APPENDIX 6-1: 2014 PAJARO VALLEY WATER MANAGEMENT AGENCY BASIN MANAGEMENT PLAN UPDATE

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Pajaro Valley
Water Management Agency

Basin Management Plan Update

Final • February 2014

carollo
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pvwma0214r1-8347.psd

Prepared under the responsible charge of

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Term
af	Acre-Feet
AFY	Acre-Feet Per Year
ASR	Aquifer Storage and Recovery
BMP	Basin Management Plan
CCRWQCB	Central Coast Regional Water Quality Control Board
CDFW	California Department of Fish and Wildlife
CIMIS	California Irrigation Management Information Systems
CDS	Coastal Distribution System
CFS	Cubic Feet Per Second
CVP	Central Valley Project
DWZ	Delivered Water Zone
EC	Electrical Conductivity
EIR	Environmental Impact Report
ET	Evapotranspiration
FOIA	Freedom of Information Act
gpm	Gallons Per Minute
IGSM	Integrated Groundwater Surface Water
IRWM	Integrated Regional Water Management
MAR	Managed Aquifer Recharge
MCL	Maximum Contaminant Level
mg	Milligram
MG	Million Gallons
mg/L	Milligram Per Liter
mmho/cm	Millimhos Per Centimeter
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Units
O&M	Operations and Maintenance
PVHM	Pajaro Valley Hydrologic Model
PVIGSWM	Pajaro Valley Integrated Groundwater and Surface Water Model
PVWMA	Pajaro Valley Water Management Agency
RCD	Resource Conservation District (Santa Cruz County)
RWF	Recycled Water Facility (Watsonville)
SAR	Sodium Adsorption Ratio
SCRWA	South County Regional Wastewater Authority
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USGS	US Geological Survey
UCCE	UC Cooperative Extension
WWTP	Wastewater Treatment Plant
WIN	Wireless Irrigation Network

EXECUTIVE SUMMARY

INTRODUCTION

Background

The Pajaro Valley Water Management Agency (PVWMA) established goals for a Basin Management Plan (BMP) Update as follows:

1. Help achieve the PVWMA charter objective.
2. Provide an update of previous planning efforts.
3. Define the appropriate course of action toward optimizing the use of available supplies and solving seawater intrusion and overdraft problems.
4. Accomplish these tasks through a community-based process that is inclusive and adaptive.

The BMP Update planning efforts and associated Environmental Impact Report (EIR) present conclusions and recommendations for management of the Pajaro Valley groundwater basin. The BMP Update includes a plan and timeline for implementation of the recommendations, including near-term and long-term actions.

Pajaro Valley Groundwater Basin

Seawater intrusion in the Pajaro Basin, a result of groundwater overdraft, was first documented in 1953 (Bulletin 5, SWRCB). Since then, the problem has become more severe. The Pajaro Valley groundwater basin is in severe overdraft, causing groundwater elevations to drop below sea level as shown in Figure ES-1 and leading to seawater intrusion. Seawater intrusion has caused chloride contamination of groundwater wells up to three miles inland, as shown in Figure ES-2. Seawater intrusion is an immediate and direct threat to the Pajaro Valley economy. The elevated chloride concentrations make the groundwater unusable for irrigating the high value, salt-sensitive crops in the coastal region of the Pajaro Valley.

2002 Revised BMP

The PVWMA Board of Directors adopted a revised BMP in February 2002. The revised BMP has been the principal document guiding all of the major projects and programs pursued by the PVWMA in the last decade.

PVWMA has completed three projects from the 2002 Revised BMP that are working together to help reduce overdraft, halt seawater intrusion, and improve and protect water quality within the entire basin. PVWMA has constructed the Harkins Slough Recharge Facilities, Recycled Water Facility, and a significant portion of the Coastal Distribution System (CDS) to partially alleviate groundwater overdraft and seawater intrusion.

