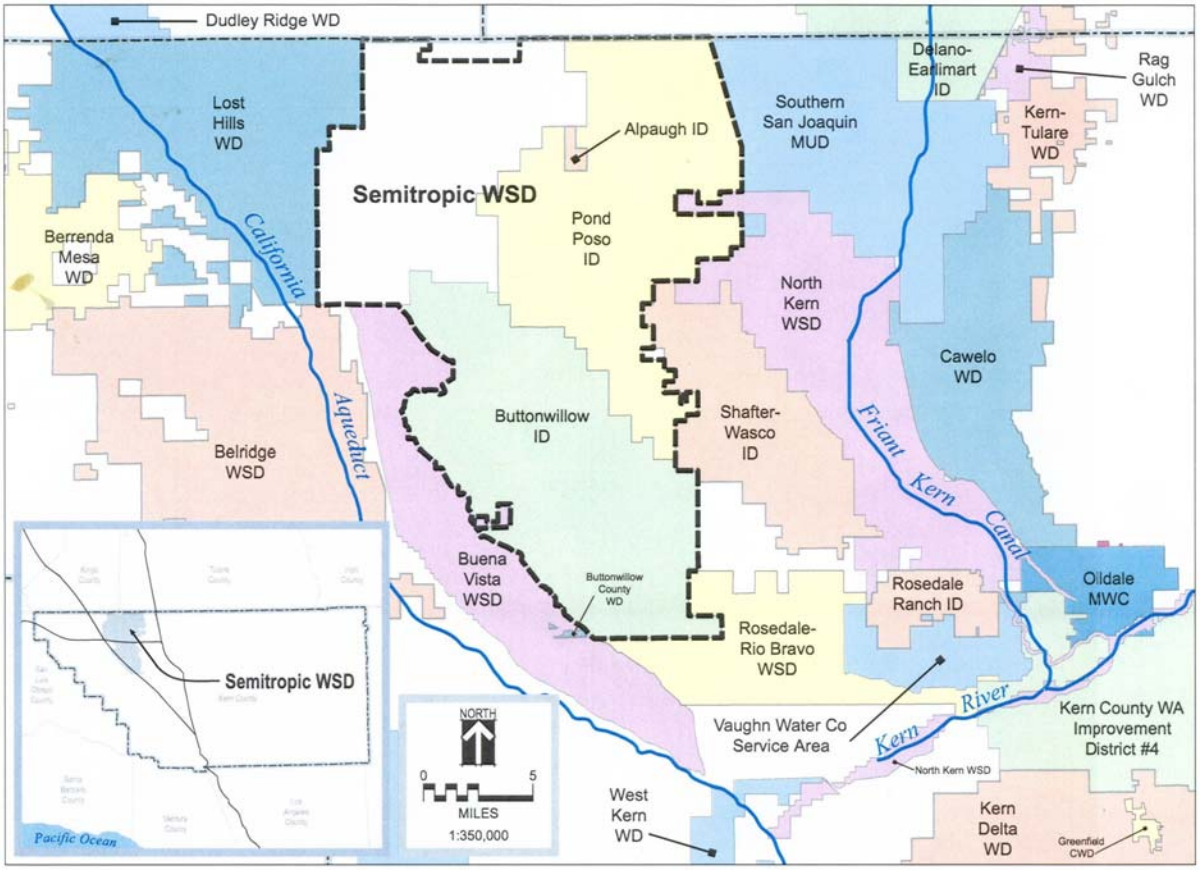

Figure ES-2
Semitropic and Neighboring Districts

The scenario assumes that Reclamation would commit $50,000,000 over a 30-year period to ensure a supply of water for Federal contractors and others from the SWRU by purchasing low and high priority shares at a distribution of 30 percent and 70 percent, respectively, given the generally higher need for dry and critically dry year water supply reliability. Table ES-1 provides a summary of estimated number of shares and the storage and pump back created by this level of investment.

Table ES-1
Summary of Hypothetical Federal Participation
with $50,000,000 Committed Over 29 Years

Water User	***Shares Purchased***	***Estimated Cost Per Acre-Foot[1]***	***Storage Available Acre-feet***	***Water Available for Recovery[2,3] Acre-feet***	***Yearly Recharge Potential[3] Acre-feet***	***Pump Back Capacity Acre-feet***
Low Priority Environmental Water	8,860.00	$280	26,580	23,922	2,924	8,860
High Priority Contractor Water	15,150.00	$390	45,450	40,905	5,000	15,150

1. Assumes 3 acre-ft of storage per share, two storage cycles per life of contract does not include initial purchase price and conveyance cost of the stored water
2. Assumes a 10% loss of water upon recovery
3. Contractually guaranteed recovery and recharge capacity. Greater quantities could be recharged and recovered if the capacity is available.

Recharge and recovery from the SWRU over a single cycle takes approximately 12 years (9 years are required to fill the SWRU and 3 years are required to extract). Figure ES-2 hypothetically demonstrates how the water could be distributed over a 29-year period and how water could be stored and extracted from the SWRU for use as both drought year M&I supply and below normal water year Shafter-Wasco supply. In this scenario, high priority water can be stored at a rate of 5,000 acre-feet (af) per year and low priority water can be stored at a rate of 2,924 af per year. The high priority water can be extracted at a rate of 15,150 af per year in dry and critically dry years and the low priority water can be extracted at a rate of 8,860 af per year in normal and above normal water years.

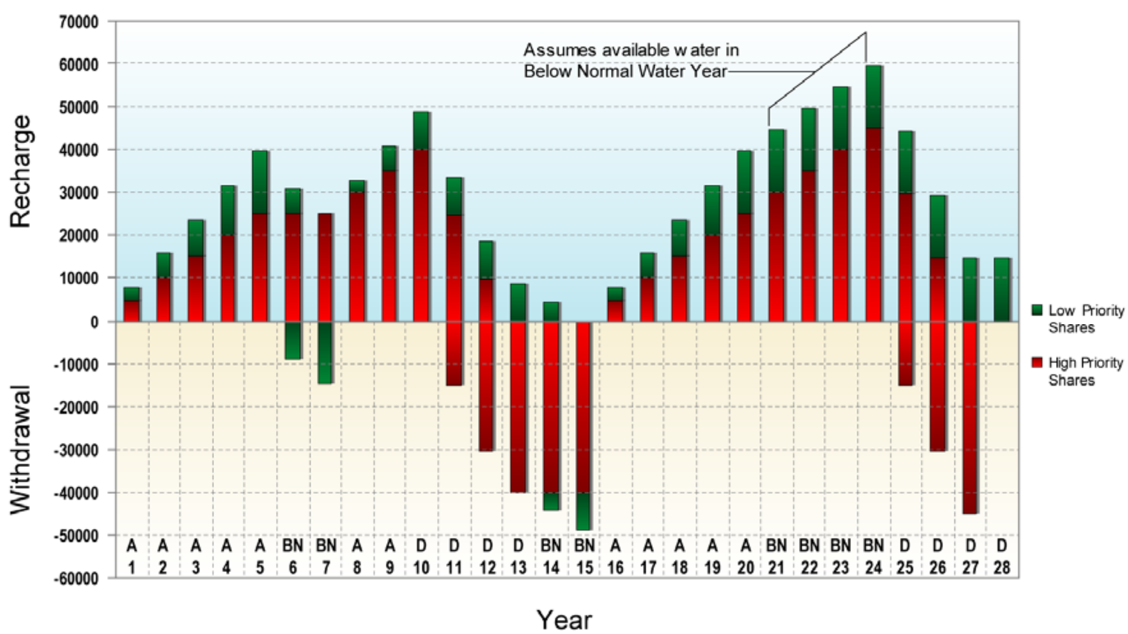

Figure ES-3
CVP Water Storage and Recovery Scenario in the SWRU

Two extraction cycles are imposed over two drought cycles and the scenario assumes low priority water would be recharged for Shafter-Wasco during the below normal water years that occur in years 21 through 24 of the scenario. Low priority water would be extracted for Shafter-Wasco during years 6, 7, 14 and 15. The scenario assumes that high priority water would not be recharged during periods of low priority water extraction.

Reclamation's participation in a high priority scenario for M&I and agricultural contractors appears justified but could be limited by the availability of surplus water in the CVP system to fully recharge the SWRU. Low priority water could be used to supply Shafter-Wasco in exchange for CVP water on the Friant-Kern System. This water is assumed to only be available in below normal non-dry years due to the limitations on pump back.

Findings and Conclusions

The SWRU is a technically and legally operable groundwater storage and recovery program with all essential SWRU Phase 1 facilities either constructed or under construction.

There may be a potential Federal interest in the SWRU as it could provide added CVP water supply reliability and operational flexibility. Reclamation's participation in the SWRU to improve CVP contractor water supply reliability and provide for environmental water could help to support the CALFED Bay-Delta Program as described in Section 103(d)(1)(A)(iii) of the CALFED Bay-Delta Authorization Act.

There may also be a potential Federal interest in the SWRU as it could provide Central Valley Improvement Act (CVPIA) water supply for protection, restoration, and enhancement of fish, wildlife, and associated habitats in the Central Valley. Reclamation's participation in the SWRU for the improvement of fish, wildlife, and habitat protection and restoration measures could be accomplished through a program funded by a cost-sharing agreement between the United States Government that would pay 75 percent of the project cost, associated with the delivery of Level 4 Refuge water supplies, and the State of California or an entity within the State that would pay the remaining 25 percent, as established by the CVPIA Section 3406(d)(5).

Costs for storage and recovery of water from the SWRU are estimated at $280 per af for normal water year supply to $390 per af for drought water year supply (costs do not include water purchase or wheeling to the SWRU). One measure to evaluate the potential Federal interest would if the benefits to cost ratios exceed 1.0 when the benefits associated with avoided costs for existing or new water supplies is greater than cost for banked water in the SWRU.

Additional benefits which may contribute to National Economic Development (NED) and Regional Economic Development (RED) include reduced agricultural production costs and increased dry year and emergency supply for M&I.

This Special Study is an assessment and synthesis of available information with an economic analysis of potential Federal participation in the SWRU. There may be a potential Federal interest for participation in the SWRU based upon, but not limited to, the management measures identified above. However, additional information and action are needed to fully determine the advantages and disadvantages of the SWRU to the CVP. These data gaps include the following:

- CVP yield analysis that quantifies the amount of water available for banking in the SWRU. Much of the baseline work is complete with existing Reclamation Studies to facilitate this analysis;
- Semitropic monthly irrigation schedule by water year type and the effect of the existing water bank and the proposed SWRU has on the in-lieu water storage capabilities;
- Analysis of the potential costs associated with utilizing land in the proposed well field operated by the California Department of Fish and Game (DFG);
- Verification of the Semitropic groundwater level declines during extended extraction. Semitropic has an existing, calibrated groundwater model that may be used for this purpose;
- Analysis of potential subsidence associated with extended groundwater extraction events;
- Wheeling arrangements with the State for delivery of CVP water to the SWRU. Several transactions of this type have already been performed by CVP Contractors;
- SWRU alternatives should be compared to other groundwater and surface water storage programs in the region that could be utilized to meet CVP supply reliability needs. Various existing studies by CALFED and the California Department of Water Resources (DWR) (e.g., evaluation of Proposition 50 applications) may facilitate this comparison;
- Engineering analysis including costing for arsenic removal from groundwater for the SWRU. Semitropic has already performed several studies, including pilot tests, that may aid in this evaluation; and
- Compliance with the National Environmental Policy Act (NEPA).

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Chapter 1
Introduction

1.1 Purpose and Scope

The purpose of this report is to present the results of a Special Study to determine if there is a potential Federal interest in participating in Semitropic Water Storage District's (Semitropic) Stored Water Recovery Unit (SWRU). The SWRU is a groundwater storage/conjunctive use project (i.e., "water bank" or "groundwater bank") with in the boundaries of Semitropic located north-west of Bakersfield, California. This report is not a Federal decision document and is not suitable for seeking Congressional authority to construct the project.

This report identifies the preliminary opportunities, issues of concern, inventories and forecasts conditions, performs a preliminary screening of management measures and presents a hypothetical scenario to assess the viability of the Bureau of Reclamation's (Reclamation) participation in the SWRU. Findings and conclusions are based upon the synthesis and analysis of existing reports, studies, and data, with the addition of an economic analysis to determine the cost and benefit of potential Federal participation in the bank. This Special Study also identifies potential management measures that could justify Federal participation in the SWRU.

This study generally followed guidelines defined in the Water Resource Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs) for water resource development planning, although certain aspects of this study were limited due to time and funding constraints. No Federal action is recommended in this report. Additional planning and analysis is needed to establish and justify a specific Federal recommendation. Authorization to construct or otherwise participate in any project requires related economic and environmental documentation.

Investigated as a part of the Special Study and presented in this report, the SWRU may have potential benefits to the region and nation that include:

- Improved reliability of the water supply to Central Valley Project (CVP) contractors through access to stored water;
- Potential storage of Central Valley Project Improvement Act (CVPIA) supplies within the SWRU through direct partnership with Semitropic; and
- Potential storage of water supplies to support Federal and/or State wildlife and habitat preservation projects around the State.

This report evaluates each of these potential benefits.

1.2 Federal Interest in Participation

Reclamation's potential participation in the SWRU could assist in providing CVP contractors with added water supply reliability. It could also provide the CVP with an additional water storage option for CVPIA consistent with the objectives of the CALFED Bay-Delta Authorization Act of 2004 (P.L. 108-361) and other Reclamation water delivery obligations in California.

1.3 Background

The Semitropic was established in 1958 to supplement existing groundwater resources within a 221,000-acre area of Kern County in the San Joaquin Valley northwest of Bakersfield. Irrigation in the Semitropic service area relied entirely on groundwater pumping until 1973, when the State Water Project (SWP) began delivery of surface water via the California Aqueduct (Aqueduct). The installation of infrastructure to provide SWP water to the 136,000 acres of irrigated agricultural land alleviated the strain on groundwater resources in Semitropic.

Prior to the formation of the water bank, SWP water was delivered to agricultural land that previously depended on groundwater, decreasing the strain on groundwater resources. Groundwater levels within Semitropic increased, and pumping costs were reduced. However, not all agricultural land within Semitropic had connection to the SWP surface supply. An Improvement District was created to consolidate existing Improvement Districts within Semitropic and to identify measures to further improve the water supply condition within Semitropic. In 1992 Semitropic developed an Improvement Projects Report that identified the implementation of a water banking program as a potential tool for the continued improvement of groundwater levels in Semitropic (2000 Supplemental Environmental Impact Report [EIR], pages 2-3).

In 1994, Semitropic developed the Semitropic Groundwater Bank to implement the water banking program identified in the 1992 Improvement Projects Report to improve the groundwater condition in Semitropic. Under this program, Semitropic has accepted deliveries of surface water belonging to its banking partners for agricultural irrigation within Semitropic in place of operating groundwater pumps and wells. Using surface water in lieu of groundwater reduced groundwater extraction and improved groundwater levels in the aquifer that underlies Semitropic. Semitropic banking partners who diverted surface water entitlements to Semitropic for use in agriculture production received credit for the groundwater they stored through agricultural in-lieu recharge (recharge), essentially "banking" this water for future use with the exception of ten percent of the total water banked that was subtracted from the banking partners' deposit to account for efficiency losses.

The original design for the banking program, proposed in the 1992 Improvement Projects Report, relied on the Kern Water Bank (KWB) to operate the program as a local element. When the State of California abandoned plans to develop the KWB as a SWP storage area, the Metropolitan Water District of Southern California (MWD) joined with Semitropic to independently continue development of the Semitropic Groundwater Bank

(2000 Supplemental EIR, page 20). MWD was the largest single banking partner in the groundwater bank until 1997 when Santa Clara Valley Water District (SCVWD) joined the groundwater bank. MWD and SCVWD each hold 35 percent of the banking capacity in Semitropic (1994 EIR, page S-8).

The original Semitropic Groundwater Bank has an estimated one million acre-feet (af) of defined storage capacity, subscribed by six banking partners: (1) MWD; (2) SCVWD; (3) Alameda County Water District; (4) Zone 7 Water Agency in Alameda County; (5) the privately owned Vidler Water Company; and (6) the privately owned Newhall Land and Farming Company. The partners cover an area from San Francisco Bay to southern San Diego County. The locations of Semitropic's original public banking partners are shown in Figure 1-1.

In 1999 Semitropic initiated environmental review of the SWRU project as a supplement to the original groundwater bank that would increase Semitropic's pump back capacity to enable a total yearly return of 290,000 af of groundwater to the banking partners. The SWRU supplemental EIR was final in 2000. The SWRU was initiated in response to requests from banking partners (from the original groundwater bank) for an improvement in banked water return rates from the 11 years needed (with the infrastructure developed in the original bank) to three and a half years as proposed for the SWRU (1994 EIR, pages 2-5). This change in recovery rate would allow the original banking partners to more effectively respond to drought years.

The 2000 Supplemental EIR also identified the potential for the creation of an additional 12,000 acres of in-lieu recharge area beyond what had been developed as part of the original groundwater banking program in 1994. In 2002 an addendum to the 2000 Supplemental EIR was prepared that proposed the implementation of the additional 650,000 af of storage capacity in the groundwater bank identified in the 2000 Supplemental EIR, which would increase the total groundwater bank capacity to 1,650,000 af. The 650,000 af increase in defined storage capacity would allow Semitropic to sign agreements for additional banking partners or create the potential option for original banking partners to increase their total recovery capacity.

1.3.1 Banking Operations

The banking process allows Semitropic to accept delivery of water from the Aqueduct in-lieu of extracting water from wells within Semitropic. The water is provided by "banking partners," the districts, agencies, and companies participating in the banking operations. To participate, these banking partners provide surplus surface water to Semitropic for use as irrigation water in-lieu of pumping groundwater. This water is delivered via the Aqueduct and an equivalent volume of groundwater (minus the 10 percent subtracted by Semitropic for estimated losses) is credited as stored water to the banking partner. The groundwater banking operation in Semitropic is split into two programs: the original groundwater banking project and the SWRU that is currently being developed. Figure 1-2 outlines the operational details in terms of storage and groundwater extraction capacity created in each program.

Figure 1-1
Semitropic Groundwater Banking Partners

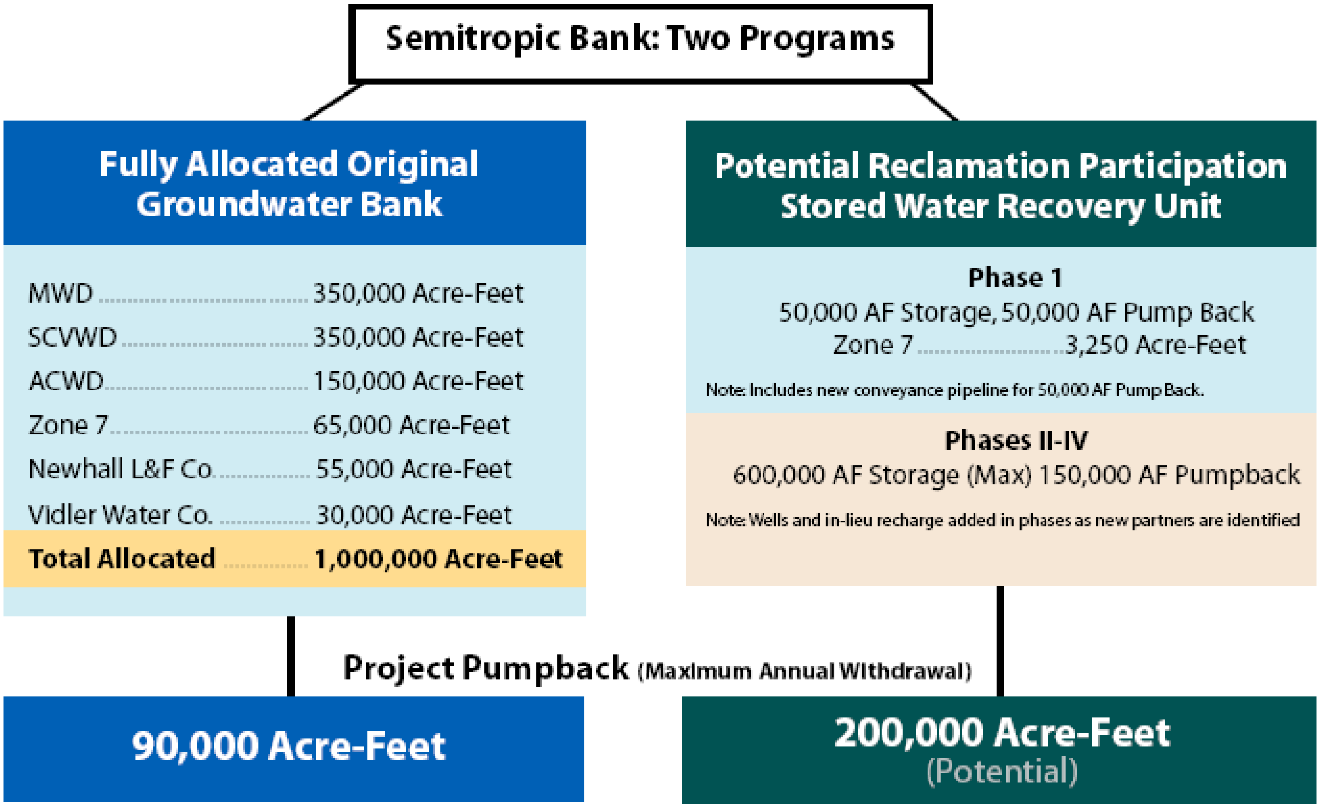


Figure 1-2
Semitropic Groundwater Bank Operations

The original bank has 1,000,000 af of storage with a total annual pump back capacity of 90,000 af. Ideally, a full 330,000 af of pump back would be available to the original bank partners. In response to this pump back shortage, original banking partners have agreed to a percentage of the available pump back if the request exceeds the 90,000 af limit. The percentage is based upon each member’s percentage of original bank shares. For example a 10 percent bank partner with 100,000 af of storage would be entitled to no more than 9,000 af of pump back in a dry year if request for pump back exceeds 90,000 af.

The limitations on withdrawal of stored groundwater are addressed in the original banking program by cooperative agreements among the original banking partners. The different water districts have designed their extraction schedules collaboratively in an attempt to limit potential conflict caused by competing withdrawal requests. To date, the original banking partners, with the exception of Zone 7 and the Vidler Water Company, have not opted to participate in the SWRU to increase recovery rates.

The SWRU project currently being developed by Semitropic creates 650,000 af of groundwater storage capacity with 200,000 af of groundwater extraction capacity per year. Access to the SWRU extraction capacity is split with 50,000 af (Phase 1) reserved for use by the original banking partners and the remaining 150,000 af (Phases 2-4) available to new banking partners. New banking partners have the option to participate through the purchase of shares with either high or low priority access to groundwater extraction infrastructure. The operational details of these shares include:

- One share in the bank equals three af of storage;
- In-lieu recharge is accepted at a rate of 0.33 af per share per year;
- Withdrawal is limited to one af per year per share. Phase 1 of the SWRU was established with a withdrawal rate of three af per year per share;
- The contract for bank operations expires in the year 2035;
- High priority shares include one af per year of pump back per share;
- Low priority are entitled to one af per year of pump back per share on an as-available basis;
- Banking partner is responsible for delivering water and the operation and maintenance (O&M) of storing and recovering water; and
- Only 90 percent of banked water can be recovered.

1.3.2 Project Timeline

The development of groundwater storage and protection measures is an ongoing process in Semitropic. The following timeline documents major milestones in the Semitropic Groundwater Bank's development.

1967 Development of State Water Project Distribution Network

Semitropic engaged in a construction effort to create a distribution network that would deliver surface water from the SWP to farms that were then relying on groundwater for irrigation. The project developed access infrastructure for the Buttonwillow Improvement District and Pond-Poso Improvement District. The original distribution network delivered up to 158,000 af of SWP water and up to 25,100 af of surplus water from the Kern County Water Agency each year. SWP deliveries began in 1973.

1992 Analysis of Alternative Water Supplies

In 1992, Semitropic investigated creating an additional water supply project. The 1992 Semitropic Improvements Project Report identified multiple options for reducing groundwater overdraft, lowering operating costs, and simplifying district operations. Semitropic investigated water banking, water conservation, and energy development as potential methods for increasing water reserves. The Semitropic Groundwater Bank was proposed in the investigation.

1994 Groundwater Bank Concept Identification (Original Groundwater Bank)

Semitropic analyzed the effects of the potential projects outlined in the 1992 Semitropic Improvement Project Report. The 1994 Semitropic Groundwater Banking Project EIR (1994 EIR) identified multiple project alternatives and the existing environmental conditions. The 1994 EIR identified groundwater banking as the preferred alternative for alleviating the strain on groundwater resources in Semitropic. The groundwater banking program was eventually developed with a recovery rate of 90,000 af per year to the Aqueduct.

2000 Groundwater Bank Expansion Analysis (SWRU)

Semitropic analyzed the alternatives for expansion of the groundwater bank to increase Semitropic's per year groundwater return potential to the SWP via the Aqueduct and to increase storage capacity for existing and future banking partners. Semitropic prepared the 2000 Supplemental EIR to identify as its preferred alternative a project that would construct a new conveyance pipeline to the Aqueduct, develop 65 new wells, a 40-acre regulating pond, construct pipeline access to existing farm wells within Semitropic to increase pump back capacity for the original banking partners, and develop an additional 12,000 acres of in-lieu recharge area..

2002 Investigation of Bank Expansion

In 2002, Semitropic completed an Addendum to the 2000 supplemental EIR that analyzed the potential effects of operating the additional 12,000 acres of in-lieu recharge land that was identified in the 2000 supplemental EIR as a tool for expansion of the 1,000,000 af groundwater bank to 1,650,000 af.

2004 Expansion of Conveyance Pipeline

In 2004, Semitropic analyzed the potential effects of an increase in the diameter of seven miles of conveyance pipeline and the replacement of some portions of the pipeline proposed in the 2000 supplemental EIR with an open canal. The analysis was presented in the Second Addendum (2004) to the 2000 Supplemental EIR. The project changes were made to allow for more efficient transmission of the water flows proposed in the 2000 supplemental EIR, and to allow for expansions of the service area in the future.