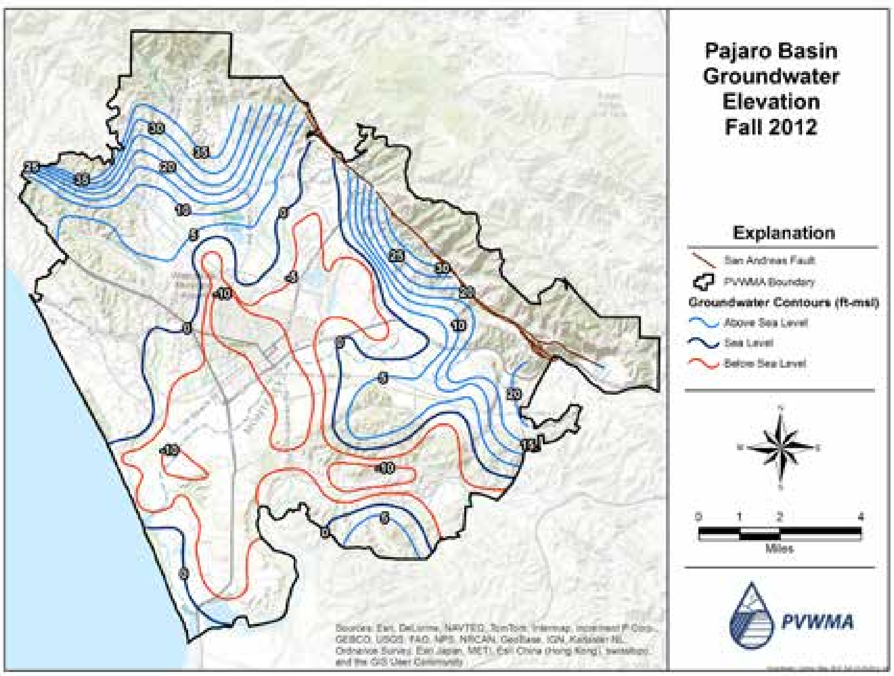

Figure ES-1. Groundwater levels in much of the basin are below sea level.