2005 Expansion of Banking Activities to Kern Water Bank and Pioneer Projects

In 2005, Semitropic addressed an operational change in the project to allow additional water banking in the KWB and the Pioneer Projects in the First Addendum (2002) to the 1994 EIR and the Third Addendum (2005) to the 2000 Supplemental EIR. The addenda respond to operational constraints that prevent Semitropic from accepting all of the water its banking partners would want to store during some portions of the year when irrigation demand schedules make the need for irrigation waters and the correlated in-lieu recharge potential low.

1.4 Authorization and Appropriation

This Special Study is being accomplished by Reclamation under general authority contained in the Reclamation Act of 1902 (P.L. 57-161, June 17, 1902), and as directed by Congress in the Conference Report (H. Rpt 109-275 for H.R. 2419) for the Energy and Water Development Appropriations Act of 2006 (P.L. 109-103 November 19, 2005). Funds in the amount of $200,000 were appropriated in fiscal year 2006 to conduct the Special Study and prepare this report.

1.5 Study Area Location and Description

The primary study area for this Special Study is Semitropic and is shown in Figure 1-3. This Special Study's secondary study area includes all current banking partners and regional water supply programs that could be affected by Federal participation in the SWRU, and extends from San Francisco Bay to southern San Diego County.

Semitropic is connected to the SWP's Aqueduct to the west by pipelines and canals that cross the Buena Vista Water Storage District and to the CVP's Friant-Kern Canal to the east via access to water transfers with the Shafter-Wasco Irrigation District (Shafter-Wasco). The 23,000-acre in-lieu service area and 12,000 acres of additional in-lieu recharge area proposed as a part of the SWRU in Semitropic are primarily existing farmland. The majority of the Kern National Wildlife Refuge (Kern NWR) is contained within Semitropic. Kern NWR, Tulare Lake Bed, and Poso Creek Flood Channel host scattered wetlands and vernal pools that provide ecosystems for sensitive species and recreational opportunities.

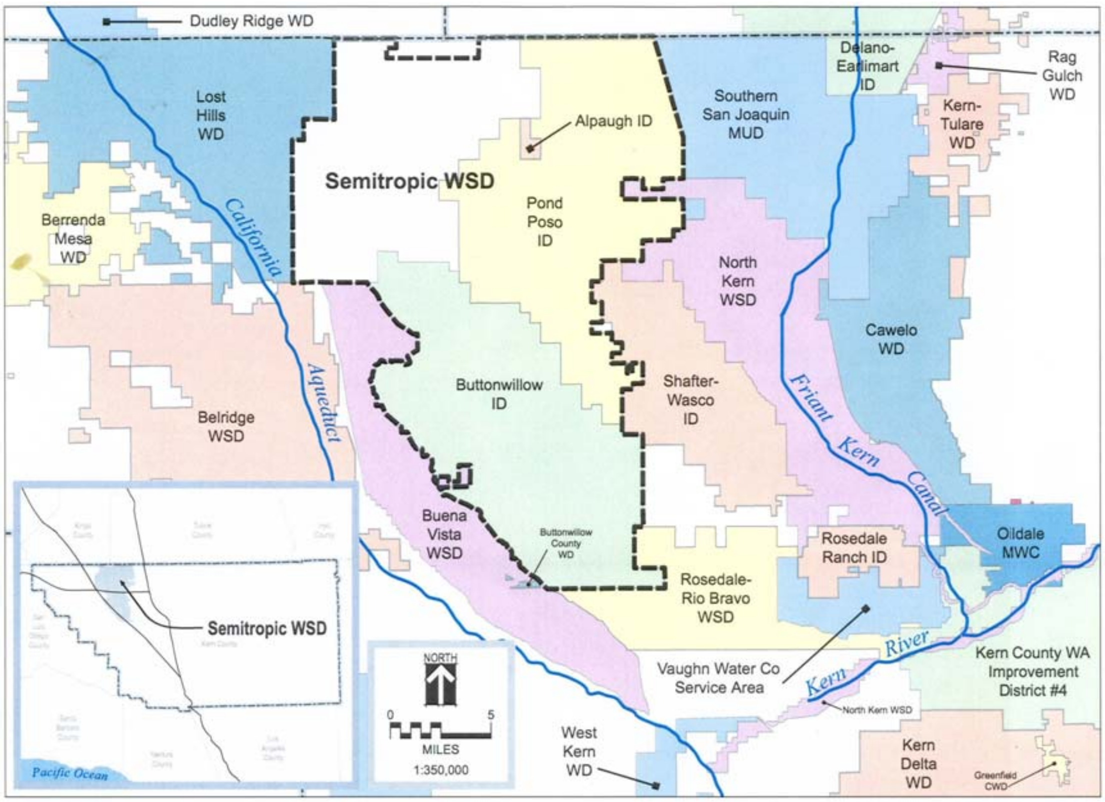


Figure 1-3
Semitropic Water Storage District

1.6 Existing Projects and Programs in the Region

Semitropic is one of many water supply projects in the Central Valley that provide or are planned to provide water for agricultural, and municipal and industrial (M&I) uses. The SWRU project area and its relation to a number of the neighboring projects and programs are outlined below. This Special Study did not review and compare these programs to the SWRU or evaluate whether these projects would address Reclamation's study objectives.

1.6.1 Kern Water Bank

The KWB consists primarily of water from the SWP, Friant-Kern Canal, and captured surface flows or flood flows from the Kern River. This facility stores water in and withdraws water from the groundwater basin through in-lieu recharge and direct recharge. The KWB has an estimated storage capacity of 1 million af. Semitropic owns 6.67% of an undivided interest in all capacities in the Kern Water Bank which also gives it rights to all unused capacity.

1.6.2 Local Elements of the Kern Water Bank

This program consists of various Kern County water districts. The California Department of Water Resources (DWR) planned to implement several in-lieu recharge banking strategies; however, there are no current known plans to implement any of the elements.

1.6.3 Pioneer Groundwater Recharge and Recovery Project

Operated by the Kern County Water Agency (KCWA), the project is based on recharge and recovery on 2,253 acres of active farmland to the east of the KWB along the Kern River. Water stored in the Pioneer Bank may only be used within the county; with the exception of the 25 percent allotment that KCWA owns and reserves the right to use at its own discretion. Semitropic owns 14% of this project.

1.6.4 Berrenda Mesa Project

This project is within the Kern Fan Element and is owned by Berrenda Mesa Irrigation District. The bank extends over an area of 369 acres and has an estimated storage capacity of 200,000 af.

1.6.5 Arvin-Edison

Operating since 1998, Arvin-Edison Water Storage District has an agreement with MWD in which Arvin-Edison allocates to MWD storage space in its groundwater bank for a 25-year period, and in exchange MWD has agreed to pay for additional banking facilities. The bank stores an estimated 250,000 af of water and has a maximum recovery rate of 40,000 af per year.

1.6.6 Goose Lake Wetland Improvement Project

Goose Lake Bed is used as a short-term surface storage unit for flood waters and surplus water. Proposed in the early 1990s, Semitropic is involved in this project with Ducks Unlimited and Buttonwillow Land and Cattle Co.

1.6.7 Shafter-Wasco Interconnection and Water Banking Program

This banking program is a joint effort between Semitropic and Shafter-Wasco; the two agencies constructed an interconnection pipeline and pumping plant to connect the distribution system of the two districts. This facilitates water movement between SWP and CVP systems. This capacity is currently 30 cfs. Semitropic has plans to increase the two-way interconnection capacity to 300 cfs.

1.6.8 2800 Acres Project

Owned by the City of Bakersfield, this recharge facility is used to replenish water to the groundwater aquifers. The site is six miles long and includes old river channels, overflow lands, and constructed spreading basins. An average of 22,000 af of water is recharged annually in the underlying groundwater aquifer.

1.6.9 North Kern Groundwater Storage Project

This water banking project serves neighboring water agencies and maintains the groundwater resource underlying North Kern Water Storage District. North Kern Water Storage District conveys Kern River water from the Beardsley-Lerdo Canal and Calloway Canal to irrigated lands and spreading ponds for percolation-driven groundwater recharge. Semitropic conveys excess water to North Kern’s spreading facilities in order to enhance the common groundwater basin condition.

1.6.10 Buena Vista Groundwater Supply Program

Buena Vista Water Storage District has developed a groundwater banking program that is carried out in conjunction with KCWA. The program distributes Kern River and SWP supplies to water users. Irrigation is supplied by groundwater wells. Semitropic and Buena Vista constructed a 50 cfs two-way interconnection to enhance beneficial use of water supplies.

1.6.11 Upper San Joaquin River Basin Storage

DWR, Reclamation, and other local, State, and Federal agencies are investigating an increase of 150,000 to 1,300,000 af of storage in the upper San Joaquin River watershed. This additional storage may be accomplished by expanding Millerton Lake by raising Friant Dam or constructing a new storage facility.

1.6.12 Intergated Regional Water Management Plan

Semitropic has taken the lead in developing an Integrated Regional Water Management Plan with its neighboring districts. This plan is essentially complete and will be released to the public in the spring of 2007.

1.7 Partners in the Original Bank

Semitropic’s original groundwater banking partners consist of six California water districts, agencies, and companies with investments in water storage within Semitropic’s groundwater bank. In combination with Semitropic, these “banking partners” have rights to the full 1,000,000 af of groundwater storage capacity created by the original groundwater banking project. While the full capacity of the original groundwater bank has been allotted, the storage space has not yet been fully utilized.

In addition to the 1,000,000 af of storage allotted to the original banking partners, Semitropic holds rights to 200,000 af of water in the SWRU. Semitropic’s portion of the stored water can be used for irrigation or sold to buyers elsewhere in the “affected area” or the area that could potentially see the effects of changes to Semitropic’s system. Outlined below are the banking partners and their respective portions of the banking capacity as of 2005.

1.7.1 Metropolitan Water District of Southern California (35%)

MWD serves 26 counties and districts totaling nearly 18 million people in Southern California. MWD relies on water from the Colorado River Aqueduct and the California Aqueduct to supplement groundwater wells in the 5,200-square-mile service area (MWD 2006). MWD's service area is the largest of the banking partners.

1.7.2 Santa Clara Valley Water District (35%)

The Santa Clara Valley Water District (SCVWD) supplies water to most of Santa Clara County. SCVWD imports water to the district from the SWP and the CVP through the South Bay Aqueduct, the Santa Clara Conduit and the Pachecho Conduit. SCVWD serves 1,300 square miles and 1.7 million people (SCVWD, 2006).

1.7.3 Alameda County Water District (15%)

The Alameda County Water District serves the Cities of Fremont, Newark, and Union City. Fifty-five percent of Alameda County Water District's water is provided by the SWP via the South Bay Aqueduct. Runoff in the Alameda Basin and releases from the South Bay Aqueduct are used to recharge the Niles Cone Groundwater Basin (Alameda County Water District, 2006).

1.7.4 Zone 7 Water Agency (Alameda County) (6.5%)

The Zone 7 Water Agency manages water supplies for the cities of Livermore and Pleasanton, and the Dublin San Ramon Services District. Zone 7 water is taken from the Lake del Valle Reservoir, local groundwater wells, and the SWP. Zone 7 can also purchase water from the Byron Bethany Irrigation District.

1.7.5 Vidler Water Company (3%)

One of two private partners in the Semitropic water banking program, Vidler originally held 18.5 percent of the rights to the 1,000,000 af of storage. Vidler held 130,000 af of storage, but has been selling portions of its holdings in recent years. Vidler operates in California, Nevada, Arizona, Colorado, and Texas.

1.7.6 Newhall Land and Farming Company (5.5%)

A development company with 51,620 acres of agriculture and real estate 30 miles north of Los Angeles, Newhall Land and Farming Company provides water for the towns of Valenica and Newhall Ranch.

1.8 Planning Process and Report Organization

Chapter 1 of this report provides an introduction to the Semitropic Groundwater Bank, how it operates and general plans for the development of the SWRU. A list of pertinent milestones in Semitropic's banking activities and the documentation Semitropic produced regarding expansions and improvements to the district's water distribution and banking systems is included in Chapter 1's project timeline.

In Chapter 2 the objectives of the SWRU are defined and potential problems and opportunities for improvement of Semitropic are discussed.

Chapter 3 describes the area in which the study takes place and the water quality conditions, geotechnical, biological, and potential effects on human activities to be expected from the SWRU. Chapter 3 also describes the expected future conditions without Reclamation’s participation in the SWRU which is identical to the condition created by Reclamation’s participation in the SWRU.

Chapter 4 provides a description of the management measures that Reclamation could address by participating in the groundwater bank. The management measures are screened against the planning objectives.

Chapter 5 presents a scenario for Federal/Reclamation’s participation in the bank.

Chapter 6 outlines other banking considerations and data gaps.

Chapter 7 describes the Special Study’s overall findings and conclusions.

Appendix A outlines supporting environmental documentation used in the development of the existing and future environmental conditions discussed in Chapter 3.

Appendix B presents the engineering information developed by Semitropic for the original bank and the SWRU.

Appendix C provides detailed economic analysis addressed in Chapter 4.

Chapter 2
Problems, Opportunities, and Planning Objectives

2.1 Project Problems and Opportunities

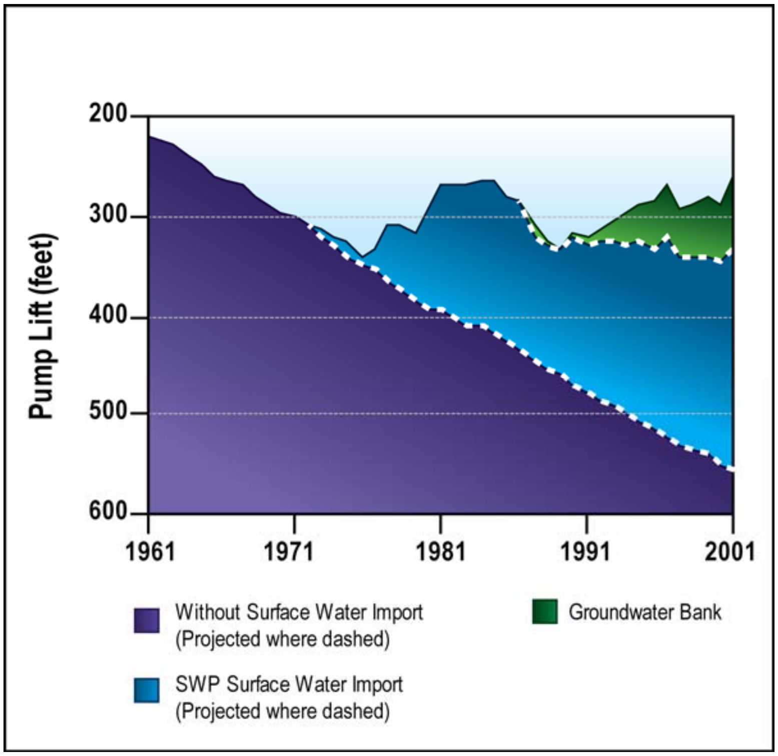
This chapter presents potential problems, public concerns, and opportunities associated with the implementation of the SWRU.

2.1.1 Problems

2.1.1.1 Semitropic Water Storage District Problems

Groundwater Level Declines

According to well records that indicate pump lift within Semitropic, groundwater levels declined from 1961 to 1971. The declines slowed with the beginning of delivery of SWP water in 1973; however, the basin conditions would likely have continued to decline without the initiation of the groundwater banking activities. Groundwater elevations in Semitropic initially recovered with the import of SWP surface water. Since 1989 (absent of the banking program) ground water elevations have been projected to slightly decline which may reflect the natural hydrological condition. (see Figure 2-1).



Source: Semitropic, 2006

Figure 2-1
Semitropic Depth to Groundwater

Costs of Pumping Groundwater

Many of the farmers within the Semitropic area rely on groundwater as their primary irrigation water supply. Deeper groundwater levels require more power for the pumps to lift the water to the ground surface. Additionally, the removal of water from the Semitropic's original Groundwater Bank and the SWRU is reliant on power. The future price of power will increase, leading to incremental storage and recovery costs. Additionally, pumping lifts from the well field are not expected to be any less than 80 feet and could exceed 300 feet during a large removal cycle.

Low Extraction Capability in Original Groundwater Bank

Current facilities in Semitropic allow for the extraction of 90,000 af of water per year and when available, exchange of Semitropic's 133,000 af per year of SWP surface water entitlement. Without surface water entitlement exchange, the full banking volume of 1,000,000 af could be extracted in a minimum of eleven years. In addition to the extraction needs of banking partners in a dry year, Semitropic's allotment of water from the SWP could be reduced due to use by the partner agencies, which are not expected to bank water during dry water years. Semitropic farms would rely upon their pumping infrastructure to supply water to the 136,000 irrigated acres as well as to make deliveries to the banking partners.

The current facilities of the original groundwater bank are undersized for banking partners if multiple, large demands called for extraction of banked water in a single year (2000 Supplemental EIR). The 2000 Supplemental EIR also analyzed worst case impacts on the groundwater basin under maximum recovery conditions. It was noted that after all irrigation demand is met and maximum recovery of Stored Water, the overall impact would be about 3 ½ acre-feet per acre within Semitropic's boundaries which is about the same as a normal irrigation demand.

2.1.1.2 CVP Problems

Water Supply Reliability

The CVP delivers water for agricultural, urban, and environmental uses throughout the Central Valley. In many years, these demands can not be met by available supplies. Additionally, sometimes unforeseen demands cause a decrease in water supply reliability during the water year.

CVP Delivery Forecasts

Reclamation has some difficulty in reliably predicting water deliveries early in a water year. Water delivery predictions are based on the amount of precipitation and snow pack within the Central Valley and the tributary watersheds. The full amount of annual precipitation is not known early in the water year; therefore, Reclamation must predict the water deliveries conservatively.

Farmers need forecasts of water deliveries to make planting decisions and secure financing. Reclamation predicts water deliveries starting in January, but the prediction is fairly rough at that time because of the uncertainty regarding precipitation and snow pack in subsequent months. Reclamation updates the forecasts every month, and the forecasts become more reliable each month. However, by the time the forecasts become final, farmers have already made planting decisions.

Kern NWR Operation

Reclamation has responsibility to provide water for the Kern NWR to meet refuge demands. Semitropic projects that groundwater levels could drop by 100 feet beneath the Kern NWR during pumping for Semitropic's original Groundwater Bank and the SWRU (2000 Supplemental EIR). The Kern NWR has multiple wells within its boundaries that it does not currently operate. These wells could potentially be used in the future and could be affected by groundwater extraction operations associated with the SWRU. The 2000 Supplemental EIR identified the potential for 1½ feet of subsidence in the center of the SWRU proposed well field which lies directly adjacent to the Kern NWR. The Refuge currently receives surface water deliveries through the Goose Lake Canal, which lies west of Semitropic, and distributes this water within the Refuge with a conveyance system that utilizes gravity flow. Any subsidence caused by groundwater extraction operations in the well field created by the SWRU could potentially disable this gravity based conveyance system and require mechanical pumping.

2.1.2 Opportunities

This section presents potential opportunities presented by the project.

2.1.2.1 Section 215 Water

Reclamation contractors have the opportunity to store Section 215 water at the SWRU. Under Section 215 of the Reclamation Reform Act (RRA) of 1982, the Secretary of the Interior is authorized to contract for temporary supplies of water resulting from an unusually large water supply, not otherwise storable for project purposes. Poso Creek Water Company is currently engaged in this type of temporary storage; Reclamation has proposed to carry out a one-year temporary water service contract with Poso Creek during the 2006 contract year for up to 15,000 af of water (Final EA, Poso Creek, 2006). In recent years a group of farmers in Westlands Water District formed the Poso Creek Water Company, LLC in order to collectively provide an emergency water supply in drought years. Poso Creek and Semitropic are almost ready to sign for 20,000 acre-feet of storage.

2.1.2.2 Contribution to CVPIA

Implementation of the SWRU could contribute to the implementation of Sections 3402 (a) and (b) of the CVPIA’s objective:

- “To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California,” and

- “To address impacts of the CVP on fish, wildlife, and associated habitats.”

The proximity of the Kern NWR to Semitropic could provide the opportunity for the delivery of refuge water to Kern NWR from storage in the SWRU. This could help facilitate the implementation of Sections 3406(d)(1) and 3406(d)(2) of Title 34 of the CVPIA, which obligated Reclamation to meet the "Dependable Water Supply Needs" of the specified California State Wildlife Areas (WA), private wetlands, and NWRs (which includes Kern NWR).

The SWRU could provide a source of water storage for Reclamation to utilize as storage for drought events. Water deliveries of banked water to the refuges could offset decreases in surface water allocations to CVP contractors during dry years.

2.1.2.3 Improve Semitropic Water Delivery Flexibility

The implementation of the SWRU could improve and preserve operational flexibility of water delivery for Semitropic. Historically, Semitropic has been vulnerable to outages of the Aqueduct and its own internal distribution system. Semitropic's stored groundwater in the SWRU could be used to replace any supply lost because of outages on the SWP.

2.1.2.4 Flexibility for Federal Contractors

The SWRU has the possibility to improve water delivery flexibility for Federal contractors through potential Federal participation or direct participation by any Federal contractors. The SWRU could reduce or eliminate Semitropic's need for surface water during dry years by directly using groundwater and exchange Semitropic's SWP Table A water allocations for use by the banking partners which could include Federal contractors. The surface water supply could further be increased by pumping back water to the Aqueduct. The banking concept was designed so that Semitropic and its banking partners could use banked surplus water during dry seasons when surface water is a less reliable source. Use of banked water would allow Federal contract water to be used in other areas.

2.1.2.5 Timing of Water Availability

Seasonal fluctuations in deliveries and conveyance of Semitropic's surface water will vary from abundant supplies during wet periods to extreme shortages during droughts. In particular, water availability and demand in Southern California are subject to broad seasonal fluctuations (1994 EIR pages 2-4). Implementation of SWRU could decrease the effects of these seasonal shifts.

2.1.2.6 Kern NWR

The SWRU's proximity to the Kern NWR and ability to store water during above average water years for later use during below average water years could provide Reclamation with a firm Level 4 water supply for delivery during below average water years.

2.1.2.7 CALFED Groundwater Storage Objectives

The CALFED Programmatic Record of Decision (ROD) includes an objective to identify 500,000 to 1 million af of new groundwater storage south of the Delta to assist in CALFED programs. The SWRU could be used to meet a portion of this total storage objective.

2.2 Objectives

2.2.1 National Objectives

Reclamation identifies in its Mission Statement a need "to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public." This mission and the declared Federal objective to contribute to National Economic Development (NED) help to shape the determination of a “Federal Interest” in a project. Reclamation identifies as a general purpose to *“increase water-related benefits provided through expanded use of voluntary water transfers and improved water conservation, and to improve the Central Valley Project’s water supply reliability and operational flexibility”* as part of its management of the CVP.

2.2.2 Regional Objectives

The purpose of the CVPIA was defined as creating a balance between competing demands for CVP water while protecting, restoring, and enhancing fish, wildlife, and associated habitats in the Central Valley. Sections 3406(d)(1) and 3406(d)(2) of Title 34 of Public Law 102-575 obligates Reclamation to meet the "Dependable Water Supply Needs" of the specified NWRs, WAs and private wetlands. Among the NWRs identified in the CVPIA is the Kern NWR located within and adjacent to Semitropic.

2.2.3 Project Objectives

The SWRU project seeks to facilitate Semitropic’s ability to respond to banking partner requests for returns of banked groundwater during times of high need. Semitropic’s original groundwater program identified the improvement of surface water availability and groundwater reliability for support of agriculture within Semitropic to supply water for environmental protection and to protect the condition of the underlying aquifer as its objectives. These original project objectives were also identified for the SWRU.

2.3 Planning Objectives

Reclamation’s planning objectives for potential Federal participation in the SWRU include the storage of CVP water to improve operational reliability and flexibility. Specifically these objectives include:

- Improve CVP water supply reliability for use during drought periods.
- Provide environmental water supply reliability for refuges and other environmental programs in the San Joaquin Valley.
- Provide additional water supply and storage to lessen the Region's reliance on Millerton Reservoir and the Friant-Kern System.
- Provide conveyance and/or storage opportunities to facilitate restoration of San Joaquin River.

Semitropic has sought Reclamation's participation in the SWRU to help meet its objectives of improving surface water availability and groundwater reliability to support agriculture production, environmental protection, and the longevity of the underlying aquifer within Semitropic.

2.4 Planning Constraints

Several constraints are associated with the study area when examining ways to meet the planning objectives. The sections below describe these constraints.

2.4.1 Water Quality

2.4.1.1 Salinity

Groundwater salinity is relatively high in Semitropic and much of the San Joaquin Valley due to agricultural activities that mobilize salts in the soil. With regard to water quality, saline groundwater exists in the western portions of Semitropic and may continue to migrate eastward into the project area due to banking activities. The shallow, unconfined groundwater zone near the surface is, in some parts of Semitropic, unsuitable for use in agriculture production or pump-back to the Aqueduct because of high salt concentrations. A substantial confined zone of fresh water in the proposed well field area with salinity levels around 160 parts lies directly under the shallow unconfined zone of unusable groundwater. This confined zone of fresh water is found below the Corcoran clay layer beginning at approximately 400 feet below the surface and ends at approximately 1,240 feet below the surface. The groundwater found in the deepest groundwater zones (i.e. below 1,300 feet) is saline and is also unsuitable for either agriculture or inclusion in the Aqueduct (2000 Supplemental EIR, pages 5-7).

Well field operation could potentially influence groundwater quality by causing the upwelling of saline groundwater that lies in the deepest groundwater horizons or by drawing the saline groundwater horizontally to Semitropic’s well extraction zone from the west where the saline groundwater horizon is closer to the surface.

2.4.1.2 Arsenic

As of 2001, arsenic concentrations exceeding the maximum contaminant level (MCL) of 50 parts per billion (ppb) were detected in water from a number of supply wells and monitor wells in Semitropic. High arsenic concentrations may be a problem because the U.S. Environmental Protection Agency (EPA) MCL of 50 ppb has been lowered to 10 ppb by the California Department of Health Services. Arsenic concentrations are generally higher in the deeper groundwater compared to the shallow groundwater. Due to possible concentrations of arsenic exceeding the MCL in groundwater beneath Semitropic, this water may not be suitable for pump-back to the Aqueduct (2001-2002 Semitropic Groundwater Monitoring Program).

Since the arsenic concentrations exceed present MCL standards, Semitropic can propose a variety of operational solutions thru exchanges and transfers that do not involve direct pump-back. Semitropic has also examined removal technologies that may be required to treat water prior to delivery to the Aqueduct.

2.4.1.3 Groundwater Overdraft

Recent land studies of the Southern San Joaquin Valley groundwater basin concluded that overall the basin is essentially in balance. While groundwater overdraft has certainly been reduced by water banking and importation of SWP water, the precise current status of groundwater overdraft in Semitropic has not been quantified. The 1994 EIR identified groundwater overdraft as an ongoing problem that Semitropic was addressing with development of the original groundwater bank. The 1994 EIR does not identify any groundwater elevation thresholds that would signal that the groundwater basin was no longer in a state of overdraft. Although the original bank has improved groundwater levels, the banking partners have not removed significant quantities of water from the bank since its inception.

2.4.2 Department of Fish and Game Parcels in Proposed Well Field

Semitropic is proposing the construction of a new well field, as part of the SWRU project, on land that is owned by numerous parties (see Figure 2-2). One section/two parcels in the proposed well field are currently owned by the State of California. This land was originally purchased by the city of Bakersfield and the parcels' title was transferred to the DFG as part of an agreement to mitigate a "habitat taking" within the city's boundaries as part of the Endangered Species Act (ESA) "take permit" granted by the FWS and California Department of Fish and Game (DFG). This mitigation land is currently managed by DFG. In the past, Semitropic attempted to purchase these parcels unsuccessfully and is still planning to develop its well field infrastructure on parcels other than the DFG parcels. Construction and operation of the well field adjacent to State owned parcels could potentially impact biological resources on the State parcels and potentially conflict with the DFG's management objectives for their parcels (Gregory, Georgiana 2006). At a recent meeting between Semitropic, the State and USFWS representatives, the use of this property was discussed in detail and there appeared to be a possibility of constructing several wells (4) on the property subject to adequate mitigation. This was in the context of a Section 7 Consultation.

2.4.3 Habitat Conservation Plan

The approval of the SWRU of the groundwater bank is related to the approval of Semitropic's Habitat Conservation Plan (HCP). This approval from FWS has been pending since 2001.

2.5 Semitropic Future Water Demands and Needs

The 1994 EIR identified an average yearly agricultural acreage in production of 116,000 acres out of the total 136,000 served by the Semitropic conveyance infrastructure. The 1994 EIR determined this average was expected to remain stable through the implementation of the project. The 1994 EIR estimates a water usage of 3.5 af per acre of agricultural production per year, which calculates to an estimated yearly water demand of 406,000 af per year.

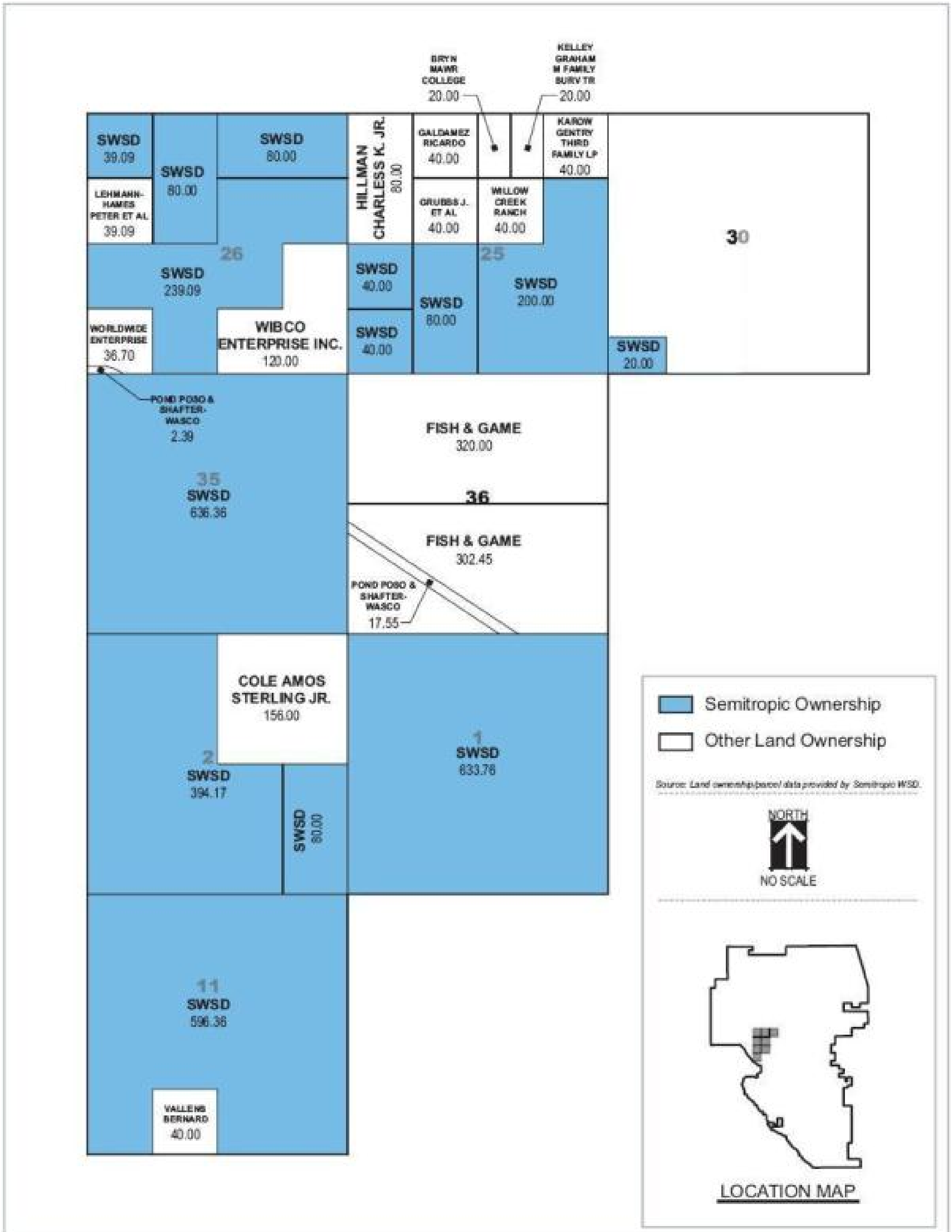


Figure 2-2
Stored Water Recovery Unit
Wellfield Land Ownership (March 2004)

Chapter 3
Study Area Conditions

This chapter describes the potentially affected environment of the SWRU in terms of existing conditions and likely future conditions without the project. The SWRU is currently being developed as new banking partners are identified and will continue to be developed with or without Reclamation's participation. Therefore, the future environmental conditions should be the same with or without Reclamation's participation in the SWRU.

This analysis of the existing and future without-project conditions is based on information provided in the 1994 EIR for the Semitropic Groundwater Banking Project (1994 EIR) and the SWRU 2000 Supplemental EIR. The following resources are discussed: (1) physiography, (2) geology, (3) water quality and hydrology, (4) biological resources and special status species, and (5) land use. If any environmental conditions changed since the preparation of the two EIR's above, those changes are not reflected in this Special Study Report.

3.1 Existing Conditions

Semitropic, in cooperation with the banking partners, is operating the groundwater bank as outlined in the original 1994 EIR. The banking partners are storing surplus water for later use during dry years. This surface water is stored within Semitropic through in-lieu recharge operations that deliver the surface water to Semitropic irrigators for agricultural use rather than pumping groundwater that underlies Semitropic. Water that naturally recharges the aquifer during this time of surface water irrigation is also considered banked water.

The original groundwater banking program (initiated in 1994) identified a total storage capacity of 1,000,000 af within the aquifer underlying Semitropic. The SWRU program proposed in 1999 and the 2002 addendum to this program identified an additional 650,000 af of storage capacity in the groundwater bank, which would increase the total groundwater bank capacity to 1,650,000 af. According to representatives from Semitropic, the SWRU construction is approximately 25 percent complete as of Febuary 2007.

Provided in the following sections are the existing conditions of the various resource areas that may be affected by the project.

3.1.1 Physiography

Semitropic is located on the southern valley floor of the San Joaquin Valley, a physiographic trough. The valley is bounded by the Sierra Nevada Range to the east, the Tehachapi Mountains to the south, and the Temblor Range and Coast Range to the west. The valley floor consists of low alluvial plains and fans and by overflow lands and old lakebeds. The main physiographic features within Semitropic include

Buttonwillow Ridge, Semitropic Ridge, Kern River Flood Canal, Jerry Slough, Goose Lake, and the low alluvial fans of the Kern River and Poso Creek.

3.1.2 Geology

Provided in this section is discussion of observed land subsidence and the presence of mineral resources and their extraction in Semitropic.

3.1.2.1 Subsidence

Water withdrawal from a groundwater aquifer tends to allow the aquifer to compress or consolidate when the equilibrium between soil particles is disturbed. Subsidence is generally greatest after the first withdrawal, but can potentially increase with the subsequent refill and withdrawal cycles (2000 Supplemental EIR, pages 5-3). Relatively slow incremental subsidence has occurred in the north-central portion of Kern County, which includes the Semitropic area where water pumping has been extensive.

According to the 1994 EIR, Semitropic surface water recharge projects had mitigated overdraft by reducing subsidence within the area. Between 1962 and 1970, this subsidence was between one and two feet. The DWR completed a first-order releveling of a line that crosses the northern portion of Semitropic with the intent that this line would serve as a baseline for the identification of future subsidence during operation of the KWB. As part of the mitigation program developed in the 2000 Supplemental EIR, Semitropic has placed an extensiometer in the proposed SWRU well field that will monitor any subsidence caused by the operation of the SWRU and potentially trigger further mitigation actions.

3.1.2.2 Mineral Resources - Petroleum

Semitropic contains petroleum and natural gas fields. Specifically named the Wasco and Semitropic oil fields, these fields contain producing oil wells and associated gas wells. The southern portion of Semitropic consists of inactive or abandoned fields. Figure 3-1 shows the oil and gas fields that lie within Semitropic.

3.1.3 Water Quality

Provided in this section is a discussion of groundwater quality condition within Semitropic. High saline concentrations and arsenic affect groundwater quality within Semitropic.

3.1.3.1 Saline Groundwater

The shallowest groundwater underlying some parts of Semitropic has been observed to have higher salinity levels than the deeper groundwater found in the confined zone. It is important to note that “shallow” refers to the unconfined groundwater zone found above the “E-Clay” or “Corcoran Clay” clay layer, approximately 350 feet below the surface. Total dissolved solids (TDS) concentrations in the shallow groundwater were less than 500 mg/l in the central part of Semitropic. However, throughout the

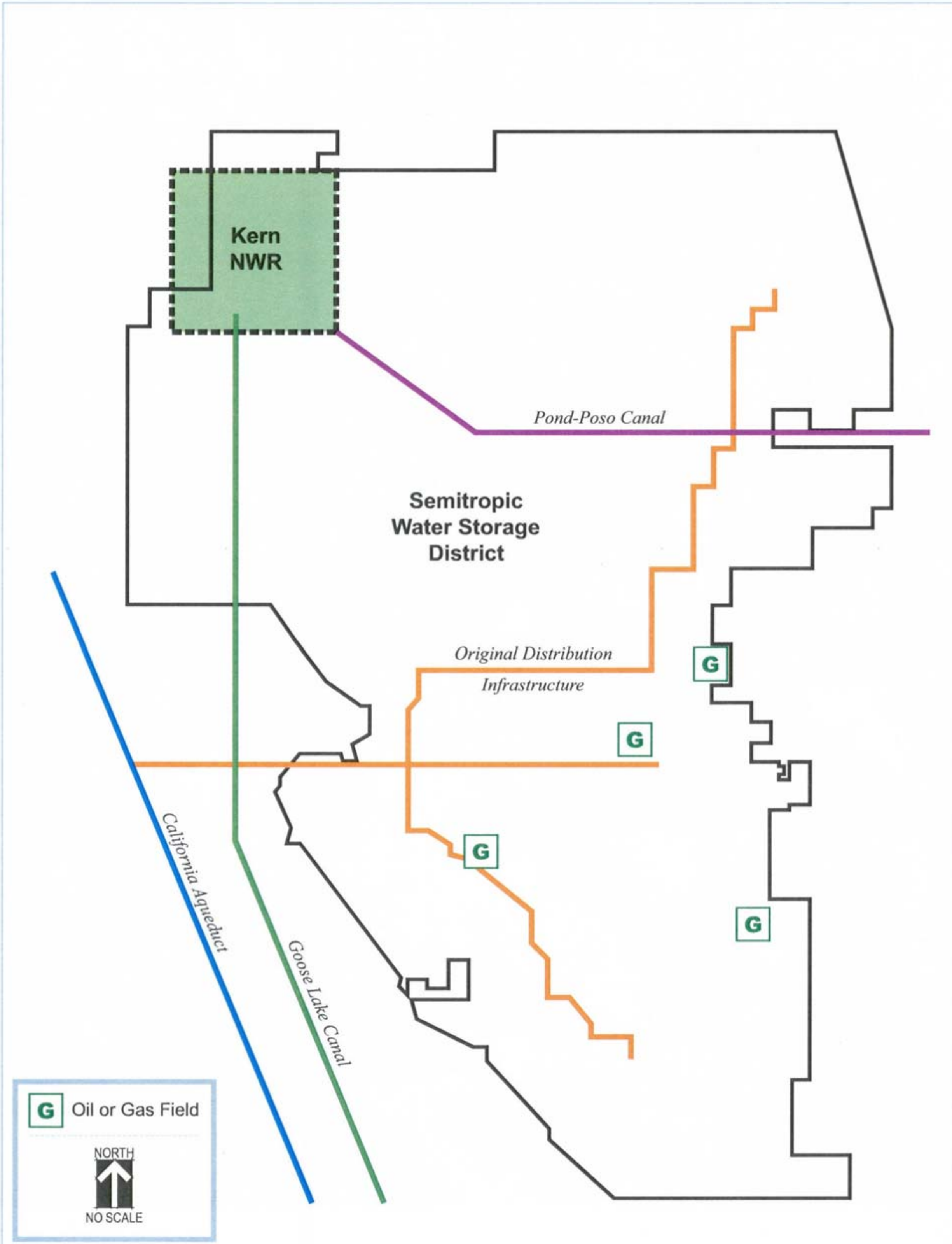


Figure 3-1
Petroleum and Natural Gas Fields

Westernmost part of Semitropic, TDS concentrations in shallow groundwater exceeded 1,000 mg/l. (2001-2002 Semitropic Groundwater Monitoring Report). It was reported in 2001 that TDS concentrations were less than 500 mg/l in the deeper groundwater underlying most of Semitropic (2001-2002 Semitropic Groundwater Monitoring Report). The groundwater found deeper than 1,240 feet below the surface is also saline and would not be accessed by the SWRU well field.

3.1.3.2 Arsenic

Arsenic concentrations in the aquifer underlying Semitropic are of concern. Arsenic concentrations were identified in water from numerous supply and monitor wells in Semitropic during April-June 2001. The lowest arsenic concentrations were found beneath the southeast part of Semitropic, with concentrations less than the detection limit of 2 ppb. The highest arsenic concentrations were found in the northwest part of Semitropic, with concentrations at two monitoring wells in the proposed SWRU well field between 50 and 60 ppb.

3.1.4 Hydrogeology

This section provides analysis of groundwater stratigraphy and observed groundwater levels in the groundwater aquifer that underlies Semitropic.

3.1.4.1 Groundwater Stratigraphy

The groundwater system beneath Semitropic consists of interbedded layers of sand, silt, and clay to a depth of about 3,000 feet below ground surface. The deep basin is divided into seven zones of groundwater. The existing groundwater conditions are primarily based upon information provided in the 2000 Supplemental EIR. The layered groundwater system shown in Figure 3-2 is described as follows:

3.1.4.1.1 Layer 1 – Unconfined Aquifer

The unconfined aquifer extends from the near ground surface to depths of about 350 feet. The majority of the water in the aquifer is generally fresh. However, on the western boundary the unconfined aquifer becomes more saline. The average depth during the late winter is approximately 20 to 30 feet. The transmissivity ranges between approximately 15,000 and 20,000 gallons per day per foot (gpd/ft). The base of this unit is the top portion of the laterally continuous “E-Clay” or “Corcoran Clay.” The water in this layer under Semitropic is often unsuitable for farm irrigation because of high saline concentrations (2000 Supplemental EIR, pages 5-7).

3.1.4.1.2 Layer 2 – E-Clay

The E-Clay forms the second layer. This layer is composed of low permeability silty clay and is approximately 50 feet thick within the area of the planned SWRU well field. It thins out towards the southeast of the well field. The E-Clay acts as an aquitard by limiting the vertical migration of groundwater between the upper unconfined aquifer and lower confined zones. The base of the E-Clay is about 400 feet deep.

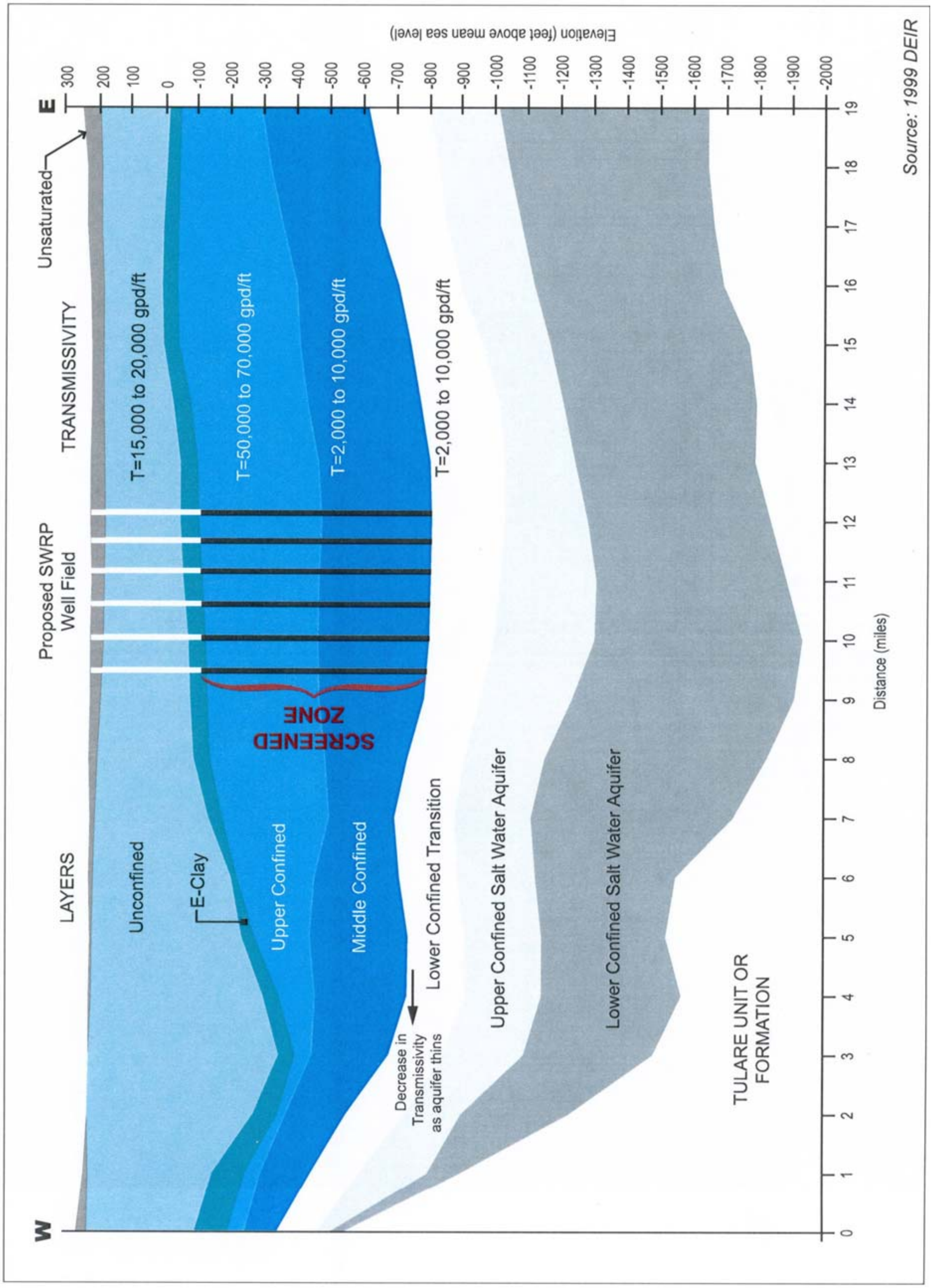


Figure 3-2
Semitropic Groundwater Zones

3.1.4.1.3 Layer 3 – Upper Confined, Fresh, Sodium Bicarbonate Aquifer

This layer lies below the E-Clay. At the base of the E-Clay lies a mixture of blue sands interbedded from 380 feet to 400 feet. At the top of this layer is 60 to 70 foot-thick sands (or a layer of sand?) with grains coarser at the base and finer upward. Similar sand occurs at the base of the third layer. The transmissivity ranges between approximately 50,000 and 70,000 gpd/ft. The groundwater in this layer is used for irrigation in Semitropic and would used by the SWRU wells to extract stored groundwater.

3.1.4.1.4 Layer 4 – Middle Confined, Fresh, Sodium Bicarbonate Aquifer

The fourth layer constitutes the aquifer from 725 to 1050 feet of depth. This is considered to be a more productive zone than Layer 3. The top 150 feet consists of several 30-foot thick sands interbedded with clay. The bottom 100 feet contain more thick and coarse-grained sand. The transmissivity ranges between approximately 2,000 and 10,000 gpd/ft. The groundwater in this layer is used for irrigation in Semitropic and would used by the SWRU wells to extract stored groundwater.

3.1.4.1.5 Layer 5 – Middle, Confined, Mixed Sodium Bicarbonate/ Chloride Brackish Aquifer

The fifth layer is a 200-foot thick zone that consists of large amounts of green-black silty clays. The sands are finer grained than those in Layers 3 and 4. This layer is estimated to be a zone of increasing salinity. The transmissivity ranges between approximately 2,000 and 10,000 gpd/ft. The proposed SWRU extraction wells are designed to pump water from the aquifer zones above this zone and the water in this layer is not used for irrigation in Semitropic and is not proposed for extraction by the SWRU.

3.1.4.1.6 Layer 6 – Lower Confined, Sodium Chloride, Saline Aquifer

The sixth layer lies below 1,250 feet of depth. The sediments are coarser grained than the layer above and the aquifer contains more saline water. This water is not used for irrigation in Semitropic and is not proposed for extraction by the SWRU.

3.1.4.1.7 Layer 7 – Saline Base Layer

The seventh layer is about 650 feet thick and extends to the base of the Tulare Formation. Salt concentrations are high, generally above 5,000 parts per million (ppm) in the upper portion. This water is not used for irrigation in Semitropic and is not proposed for extraction by the SWRU.

3.1.4.2 Groundwater Levels

The change of groundwater-level elevations below the E-clay layer (between spring 1995 and spring 2003) ranged between a 10 foot groundwater elevation drop in the northwest area of Semitropic to a 30 foot increase in the central and southeastern areas in Semitropic. The 2001-2002 Groundwater Monitoring Report attributed these groundwater level increases in the southeastern part of the Semitropic with the Kern County alluvial fan groundwater banking projects that are operating in water districts east of Semitropic. In the area north of Highway 155, water levels fell between 1995 and 2003. The Groundwater Monitoring Report attributed these drops to pumping in water districts north of Semitropic. (2001-2002 Groundwater Monitoring Report, published 2005) water districts north of Semitropic. (2001-2002 Groundwater Monitoring Report, published 2005)

3.1.5 Biological Resources and Special Status Species

Seven plant communities exist in the Semitropic area: the valley saltbush scrub, valley sink scrub, valley sacaton grassland, central and valley freshwater marsh, cismontane alkali marsh, cottonwood-willow riparian woodland, and disturbed herbaceous riparian. These communities provide important habitat for the special interest species described in Table 3-1.

Table 3-1
Special Interest Wildlife and Vegetation

	Federal Status	***State Status (CA)***
Wildlife		
San Joaquin kit fox	Endangered	Threatened
Tipton kangaroo rat	Endangered	Endangered
Buena Vista shrew	Endangered	Species of Concern
blunt-nosed leopard lizard	Endangered	Endangered
San Joaquin antelope squirrel	Species of Concern	Threatened
western pond turtle	Species of Concern	Species of Concern
giant garter snake	Threatened	Threatened
burrowing owl	Species of Concern	Species of Concern
American badger	None	Species of Concern
Tulare grasshopper mouse	None	Species of Concern
short eared owl	None	Species of Concern
pallid bat	None	Species of Concern
California mastiff bat	None	Species of Concern
loggerhead shrike	None	Species of Concern
Le Conte's thrasher	None	Species of Concern
Swainsons hawk	None	Threatened
Molestan blister beetle	Species of Concern	None
valley elderberry longhorn beetle	Threatened	None
Vegetation		
Kern mallow	Endangered	None
Hoover's eriastrum	Threatened	None
San Joaquin bluecurls	None	None
lesser saltbush	None	None
San Joaquin wooly threads	Endangered	None

3.1.6 Land Use

Semitropic covers approximately 221,000 acres which is mostly used for agriculture. The northwest portion is relatively undeveloped and includes over 8,000 acres of the 10,600 acre Kern NWR. The majority of the land within Semitropic is designated by the U.S. Department of Agriculture (USDA) as important national or State farmland.

About 25 percent is prime farmland of national importance, 30 percent is farmland of state-wide importance, and 10 percent is unique farmland.

According to the 1994 EIR, most of the land (95 percent) within Semitropic is designated agricultural in the *Kern County General Plan*. The remaining 5 percent of land within Semitropic consists of Federal or State land, incorporated cities, solid waste facilities, accepted county plan areas or rural communities, residential area, a highway commercial area, and service industrial areas. A portion of the Kern NWR (managed by the FWS) falls within Semitropic's boundaries.

The DFG owns two parcels for a total of 622.45 acres of land that falls within the area proposed by Semitropic for the SWRU well field. These two parcels were acquired for their threatened and endangered value in 1995 by DFG as a part of the mitigation program in Metropolitan Bakersfield's HCP.

About 65 percent of Semitropic agricultural land is irrigated. Irrigated crops consist of cotton, alfalfa, and deciduous trees (almond, pistachio, olive, prune, and walnut). Dryland agricultural areas consist of barley, wheat, and oats.

3.2 Future Without-Project Conditions

This section describes the anticipated future environmental conditions without Reclamation's participation in the SWRU. Without Federal participation, it is assumed that Semitropic would continue operation of facilities already constructed for the SWRU and would continue to develop the SWRU as new banking partners become participants in the bank.