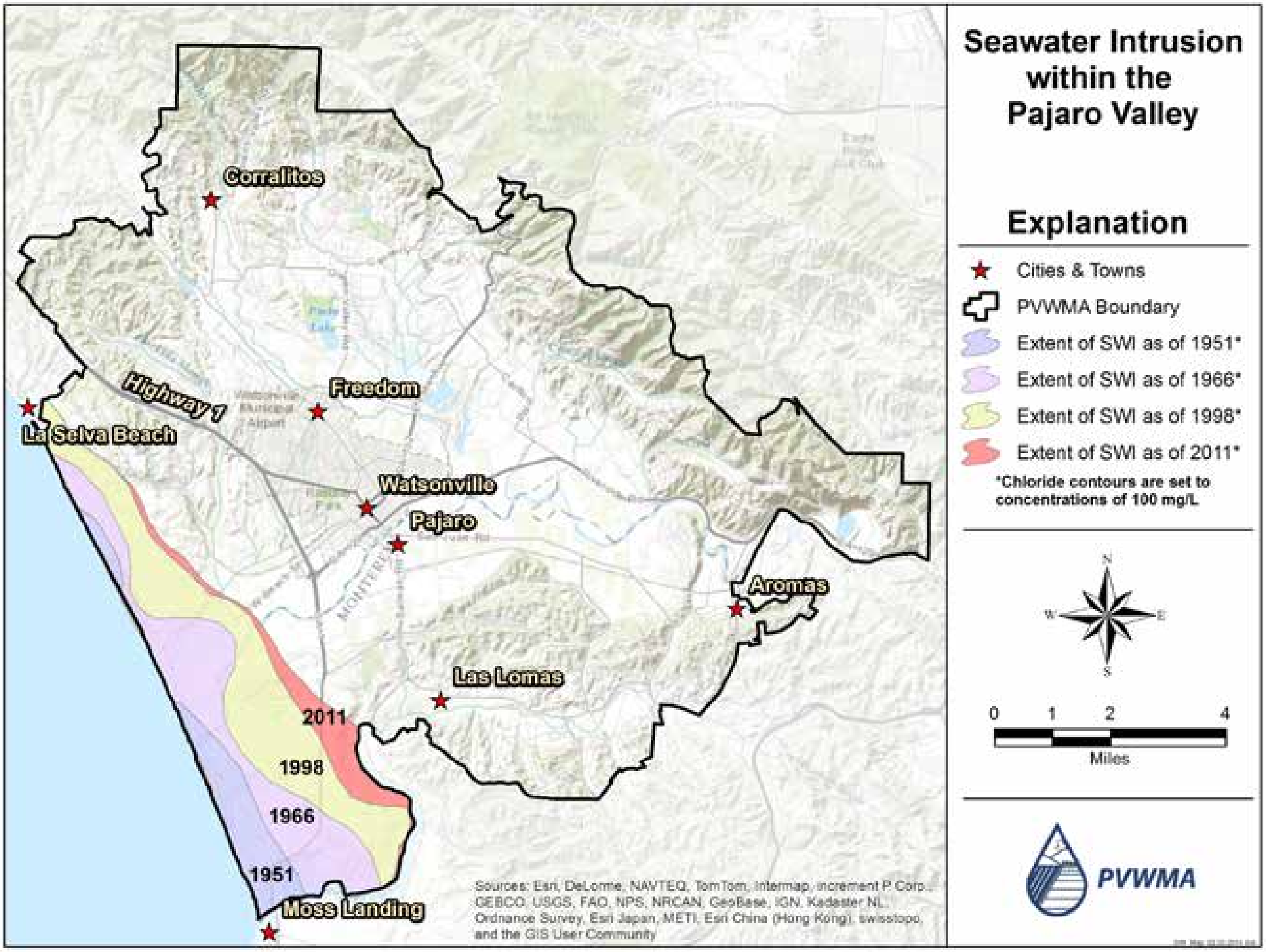

Figure ES-2. Seawater continues to degrade groundwater along the coast.

The quantity of water delivered from these projects has increased approximately 20% annually the past five years to more than 4,000 acre-feet (af) in 2013.

BMP Update Approach

With the successful vote approving new service charges in 2010, the PVWMA refocused its efforts to address the groundwater overdraft and seawater intrusion in the Pajaro Basin. In October of 2010, the Board voted in favor of forming an Ad Hoc BMP Committee to help increase the Pajaro Valley community participation in the development of the BMP Update. This Ad Hoc Committee served as advisors to the PVWMA Board of Directors on matters related to the BMP Update. Throughout the development of the BMP Update, the Committee provided input on the following:

- BMP projects, programs, and policies.
- Basin management strategies.
- Project screening/ranking.
- Project schedule.

Scope of the BMP Update

PVWMA staff and the Ad Hoc BMP Committee developed BMP Update goals and objectives, and a scope of work that they felt met the PVWMA's charter objectives, satisfied the groundwater management plan requirements of AB 3030, and satisfied the community involvement expectations set by the Board. The relationship of the Committee to Agency staff and the consultant team is illustrated in Figure ES-3.

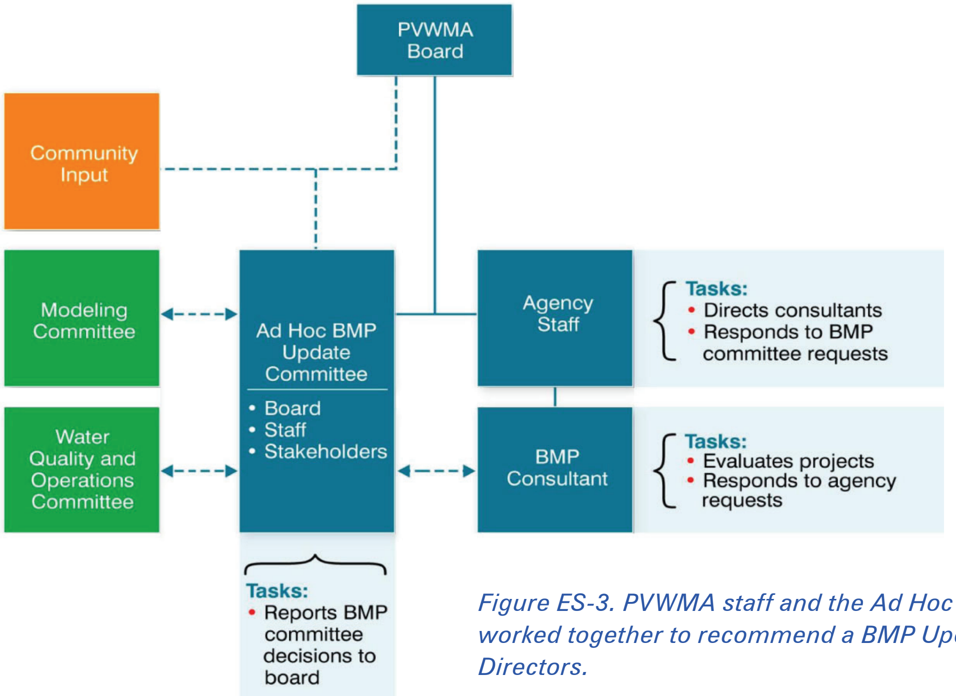

Figure ES-3. PVWMA staff and the Ad Hoc BMP Committee worked together to recommend a BMP Update to the Board of Directors.