The resource areas discussed in this section were also discussed in the existing conditions section of this chapter, but investigate a future with full operation of the original groundwater bank and the completion and operation of the SWRU.

The SWRU is designed to increase the rate of recovery of the banked water and to add 12,000 acres to the in-lieu system to increase groundwater storage capacity by 650,000 af. The following SWRU facilities have been constructed or are currently being constructed: 7.2 miles of pipeline and a turn-in turn-out facility at the Aqueduct.

To complete the SWRU, the following facilities would need to be constructed: (1) pumping plants, (2) a well field with 65 wells, (3) regulating reservoirs, (4) conveyance pipeline and canal, and (5) an arsenic treatment facility. Figure 3-3 shows the conveyance and groundwater infrastructure (in orange) associated with the original banking program and the infrastructure (in blue) associated with the SWRU.

3.2.1 Land Subsidence

Land subsidence within Semitropic occurred prior to the delivery of SWP surface water supplies. This land subsidence was concentrated in the northeastern portion of Semitropic and was linked to the overdrafting of the groundwater basin.

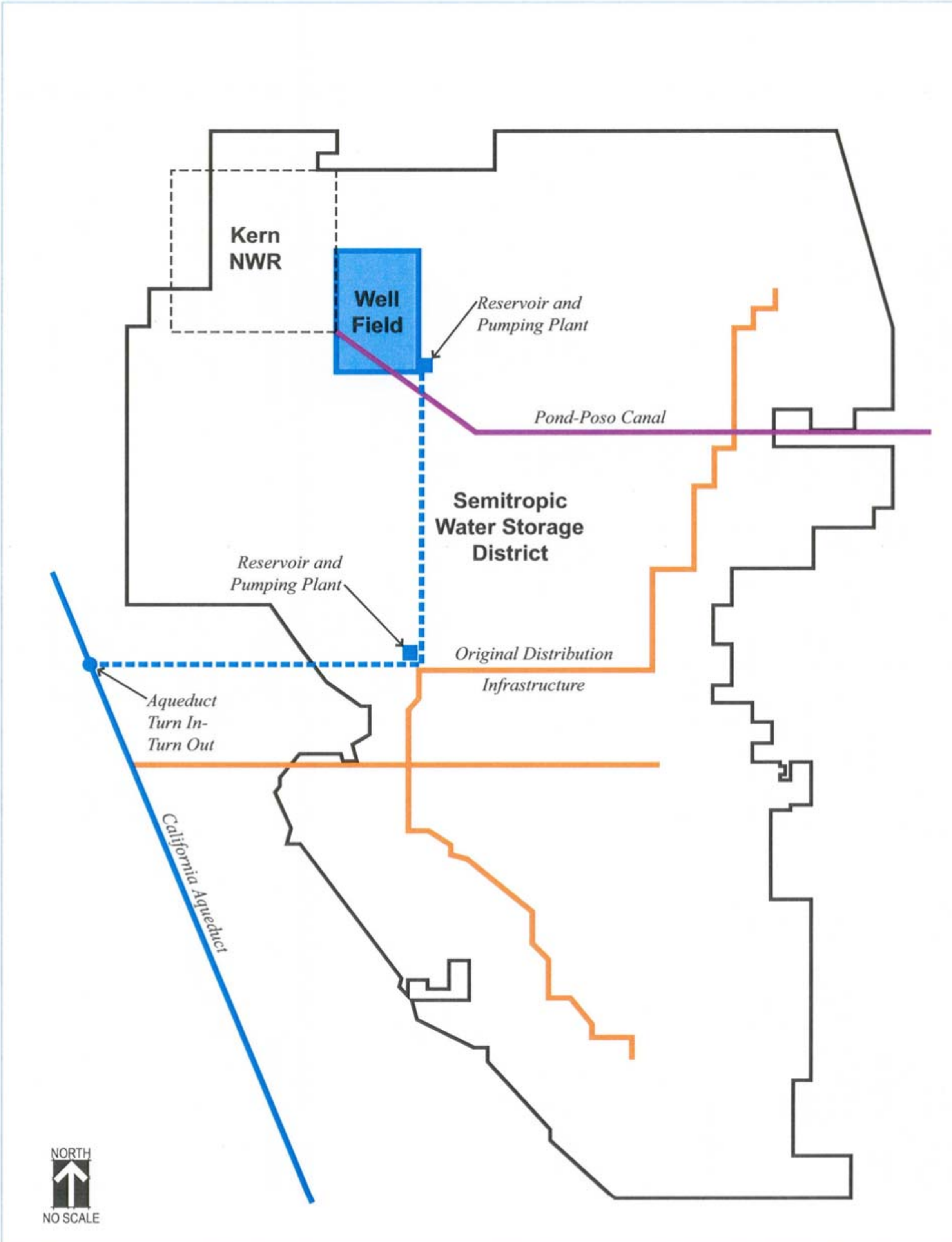


Figure 3-3
Semitropic Original Groundwater Bank and SWRU

The supplemental water deliveries from the SWP stabilized groundwater elevations and the occurrence of land subsidence. The groundwater banking project seeks to further stabilize and increase groundwater elevations.

The future without-project condition assumes continued delivery of Semitropic's SWP entitlement along with the additional contribution of banking partners' water to the full capacity of 1,650,000 af. Land subsidence would not occur until groundwater elevations fell below the historically observed level that had last initiated the settling. Land subsidence in the northwestern area of Semitropic could potentially cause a change in the Kern NWR's ability to distribute water throughout its network of canals given the current reliance on gravity flows.

The 2000 Supplemental EIR reported that localized groundwater elevation drops and associated land subsidence at the proposed SWRU well field could create the potential for approximately 1½ foot of subsidence in the center of the well field that diminished to zero at a distance of five miles from the well field. The potential effect of land subsidence (as a result of operation of the SWRU on the Kern NWR) was analyzed in 2003 by Semitropic and was determined to create the potential for approximately eight inches of subsidence at the Kern NWR (Semitropic, 2003a). Semitropic outlined a mitigation plan for any effects the potential subsidence could create for the Kern NWR that included the grading of the Refuge's irrigation ditches to restore any lost water conveyance capacity.

3.2.2 Water Quality and Hydrogeology

Operation of the existing groundwater bank and the proposed SWRU (according to the 1994 EIR and 2000 Supplemental EIR) would improve water quality and hydrology through achieving long-term groundwater elevations above the levels maintained by surface water delivery from the SWP alone. The improved groundwater elevations would help to prevent poor quality groundwater from migrating into Semitropic. The 1994 EIR and the 2000 Supplemental EIR do not address the presence of arsenic in groundwater extracted from the northwestern portion of Semitropic.

The operation of the groundwater bank, as it would be developed with the proposed SWRU, has not been analyzed by either the 1994 EIR or the 2000 Supplemental EIR for water quality issues associated with arsenic. The only documentation that analyzes arsenic beneath Semitropic is the 2001-2002 Groundwater Monitoring Report. The 2001-2002 Groundwater Monitoring Report identifies arsenic levels but does not analyze the potential water quality effects that arsenic could cause with ongoing operation of the groundwater bank. The future effect of arsenic on the operation of the SWRU is unknown.

3.2.3 Biological Resources and Special Status Species

Operation of the original groundwater bank and the proposed SWRU could have indirect effects on plant and wildlife species within the project area. The 1994 EIR and the 2000 Supplemental EIR analyzed these potential effects and determined they did not pose a threat to regional populations of biological species.

Construction of the well field proposed as part of the SWRU requires the completion of a HCP because of the project’s potential take of threatened and endangered species. Semitropic has prepared a HCP; however, it it has not yet been approved by the DFG or by the FWS. A completed HCP would establish mitigation measures for any impacts to threatened and endangered species created by completion and operation of the project.

3.2.4 Land Use

Operation of the original groundwater bank and SWRU would prevent groundwater elevations from falling below the baseline elevation established at the beginning of groundwater banking. The 1994 EIR determined that agricultural land use patterns would not be affected negatively by the further stabilization and potential improvement of groundwater elevations created by the operation of the groundwater banking program. The potential improvement of groundwater levels could improve the viability and help contribute to the protection of agriculture operations in Semitropic.

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Chapter 4
Planning Approach

4.1 Introduction

As discussed in Chapter 1, this Special Study evaluates the potential for Reclamation's participation in the SWRU to achieve its planning objectives. This chapter describes the planning approach and process to formulate alternative ways for Reclamation to participate in the SWRU.

The first step is to identify management measures, which represent specific features and/or activities to address problems, take advantage of opportunities, and achieve the planning objectives. These measures are formulated and evaluated in consideration of Federal planning criteria, which include completeness, effectiveness, efficiency, and acceptability (P&G, 1983).

After identifying the management measures, the next step is to evaluate how well each measure achieves the Federal planning criteria. The evaluation includes the following steps:

- Evaluate how well each measure performs related to each criterion ("performance measures");
- Develop rating scales to allow even application of performance measures to each management measure; and
- Compile evaluation results into a matrix to understand and display results.

The results of the management measure evaluation are then used to combine measures into alternatives that better meet the planning criteria than one measure alone. The next steps of the planning process are presented in the remaining Chapters 5, 6, and 7.

4.2 Management Measures

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. A feature requires construction or assembly on site, and an activity is defined as a non-structural action. If Reclamation funds a portion of the SWRU, it could participate in the banking project with storage and pump back benefits for a variety of different sectors. The following sections describe different ways that Reclamation could participate in the SWRU.

Reclamation identified measures through several means:

- Technical expertise of the study team;
- Existing Reclamation and Semitropic documents; and

- Semitropic conceptual development of the SWRU.

4.2.1 Environmental Measures

Reclamation could use the banking capacity in the SWRU to provide environmental benefits in several ways, as described below.

4.2.1.1 Refuge Water

The Kern NWR measure would establish a mechanism for the SWRU to regularly supply water to the Kern NWR. The objective would be to increase the amount of normal and dry year water available to the Refuge which could help to improve habitat management opportunities.

The Kern NWR is at the northwest corner of Semitropic, with approximately 80 percent of refuge land within Semitropic's boundary. Reclamation delivers water to the Refuge as a part of the CVPIA requirements for firm water supplies of "Level 2" water to all refuges in the Central Valley.[1] The CVPIA also directs Reclamation to provide "Level 4" supplies through the acquisition of water from willing sellers. Reclamation currently has a contract for refuge water with the San Joaquin Exchange Contractors that provides up to 50,000 af of water per year for $105 per af during wet years and 20,000 af of water per year for $300 per af during drought years. The water received from the Exchange Contractors is split amongst the Central Valley refuges. The portion of this water allocated to the Kern NWR is delivered through the Aqueduct and then conveyed to the Refuge in the Goose Lake Canal under a long-term wheeling agreement with the Buena Vista Water Storage District.

The annual water amount provided by the Exchange Contractors is established each May, with firm delivery of approximately 10,000 af every year and an additional flex quantity that varies between 10,000 and 40,000 af depending on hydrology. Reclamation can enter into contracts for additional water and can schedule summer water levels and fall flood levels to distribute available water for summer habitat beginning in May or for critical fall floods.

In the past, Reclamation's Water Acquisition Program has negotiated some single-year purchases from Semitropic on-the-spot market, but they have not created a long-term agreement. Semitropic has been unable to provide firm water delivery commitments until May, when it receives surface water delivery schedules for the Aqueduct from the DWR.

Semitropic could provide water from the SWRU to the Kern NWR by connecting the existing Semitropic pipeline (conveying water from the Aqueduct to Semitropic) to the Goose Lake Canal with the construction of a new turnout (see Figure 4-1).

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[1] Level 2 water supplies consist of the average annual historic supplies available to the refuges and Level 4 water supplies are those that would be required for optimum habitat management (Reclamation, 2005).

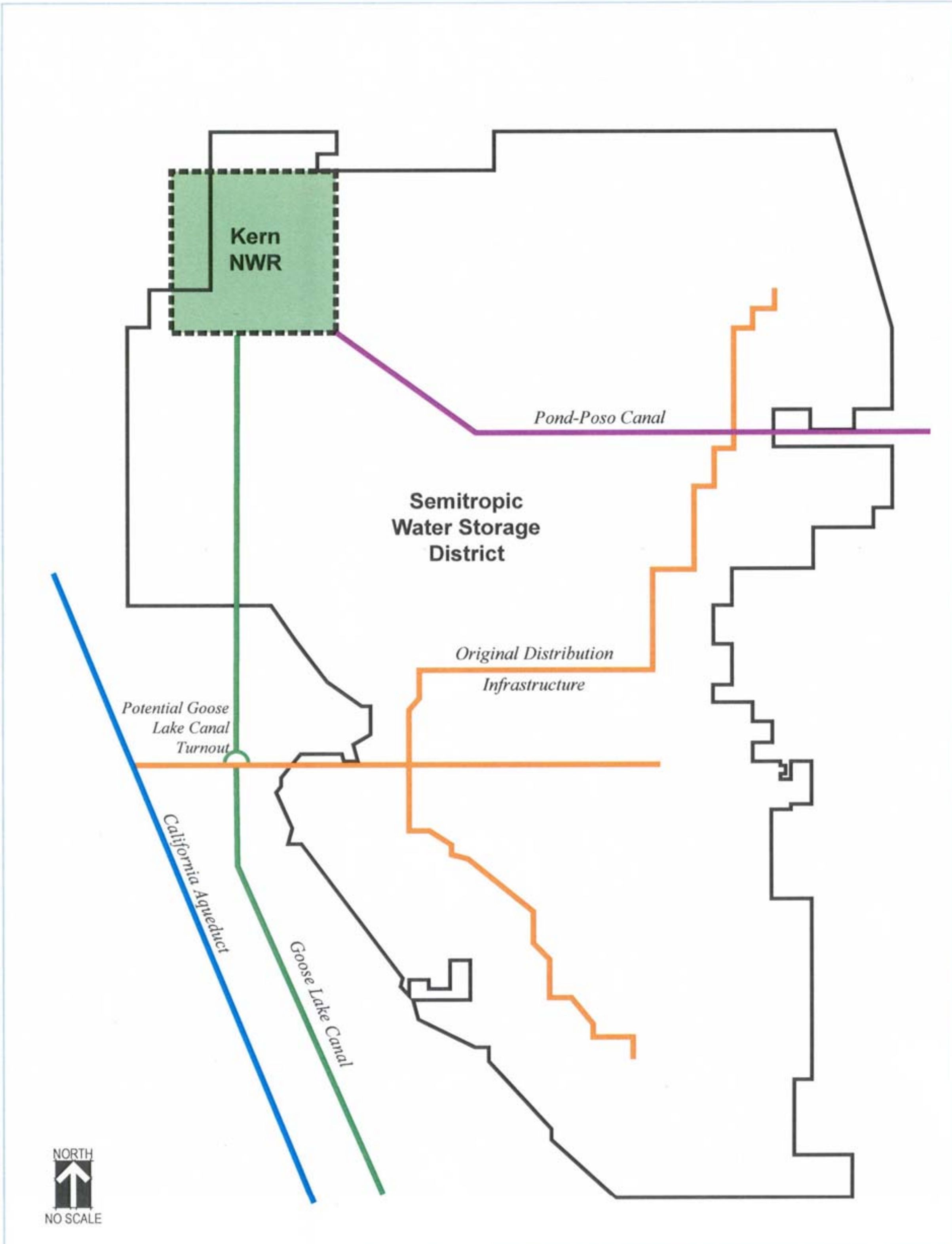

Figure 4-1
Potential Conveyance to Kern NWR

Reclamation could store Level 4 water in the SWRU in wet years that could be later provided to the Kern NWR. Semitropic would provide Kern NWR water supply either by pumping groundwater into the Goose Lake Canal or through an exchange for Semitropic SWP allocation. Storing water in advance would provide a reliable supply for refuge managers without the timing constraints of spot market water transfers.

The Kern NWR Level 2 demands are 9,950 af, but Reclamation is only required to deliver 75 percent of those demands (7,460 af) in critically dry years. The incremental Level 4 supply, acquired by Reclamation's Water Acquisition Program is 15,050 af (FWS, 2005).

4.2.1.2 Environmental Water Account or Equivalent

Reclamation, in cooperation with other State and Federal agencies, is implementing the Environmental Water Account (EWA) to protect and restore at-risk native fish species of the Delta and improve water supply reliability. The EWA agencies acquire water through changes in Delta operations, short-term transfers, and long-term transfers. Reclamation could store water for the EWA in the SWRU for future fish needs. Use of the bank would allow the EWA agencies to acquire water during years when it is more available and less expensive. Storage in the bank would also protect EWA supplies from being lost due to lower storage priorities at CVP and SWP surface water facilities.

Most of EWA's water acquisitions are available at times when the water cannot immediately be used to protect or restore fish. For example, most transfers occur during the irrigation season from March through September, but most actions to protect fish occur from December through June. The EWA agencies could use groundwater storage in the SWRU to address timing and location issues associated with water acquisitions. The EWA agencies prefer to acquire water upstream from the Delta because it is less expensive. This water then needs to be conveyed through the Delta to CVP and SWP contractors to replace water supplies not delivered due to reduced export pumping to protect fish. Generally, capacity at the CVP and SWP pumps becomes increasingly available from below normal to dry to critically dry years. However, the EWA needs greater quantities of water to take actions to protect fish and compensate water users in wet years.[2] Therefore, in wet years, when the EWA agencies need the most water to take actions to protect fish, the CVP and SWP pumping facilities have little or no availability to help the EWA convey water. Use of the SWRU could address this problem by accepting water during below normal and dry years and storing it until a subsequent above normal year.

Additionally, in some years, the EWA agencies acquire more water than is needed, which must be stored for future years. The EWA agencies currently borrow storage

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[2] When the EWA agencies reduce pumping at the export facilities, they are responsible to compensate the Projects for the difference between the new pumping rate and what the pumping rate would have been absent the EWA. In a wet year, the pumping would generally be higher than in dry years; therefore, the water needed to compensate for fish actions is higher.

capacity from the CVP and SWP, but any water stored in CVP and SWP facilities is converted to Project water during the wet season if the facility fills. Therefore, any EWA water stored in CVP and SWP facilities may not be available in the following year. Using the SWRU for EWA water would ensure that any water stored was not lost during the wet season before it could be used.

Generally, the EWA agencies would only need to take water out of the SWRU during above normal and wet years; therefore, the EWA program would participate as a low priority participant in the groundwater bank. The EWA agencies would provide water for recharge through the Aqueduct. They would want their water returned either as an exchange for Semitropic contract water in San Luis Reservoir, or through direct pump back into the Aqueduct. The maximum quantity of water in storage for the EWA would be up to 200,000 af because the CALFED ROD identified a need for 200,000 af of storage south of the Delta. It is noted that Semitropic has sold water previously stored in its share of the KWB. Similar arrangements could be implemented within the SWRU as well as the KWB.

4.2.1.3 Shafter-Wasco Intertie

Shafter-Wasco is a CVP water contractor and receives deliveries from Millerton Lake that are conveyed to Shafter-Wasco through the Friant-Kern Canal (see Figure 4-2). The Shafter-Wasco intertie measure would use an intertie between Semitropic and the adjacent Shafter-Wasco to allow substitution of Delta water for Shafter-Wasco's existing supply of water from the Friant-Kern Canal, or storage of Friant flood flows for later use in Shafter-Wasco. The objective would be to reduce demands on the Friant-Kern System, which could help alleviate conflicts between environmental and agricultural water needs.

The Department of the Interiorhas recently entered into a Stipulation of Settlement (Settlement) in the case of *NRDC et al. v. Rodgers, et al.* This Settlement, if authorized by Congress, would end 18 years of litigation regarding long-term water service contracts in the Friant Division and operation of Friant Dam. The court approved the Settlement on October 23, 2006. The Settlement contains both Restoration and Water Management goals. A Shafter-Wasco Intertie could allow the SWRU to be part of a banking strategy for storage of water acquired by the Secretary to be used to implement the Restoration Goal. The Shafter-Wasco Intertie could also be a component of a plan to convey recaptured flows back to the Friant Division to meet the Water Management Goal. These opportunities will be considered more fully as alternatives for implementing the Settlement are developed and analyzed.

Semitropic has infrastructure capable of conveying water from the Aqueduct to a Shafter-Wasco distribution lateral. This connection has an estimated transfer capacity of 30 cubic feet per second (cfs) (Semitropic, 2003b). Semitropic has completed initial construction of infrastructure for an additional 120 cfs and has proposed construction of additional facilities to increase the capacity by an additional 150 cfs for a total planned capacity of at least 300 cfs. The additional infrastructure may provide some increased capacity for this measure, but is not necessary for the measure to move

Figure 4-2
Mechanisms of Water
Delivery to Semitropic

forward. The interconnection between Semitropic and Shafter-Wasco offers two mechanisms to supply water to Shafter-Wasco and decrease its reliance on Friant-Kern supplies.

First, the SWRU could store water from the CVP's Friant Division, particularly flood flows, for later use in Shafter-Wasco. Semitropic's location adjacent to Shafter-Wasco allows for the conveyance facilities to deliver Friant-Kern water through Shafter-Wasco for storage, and then back to Shafter-Wasco for irrigation use in the summer. The SWRU could receive this water through either existing or future conveyance structures or through Poso Creek, a conveyance facility that crosses both Districts (Reclamation, 2006a).

Second, the connection between Semitropic and Shafter-Wasco also creates the potential for the substitution of CVP Delta water as a Shafter-Wasco supply. The CVP would pump Delta water during the wet season when the Delta is experiencing excess conditions and store that water for later use in Shafter-Wasco. Shafter-Wasco would accept the water from the SWRU for use within its area and exchange its water in Millerton Lake with Reclamation. The SWRU allows for the new water supply for Shafter-Wasco to be made available during the wet season and stored until needed for irrigation.

Semitropic has investigated the expansion of the intertie with Shafter-Wasco to develop increased transfer potential beyond the planned 150 cfs. Semitropic has completed a portion of the infrastructure needed to increase the capacity of the current connection to Shafter-Wasco from 30 cfs to 150 cfs. It estimates that approximately $12 million is needed to complete the next phase of the planned expansion (Boschman 2006). The proposed additional conveyance capacity would also improve operational flexibility by offering the potential for two-directional flow if it was needed. This expansion would also develop a direct connection to the Friant-Kern Canal by extending existing Shafter-Wasco water conveyance infrastructure to the east beyond its current connection to the Calloway Canal, making direct transfers to other CVP users possible. Semitropic estimated the costs of the parallel pipeline to be $52,914,000 (Semitropic 2003b).

The upper limit for this measure is the full amount of water that Shafter-Wasco would receive through its contract with Reclamation for Friant-Kern water. Shafter-Wasco's contract is up to 50,000 af of Class 1 water, and up to 39,600 af of Class 2 water (Reclamation, 2001).[3] It should also be noted that Semitropic has the first right to use Shafter-Wasco's exchange capability for up to 50,000 acre-feet per year.

4.2.2 Measures to Provide Water to CVP Contractors

This management measure would create a new water storage resource for Reclamation to provide water to Federal M&I and agricultural contractors through Reclamation's banking of groundwater in the SWRU. The objective would be to improve

[3] Shafter-Wasco's contract specifies that Class 1 is "a dependable water supply during each year" and Class 2 is "undependable in character and will be furnished only if, as, and when it can be made available as determined by the Contracting Officer" (Reclamation, 2001).

Reclamation's operational flexibility with the ability to extract banked groundwater and deliver it to Federal contractors when needed.

Federal contractors currently are subject to delivery fluctuations depending on the water year type. In dry water years the total proportion of contract entitlement delivered is reduced and contractors replace this water with other local supplies, acquire supplies on the spot market, or go without the water. Reclamation's participation in the SWRU would allow Reclamation to store water in the groundwater bank during wetter years and extract and deliver this water during dry years. This dry year delivery of stored groundwater would help to improve regional water supply reliability.

Reclamation also has difficulty in reliably predicting CVP water deliveries early in a water year. Reclamation typically cannot accurately forecast water deliveries until farmers have already made planting decisions and secured financing. If Reclamation had water stored in the SWRU, it could provide backup water supplies for Reclamation. Reclamation could be less conservative in earlier water forecasts with the knowledge that these backup supplies are available if needed. More reliable forecasts for greater quantities of agricultural deliveries would allow farmers to secure financing for greater amounts of planting.

Semitropic currently has the facilities available to deliver stored groundwater to the Aqueduct and to the neighboring Shafter-Wasco, a Federal contractor. Reclamation would need to create operational agreements with the SWP to send water to the SWRU for storage and to withdraw water. Reclamation could withdraw water in two ways:

- A portion of Semitropic's SWP water in storage in the San Luis Reservoir would convert to CVP water; or
- A portion of SWP supplies in San Luis Reservoir would convert to CVP water, and Semitropic would pump the same amount of water from the SWRU into the Aqueduct for SWP use.

Reclamation participation in the bank would be limited by funding availability and interest among the CVP contractors.

4.3 Management Measure Screening and Comparison

4.3.1 Measure Screening

As discussed in Chapter 1, Semitropic has two ways for shareholders to participate in the SWRU – high priority and low priority. High priority has the first priority for withdrawal, which means the banking partner would be more likely to withdraw water during the peak dry season of dry or critically dry years. Low priority partners have a lower priority for withdrawal. They may be able to withdraw water during drier years if withdrawal capacity is available, but likely will not be able to withdraw water during the peak dry season of the driest years. Low priority partners pay less to participate in the SWRU than high priority partners.

If Reclamation participates in the SWRU to provide environmental benefits, it would likely choose to participate at a low priority. This decision would be based on need and cost-effectiveness. For wildlife refuge water supplies, the Kern NWR may need alternative water supplies throughout the season (particularly in dry years), but much of the water would be required in the fall to flood the wetland units in Kern NWR. Fall flooding would likely occur at a different time than other banking partners would need the water, so low priority would still allow Reclamation to meet Kern NWR needs. Additionally, Reclamation now pays approximately $300 per af for refuge supplies during dry years, which is generally comparable to the price of water from the SWRU stored under low priority shares. The actual cost per af of low priority water extracted from the SWRU is dependent on the initial cost of obtaining the water to store in the bank and could potentially (if low cost water is unavailable for storage) make banked water more expensive than the water guaranteed by contract with the Exchange Contractors.