BMP Phasing

Figure ES-4 outlines the steps and time frame required for completing the remaining BMP Update phases. The steps required (by phase) are as follows:

1. Project Development Phase
2. BMP Report Phase
3. EIR Phase
4. Financing Phase
5. Board Acceptance and Majority Protest Phase

STATE OF THE BASIN

Historical and existing conditions of the groundwater basin within the PVWMA service area were modeled utilizing the Pajaro Valley Hydrologic Model (PVHM). Projects built and implemented by the PVWMA to date were confirmed to reduce, but not solve, both the seawater intrusion and the groundwater overdraft problems. The basin shortfall was estimated to be approximately 12,000 AFY. The baseline simulation was used to provide a benchmark to which future scenarios were compared. The groundwater modeling suggested the following state of the basin:

- Overdraft in the Alluvial aquifer, the Upper Aromas aquifer, and the Lower Aromas aquifer (the aquifers of interest) is approximately 1,400 af per year.
- Seawater intrusion in the Alluvial aquifer, the Upper Aromas aquifer, and the Lower Aromas aquifer (the aquifers of interest) is approximately 1,900 af per year.

Water Use

Pajaro Valley water use for 2000 to 2013 is shown in Figure ES 1-5. The five-year average for groundwater

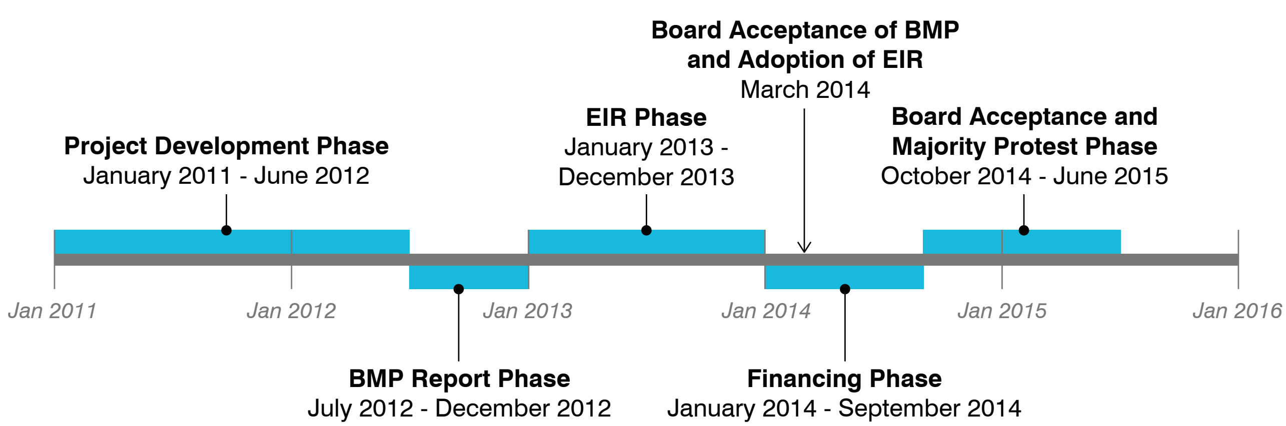

Figure ES-4. BMP process phases.

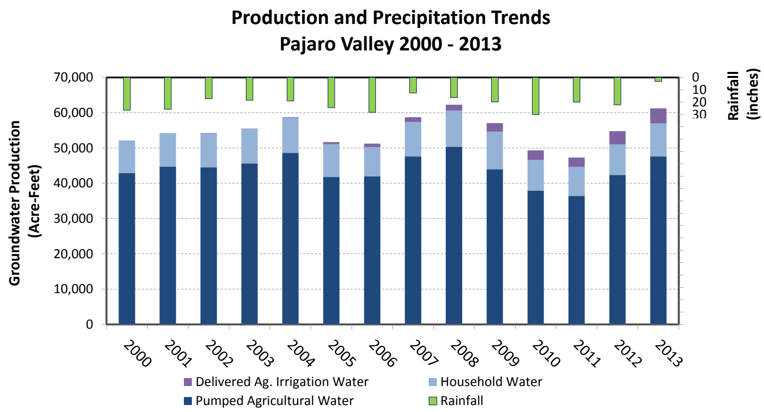

Figure ES-5. Pajaro Valley water use.

use from 2009-2013 is approximately 52,000 af. The five-year average from 2009-2013 for total water use, including delivered water (blended recycled project water) and City of Watsonville surface water use, is approximately 55,000 afy.