As described in Section 4.2.1.2, Reclamation would be primarily interested in withdrawing water from storage for the EWA type of program during wetter years; therefore, low priority shares are more appropriate for this measure. Reclamation could use water for the Shafter-Wasco intertie in most year-types, so low priority would be more efficient because participation would cost less.

Measures that provide water for CVP contractors would involve participation in the SWRU at a high priority because CVP contractors are most interested in the water during dry years. Table 4-1 summarizes the priority for participation associated with each measure.

Table 4-1
Management Measure Screening

Measure Category	***Measure***	***High Priority***	***Low Priority***
Environmental	Refuge water		X
	EWA or Equivalent		X
	Shafter-Wasco intertie		X
CVP Contractors	Municipal & industrial	X	
	Agricultural	X	

4.3.2 Planning Criteria and Performance Measures

The P&Gs identify four planning criteria to consider during the development of Federal water projects: completeness, effectiveness, efficiency, and acceptability. The evaluation of management measures examines how well the management measures follow these planning criteria. Table 4-2 defines each criterion and defines performance measures to measure how well each resource management measure achieves each criterion.

Table 4-2
Performance Measures

Planning Criterion	***Description***	***Performance Measures***
Completeness	How well a measure accounts for all investments necessary to realize the planned effects; how well the alternative achieves the planning objectives	Quantity of water available for dry-year supply for M&I users
		Quantity of water available for dry-year supply for agricultural users
		Quantity of environmental water available
		Agricultural production
Effectiveness	How well a measure alleviates problems and achieves opportunities	Amount of groundwater recharge
		Groundwater pumping costs in Semitropic
		Ability to capture floodflows or available excess flows
		Ability to accurately forecast water deliveries early in the water year
		Change in CVP yield or refuge deliveries
Efficiency	How well a measure capitalizes on financial benefits (is cost-effective)	Cost-benefit ratio
Acceptability	Viability of a measure with respect to acceptance by state and local entities and compatibility with existing laws	Public acceptance (does the measure trigger any institutional, legal, or public opinion controversies that would result in a longer period for implementation)
		State acceptance, particularly with respect to cooperation regarding conveyance facilities

Each performance measure has a rating scale to ensure an even application of the performance measure. Figure 4-3 presents the rating scales, which include colors to reflect the degree to which management measures meet each performance measure. The green level shows a good performance; the yellow level shows a neutral performance; and the orange levels show poor performance.

Quantity of water available for dry-year supply for M&I users
Increase in M&I supply
No change in M&I supply
Decrease in M&I supply

Quantity of water available for dry-year supply for agricultural users
Increase in agricultural supply
No change in agricultural supply
Decrease in agricultural supply

Quantity of environmental water available
Increase in environmental water
No change in environmental water
Decrease in environmental water

Agricultural production
Increase in value of agricultural production
No change in value of agricultural production
Decrease in value of agricultural production

Amount of groundwater recharge
Increase in net groundwater recharge
No change in groundwater recharge
Decrease in groundwater recharge

Groundwater pumping costs in Semitropic
Decrease in groundwater pumping costs
No change in groundwater pumping costs
Increase in groundwater pumping costs

Ability to capture floodflows or available excess flows
Increase in ability to capture excess flows
No change in ability to capture excess flows
Decrease in ability to capture excess flows

Ability to accurately forecast water deliveries early in the water year
Increase in forecasting ability
No change in forecasting ability
Decrease in forecasting ability

Change in CVP yield or refuge deliveries
Increase in CVP yield
No change in CVP yield
Decrease in CVP yield

Cost-benefit ratio
Cost benefit ratio over 1
Cost benefit ratio approximately equal to 1
Cost benefit ratio below 1

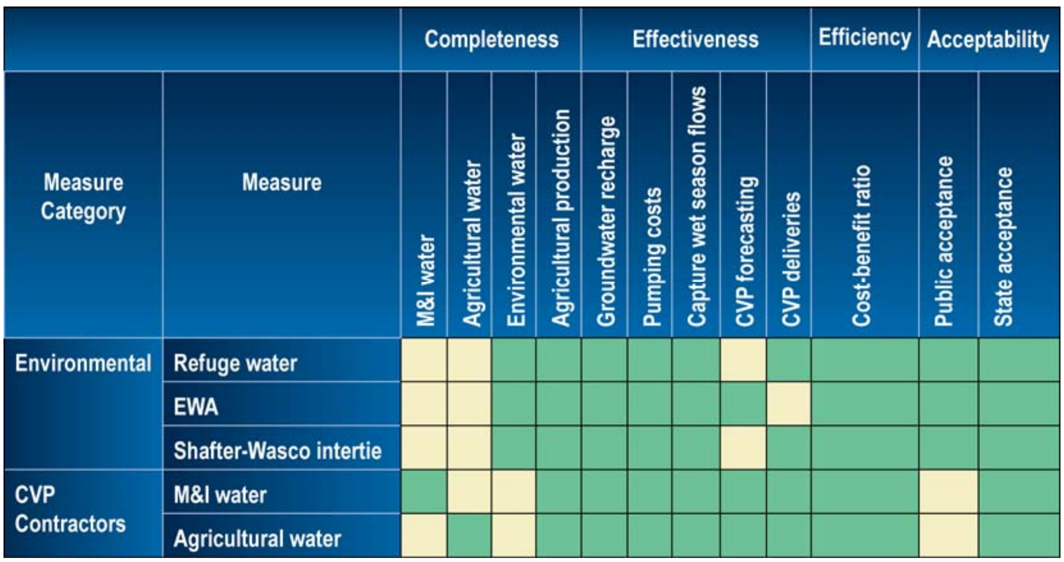
Public acceptance
Most of the public approves
Some public objection to elements of the measure, but general acceptance
Most of the public disapproves

State acceptance
General state government approval
General state government acceptance
General state government disapproval

Figure 4-3
Performance Measure Rating Scales

4.3.3 Evaluation of Management Measures

The preliminary evaluation describes how the management measures perform relative to the planning criteria. Figure 4-4 summarizes the evaluation results. The figure shows the management measures in the left columns and the planning criteria and performance measures along the top rows. While the rating scales identified the possibility of negative ratings, Figure 4-4 shows that none of the resource management measures performed poorly relative to any performance measure. Generally, all of the resource management measures would achieve the planning criteria to some degree.



Green = good performance
Yellow = neutral performance
Orange = poor performance

Figure 4-4
Evaluation Results

4.3.3.1 Quantity of Water Available for Dry Year Supply for M&I Users

Only the CVP contractor management measure focusing on M&I supply would provide additional supplies for these users. The remainder of the management measures would not affect M&I supplies.

4.3.3.2 Quantity of Water Available for Dry Year Supply for Agricultural Users

The management measure providing water to agricultural CVP contractors would increase water supply available for agricultural users. The rest of the management measures would not affect agricultural users.

4.3.3.3 Quantity of Environmental Water Available

All three environmental measures (refuge water, EWA, and the Shafter-Wasco intertie) would increase environmental water. The quantities would vary for each management measure based on need and capacity. The Kern NWR water needs are relatively low (approximately 25,000 af per year) and the Shafter-Wasco intertie is limited by the intertie capacity and Shafter-Wasco's CVP contract (to 70,000 af per year as a maximum). The EWA could use up to 200,000 af of storage, which would amount to approximately 67,000 af of withdrawal in one year on a first priority basis and significantly more in average years. The CVP contractor measures would not affect the overall quantity of environmental water available.

4.3.3.4 Agricultural Production

By participating in the SWRU, all measures would help to support agricultural production on existing farmland within Semitropic's boundaries. Constructing the SWRU will improve and expand the infrastructure utilized bySemitropic, which improves long-term water supply reliability by enabling growers to receive both surface water and groundwater supplies. One of the major consequences of this improved reliability (as demonstrated by Semitropic's past experience) is that farmers will be more able to obtain loans to convert from lower value row crops such as cotton to higher value permanent crops such as almonds. These higher value permanent crops use less water and generate significantly more revenue within the local farm economy.

4.3.3.5 Amount of Groundwater Recharge

The terms of participation in the SWRU call for a 10 percent loss initially charged to banked water. A small portion of these charged losses are irrecoverable to the aquifer, therefore, all management measures would result in a net increase of recharge within Semitropic.

4.3.3.6 Groundwater Pumping Costs in Semitropic

Temporary groundwater stored in the bank and groundwater left in the aquifer after withdrawal will raise groundwater levels in Semitropic. Increased groundwater levels will decrease the amount of lift needed to pump groundwater, which will decrease groundwater pumping costs with all measures.

4.3.3.7 Ability to Capture Floodflows or Available Excess Flows

All measures would improve the CVP's ability to capture floodflows or available excess flows by providing a storage facility south of the Delta.

4.3.3.8 Ability to Accurately Forecast Water Deliveries Early in the Water Year

Storing water in the SWRU would provide Reclamation with a backup water supply in case early water forecasts are complicated by precipitation. Reclamation currently keeps early forecasts conservative to address the uncertainty associated with precipitation, but backup supply in the SWRU would allow less conservative forecasts. The measures that would provide water to CVP contractors (both M&I and agricultural) would assist with the forecasts.

Additional uncertainty in forecasting is related to potential actions that reduce Delta export pumping to protect fish. The EWA would reduce these uncertainties, thereby increasing the ability to forecast deliveries.

4.3.3.9 Change in CVP Yield or Refuge Deliveries

All management measures that help meet CVP obligations would help achieve this performance measure. CVP obligations include refuge supplies, Friant-Kern supplies (and San Joaquin River flows), and contractor supplies. The only measure that does not increase CVP yields is the EWA.

4.3.3.10 Determination of Benefits and Costs

Chapter 5 derives the costs per af of water stored in the SWRU; the results show that high priority water ranges from $390-430/af and low priority water ranges from $240-280/af[4]. The environmental measures (refuge water, EWA, and Shafter-Wasco) would participate in the SWRU at a low priority, and the CVP contractors would participate in the SWRU at high priority. The benefits for the measure are calculated based on avoided costs and available water supply studies:

- Refuge water: other dry-year purchases cost $300/af;
- EWA: other purchases range from $215/af in 2006 to $374/af in 2034;
- Shafter-Wasco intertie: other purchases in the San Joaquin River Basin range from $215-400/af;
- M&I water: other dry-year purchases range from $215-374/af, the water from other storage projects ranges from $330-400/af other types of supply (i.e., desalination) costs up to $1050/af, and emergency supply ranges from $1300-1700/af; and
- Agricultural water: produces benefits not only associated with avoided costs of other water sources but can also result in planting higher value crops.

Appendix C describes the economic calculations in more detail, including sources of information. The benefits, calculated from avoided costs and other available water prices, are greater than the costs to participate in the SWRU for all measures.

4.3.3.11 Public Acceptance

All management measures would require water to be deposited into the bank, which would involve increased diversions from surface water bodies. Increasing diversions typically encounters some public resistance. However, public opinion regarding groundwater storage seems to be generally positive. The environmental measures may produce positive environmental benefits to offset the concerns regarding increased diversions. The CVP contractor supply measures do not have the same potential environmental benefits; therefore, public opinion may be mixed.

[4] Purchase and transfer cost for water to Semitropic are not included

4.3.3.12 State Acceptance

The DWR is likely to help implement the SWRU measures because the operations groups for the SWP and CVP generally cooperate on operations (as long as the cooperation does not adversely affect either party). The State is likely to approve of measures to increase supplies south of the Delta; therefore, all measures are likely to have State acceptance.

4.4 Future Planning Requirements

Chapter 4 has presented a screening and ranking of the potential management measures that Reclamation could undertake to satisfy study objectives. This report does not further combine these management measures into refined alternative plans for comparison but rather presents a single potential scenario in Chapter 5 to demonstrate how Reclamation could potentially participate in the SWRU. [To assess the potential for Federal participation in the SWRU consistent with the P&Gs and NEPA, the development and comparison of alternatives to a no-action alternative would be required if further studies are undertaken.]

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Chapter 5
Scenario for Federal Participation in the SWRU

This Chapter presents an example scenario for Reclamation's potential participation in the SWRU.

5.1 Example Scenario- Dry Year Contractor Supply and Normal Year Transfer to Shafter-Wasco Irrigation District for Additional San Joaquin River Flow

5.1.1 Description of Scenario

This example scenario includes combining two resource management measures- drought water supply reliability to CVP contractors and environmental water to the San Joaquin River by exchanging banked water in the SWRU for Shafter-Wasco contract deliveries on the Friant-Kern System. Both resource management measures are described in detail in Chapter 4 and are summarized below. These two resource management measures would be combined to form a single alternative.

Semitropic and Shafter-Wasco Irrigation District Intertie - Reduce Demand on Friant Kern System

Shafter-Wasco is a CVP contractor which takes water off the Friant-Kern Canal. A transfer of water through the SWRU and the SWP in exchange for CVP Friant water would provide Reclamation with storage capability in Millerton Lake for release to the San Joaquin River as environmental flow. Shafter-Wasco is currently connected to the SWRU through existing conveyance canals and pipelines with a conveyance capacity up to 30 cfs (21,718 af of water per year). Little change to existing infrastructure is needed to fulfill the objectives of the resource management measure.

Provide Dry-Year Supplies for CVP contractors

Reclamation delivers water to M&I and agricultural contractors throughout the State. Delivery amounts fluctuate based on water year type: more water is delivered during wet years and less water during dry years. Storage in the SWRU could improve the supply reliability to CVP contractors in dry years. South of the Delta M&I contractors that could utilize water banked in the SWRU through existing SWP conveyance facilities with relatively uncomplicated transfer agreements include: Contra Costa Water District, East Bay Municipal Utilities District, SCVWD, and the City of Tracy.

5.1.2 Estimated Cost to Bank Water in the SWRU

Participation in the SWRU occurs through the purchase of shares which goes towards construction of infrastructure (capital cost) to move water in and out of the SWRU. Table 5-1 presents the estimated cost to store and recover water over the life of the SWRU. This cost includes O&M and share costs distributed over two storage and recovery cycles. These costs are based upon the contractual operations established for the SWRU and presented in Chapter 1. All costs cited in this entire report are in 2003 dollars adopted by the Semitropic Board in January 2004.

Table 5-1
Estimated Per Acre Foot Price for Storage in the SWRU

Agreement Level		High Priority		Low Priority	
Total Number of Shares		150,000		100,000	
Cost Structure/Cost per [1]	(shares/$ per share)	(1-14,999 shares)/1200	(15,000-150,000 shares)/950	(1-14,999 shares)/700	(15,000-150,000 shares)/500
Distributive Share Cost per AF[2,3]	($ per AF per cycle)	200	160	120	83
Cost for pump in/out	($ per AF per cycle)	76	76	38	38
Cost for Management[3]	($ per AF per cycle)	24	25	14	14
Cost for Maintenance[3]	($ per AF per cycle)	39	39	19	19
Pump Costs Electricity[4, 5]	($ per AF per cycle)	90	90	90	90
Total Approx./Est. Cost[6]	($ per AF)	430	390	280	240

1. 3 AF of storage per share for life of contract and 2 put/take cycles over life of contract based on contractually guaranteed recharge capacity, when available up to 180,000 acre feet could be recharged
2. Cost per share divided by 2 cycles and Acre-ft Capital Cost assumes 2 put\take cycles, restricted by input rate of 0.33 AF/year
3. Contract expires 2035, contract life is 29 years, assumes two put/take cycles (14.5 yrs)
4. Assumes 10% loss of water upon recovery
5. Lift assumes the Piezometric surface is 200 ft below the ground surface, drawdown is 15 ft (drawdown for well field is unknown and could be substantially greater) and 185 ft of additional lift required to reach the State Water Project Aqueduct . Cost per foot of lift =$0.25 per AF per ft of lift)
6. Purchase and conveyance cost for water to Semitropic are not included

5.1.3 Hypothetical Level of Participation by Reclamation

This scenario assumes hypothetically that Reclamation would commit $50,000,000 to develop a supply of water from the SWRU. It further assumes that Reclamation would purchase low and high priority shares at a distribution of 30 percent and 70 percent respectively, given the generally higher need for dry and critically dry year water supply reliability needed by CVP contractors.

Table 5-2 provides a summary of the estimated number of shares and the storage and pump back created by this level of investment. High priority shares would be utilized in dry or critical years while low priority shares would be utilized in above normal or below normal years. A detailed cost breakdown of hypothetical Federal participation in the SWRU is presented in Table 5-3. These costs are presented as estimates for general comparison purposes and could be subject to change in the future.

Table 5-2 Summary of Hypothetical Federal Participation with $50,000,000 Committed Over 29 Years						
Water User	***Shares Purchased***	***Estimated Cost Per Acre-Foot[1]***	***Storage Available Acre-feet***	***Water Available for Recovery[2,3] Acre-feet***	***Yearly Recharge Potential[3] Acre-feet***	***Pump Back Capacity Acre-feet***
Low Priority Environmental Water	8,860.00	$280	26,580	23,922	2,924	8,860
High Priority Contractor Water	15,150.00	$390	45,450	40,905	5,000	15,150

1. Assumes 3 acre-ft of storage per share, two storage cycles per life of contract does not include initial purchase price and conveyance cost of the stored water
2. Assumes a 10% loss of water upon recovery
3. Contractually guaranteed recovery and recharge capacity. Greater quantities could be recharged and recovered if the capacity is available.

Table 5-3 Initial Estimated Costs for Hypothetical Federal Participation Including O&M and Share Purchase			
	Units	***High Priority***	***Low Priority***
Number of Shares[1]	(share)	15,150	8,860
Cost of Share	($ per share)	950	700
Cost for pump in/out[2,3]	($ per share)	456	228
Cost for Management[4]	($ per share)	145	87
Cost for Maintenance[5]	($ per share)	232	116
Pump Costs Electricity[6]	($ per share)	540	540
Total Operations and Maintenance Cost per Share	($ per share)	1373	971
Total Operations and Maintenance Cost	($)	20,800,950	8,603,060
Total Cost per Share	($ per share)	2323	1671
Total Cost of Shares	($)	14,392,500	6,202,000
Total Estimated Cost[7]	($)	35,193,450	14,805,060

1. Assumes 30% of the investment is spent on Low Priority shares
2. High Priority: $40 per acre-ft to pump in and $40 per acre-ft to pump out, three acre-ft in one share, assumes two put/take cycles over the life of the contract, 10% loss of water upon takeout
3. Low Priority: $20 per acre-ft to pump in and $20 per acre-ft to pump out, three acre-ft in one share, assumes two put/take cycles over the life of the contract, 10% loss of water upon takeout
4. High Priority: $5 per share per year, Low Priority: $3 per share per year, assumes project life of 29 years (contract expires 2035)
5. High Priority: $8 per share per year, Low Priority: $4 per share per year, assumes project life of 29 years (contract expires 2035)
6. Cost for operations and maintenance of the project as contractually established by Semitropic for the SWRU
7. Total Estimated Cost does not include the purchase and conveyance cost for water to the SWRU.

Table 5-4 presents a summary of the estimated costs for hypothetical ***Federal*** participation in the SWRU. An investment by Reclamation of approximately $20.6 million in the purchase of shares will yield 45,450 af (15,150 shares) of high priority storage and 26,580 af (8,860 shares) of low priority storage. The operations and maintenance cost associated with moving water in and out of the SWRU over two withdrawal cycles is estimated at $29.4 million.

Table 5-4 ***Summary of Estimated Cost[1] for Hypothetical Federal Participation***		
Cost of High Priority Shares	(15,150 shares)	$14,392,500.00
Cost of Low Priority Shares	(8,860 shares)	$6,202,000.00
Total Share Cost		$20,594,500.00
Total O&M Cost		$29,404,010.00
Total Federal Participation Cost		$49,998,510.00
1. Does not include initial purchase price and conveyance cost of the stored water		

5.1.4 Recharge and Recovery

This section describes how water would be moved in and out of the SWRU and identifies limitations associated with the scenario.

Based on the assumptions, recharge and recovery from the SWRU over a single cycle takes approximately 12 years (nine years are required to fill the shares purchased in the SWRU and three years are required to extract). Therefore, no more than two cycles of water would be stored and recovered from the SWRU. Assuming a 29-year period of participation in the SWRU (2006- 2035) and applying the frequency of recurrence of water year types (see Table 5-5), 43 percent of water years (13 years) are wet or above normal, 54 percent are below normal or dry, and 21 percent (6 years) are critically dry or the driest years.

Table 5-5
Frequency of Water Year Types

Year Type	***Frequency (%)***		***Estimated number of years in 29***
Wet	28.8	42.8	13
Above Normal	14		
Below Normal	19.2	35.6	10
Dry	16.4		
Critically Dry	2.4	21.6	6
Driest[1]	19.2		

[1] Driest years include 1924, 1929-1934, 1977, and 1987-1992

Source: Reclamation 2006

Figures 5-1 and 5-2 demonstrate how the water years could be hypothetically distributed over a 29-year period and how water could be stored and extracted from the SWRU for use as high priority water for M&I and agriculture in dry years and or low priority water for Shafter-Wasco in below normal years. In the figures, wet and above normal years are marked with an "A," below normal and dry are marked with a "BN," and critically dry and driest years are marked with a "D." The pattern of water-year types reflects the historic distribution in Table 5-5, but does not directly reflect a specific historical period.

In both scenarios high priority water can be stored at a rate of 5,000 af per year and low priority water can be stored at a rate of 2,924 af per year. The high priority water can be extracted at a rate of 15,150 af per year in dry and critically dry years and the low priority water can be extracted at a rate of 8,860 af per year.

For the scenario shown in Figure 5-1, two extraction cycles are imposed over two drought cycles and the scenario assumes that low priority water would be recharged for Shafter-Wasco during the below normal water years that occur in years 21 through 24 of the scenario. Low priority water would be extracted for Shafter-Wasco during years 6, 7, 14 and 15. The scenario assumes that high priority water would not be recharged during periods of low priority water extraction.

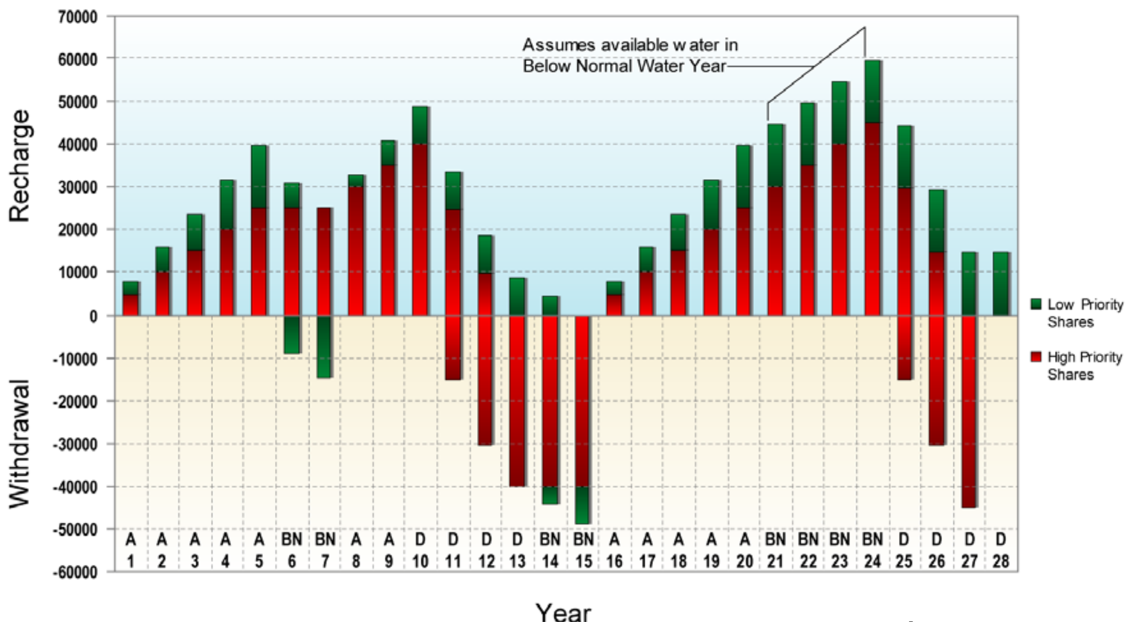

Figure 5-1
Scenario 1 – Recharge Potential in 4 of 8 Below Normal Years
Shafter-Wasco Supply in Below Normal Non-Recharge Years
Contractor Supply All Years

For the scenario shown in Figure 5-2, two extraction cycles are imposed over two drought cycles and the scenario assumes that water would not be available for high priority recharge during the four below normal water years that occur in years 21 through 24 of the scenario. The scenario also assumes that low priority and high priority water are not extracted in the same year.

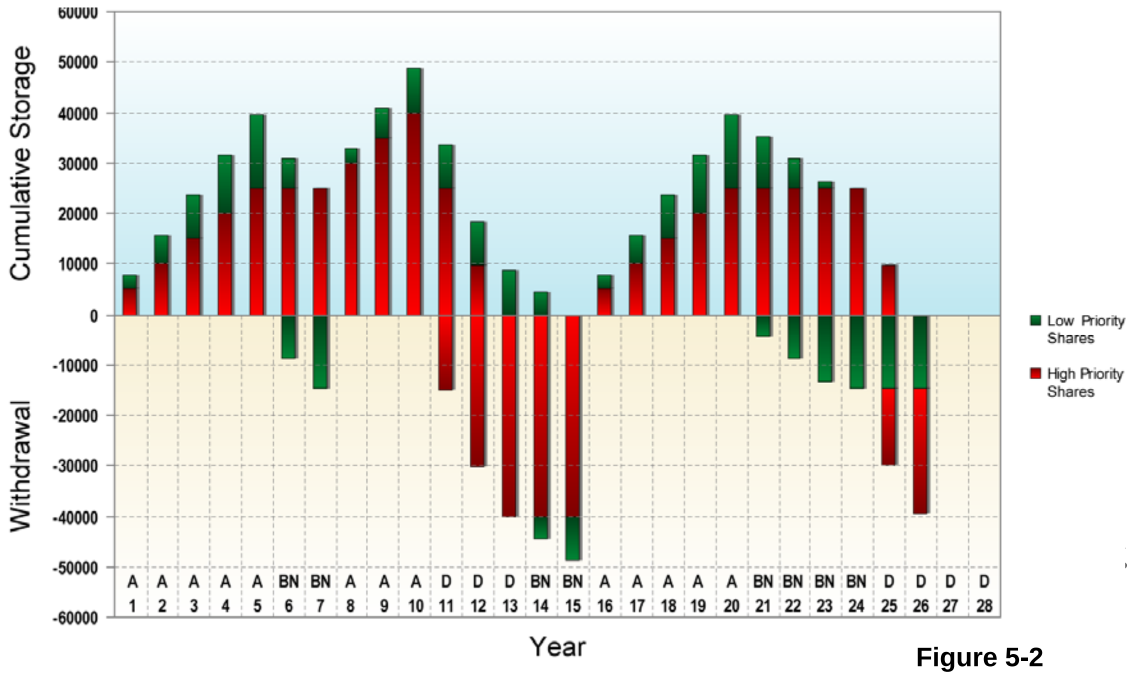

Figure 5-2
Scenario 2 – Low Priority Shafter-Wasco Supply in Below Normal Years
High Priority Contractor Supply in Dry Years

5.1.5 Estimated Project Benefits

Table 5-6 summarizes the estimated benefits of the hypothetical scenario, which includes 8,860 low priority shares for environmental water and 15,150 shares of high priority water for dry year and emergency needs. The total annualized benefits quantified for this scenario range from $4.13 to $4.25 million.