Water Quality

Water resources in the Pajaro Valley include both surface water and groundwater. Currently, groundwater is the predominant source of supply. However, since surface water represents potential sources for the future, it is important to understand the current state of both groundwater and surface water quality in the basin. The largest source of nutrients is likely from applied fertilizer. The largest source of salts in the valley is from seawater intrusion, followed by water flowing into the basin from outside the agency's boundary (i.e., the Pajaro River).

BMP UPDATE DEVELOPMENT PROCESS

The Ad Hoc BMP Committee met regularly over an 18-month period. The primary focus of the Committee over this time was to work with PVWMA staff and project consultants to identify, analyze, short-list, and ultimately recommend a portfolio of projects and programs to "solve" the basin problem, i.e., solve seawater intrusion and basin overdraft. Figure ES-6 provides an overview of the process developed and utilized by the Committee to prepare the BMP Update.

The Committee's priorities for identifying individual BMP projects were:

- Prioritize water use efficiency and water demand reduction alternatives that have the potential to reduce basin demands.
- Prioritize improvements to existing infrastructure to maximize supply.
- Prioritize new supply projects to balance the groundwater basin and prevent long-term overdraft.

The Committee addressed these priorities by first developing a list of potential BMP programs and projects and then conducting a screening analysis. Forty-four alternative projects were identified, including projects from PVWMA's previous basin management planning efforts, Committee-developed projects, community group-developed projects, integrated regional water management projects, and consultant-developed projects.

Following initial identification, each program or project was defined to a planning level of detail that included a project description, site plan, project schematic, and conceptual-level cost estimate. The Committee then conducted a multistage screening process to select the most promising projects to include in the BMP. Fourteen projects passed the initial screening process. These projects were used by the Committee to (1) develop a portfolio of projects that together could achieve the dual goals of balancing the basin and halting seawater intrusion and to (2) recommend which of the projects to include in the first phase of the BMP.

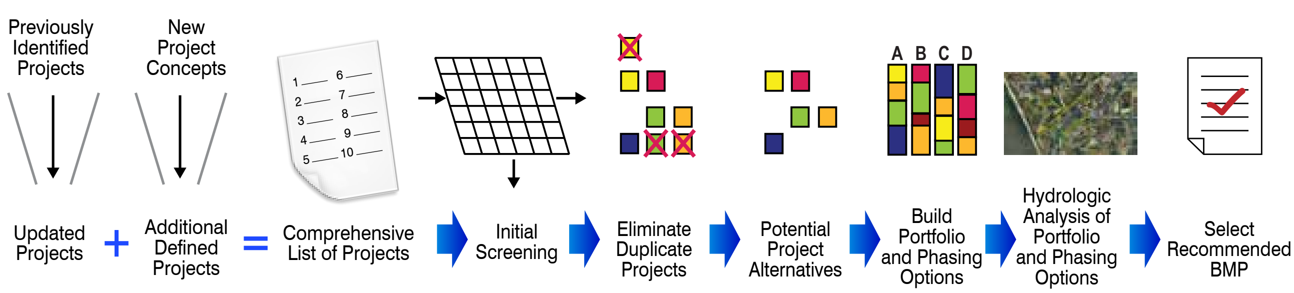

Figure ES-6. The BMP Update was developed utilizing a community-based, multi-phased process.

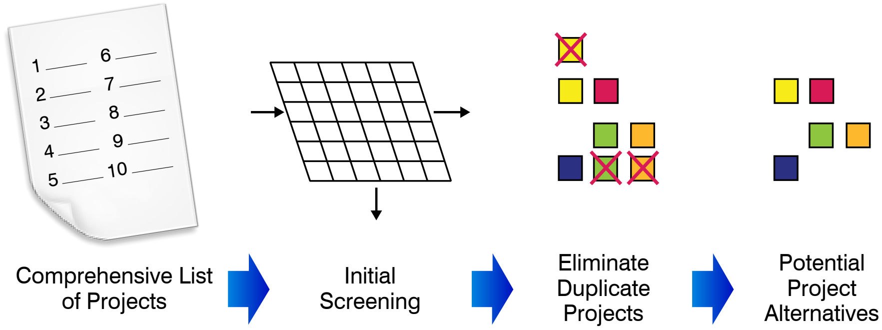

Figure ES-7. The multistage screening process focused the BMP on 14 project alternatives.

Phasing Analysis

The BMP is envisioned as a 30-year plan to be implemented in three phases.

- Phase 1 would begin with Board adoption of the BMP and BMP EIR in 2014 and public approval of a new rate structure in 2015, followed by project implementation and operation through 2024.
- Phase 2 would begin in 2025 and would continue through 2034.
- Phase 3, if required, would begin in 2035 and would go through 2044.

The plan implementation will include planning, design, construction, and monitoring of programs and project effects on the basin. It is anticipated that the majority of selected portfolio projects would be constructed and operational in the first 20 years (first two phases of the plan). The number of projects and the schedule for implementation of those projects was a key recommendation decision to be made by the BMP Committee. It was also anticipated that careful basin monitoring would continue throughout the 30-year BMP as a critical component of the plan implementation.

PORTFOLIO SELECTION AND PHASING EVALUATION

Project Selection

Following the initial ranking of projects, and after considerable analysis and discussion, the BMP Committee selected the seven lowest cost per af projects for inclusion in a BMP portfolio. These seven projects, if implemented and operated as anticipated, were estimated to solve 90 percent of the seawater intrusion and 100 percent of the basin overdraft problems. The remaining seven projects are included as potential future projects in the BMP, should the yield or the measured results on overdraft and seawater intrusion of the first seven projects not meet the expectations of the planning-level estimates.

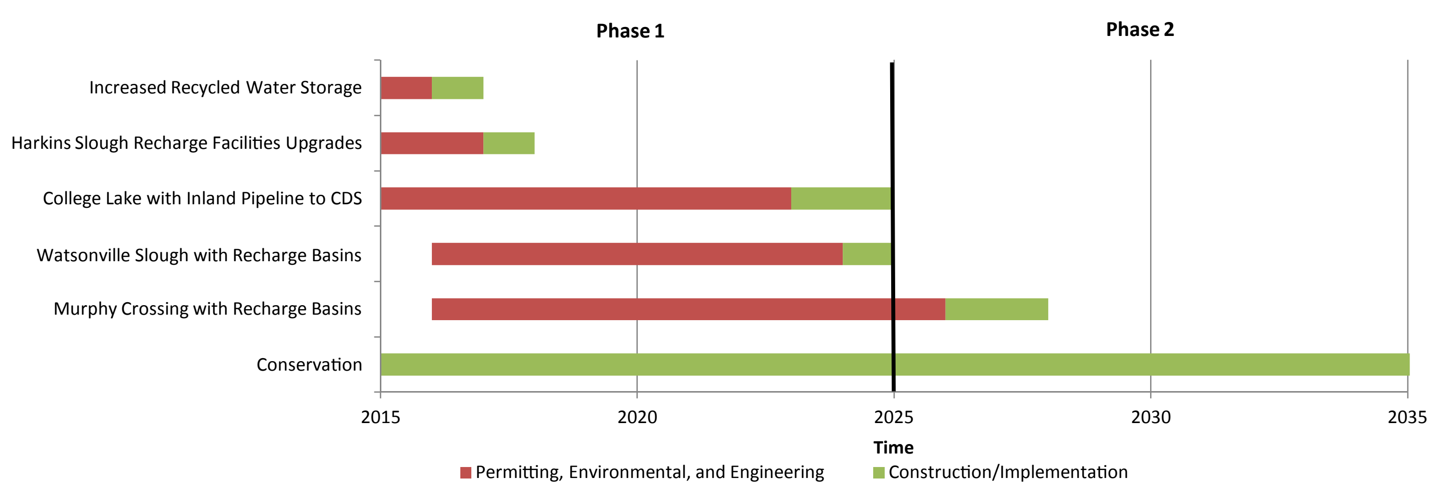

Figure ES-8. Project scheduling used in cash flow model.