Table 5-6
Estimated Benefits of Hypothetical Federal Participation[1]

	Annual Value of Benefits	
Project Benefits	**1.1% growth rate**	**2% growth rate**
San Joaquin River Flow Supplies	$303,300	$332,400
M&I Water Supply Reliability and 2 years of Emergency Water Supply	$1,426,200	$1,522,300
Groundwater Pumping Costs Reductions	$2,401,500	$2,401,500
Total Estimated Benefits	$4,131,000	$4,256,200

1. From Appendix C

5.1.6 Project Implementation Costs

The hypothetical scenario assumes that Reclamation has committed $50 million to develop a supply of water from the SWRU. It was further assumed that Reclamation would purchase high and low priority shares at a distribution of 70 percent and 30 percent, respectively, given the generally higher need for dry and critically dry year water supply reliability addressed with high priority shares. The annual cost over the 29-year period would be $3.4 million based on a 5.125 percent discount rate.

5.1.7 Analysis of Benefits and Costs

Table 5-7 summarizes estimated benefits and costs for the scenario evaluated in this report. Based on the initial economic analysis, this scenario appears to be economically feasible, resulting in average annual positive net benefits of about $4.1 to $4.3 million. The benefits exceed the costs for the proposed alternative.

Table 5-7
Benefits and Costs for Hypothetical Federal Participation[1]

Total Estimated Annual Benefits	$4.1 to 4.3 million
Total Estimated Annual Costs[2]	$3.4 million

1. From Appendix C
2. Does not include initial purchase price and conveyance cost of the stored water

5.1.8 Preliminary Findings

Provided below are preliminary findings associated with development of the example scenario:

- Reclamation's participation in a high priority scenario for M&I and agricultural contractors appears justified but could be limited by the availability of surplus water in the CVP system to fully recharge Reclamation's portion of the SWRU. In both scenarios presented in Figures 5-1 and 5-2 the shares purchased by Reclamation in the SWRU would not completely filled;

- Low priority water would be used to supply Shafter-Wasco in exchange for CVP water on the Friant-Kern system. This water is assumed to only be available in below normal non-dry years due to the limitations on pump back. The estimated $280 af cost for water appears to be reasonable when compared to other water storage programs; however, adequately filling Reclamation's portion of the SWRU is a demonstrated limitation and a percentage of the banked water remains in storage at the end of the scenario 2 cycle (year 29);

- CVP Yield analysis information on surplus water is needed to determine the appropriate Federal participation level in the SWRU; and

- Higher yearly recharge rates would make both the high and low priority scenarios more favorable to fully recharge the SWRU. When maximum recharge amounts are superimposed on the average year types, it is difficult to recharge a full two water cycles (see Figures 5-1 and 5-2).

Chapter 6
Other Considerations of Federal Participation in the SWRU, Data Gaps and Need for Further Study

6.1 Other Banking Considerations

This section presents other factors that could affect Reclamation's potential participation in the SWRU.

6.1.1 Optimization of Federal Participation

If Reclamation could hypothetically contribute $50 million to participate in the SWRU, the level of direct investment (purchase of shares) would be $20.6 million. Over the contractual life of the bank with two extraction cycles, Reclamation would spend an additional $29.4 million for O&M to move water in and out of the SWRU (see Table 5-3). The level of Reclamation's participation could be greater or less depending upon such factors as contractor dry year need, availability of surplus water in the CVP for storage, and Semitropic's ability to accept greater quantities of in-lieu recharge above that stated in their contractual terms presented in Chapter 1. Additional analysis is needed on these factors to refine the level of optimal Federal participation in the SWRU.

6.1.2 Direct and Indirect Participation

The hypothetical bank operations scenario illustrates a direct participation by Reclamation in the SWRU through the purchase of shares. Direct participation improves CVP operational flexibility by allowing Reclamation to utilize stored water for the greatest beneficial use and need.

Reclamation could also possibly participate in the SWRU indirectly through sponsorship of the construction of remaining infrastructure without purchasing shares or by purchasing a percentage of shares and holding the storage space available for existing contractors to improve their individual water supply reliability by participating in the SWRU.

Subsidizing the SWRU would reduce share prices for contractors and potentially other bank participants through reduction in the SWRU capital costs paid through the purchase of shares. Reclamation could offer this subsidy and require specific provision for water storage. An example provision could be storage set aside for CVP contractors to meet critical dry year supply. The provision could be drafted in a Memorandum of Understanding (MOU) for SWRU operations. The level of Reclamation's participation should be tied to contractor ability to pay for water in the bank. The subsidy should reduce share prices below threshold levels at which banking becomes financially advantageous for those that currently do not have the ability to pay for additional supplies.

6.1.3 Limitation on Groundwater Pump Back

The original bank has 1,000,000 af of storage with a total annual pump back capacity of 90,000 af. Original banking partners also have access to Semitropic's 133,000 af SWP Table A surface water allocation when it is available. This allocation is subject to cuts during dry water years and original banking partners are only guaranteed access to their pump back capacity as outlined in their contracts. In response to potential pump back demand that exceeds capacity in a critical year, original banking partners have agreed on a method to distribute the available pump back capacity among the partners if the request exceeds the 90,000 af limit.

The pump back of the SWRU is 50,000 af per year with an additional 150,000 af per year planned. Assuring contractual pump back capacities in the SWRU during dry years is critical to making this program viable for Reclamation's participation.

6.1.4 Water Storage in Wet Years

Semitropic has little direct recharge capability but instead relies on in-lieu recharge through the use of surface water on crops that would otherwise be irrigated with groundwater. Partners in the original bank have historically recharged excess SWP entitlement water and have the ability to deliver this water throughout the growing season when most needed for irrigation. Semitropic has initiated the development of direct recharge capacity through the planned purchase of new parcels near the Pond-Poso Canal for use as surface spreading grounds. This new direct recharge capacity could make groundwater bank recharge capacity available to banking partners when additional irrigation water is not needed and additional in-lieu recharge capacity is not possible (Semitropic, 2006). Semitropic also has direct recharge capacity in the Kern Water Bank, Pioneer, and used North Kern Water Storage District facilities for this purpose.

Surplus water in the CVP is generally available in wet years between January and June. Semitropic's ability to accept large quantities of surplus water during winter and spring requires further study along with CVP yield and timing.

6.1.5 Remaining Portion of SWRU Phase I

Phase 1 of the SWRU included 50,000 af of pump back and storage at a one-to-one ratio. The remainder of the SWRU (600,000 af) is set at a ratio of three af of storage to one af of pump back. This initial portion of the Phase 1 bank was set aside for the original bank members. To date, Zone 7 Water District has purchased 3,250 shares, Vidler Water Company has purchased 1,500 shares, and 20,000 shares has been committed to Westlands Water District farmers leaving 25,250 shares. These shares are significantly more valuable than later planned phases of the bank at the higher pump back ratio. Sales of these shares are subject to the Semitropic Board of Directors. The availability of these shares should be investigated.

6.1.6 CVP Institutional and Operational Constraints

There is no precedent for direct Federal participation in a California groundwater bank and the CVP has little "surplus" water that is not already allocated on a priority basis to the CVP contractors. Section 215 water which is surplus to all allocations, may also be subject to being made available to CVP contractors. Reclamation's direct participation in the SWRU would require the identification, transfer, and ultimate banking of surplus CVP water which may require changes in the institutional, legal, and operational aspects of the CVP and contractor entitlements.

6.2 Data Gaps and Need for Further Study

6.2.1 Environmental Review

This Special Study was prepared using information provided by Semitropic for compliance with the California Environmental Quality Act (CEQA). The initial EIR was prepared in 1994 and provides the largest amount of detail on the project. A Supplemental EIR was completed in 2000 for the SWRU that updated environmental information specific to the construction and operation of the SWRU. Federal participation in the SWRU will require new environmental evaluation, documentation, review, and compliance consistent with NEPA and other pertinent law and policy.

This new environmental review would need to investigate the current condition of environmental resources within Semitropic recognizing that the original banking program has been operating since 1994 and has likely generated a new environmental baseline on which to review the potential effects. Some resources would not be expected to change since the completion of the 1994 EIR. However, many of the areas (such as biological resources, hydrology, public services, and traffic) have likely changed. The 2000 Supplemental EIR for the SWRU also does not include all of the necessary review required to satisfy NEPA requirements; however, Semitropic is currently proceeding with Section 7 Consultation with USFWS through the Corps of Engineers.

6.2.2 Arsenic Treatment

The SWRU rate structure establishes total capital cost for construction of the SWRU facilities at $150 million of which $40 million is set aside for arsenic treatment. Semitropic prepared a preliminary engineering evaluation for arsenic removal and estimated the cost for arsenic removal at a production rate of 400 cfs at $49 per af (Semitropic, 2005). Semitropic's ability to deliver untreated groundwater with arsenic levels that exceed the EPA drinking water maximum contaminant load standard of 10 ppb to the SWP is still under study. Given the high cost and technical difficulties of arsenic removal at varying rates of production, further study of the arsenic condition is needed from a regulatory, treatment, and cost effectiveness stand point.

6.2.3 Effects of Extended Pumping on Water Levels and Subsidence

The original Semitropic Groundwater Bank has been in existence since 1993 and its capacity to recover water has largely been untested due to ten years of normal to above normal precipitation. A full testing of the original bank would include maximum pump back (90,000 af) annually for an extended period- four to five years. To date, the cumulative removal from the original bank totals only 182,783 af. The 2000 Supplemental EIR produced to evaluate the impacts of the SWRU has stated that no adverse impacts are expected to groundwater levels or subsidence. However, during an extended drought, extraction from the original bank and the SWRU could total 290,000 af annually for a four to five year period.

Semitropic has established measures to prevent subsidence and overdraft. For overdraft, if groundwater levels drop 15 feet below the three year average elevation that would be predicted with no extraction of banked groundwater in Semitropic, pumping will be moved elsewhere, reduced or stopped. If the project induces subsidence, Semitropic will consult with the DWR to develop mitigation measures. Any reduction in pumping during a dry year would reduce the reliability of the SWRU.

Further analysis is required of groundwater pumping, including a review of Semitropic’s groundwater model that predicts drawdown. Further analysis should also review the long-term and potential impacts associated with subsidence on infrastructure and the Kern NWR.

6.2.4 Economic and Financial Analysis

The water supply reliability for M&I use, especially during drought years, is one of the most important benefits provided by the SWRU. The analysis of unmet demand for water in the future from CVP and SWP supplies relies on future spot market transfer prices to estimate the benefits of water supply reliability. Many contractors are currently participating in spot market transfers to increase supplies; however, because of capacity constraints in the Delta, these transfers are not reliable supplies in dry years. Contractors would likely be willing to pay higher prices for additional water supplies than the estimated price of water transfers. Therefore, spot market water transfer prices underestimate the true price of water into the future and further analysis would reduce the uncertainty of these prices.

Several groundwater and surface water supply projects that meet multiple objectives, including improved reliability are planned. Reclamation is considering building new reservoirs and expanding existing reservoirs to meet future water needs. The total costs of individual surface storage projects exceed $500 million in some instances. Further analysis of these other projects would provide a better comparison for the potential Federal participation in the SWRU.

In the California Water Plan Update (2006), DWR is focusing on improving groundwater storage and management through technical and financial assistance programs. DWR has recognized the value of groundwater resources for future water supplies and reliability. This value indicates the benefits of groundwater storage and recovery projects, such as the SWRU should be further analyzed.

Additional research needs to be done on developing procedures to estimate the value of water supply reliability and defining typical water supply values. The real value is likely higher than that estimated in the above analysis.

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Chapter 7
Summary of Findings and Conclusions

This report is not a decision document, but rather an assessment and synthesis of available information together with an economic analysis of potential Federal participation in the SWRU.

7.1 Findings

The following summarizes the significant findings of the Special Study:

- The SWRU is a technically and legally operable groundwater storage and recovery program in California with all essential SWRU Phase 1 facilities constructed or under construction. Semitropic is developing the SWRU with or without Reclamation’s participation; therefore, the future development with and without Reclamation’s participation is the same.

- The SWRU is strategically located between the CVP’s Friant-Kern Canal and the SWP’s Aqueduct. Specific Management Measures that could benefit from Reclamation’s participation in the SWRU include: drought supply for CVP contractors; enhanced San Joaquin River flows through a Shafter-Wasco intertie and exchange program for water on the Friant-Kern System; and environmental water for programs similar EWA and the Kern NWR.

- Costs for storage and recovery of water from the SWRU are estimated at $280 per af for normal water year supply to $390 per af for drought water year supply (costs do not include water purchase or conveyance to Semitropic).

- Several outstanding data gaps exist that could influence Reclamation’s decision to participate in the SWRU. The most important of these include the effects of long-term high-rate extraction from the entire bank (SWRU and the original bank) on groundwater levels and subsidence, the feasibility of treating arsenic laden groundwater from the SWRU, and the availability of surplus CVP water for storage in the SWRU.

- Additional NED benefits are realized and quantified in Appendix C for reduced production cost for agriculture and increased dry year and emergency supply for M&I.

7.2 Conclusions

Reclamation’s potential participation in the SWRU could help improve CVP water supply reliability by providing cost-effective water supply for use during drought periods, improvements in regional water delivery efficiency, and assistance to regional environmental programs, such as assistance in enhancing flows on the San Joaquin River through the Shafter-Wasco intertie, in which Reclamation is a participant.

Reclamation's participation in the SWRU for the improvement of fish, wildlife, and habitat protection and restoration measures could be accomplished through a program funded by a cost sharing agreement between the United States Government that would pay 75 percent of the project cost and the State of California (or an entity with in the State) that would pay the remaining 25 percent as established by the CVPIA, Section 3406(d)(3). Reclamation's participation in the SWRU to improve CVP contractor water supply reliability and provide for environmental water, could help to support the CALFED Bay-Delta Program as described in Section 103(d)(1)(A)(iii) of the CALFED Bay-Delta Authorization Act

This Special Study is an assessment and synthesis of available information together with an economic analysis of potential federal participation in the SWRU. There may be a potential Federal interest for participation in the SWRU based upon, but not limited to, the information gathered for this report. However, additional information is needed to fully determine the advantages and disadvantages of the SWRU to the CVP. These data gaps include the following:

- CVP yield analysis that quantifies the amount of water available for banking in SWRU. Much of the baseline work is complete with existing Reclamation Studies to facilitate this analysis;
- Semitropic monthly irrigation schedule by water year type and the effect of the existing water bank and the proposed SWRU have on water storage capabilities;
- Analysis of the potential costs associated with utilizing land in the proposed well field operated by the DFG;
- Verification of the Semitropic groundwater level declines during extended extraction. Semitropic has an existing, calibrated groundwater model that may be used for this purpose;
- Analysis of potential subsidence associated with extended groundwater extraction events;
- Wheeling arrangements with the State for delivery of CVP water to the SWRU. Several transactions of this type have already been performed by CVP Contractors.
- SWRU alternatives should be compared to other groundwater and surface water storage programs in the region that could be utilized to meet CVP supply reliability needs. Various existing studies by CALFED and the DWR (e.g. evaluation of Proposition 50 applications) may facilitate this comparison;
- Analysis to refine the total cost effectiveness of the program;
- Engineering analysis including costing for arsenic removal from groundwater for the SWRU. Semitropic has already performed several studies, including pilot tests, that may aid in this evaluation; and
- Compliance with NEPA/CEQA and other pertinent law and policy.

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Appendix A
Supporting Environmental Documentation

A.1 Environmental Consequences and Requirements

This section presents the potential environmental consequences and requirements for the completion of the SWRU. The following information is derived from the 1994 EIR of the Semitropic Groundwater Banking Project (1994 EIR), the SWRU Supplemental EIR completed in 2000 (2000 Supplemental EIR), and the 2001-2002 Biennial Groundwater Monitoring Report for Semitropic Water-Banking Project (2001-2002 Groundwater Monitoring Report).

A.1.1 Geology

A.1.1.1 Project Construction

A.1.1.1.1 Soil Excavation

According to the 1994 EIR, the construction of the original groundwater bank and the SWRU would result in the excavation of approximately 2,872,000 cubic yards of soil for the construction of wells, pipelines, canals, siphons, pumping plants, and regulating ponds. This soil will be used on site for new embankment construction along canals and around siphons, pipeline trench backfill, with soils placed in a manner that will prepare the site for any settling. Excavated soils would also be used for the construction of approach ramps on both sides of all new siphons.

A.1.1.1.2 Soil Excavation Mitigation

Excavated soils would be handled during construction in accordance with all project specifications for compaction and site watering to control wind erosion and fugitive dust generation.

A.1.1.1.3 Erosion and Shrink-Swell

The soil classes found within the project area are susceptible to water erosion but are only slightly erodible by wind. The flat nature of planned construction sites and only temporary planned presence of uncompacted soils makes water erosion during construction unlikely. The soils in the project area have a corrosive nature on uncoated steel pipe but have only low to moderate corrosiveness for concrete pipe. The soil also exhibits shrink-swell characteristics that could affect structures developed in the project area. These impacts are based upon information contained in the 1994 EIR.

A.1.1.1.4 Erosion and Shrink-Swell Mitigation

New facilities design and construction would be in compliance with the Uniform Building Code and with recommendations made in a geotechnical report completed prior to facility design to determine the potential for construction related erosion and the potential effect of shrink-swell actions on new facilities.

A.1.1.2 Project Operation

A.1.1.2.1 Seismicity

The project area does not cross any major active fault lines, but is subject to the effects of seismic events given the proximity of other major fault zones capable of generating an event with the potential to damage facilities in Semitropic. A seismic event could potentially cause the interruption of electricity that would shut down pumps, and could cause the fracture of wells, pipelines and canals within Semitropic.

A.1.1.2.2 Seismicity Mitigation

The potential effects of seismic events have been taken into account during development of plans for new facilities and construction programs to minimize damage due to ground shaking events. Design features include flexible pipeline joints that would resist fracture during earth shaking events, shut-off valves that would automatically detect pipe rupture and shut off flow to minimize water losses and any associated soil erosion or flooding.

A.1.1.2.3 Land Subsidence

Subsidence has been observed in Semitropic with the most pronounced effects seen in the northeastern portion of the service area. The subsidence was directly related to the extraction of groundwater in Semitropic and the corresponding decreases in groundwater elevation. The introduction of SWP surface water deliveries stabilized groundwater elevations and stabilized land subsidence in Semitropic. The SWRU would store water in the groundwater aquifers as a supplement to groundwater not extracted because of importation of SWP surface water.

All water banked would increase the already stabilized groundwater elevation and Semitropic operations policies as established by the Board of Directors (1994 EIR pages 3-6) prevent the extraction of groundwater in excess of what was banked as part of the SWRU implementation. The 1999 EIR did identify the potential for an estimated 1½ feet of subsidence at the center of the proposed well field that would diminish to zero feet at a distance of approximately five miles from the center of the well field as a potential result of full extraction of 150,000 af of groundwater per year.

A.1.1.2.4 Land Subsidence Mitigation

Mitigation measures developed in the 1999 EIR for land subsidence included the complete survey of surface elevations prior to operation of the SWRU well field to establish a baseline, installation of an extensiometer within the well field in conjunction with the creation of a ongoing monitoring program that would monitor land subsidence, and in the event of measured land subsidence Semitropic would consult with the DWR to address appropriate measures for the mitigation of the subsidence.

A.1.2 Water Quality and Hydrology

A.1.2.1 Groundwater Elevation

Semitropic has developed a policy to monitor groundwater levels during active groundwater pumping operations and compare them to projected groundwater elevations without groundwater extraction. This is to predict overall groundwater elevation status and initiate operational changes if the three year average groundwater elevation decreases 15 feet below the level predicted without groundwater extraction. This “15 foot-three-year rule” would be modified on site or groundwater extraction would be shifted to other zones if the groundwater elevations in any specific zone ever drop below the 15 foot threshold. Proposed wells would be developed no closer than 0.25 mile from any existing well.

A.1.2.2 Groundwater Elevation Mitigation

If any existing well in production or planned for production is significantly affected by Semitropic extraction operations at its well field or by any private wells participating in the Semitropic water exchange operations, Semitropic would either stop pumping or compensate the private well owner for any losses or improvements needed to remedy well inoperability.

A.1.2.3 Saline Groundwater Movement

The movement of poor quality groundwater and, specifically, groundwater with high salt concentrations, into Semitropic has been shown to relate directly to groundwater levels within Semitropic. When groundwater levels drop, groundwater with lower water quality from neighboring regions to the northwest migrates into Semitropic. The importation of SWP surface water has stabilized groundwater levels and the groundwater banking program has further increased groundwater elevations in Semitropic and more effectively prevented the inflow of low quality groundwater.

A.1.2.4 Saline Groundwater Movement Mitigation

The migration of groundwater of lower quality into Semitropic is directly related to groundwater elevations within Semitropic. Groundwater elevation stabilized with the initiation of surface water imports from the Aqueduct and improved with the operation of the original Groundwater Banking Project with further improvement expected from the operation of the SWRU. No mitigation measures were developed for the migration of low quality groundwater into Semitropic because of the prediction that this migration would not occur because of improved groundwater elevations.

A.1.2.5 Groundwater Quality: Arsenic

The groundwater extracted from the northwestern portions of Semitropic where the SWRU well field is proposed has arsenic that has been measured at levels between 100 and 140 ppb (2001-2002 Groundwater Monitoring Report). The maximum contaminant level for arsenic in drinking water, as defined by the EPA, was 50 ppb at the time of the Groundwater Monitoring Report. This maximum contaminant level has now been lowered to 10 ppb. Semitropic has the ability to blend water with arsenic levels that exceed the MCL with water extracted from other wells with lower arsenic levels to bring down the total arsenic level in water it would deliver to the SWP aqueduct. Semitropic’s ability to deliver water to the SWP with arsenic levels that exceed the EPA MCL is not known.

A.1.2.6 Arsenic Groundwater Mitigation

The presence of arsenic in groundwater extracted from the northwestern portion of Semitropic, where groundwater extraction wells are proposed in the Groundwater Banking Project and the SWRU program, was not addressed in the 1994 EIR or the 2000 supplemental EIR. Water quality tests performed as part of the 1994 EIR preparation identified arsenic in every well tested, but none of the wells exceeded the MCL that was in place when the 1994 EIR was written. Arsenic has been analyzed in a groundwater monitoring report developed for the groundwater monitoring committee made up of representatives from Semitropic, five neighboring water districts and banking participants. Semitropic has plans to mitigate this by operational adjustments, transfers and exchanges. Participants in the SWRU pay a portion of an identified $40 million (2003 dollars) needed for the potential construction of an arsenic treatment plant. The $40 million is a maximum contribution that is split out amongst the shares in the SWRU that are sold. The actual estimated costs for constructing an arsenic treatment plant for Semitropic, that was presented in a 2005 report “Arsenic Removal Technology Evaluation”, was $66 million.

A.1.3 Biological Resources and Special Status Species

A.1.3.1 Vegetation

The development of pipelines, canals, and pumping facilities has the potential to cause significant effects on vegetation resources in the project area. This is dependent on the alignment and location of the facilities. According to the 1994 EIR, avoidance of vegetation resources has consistently been more successful at protecting plant communities than replanting and restoration efforts following construction related disturbances. The project area soils exhibit a cryptogamic crust that is thought to be critical to the continued success of native plant communities in the area. When disturbed by construction activities, this crust is difficult to reestablish and, without it reestablished, native plants face significant competitive challenges from non-native invasive plant species. Design of the project to avoid impacts to important plant communities has reduced impacts to valley saltbrush from 57.5 acres as proposed initially to 1.15 acres after consultation with biological consultants. Indirect impacts are also possible as a result of pipeline and facility construction generating soil erosion and dust accumulation on plants.

A.1.3.2 Wildlife

The construction and operation of the SWRU has the potential to impact wildlife including direct mortality or injury during site grading, increased human activity during construction periods as well during project operations, and added vehicle traffic during both project construction and operations and maintenance of completed project facilities. Biological consultants helped to develop facility and pipeline alignments in order to minimize direct impacts to biological resources with extra attention and review of potential special status species locations. The final facility location and pipeline alignment layout minimized to the maximum extent possible, while maintaining project functionality, the potential for impacts to biological resources. The majority of unavoidable impacts would be long-term and could include the loss of habitat, behavioral disruption, population displacement, and species mortality for individuals unable to avoid construction operations because of limited mobility. The loss of wildlife is not expected to represent a significant effect to regional populations of any species. Species intolerant of human presence in their habitat could be displaced from the project area but the completed project is not expected to produce a significant barrier to regional wildlife populations.

A.1.3.3 Special Status Species

The project as originally designed would have negatively affected a number of sensitive plant populations and all of the species that depend on these plant populations. Indirect impacts could occur as a result of project construction in nearby areas (e.g., fugitive dust emissions coating the leaves of sensitive plant species and the effects of construction activities on species intolerant of human interaction nearby). Long-term indirect impacts could potentially result from habitat loss with the potential introduction of invasive non-native species from adjacent construction areas possible. Impacts to special status wildlife species were not expected during project construction because of the migratory nature of larger wildlife observed in the area like the San Joaquin kit fox (vulpes macrotis mutica), and the expectation that these species would vacate the area upon initiation of project construction. The project area was identified as containing 14 burrowing owl burrows that would be directly affected by project construction. This effect could result in the mortality of individual burrowing owls and would permanently remove the burrows. Smaller scale and less transitory special status wildlife species were not observed in the project area during pre-project design biological surveys.