Table 4-1 Ranking of Screened Projects

Project or Program		Estimated Yield, AFY	Planning Level Cost Estimate, $/af
D-6	**Increased Recycled Water Deliveries**	**1,250**	**[1]**
D-7	**Conservation**	**5,000**	**200[2]**
S-22	**Harkins Slough Recharge Facilities Upgrades**	**1,000**	**500**
R-6	**Increased Recycled Water Storage at Treatment Plant**	**750**	**700**
S-2	**Watsonville Slough with Recharge Basins**	**1,200**	**1,000**
S-3	**College Lake with Inland Pipeline to CDS**	**2,400[3]**	**1,100**
S-1	**Murphy Crossing with Recharge Basins**	**500**	**1,400**
I-1	CDS expansion	[4]	[4]
R-11	Winter Recycled Water Deep Aquifer ASR	3,200	1,500
S-11	River Conveyance of Water for Recharge at Murphy Crossing	2,000	1,500
G-3	San Benito County Groundwater Demineralization at Watsonville WWTP	3,000	2,500
S-4	Expanded College Lake, Pinto Lake, Corralitos Creek, Watsonville Slough, and Aquifer Storage and Recovery	2,000	2,900
SEA-1	Seawater Desalination	7,500	3,400
S-5	Bolsa de San Cayetano with Pajaro River Diversion	3,500	3,500

Key:
Green = Could be implemented within the first 10 years of the BMP (by 2025)
Orange = Could be implemented after 2025
Bold = Seven projects included in BMP portfolio
Not bold = Seven projects potentially added in the future if needed

[1]No cost is associated with increased recycled water deliveries.
[2]Cost does not include 3- to 5-year program cost of approximately $250,000-300,000 annually.
[3]College Lake with Inland Pipeline to CDS yield changed to a range of 2,100 to 2,400 AFY based on 2014 RCD College Lake Study (see College Lake project description in Chapter 5).
[4]The estimated capital cost of CDS expansion is $13 million. Since the project conveys water from other projects, it does not have a yield.

BASIN MANAGEMENT PLAN

On August 15, 2012 the Board accepted the Committee's recommended BMP. The BMP outlines the steps to increase the Pajaro Valley groundwater basin's water supply by 12,100 afy. The BMP consists of three main components: 1) conservation measures; 2) optimization of existing supplies; and 3) new supply projects. Seven programs and projects were included. Capital costs and yield are shown in Figure ES-9.

Irrigation efficiency is proposed to provide 40% of the reduced groundwater pumping needed to solve the basin problem. Upgrades to recycled water storage, increased water deliveries, and Harkins Slough recharge facilities will allow production of more water from existing infrastructure. Supplemental supply

> The conservation component of the BMP Update focuses on agriculture, where most water is used and the potential for savings is greatest.

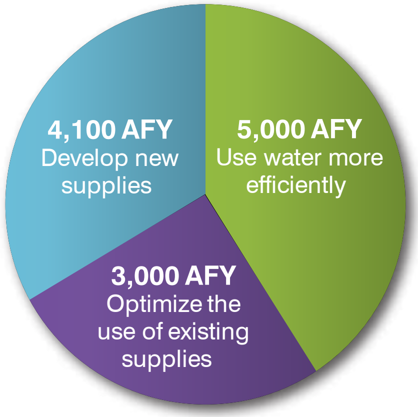

Figure ES-9. The BMP identifies seven core programs and projects to balance the Pajaro Valley groundwater basin and halt seawater intrusion.

	Estimated Capital Cost*	Estimated Yield, afy
• Conservation	–	5,000
• Increased Recycled Water Deliveries	–	1,250
• Harkins Slough Recharge Facilities Upgrades	$5.8 M	1,000
• Increased Recycled Water Storage at Treatment Plant	6.2 M	750
• Watsonville Slough with Recharge Basins	14.7 M	1,200
• College Lake Diversion with Inland Pipeline to Coastal Distribution System	31.5 M	2,400
• Murphy Crossing Diversion with Recharge Basins	8.7 M	500
	$66.9 M	**12,100**

* Costs are expressed in 2011 dollars. Inflation, which will occur between 2011 and actual project construction, will increase these costs.

projects will provide new sources of water to replace groundwater pumping.

The plan would be implemented over a 30-year period, and requires water rights and environmental issues be resolved for the supplemental supply projects. PVWMA has been very successful in obtaining outside grant funding to help fund capital projects, and such funding would be actively pursued for the BMP projects.

Hydrologic modeling of the BMP programs and projects was conducted to assess their ability to stop basin overdraft and seawater intrusion. The modeling showed that, based on likely future hydrologic conditions, implementing the BMP will eliminate overdraft in the Alluvial Aquifer, Upper Aromas Aquifer, and the Lower Aromas Aquifer--the most productive aquifers in the Pajaro Valley. The simulations also indicated that seawater intrusion in these aquifers would be reduced to a rate of 200 afy, which is within the accuracy of the model.