A.1.3.4 Vegetation, Wildlife, and Special Status Species Mitigation Measures

A revegetation plan described in the 1994 EIR would be implemented to mitigate for the loss of 1.15 acres of valley saltbush scrub habitat as a result of the development of the SWRU. Note that this re-vegetation plan could potentially change, and that updated information may be required. The revegetation plan would include the following measures:

- Plant propagules on land scheduled for grading would be collected and the soil surface would be collected and saved prior to construction. Following construction, the disturbed site would be scraped to ensure the complete removal of any non-native invasive species and then would have the saved topsoil reapplied and replanted with the preserved plant propagules. These operations would be initiated in late fall to use winter rains for establishment purposes. The replanted area will be observed in parallel to an undisturbed native habitat area adjacent to the project area to help judge the replanting program success.

- The project area will be inspected by a qualified biologist prior to construction for San Joaquin kit fox dens and in the event one is found a qualified biologist would supervise the hand excavation of the den to prevent unintentional mortality.

- Natural lands that neighbor the site would be avoided to minimize the potential for disturbances to biological resources. If necessary, the project area would be fenced off to prevent negative interaction between wildlife species and construction operations. Trash from the project area would be collected everyday to prevent the attraction of San Joaquin kit fox and other transitory wildlife species.
- Pipeline corridors and proposed access roads will have proposed boundaries clearly marked on site to prevent incursion into adjacent habitat areas.
- Vehicles related to construction operations would be limited to marked work areas and path/roads.
- Open trenches and pipe would be inspected prior to daily construction operations for sensitive species trapped or hiding. In the event species are discovered they would be removed by qualified personnel trained in the required techniques for sensitive species removal and placement off site. Open pipes in trenches would be closed every night at the conclusion of construction activities.
- The potential impacts to burrowing owls on site would be mitigated by Semitropic through the acquisition of 14 acres of natural vegetation in the Semitropic Ridge Preserve located in the northwestern area of the district.
- Construction impacts on western pond turtles would be mitigated by trapping turtles found in the project area prior to construction and releasing them off site. No work would begin on site until all of the turtles were relocated off site. Temporary barriers could be erected to prevent any returning turtles from inhabiting the construction area.

A.1.4 Land Use

A.1.4.1 Project Construction and Operation

The SWRU would be located within Semitropic boundaries, surrounded by primarily agricultural and some rural residential lands. Construction and operation of the project may result in some loss of cropland. Rural residences may also be located near the proposed pipeline distribution system, and the pipeline would cross existing roadways. In addition, the well field proposed in the locally preferred plan consists of one square mile that is presently owned by the DFG; however, Semitropic has not yet acquired this land. As of the 1994 EIR, overall impacts were expected to be short-term, construction-related, and would only temporarily alter land use. Pipelines would be buried after construction, and land would be restored to its original use. The project is not expected to have a long-term impact on land uses.

A.1.4.2 Project Construction and Operation Mitigation Measures

The following mitigation measures will be implemented:

- Semitropic will provide advance notice of construction activities to property owners and residents.
- Semitropic will incorporate mitigation measures in construction contract documents.
- Semitropic and its contractors will acquire necessary permits, comply with permit conditions to minimize construction impacts, and assign a construction monitor to oversee mitigation activities.
- Semitropic will ensure that pipeline distribution systems avoid existing structures, to the extent conceivable.
- Semitropic could swap land with DFG.
- HCP pending since 2000, will help guide pertinent environmental protection and or mitigation. In lieu of this, Section 7 Consultation is underway.

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Appendix B
Engineering

B.1 Features and Accomplishments

The SWRU will store approximately 650,000 af of water when fully completed in addition to the 1,000,000 af of existing storage in Semitropic's original Ground Water Bank. The capacity for recovery of banked water with the completion of the SWRU will be 200,000 af per year with 50,000 af initially reserved for the original banking partners, but now available to new banking partners with Semitropic Board approval. Overall, 290,000 af per year of pump back capacity will exist to the Aqueduct.

The SWRU is designed to increase the rate of recovery of the banked water and to add 12,000 acres to the in-lieu system. The following SWRU facilities have been constructed or are currently being constructed:

- 7.2 miles of 120" diameter lined concrete pipe
- Aqueduct Turn in\ Turn Out Facility
- Pond-Poso Canal Intertie
- Junction Reservoir
- Junction Pumping Plant
- Pond-Poso Canal Low Lift Pumping Plant

To complete the SWRU, the following facilities remain to be constructed:

- Well Field containing 65 wells and related piping
- Well Field Reservoir
- Well Field Pumping Plants
- 2.8 miles of 84" diameter lined concrete pipe
- 4.6 miles of Canal
- Poso Creek Low Lift Pumping Plant
- 4 booster pumping plants
- Arsenic Water Treatment Facility (if required)

B.2 Design and Construction Considerations

The primary conveyance facilities of the SWRU are the conveyance pipeline, consisting of 84- and 120-inch Reinforced Concrete (RC) pipe, and a series of concrete canals. Starting from the CA connection, a 120-inch RC pipe extends east 7.2 miles until reaching the Junction Pumping Plant. East of the pumping plant, the pipe is converted to a canal which extends 0.5 miles to connect to the Pond-Poso Canal via a low lift pump station. North of the junction, the conveyance system extends another 0.3 miles of canal that converts to an 84-inch RC pipe.

The 84-inch pipe runs 2.7 miles in a northerly direction until it reaches the Well Field Pumping Plant. North of the Well Field Pumping Plant is 3.7 miles of canal which ends at the Well Field Reservoir and the Poso Creek Connection (Semitropic, September 1999 and July 1999). This system can be run forward via gravity to distribute SWP water for in-lieu recharge purposes, or run reverse flow to deliver recovered water to the Aqueduct.

The proposed Well Field consists of approximately sixty-five (65) wells collectively designed to pump 150,000 acre-feet per year. The wells would be spaced so there is at least one-third of a mile between each well making the total area about six square miles. Assuming each well has a discharge rate of four (4) cfs and two wells are offline, the total flowrate from the Well Field would be about 250 cfs. The estimated well depth is 800 to 900 feet, with a perforated interval of 400 feet. Each well requires a 300-horsepower motor, which comes to 19,500 HP when totaled. Also, approximately 21 miles of 12- to 66-inch manifold piping is required to collect the well discharge and convey it to the Well Field Reservoir (Semitropic, July 1999).

Two storage sites are required for the project. The Well Field Reservoir is located adjacent to the Well Field and will have a capacity of 125 cfs. The second storage site consists of a reservoir and a series of canals located at the junction of the 84” and 120” pipeline, just west of the Pond-Poso Canal connection. The canals in this area serve as storage and conveyance. In addition to the canal storage, 120 acres would be set aside for additional storage; it is estimated that a 75 acre reservoir will be required (Semitropic, September 1999 and June 2004).

Two pumping plants are required to run the system reverse flow. The Well Field Pumping Plant is located approximately 3.7 miles south of the Well Field. The canals to the North of Well Field Pumping Plant act as a forebay for the plant. The Well Field Pumping Plant conveys water from the canals south of the Well Field to the Junction Reservoir canals at a rate of 250 cfs. For the given flowrate, 4,250 Horsepower is required to give a Total Discharge Head (TDH) of 100 ft. The Junction Pumping Plant requires 6,850 HP and a TDH of 100 feet to convey 420 cfs from the canals adjacent to the Pond-Poso Canal connection to the Aqueduct via the 120-inch pipe. In addition to these two pumping plants, two low lift plants are required. One is needed to lift water from the Pond-Poso Canal to the proposed canals to the east of the Junction Pumping

Plant. The second is required to lift water from the Poso Creek into the proposed canals to the east of the Well Field.

An Aqueduct Turn-in\Turn-out facility is required to connect the system to the Aqueduct.

The Well Field and the Well Field Pumping Plant require an 115kV wood pole power line to convey power to the location. At the Well Field, multiple 12kV power lines are required to bring power to each individual well and the pumping plants. Semitropic has developed electricity generation capacity through construction of natural gas turbines and a solar power generation facility and has proposed the construction of additional solar power generation capability to help meet the new demand created by SWRU operations.

Approximately 29 miles of access roads must be built to maintain the Well Field and Pumping Plants.

To serve the adjacent 12,000 acres, four booster pumps are required along the north-south reach of the conveyance system. These booster pumps will discharge into a new distribution network consisting of 12- to 66-inch pipes.

A future possibility is an arsenic treatment facility. The MCL for arsenic is currently ten (10) micrograms per liter for potable water. When rules are established to commingle raw water, it will determine whether an arsenic treatment plant will be needed in the future.

B.3 Operations and Maintenance Considerations

During wet or non-drought years, the system would operate as a distribution system to the local farmers that have agreed to use surface water in-lieu of groundwater. This is accomplished by the canal system that is currently in place and by the proposed conveyance system. The SWRU will create new delivery infrastructure for surface water irrigation on 12,000 acres of existing farmland that currently uses groundwater (Semitropic, July 1999).

The recovery system would be operated during dry or drought years. During dry years, farmers will pump groundwater using their wells and discharge water into the canal system. Semitropic’s Well Field and privately owned farm wells will pump water into the canal system to convey the water to the Aqueduct. The current recovery rate of the original groundwater bank is 90,000 af per year. This is provided by existing Semitropic wells and privately owned farm wells. Additional existing agricultural wells are being added as part of Phase I of the SWRU creating 50,000 af of extraction capacity. The proposed SWRU Well Field would add 150,000 af per year capacity to the system. This would bring the total recovery rate to 290,000 af per year (Semitropic, July 1999).

The current and proposed system would require certain regular maintenance. During wet years when the wells are not in use, the groundwater wells must be exercised annually. Motors, pumps, and control valves should be lubricated and electrical and instrumentation equipment should be tested and, when needed, replaced. Canals and pipelines should be inspected regularly. Inlet/Outlet structures should be kept free of debris and inspected on a regular basis.

B.4 Detailed Cost Estimate

In the SWRU Engineering Report, the SWRU was estimated to cost $112 million (1999 dollars). This cost included the conveyance pipeline, two reservoirs, two pumping plants, four booster pumps, and all Well Field and new distribution system materials. Some SWRU facilities have been built. For the proposed facilities described in the 1999 Engineering Report that have not been built, the estimated project cost to complete (in 2003 dollars) is $107 million (Semitropic, July 1999). In addition to this cost, the construction of a water treatment facility to treat arsenic has been estimated to cost $40 million to complete. Table B-1 outlines the conversion of 1999 project cost estimates to 2003 dollars by project feature.

Table B-1
Update of the 1999 Engineering Report Cost Analysis
Conversion to 2005 dollars

Core Improvements Multiplier 1.229 2005 CCI average

Features: Discharge Pipelines, Pumping Plants, and Reservoirs

Item	*Quantity*	*Unit*	*1999 Unit Price*	*2005 Unit Price*	*Cost*
Well Field Reservoir	1	L.S.	243,000	298,627	298,627
Well Field Pumping Plant	4,250	H.P.	1,000	1,229	5,222,892
Inlet Structure	1	L.S.	50,000	61,446	61,446
84-inch Outlet Structure	1	L.S.	50,000	61,446	61,446
84-inch RCP (100 ft head)[1]	36,200	L.F.	300	369	13,346,024
84-inch flanged outlet	1	Each	12,000	14,747	14,747
60-inch flanged outlet	1	Each	8,000	9,831	9,831
48-inch flanged outlet	1	Each	6,000	7,373	7,373
42-inch flanged outlet	1	Each	5,000	6,145	6,145
30-inch flanged outlet	1	Each	4,000	4,916	4,916
45-degree elbow (84-inch)	10	Each	15,000	18,434	184,337
Hwy. 46 bored crossing	1	L.S.	160,000	196,627	196,627
96-inch RCP (100 ft head)[1,2]	3,900	L.F.	400	492	1,917,108
45-degree elbow (96-inch)[3]	3	Each	17,000	20,892	62,675
84-inch flanged outlet	1	Each	15,000	18,434	18,434
72-inch isolation valve	1	Each	60,000	73,735	73,735
Total					21,486,361

1. Approximately 4.6 miles of canal will be built instead of 84-inch pipe and 120-inch pipe. Pipe cost were used for cost estimation. Actual cost will be lower.

2. Seven miles of 120-inch pipe has been constructed. 3,900 linear feet of 120-inch pipe still needs to be constructed. Original project called for 96-inch pipe, so the unit price for 96-inch pipe was used. Actual cost for construction will be higher.

3. It was assumed that three elbows remain to be construced. The actual elbows will be for the 120-inch pipe. The original project called out for 96-inch pipe, so the unit price for 96-inch elbows was used. Actual cost for construction will be higher.

Table B-1
Update of the 1999 Engineering Report Cost Analysis
Conversion to 2005 dollars

Features: Wells and Well Field Manifold Piping

Item	*Quantity*	*Unit*	*1999 Unit Price*	*2005 Unit Price*	*Cost*
Wells	65	Each	200,000	245,783	15,975,904
12-inch	56,320	L.F.	35	43	2,422,439
18-inch	14,080	L.F.	45	55	778,641
21-inch	7,040	L.F.	49	60	423,927
24-inch	3,520	L.F.	57	70	246,570
27-inch	1,760	L.F.	62	76	134,099
30-inch	1,760	L.F.	70	86	151,402
36-inch	5,280	L.F.	84	103	545,049
42-inch	3,520	L.F.	102	125	441,230
45-inch	3,520	L.F.	111	136	480,162
48-inch	1,760	L.F.	122	150	263,873
51-inch	2,760	L.F.	133	163	451,110
57-inch	1,760	L.F.	162	199	350,388
60-inch	1,760	L.F.	178	219	384,995
66-inch	5,280	L.F.	213	262	1,382,088
Sub-Total					24,431,876
Appurtenances	(10% of Pipe Cost)				
Total					25,277,473

Features: Pipeline and Well Field Right of Way

Item	*Quantity*	*Unit*	*1999 Unit Price*	*2005 Unit Price*	*Cost*
Well Field Land Cost	3,840	Acres	500	614	2,359,518
84-inch Pipeline Right of Way	34	Acres	2,000	2,458	83,566
96-inch Pipeline Right of Way	38	Acres	2,000	2,458	93,398
Construction easements	107	Acres	500	614	65,747
Total					2,602,229

Total Core Improvements	**49,366,063**

Table B-1
Update of the 1999 Engineering Report Cost Analysis
Conversion to 2005 dollars

Optional Improvements
Features: In-Lieu Distribution Systems

Item	*Quantity*	*Unit*	*1999 Unit Price*	*2005 Unit Price*	*Cost*
12-inch	2,640	L.F.	35	43	113,552
15-inch	85,800	L.F.	40	49	4,217,639
18-inch	36,960	L.F.	45	55	2,043,933
21-inch	21,120	L.F.	49	60	1,271,780
24-inch	5,280	L.F.	57	70	369,854
27-inch	7,920	L.F.	62	76	603,447
30-inch	13,200	L.F.	70	86	1,135,518
33-inch	5,280	L.F.	76	93	493,139
39-inch	5,280	L.F.	93	114	603,447
42-inch	7,920	L.F.	102	125	992,767
45-inch	5,280	L.F.	111	136	720,243
48-inch	5,280	L.F.	122	150	791,618
51-inch	2,640	L.F.	133	163	431,497
54-inch	2,640	L.F.	147	181	476,918
57-inch	2,640	L.F.	162	199	525,583
60-inch	6,500	L.F.	178	219	1,421,855
66-inch	5,280	L.F.	213	262	1,382,088
Booster Plant BP-1	150	H.P.	1,500	1,843	276,506
Booster Plant BP-2	350	H.P.	1,500	1,843	645,181
Booster Plant BP-3	390	H.P.	1,500	1,843	718,916
Booster Plant BP-4	750	H.P.	1,200	1,475	1,106,024
Farm Turnouts	80	Each	8,000	9,831	786,506
Sub-total					21,128,010
Appurtenances	(10% of Pipe Cost)				
Total					22,887,497

Table B-1
Update of the 1999 Engineering Report Cost Analysis
Conversion to 2005 dollars

Features: In-Lieu Distribution Right of Way

Item	*Quantity*	*Unit*	*1999 Unit Price*	*2005 Unit Price*	*Cost*
Pipeline Right of Way	155	Acres	2,000	2,458	310,000
Construction Easements	305	Acres	500	614	152,500
Total					462,500
Total Optional Improvements					**23,349,997**
Project Cost					
Contigencies	(20% of project cost)				14,543,212
Sub-Total					
Administrative, Legal, and Engineering	(15% of subtotal)				13,088,891

Appendix C
Economic Analysis of Benefits and Costs

C.1 Introduction

The purpose of this initial economic evaluation is to provide a preliminary economic evaluation of project costs and future benefits relevant to the proposed SWRU project. Reclamation is undertaking this Special Study to determine if a potential Federal interest could exist in participating in the SWRU. This study is not intended to represent a Federal Decision Document, the identification of recommended or preferred alternative plans for display in a Feasibility Report, or for consideration by Congress for appropriations.

The following sections describe the SWRU, discuss potential project benefits, and identify projects costs. The benefits and costs are calculated for a potential hypothetical Federal participation that includes use of the SWRU to provide water for the San Joaquin River and for M&I contractors during dry and emergency years. This represents one potential scenario for the use of water in the SWRU. Benefits of other potential uses are described qualitatively.

C.1.1 National Economic Development

The P&Gs state that the Federal objective of water and related land resources planning and formulation is to contribute to national economic development consistent with protecting and contributing to the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements. *Contributions to the National Economic Development (NED outputs) are increases in the net value of the national output of goods and services, expressed in monetary units, and are the direct net benefits that accrue in the planning area and the rest of the Nation.* Contributions to National Ecosystem Restoration (NER outputs expressed in non-monetary units) are increases in the net quantity and/or quality of desired ecosystem resources. These net changes are measured in the planning area and in the rest of the Nation. Multipurpose plans that include ecosystem restoration shall contribute to both NED outputs and NER outputs.

In this respect, this study shows that the water and related land resources made available through the SWRU will provide both NED and NER outputs to society of this immediate region and also contribute to the overall well being of the nation as a whole. Reclamation, their contractors, the general public, and the Nation will benefit from increased water made available within this region.

C.1.2 Planning Principals and Guidelines

The planning principals and guidelines involving alternative plan formulation, evaluation, and comparison will not be undertaken during the evaluation. This evaluation solely focuses on providing a preliminary depiction of the economic consequences associated with implementing the SWRU. The findings contained within the report are based on canvassing available information and data developed through relevant reports and provided by Federal, State, local authorities, and municipalities.

C.1.3 Project Location

Figure C-1
Semitropic Project Location

Semitropic is located in southern San Joaquin Valley, south of the Delta and north of Los Angeles (Figure C-1). Because of its location near the Aqueduct and the Federal Friant-Kern Canal, Semitropic is ideally suited for groundwater banking and delivery of water during emergency periods. The entire region hosts nine underground water storage and recovery facilities, including two of the largest in the world: Semitropic and KWB. This location allows for flexible operation in managing water supplies during both surplus and drought periods.

C.2 Problem Identification

C.2.1 Statewide Population Growth

The California Department of Finance estimates that the State's population will increase from 36.5 million in 2004 to about 48 million by 2030. Southern California will continue to be the most populous region of California. By 2030, the population in Los Angeles County is projected to exceed 11 million. By 2030, San Diego and Orange counties are expected to increase to 4.0 million and 3.7 million, respectively. The State's population is projected to reach nearly 55 million people by 2050.

C.2.2 Increased Water Demand

The projected increase in population growth will result in increasing urban demands on water resources. In the past, growing water demands have been largely met by the CVP and SWP. However, both CVP and SWP are over-allocated and water supplies can be significantly limited during dry weather years and droughts. Additionally, water quality and ESA requirements in the Delta could further reduce CVP and SWP water supplies. Water transfers from north of the Delta cannot be relied upon to meet increasing water demands south of the Delta.

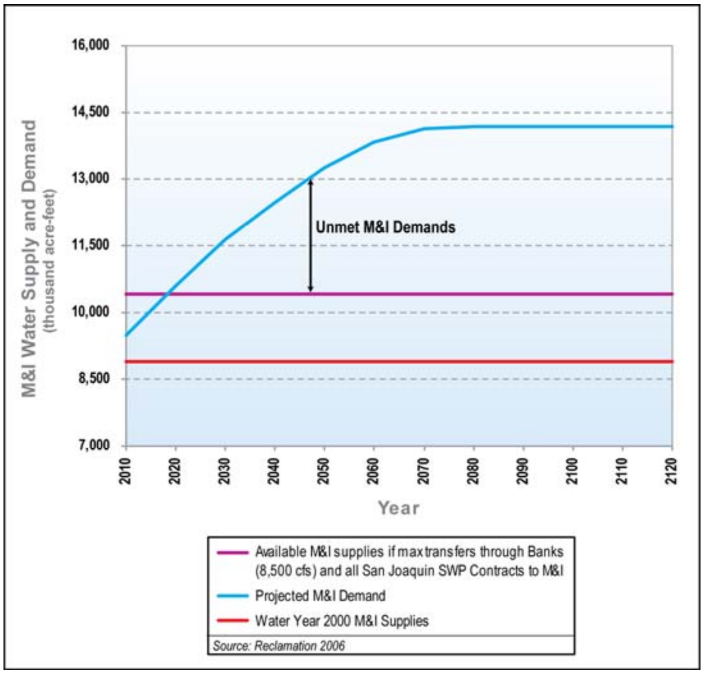

Figure C-2
Estimated Future M&I Supplies and Demands

Figure C-2 displays the estimated California M&I water demands and supplies from year 2010 to 2120 (Reclamation 2006). Projections reveal that in excess of 6 MAF will be needed by 2120. Estimated supply of 8.9 MAF represents year 2000 water supplies including SWP Table A contracts, CVP supplies, and local supplies. Year 2000 was an above normal water year, where most contractors requests for water were met. This value can change based on contractor demands, hydrologic conditions, and increased local supplies.

The figure indicates the potential difference between future demand and supplies. When the CVP and SWP reach conveyance capacity, additional water cannot be transferred from the north to meet these southern California M&I demands. Thus, it should be emphasized that reliance on North-of-the-Delta water transferred to meet South-of-the-Delta demands presents an inadequate plan.

C.2.3 Future Drought

Although California has not experienced a prolonged statewide drought in over a decade, these conditions cannot be expected to continue. During multi-year drought periods, water demands will exceed supplies in many areas of California. Past droughts have cost California billions of dollars. The 1976 to 1977 drought left California reservoirs with very little storage and groundwater levels very low. Economic losses from this drought were estimated at $2.5 billion, about $6.5 billion in 2005 dollars (DWR 2005). The most recent 1987 to 1992 drought resulted in groundwater overdraft of 11 million af in the San Joaquin Valley. DWR estimated that from 1990 to 1992, economic losses totaled over $1.2 billion (DWR 2005).

C.2.4 Future Inflated Price of Spot Market Water Transfers

In response to increasing urban water needs, and the deficiency of planned new supplies, urban water users will rely increasingly on water transfers in spot markets to bridge the gap between supply and demand. As early as 2020, traditional sources of spot market supply may be unable to respond to price signals and put more water on the market because of conveyance and contract constraints. Unlike many other commodities subject to supply and demand, no substitutes exist for water, which is essential to life.

This implies that as water demands increase, spot market prices will increase without significant augmentation of supply and associated conveyance improvements. As competition for water increases, prices will continue to increase. The unavailability of new water supplies to meet the growing State water needs will result in water prices rising above the rate of inflation. That is, water prices will increase faster than the prices of other goods, due to scarcity. The effect of scarcity on water prices is built into the water market process through both demand and supply relationships. On the demand side, water is a necessary good for which there is an absolute need and no substitute. On the supply side, conveyance, hydrology, and regulatory constraints limit availability.

C.3 Semitropic Groundwater Bank and the SWRU

Several opportunities exist to offset future water shortages including increased water conservation, new surface storage reservoirs, expansion of existing reservoirs, groundwater and seawater desalination plants, recycled water, and ground water banking. Ground water banking has been demonstrated as a cost effective means to store water and improve water supply reliability, especially during dry periods. By using dewatered aquifer space to store water during wet years (years when there is abundant rainfall and surplus water available), it can be pumped and used during dry years (years with little rainfall and no surplus water). Groundwater banking is accomplished two ways: through in-lieu and direct recharge. In-lieu recharge is storing water by utilizing surface water “in-lieu” of pumping

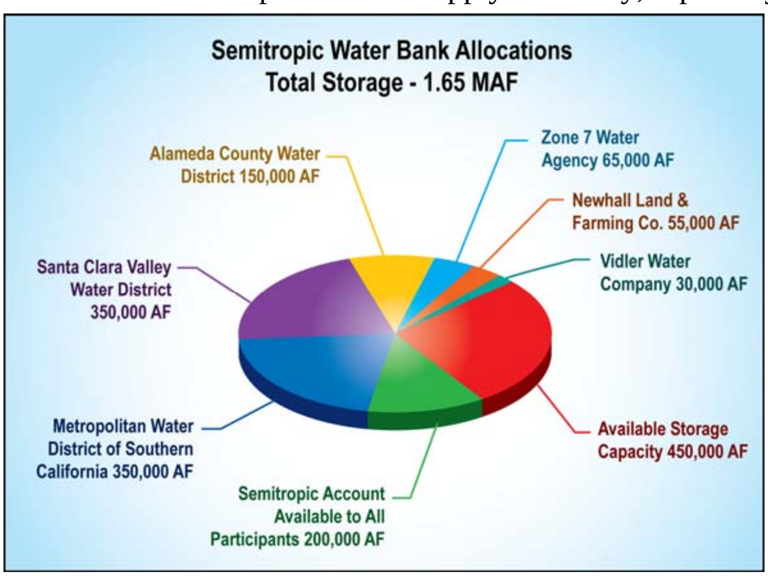

Figure C-3
Existing Water Bank Allocations and Available Capacity

groundwater, thereby storing an equal amount in the groundwater basin. Direct recharge is storing water by allowing it to percolate directly to storage in the groundwater basin.

C.3.1 Description

Semitropic's original Groundwater Storage Bank is a proven, effective water storage system that began operation in the early 1990s. It is now one of, if not the largest, groundwater banking programs in the world. In wet years, participating banking partners deliver their surplus water to Semitropic. As of August 2006, 907,362 af of water had been banked in the original groundwater banking program. Original banking partners include public agencies, metropolitan sub-agencies, private investors, power companies, and developers.

Figure C-3 displays the Semitropic's banking partners and their reserved storage capacities. Whenever necessary, Semitropic returns the stored water to the Aqueduct for use by its partners either by exchanging its entitlement or by reversing the intake facility, which is called "pump back." Through pump back, Semitropic can contribute a maximum of 90,000 aft of water per year into the Aqueduct. The State would then deliver the water to the banking partners.

Semitropic's original groundwater bank capacity is estimated at one million af. The expanded SWRU will increase storage by 650,000 af and increase recovery capacity by 200,000 af per year. Total guaranteed or pumpback capacity will be 290,000 af per year with a maximum storage capacity of 1.65 million af. Reclamation would participate in the expanded SWRU portion of the bank.

Table 5-1 shows costs of Federal participation in the SWRU. The total cost for high priority water ranges from $390 to $430 per af and the total cost for low priority ranges from $240 to $280 per af. Chapter 5 further describes costs and the level of Federal participation in the SWRU.

C.3.2 Resource Management Opportunities

As discussed above, approximately 650,000 af of capacity is available for new banking partners in the SWRU. This would yield 200,000 af of pump back per year. These opportunities represent various ways that Reclamation could use capacity in the SWRU. This section summarizes the different opportunities that Reclamation could use the SWRU to meet these resource management measures. Chapter 4 includes detailed descriptions of each measure. Resource management opportunities include:

- Water for CVP contractors – Includes M&I and agricultural contractors

- Environmental Water – Includes water for Kern NWR, EWA, and San Joaquin River flows

- Shafter-Wasco intertie – Supplying Shafter-Wasco with water from the SWRU in exchange for their CVP entitlement on the Friant-Kern System.

SWRU Banked Water to CVP Contractors

This resource management opportunity would create a new water storage resource for Reclamation to provide water to Federal M&I and agricultural contractors through Reclamation's banking of groundwater in the SWRU. The objective would be to improve Reclamation's operational flexibility with the ability to extract banked groundwater from the SWRU and deliver it to Federal contractors when needed.

SWRU Banked Water for Environmental Water Needs

This resource management opportunity would provide water supplies for the Kern NWR or the EWA. The Kern NWR measure would establish a mechanism for the SWRU to regularly supply water to the refuge. The objective would be to increase the amount of dry year water available to the Refuge which could help to improve habitat management opportunities.

Reclamation could store water for the EWA or similar programs in the SWRU for future fish needs. Use of the SWRU would allow the EWA agencies to acquire water during years when it is more available and less expensive. Storage in the SWRU would also protect EWA supplies from being lost due to lower storage priorities at CVP and SWP surface water storage facilities.

Shafter-Wasco Irrigation District Intertie

The Shafter-Wasco intertie alternative would utilize, or potentially expand, an existing intertie between Semitropic and the adjacent Shafter-Wasco. This management opportunity would allow the substitution of Delta water for Shafter-Wasco's existing supply of water from the Friant-Kern Canal, or storage of Friant flood flows for later use in Shafter-Wasco. The objective would be to reduce demands on the Friant-Kern system, which could help alleviate conflicts between environmental and agricultural water needs. The Shafter-Wasco Intertie could also be an asset in meeting the goals set forth in the Stipulation of Settlement in *NRDC v. Rodgers*.

C.4 Project Benefits

Reclamation's participation in the SWRU could provide various types of benefits, including reduced pumping costs to agricultural users in the Semitropic service area, water supply reliability during drought years for CVP contractors, emergency water supply, and environmental benefits.

Reduced pumping costs

Reclamation's participation in the SWRU could also benefit agricultural users in the Semitropic service area by increasing groundwater levels and lowering pumping costs. As groundwater levels drop, more energy is required to pump groundwater to the surface, which increases prices for groundwater users. Farmers might respond by switching to lower water use crops, which may also be lower value crops. On average, farmers pay about $0.25 to pump one af of water per foot of lift. Therefore, if groundwater levels decrease 60 feet, the user would need to pay an additional $15 per af in pumping costs. Recharge into the SWRU would maintain groundwater levels and prevent excessive increases in pumping costs. This would benefit farmers in the Semitropic service area by decreasing production costs and potentially increasing net revenues. Section C.5 includes an estimation of reduced pumping costs.

Water Supply Reliability

Reclamation could use the SWRU to store water for CVP contractors. The SWRU could provide water supply reliability for CVP contractors that provide water to both M&I and agricultural users. CVP contractors could use water from the SWRU during dry years when CVP contract allocations are not at the full supply. Water deposited in to the SWRU could replace or supplement any alternate supplies that contractors are looking to purchase during dry years.

For M&I users, increased water supply reliability would provide firm drinking water supplies for growing cities. For agricultural users, improved water supply reliability would improve existing crop yields and allow farmers the opportunity to plant high value, permanent crops that require a consistent annual water supply. This could increase net revenues to farmers. University of California Crop Extension (UCCE) crop budgets indicate that almond crops in the San Joaquin Valley yield a net return per acre above operating costs of about $365 to $2200 per acre depending on the age and yield of the orchard and a price of $1.60 per pound (UCCE 2006). In contrast, net returns above operating costs to produce an acre of cotton are $332 per acre (UCCE 2003). This analysis does not conduct an NED analysis on agricultural benefits. If an NED analysis is conducted, steps would need to be taken to determine if the potential high value crops can be considered basic crops and that increased production would not be offset by decreases in other parts of the nation.

Throughout the State, water agencies are planning and implementing projects to increase water supplies and storage to accommodate increasing demands and for use during future dry years. Water projects include groundwater and seawater desalination, recycled water, new off-stream storage facilities, enlarging existing reservoirs, and groundwater banks. Agencies are preparing urban water management plans and integrated water resource plans to determine the projects that best meet their needs. Spot market water transfers are also a common tool to increase water supplies for M&I contractors. Agencies are paying varying prices to develop these new supplies. Participation in the SWRU would provide similar water supply reliability benefits as other water projects. Therefore, prices those agencies are willing to pay for other projects can be used to infer the expected value of benefits of the SWRU.

Table C-2 provides some examples of recent, planned, or potential projects that M&I contractors have implemented or considered implementing to improve water supply reliability. Seawater desalination represents the highest cost that contractors have been willing to pay for water supplies. Desalination costs include water, treatment, and distribution. MWD's cost for delivery, power, and treatment (not supply) is currently $370 per af. Based on professional estimates, annual capital and operation and maintenance costs for conventional or membrane treatment are on the order of $200 to $250 per af, which would represent a portion of MWD's cost of $370 per af. Water from other sources/projects listed in Table C-2 would need additional treatment to meet drinking water standards.

Table C-2
Estimated Costs of Proposed Projects to Improve Water Supply Reliability

Water Supply Project	Preliminary Total Cost (million $)	Cost per Acre-Foot ($/AF)
Los Vaqueros Expansion	$667	$330/AF
Upper San Joaquin River Basin Storage Investigation	$220 to $1,000	Not available
Madera Ranch Groundwater Bank	$72 to $75	$400/AF
Mokelumne River Regional Water Storage and Conjunctive Use Project	$323 to $1,009	$208 to $367/AF
Shasta Dam Enlargement Project	$280 to $480	Not available
Seawater Desalination		$800 to $1,300/AF
Groundwater Brackish Desalination		$700 to $1,000/AF
Sources: Reclamation 2006; Reclamation 2005; Reclamation 2004; Mokelumne River Water and Power Authority 2004, CDM 2005		

In addition to willingness to pay for alternative water supplies, current participation in Semitropic's original ground bank indicates a value of water supply reliability for the SWRU. Existing banking partners, listed in Figure C-3, have already banked over 900,000 af in the original bank.

In comparison, the SWRU would cost participants from $390 to $430 per af for high priority water and $240 to $280 for low priority water, depending on the amount of shares purchased. Reclamation would purchase high priority shares for M&I users so that the water can be recovered during dry years.

Emergency Water Supplies

The Delta levees and other water control structures that convey water to the southern San Joaquin Valley and southern California are vulnerable to earthquakes, floods, and other natural disasters. Numerous faults run directly through the Delta and pose an immediate risk to levees and the Aqueduct. The 2005 California Water Plan Update identifies a 62 percent chance of a 6.7 or greater magnitude earthquake to hit the Bay Area by 2032. Additionally, over time, the Delta levees have deteriorated due to deficiencies in the original design and deferred maintenance. A 2004 Army Corps of Engineers study found 183 spots along the Sacramento River where levees have visibly eroded, including 25 "critical" sites. Levees could fail during any major storm event, periods of high tide, or high winds. The Upper Jones Tract levee failure in 2004 occurred during dry conditions potentially from a problem in the levee's foundation, though the exact cause is unknown. Earthquakes or a large flood could cause Delta levees to fail and water would not be able to be pumped south of the Delta. In case of a catastrophe in the Delta and shutdown of CVP and SWP pumps, Semitropic could pump water into the Aqueduct to supply southern needs.

Environmental Benefits

Reclamation's participation in the SWRU could also benefit wildlife refuges, San Joaquin River restoration, or Delta fisheries by supplying environmental water needs. In general, environmental benefits are difficult to quantify because of the uncertainty of how benefits would accrue within the ecosystem. If ecosystem benefits are identified and quantified, then market data is needed to determine a monetary value of the habitat improvement. If market data is not available, various imputed value, contingent value, or benefits transfer methods can be used. This section describes potential benefits qualitatively and, if applicable, identifies projects that are being evaluated to achieve similar benefits. The costs of these alternative projects suggest a preliminary willingness to pay for the environmental benefit.

Kern NWR Water Supplies

Reclamation purchases water annually for the Water Acquisition Program (WAP) to help meet CVPIA Refuge supplies. Water is currently purchased through short- and long-term transfer agreements. WAP has a contract with the San Joaquin Exchange contractors to purchase water for about $105 in wet years and about $300 per af during dry years (Gregory 2006). Reclamation could store water in the SWRU in wet years that could be later provided to Kern NWR. Environmental benefits could include enhanced wetland habitat for migratory birds and wildlife. As a result, migratory bird populations could increase at the refuge. Other benefits may include increased visitation and recreation opportunities, such as bird watching.

EWA Water Purchases

Reclamation could use the SWRU for EWA or similar programs to protect and restore fisheries in the Delta. The EWA protects Delta smelt at the CVP and SWP pumps and provides flow benefits to anadromous fish during the migratory season. The SWRU could be used for storage for EWA water supplies. Reclamation is currently investigating expansion of Los Vaqueros Reservoir to provide water supplies to the EWA or similar program. Reclamation has estimated the expansion would have an average supply yield of about 104,000 af and cost about $667 million.

The EWA agencies currently purchase water through short-term and long-term water transfers. In general, purchases during wet years and north of the Delta are the least expensive; however, this water is also the most difficult to convey through the Delta. Prices paid for EWA water varies by water year and location purchased. Table C-3, from the Los Vaqueros Initial Economic Evaluation for Plan Formulation (2006), summarizes estimated average EWA prices for water purchased south of the Delta during each year type. Estimates of EWA water acquisition prices are based on historical transfer prices, recent trends in water transfer acquisitions, and an initial estimate of the effect of acquisitions on prices. In wet years, water prices average about $160 per af and in the driest years water prices average about $340 per af, in 2006 dollars. These spot market prices will likely increase at rates above inflation into the future.

Table C-3
Spot Market Water Transfer Prices

Year Type	Frequency (%)	Purchase Price ($/AF)	
		2004	2006
Wet	28.8	$151	$160
Above Normal	14	$172	$182
Below Normal	19.2	$190	$201
Dry	16.4	$268	$284
Critically Dry	2.4	$268	$284
Driest[1]	19.2	$321	$340
Weighted Average Price		$203	$215

1- Driest years include 1924, 1929-1934, 1977, and 1987-1992
Source: Reclamation 2006

San Joaquin River Restoration

An exchange of water banked in the SWRU with Shafter-Wasco Irrigation District's CVP supplies from the Friant Division could be a component of a plan to implement the Secretary's obligations in the Stipulation of Settlement in *NRDC v. Rodgers*. A goal of the Settlement is to restore and maintain naturally-reproducing and self-sustaining populations of salmon and other fish in the San Joaquin River below Friant Dam.

The 2005 California Water Plan Update identifies an unmet need of 268,000 af of water on the San Joaquin River below Friant Dam. Reclamation, DWR, and other stakeholders are investigating projects to improve water supplies and increase flows on the San Joaquin River. The Upper San Joaquin River Basin Storage Investigation is evaluating alternatives to develop water supplies on the San Joaquin River for environmental restoration and water quality purposes, and to enhance conjunctive management and exchanges to supply high quality water to urban users (Reclamation 2005). The alternatives include new storage reservoirs with varying storage capacity and one alternative to raise Friant Dam. Table C-4 summarizes estimated costs for each alternative.

Table C-4
Estimated Prices of Upper San Joaquin River Basin Storage Investigation Alternatives

Alternative	Average New Water Supply (AF/year)	Total Construction Cost (million $)
Raise Friant Dam 25 feet	24,000	$220
Fine Gold Reservoir 400 TAF	65,000	$470
Fine Gold Reservoir Elevation 800 TAF	113,000	$640
Temperance Flat RM 274 1,300 TAF	165,000	$1,000
Temperance Flat RM 279 450 TAF	86,000	$670-$800
Temperance Flat RM 279 725 TAF	122,000	$870-$1,000
Source: Reclamation 2005		

The Madera Ranch bank could also be used to increase San Joaquin River flows. The Madera Irrigation District (MID) is implementing the Madera Water Supply Enhancement Project to increase storage and reduce groundwater overdraft in the region. MID purchased over 13,600 acres of land, known as the Madera Ranch, to create a groundwater banking program to store water for use during dry years. As planned, the banking facility can store up to 250,000 af and can move about 55,000 af of water in and out of storage each year. MID has estimated that the Madera Ranch bank would cost between $72 and $75 million. MID could use water from Madera Ranch to reduce demand on the Friant-Kern System. MID water from Friant Dam could be released into the San Joaquin River for restoration purposes.

The Upper San Joaquin River Basin Storage Investigation and the Madera Ranch meet both water supply and environmental objectives. A portion of the above prices reflects a willingness to pay for increased flows on the San Joaquin River. A more detailed analysis would need to be completed to determine actual values attributed to environmental benefits on the San Joaquin River.

C.5 Benefits Estimation of Hypothetical Federal Participation

The following is a detailed description of the methods employed to quantify the economic benefits associated with the SWRU alternative described in Chapter 5. In essence, project benefits are developed in the economic analysis based on future conditions with and without the proposed project. Project benefits are measured as the difference between two alternative futures: the without-project condition (future without any action) and with-project condition. The following sections quantify benefits of supplying water to the San Joaquin River, reducing ground water pumping costs, and providing dry year and emergency water supplies to M&I contractors.

C.5.1 Economic Parameters

The following preliminary economic analysis was performed at the concept level (pre-feasibility) and estimates potential project benefits accruing over the expected project lifespan. Semitropic is currently constructing and operating the SWRU in different phases. For evaluation purposes, this analysis assumes that Reclamation would provide $50 million to purchase shares in the SWRU and use the SWRU's storage and recovery facilities through the end of the contract in 2035. The economic benefits and annual operating costs of the project would begin to accrue in 2006, and were analyzed over a 29-year period ending in 2035. The Federal discount rate of 5-1/8 percent was used in this initial economic analysis to adjust the stream of benefits and costs to the base year of 2006.

C.5.2 Benefit Categories

Although there were many benefit categories considered within this report and discussed in the above sections, only select categories were deemed quantifiable given study time constraints and availability of information. The project benefits include: (1) reductions in future inflated purchases of spot market water transfers for San Joaquin River flows, (2) reduced groundwater pumping costs associated with agricultural producers, (3) reductions in future inflated purchases of spot market water transfers for dry year supplies for M&I transfers, and (4) emergency water made available to south of the Delta water users.

Other benefits attributable to increased water supplies that could be explored through a more in-depth analysis would involve other beneficial environmental effects, avoided costs of alternative water storage facilities, agricultural intensification/location production, and a more detailed analysis for the benefits of M&I dry year water. It should be emphasized that the most important benefit category is water reliability for M&I use, especially during drought years. Inclusion of these other benefits would certainly improve the economic feasibility of the SWRU.

C.5.3 Supplementing San Joaquin River Flows

The Stipulation of Settlement in *NRDC v. Rodgers* requires the Secretary to purchase water each year to insure that unforeseen seepage losses do not impact the restoration flows. This could require the Secretary to purchase on the spot market to meet the obligations in the Settlement. The proposed hypothetical Federal participation includes purchasing 8,860 low priority shares to supplement San Joaquin River Flows.

Without a firm water supply to supplement San Joaquin River flows, Reclamation would need to purchase spot market transfers to meet flow requirements. The Los Vaqueros Expansion Investigation (Reclamation 2006) estimates the price of future spot market water transfers for EWA purchases. This analysis assumes that Reclamation would pay similar spot market prices to supplement flows for the San Joaquin River.

The CALFED Common Assumptions Economic Workgroup (CAEWG) developed interim estimates for future water market prices to value EWA benefits to support ongoing plan formulation for the LVE. CAEWG estimated that because of water shortages and distribution constraints, spot market water prices will increase over time above the rate of inflation. The CAEWG made an interim recommendation that water prices would increase 1 to 2 percent above inflation (Mann 2006). Table C-3 identifies the 2006 average price for EWA water transfers to be $215 per af (Reclamation 2006). To develop a range of likely outcomes, 1.1 percent, and 2.0 percent growth rates were applied to the starting price of $215 to reflect future price increases over the planning horizon.

The Los Vaqueros Expansion investigation methodologies described were adopted in this economic analysis to evaluate benefits of the SWRU for San Joaquin River flows. Figure C-4 shows future spot market prices based on a starting price of $215 and growth rates of zero percent, 1.1 percent, and 2.0 percent over the 100 year period of analysis. The zero percent growth rate is included as a low bookend, but is not likely to occur (Reclamation 2006). The estimated cost of desalinated water, minus conventional treatment costs, is also shown as an alternate water supply. At the 2 percent growth rate, spot market transfer prices would exceed the cost of desalination, less treatment, around the year 2080.

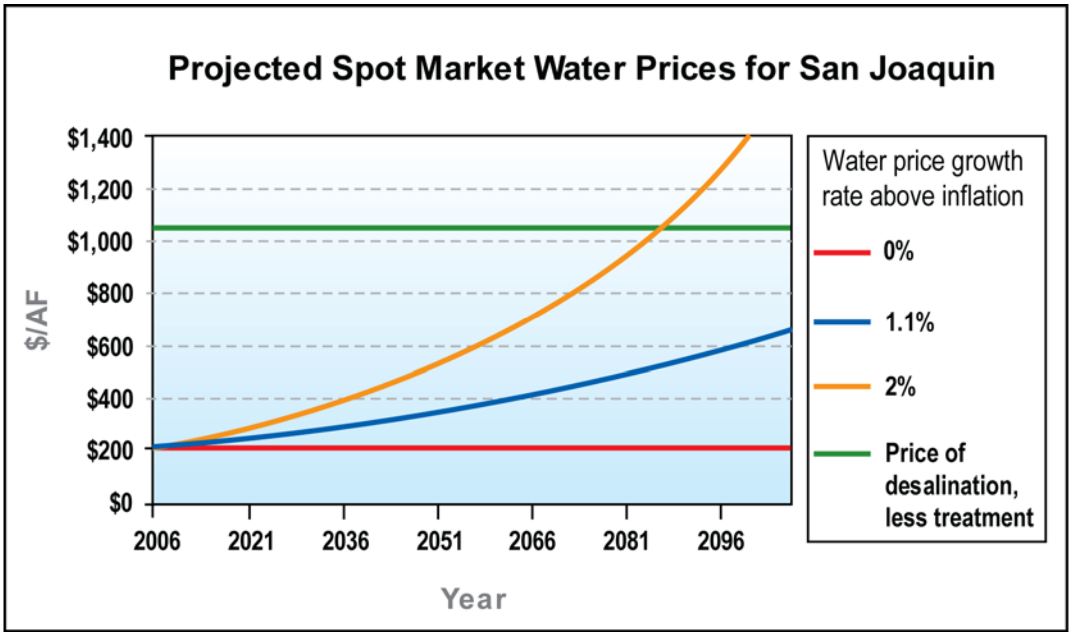

Figure C-4
Future Spot Market Water Transfer Prices for San Joaquin River Flows

Table C-5 displays the net present value and equivalent annual benefit of the SWRU providing San Joaquin River flows for the assumed rates of future real price growth. These values are based on 8,860 low priority shares used over a 29-year period.

Table C-5
San Joaquin River Flows Benefits based on Future Growth Rates above Inflation, Starting Price $215 per acre foot

Growth Rate	Net Present Value of Future Benefits	Equivalent Annual Value of Benefits
1.1% real price escalation	$4.46 million	$303,300
2% real price escalation	$4.89 million	$332,400

C.5.4 M&I Dry Year Water Supplies

The proposed scenario assumes that Reclamation would purchase 15,150 high priority shares to supply dry year water supplies. This analysis relies on the avoided costs of water transfers during dry years to determine M&I water supply benefits. Table C-3 indicates that future dry year transfer prices range from $284 to $340 per af. The frequency of each of these prices occurring is about the same, so an average of $312 per af was assumed for this analysis. Similar to environmental water transfers, this analysis also assumes that spot market prices for M&I water would increase 1 to 2 percent above inflation. Avoided costs were determined for both 1.1 and 2 percent growth rates. Table C-6 summarizes estimated benefits of M&I dry year water supplies based on future spot market water transfer prices.

Table C-6
M&I Dry Year Supply Benefits based on Future Growth Rates above Inflation, Starting Price $312 per acre foot

Growth Rate	Net Present Value of Future Benefit	Equivalent Annual Value of Benefits
1.1% real price escalation	$12.8 million	$872,500
2% real price escalation	$14.8 million	$1.43 million

C.5.5 Emergency Water Supply

In case of an emergency in the Delta, the SWRU could provide emergency supplies to water users south of the Delta. The water supply reliability benefits are based solely on preliminary estimates of the value of these emergency supplies. This analysis assumes that M&I contractors would pay the cost of the most expensive water supply project for raw water emergency supplies. M&I contractors are willing to pay $1,300 per af for seawater desalination, which is treated to drinking water standards. In an emergency, this analysis assumes that contractors would be willing to pay this price for raw water, which would then need to be treated at local facilities (about $200 to $250 per af). Reclamation (2006) indicates M&I contractors would pay $1,700 per af for emergency supplies.

Multiple studies have estimated the risk of levee failure. Studies indicate that a major earthquake or flood could have catastrophic effects in the Delta and affect water exports. Mount (2005) estimates that the odds of a major earthquake or flood occurring in the next 50 years are 64 percent. CALFED (2005) estimates a greater than ten percent chance of 30 simultaneous levee breeches in the next 50 years. The 2005 California Water Plan Update identifies a 62 percent change of a 6.7 or greater magnitude earthquake to hit the Bay Area by 2032. Reclamation (2006) uses the combined probability of an earthquake or levee emergency occurring as once in every 50 years, or a two percent chance in any year. This analysis assumes that emergency water would be required during two years of the 29-year period, at a price of $1,300 per af. The analysis substitutes a price of $1,300 per af for the future price of spot market transfers during two dry years of the contract period.

C.5.6 Groundwater Pumping

Reclamation's participation in the SWRU could also benefit agricultural users in the Semitropic service area by increasing groundwater levels and lowering pumping costs. As groundwater levels drop, more energy is required to pump groundwater to the surface, which increases prices for groundwater users. This analysis relies on Bookman Edmonston Engineering (2002) Proposition 13 Grant Application for the SWRU to determine changes in groundwater levels and groundwater use for irrigation within the Semitropic service area. Bookman Edmonston Engineering (2002) estimated that 139,371 acres in Semitropic rely on groundwater and pump approximately 425,000 af, less in-lieu recharge. This analysis assumes it costs $0.25 per af of groundwater per foot of lift.

Based on the proposed scenario, Reclamation would provide a cumulative recharge of up to 47,500 af during the 29 year contract period. This recharge would reduce pumping costs for the Semitropic groundwater users. Reduced pumping costs are estimated to be about $35 million over the contract period, or $2.4 million annually.

C.5.7 Total Project Benefits

Table C-7 summarizes the benefits of the proposed SWRU scenario, which includes 8,860 low priority shares for environmental water and 15,150 shares of high priority water for dry year and emergency needs. Chapter 5 describes operations of the scenario over the 29-year period. The total annualized benefits quantified for the hypothetical Federal participation amount to $4.04 to $4.14 million.

Table C-7
Estimated Benefits of Hypothetical Federal Participation

	Annual Value of Benefits	
Project Benefits	**1.1% growth rate**	**2% growth rate**
San Joaquin River Flow Supplies	$303,300	$332,400
M&I Water Supply Reliability and 2 years of Emergency Water Supply	$1,426,200	$1,522,300
Groundwater Pumping Costs Reductions	$2,401,500	$2,401,500
Total	$4,131,000	$4,256,200

C.6 Project Implementation Costs

The hypothetical Federal participation assumes that Reclamation has committed $50 million to develop a supply of water from the SWRU. It was further assumed that Reclamation would purchase high and low priority shares at a distribution of 70 percent and 30 percent, respectively, given the generally higher need for dry and critically dry year water supply reliability addressed with high priority shares. Table C-8 summarizes the costs of the proposed hypothetical Federal participation. The annual cost over the 29-year period would be $3.4 million based on a 5.125 percent discount rate.

Table C-8
Summary of Estimated Costs for Hypothetical Federal Participation based on $50 million Contribution by Reclamation

Total High Priority Shares	15,150
Total Low Priority Shares	8,860
Total Spent on Operations	$29.4 million
Total Spent on Shares	$20.6 million
Total Spent	$50 million

1. Does not include initial purchase price and conveyance cost of the stored water

C.7 Analysis of Benefits and Costs

Table C-9 summarizes estimated benefits and costs for the hypothetical Federal participation evaluated in this report. Based on the initial economic analysis, this hypothetical Federal participation appears to be economically feasible, resulting in average annual positive net benefits of about $4.1 to $4.3 million. The benefits exceed the costs for the proposed hypothetical Federal participation.

Table C-9
Benefits and Costs for Hypothetical Federal Participation

Total Annual Benefits	$4.1 to 4.3 million
Total Annual Costs[2]	$3.4 million
1. Does not include initial purchase price and conveyance cost of the stored water	

C.8 References

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