BMP IMPLEMENTATION

The proposed phasing for the BMP projects and programs is shown on Figure ES-10.

The trigger for initiating the BMP implementation will be a successful rate setting process scheduled for mid-2015. However, there are project-related activities that will take place prior to mid-2015 that are required to build on the momentum created by the community-driven BMP development process and to prepare the BMP to be “planning ready” immediately following a successful rate setting process. The implementation schedule is largely driven by environmental, permitting, and water rights-related issues required for the implementation of each project.

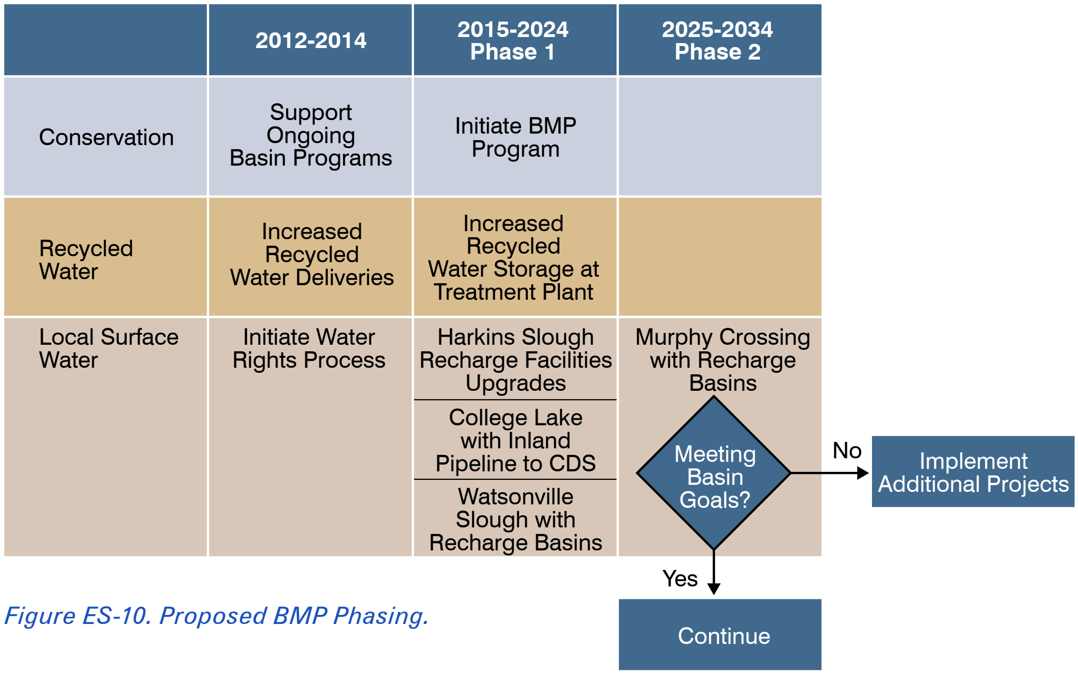

Figure ES-10. Proposed BMP Phasing.

The proposed schedule for activities prior to and following adoption of a new rate structure are summarized in Figure ES-11.

Measuring Basin Improvement

PVWMA regularly measures groundwater levels, water quality, groundwater production, and delivered water use. Continued monitoring of these parameters will be a key component of the implementation of the BMP, and determining if the plan is on track to solve the basin overdraft and halt seawater intrusion.

> Ongoing monitoring will determine if the BMP is meeting its objectives or if additional actions are needed.

The effectiveness of the BMP projects to balance the basin and halt seawater intrusion will be monitored and measured through the ongoing groundwater basin-monitoring program. The purpose of the monitoring program will be:

- To understand the impact of conservation (is pumping basin-wide reduced over a given period of time? are groundwater levels improving?).
- To understand the impact of delivered water use (has groundwater production declined in the delivered water zone? how is the decline in groundwater production affecting water levels and water quality?).
- To measure the yield of capital projects (are capital projects producing the anticipated yield?).
- To determine if new projects need to be considered to solve the remaining basin overdraft and/or seawater intrusion (are existing facilities, in combination with increased water use efficiency programs, stopping groundwater overdraft and halting seawater intrusion?).

The proposed timing for evaluating and adapting the BMP is summarized in Figure ES-12.

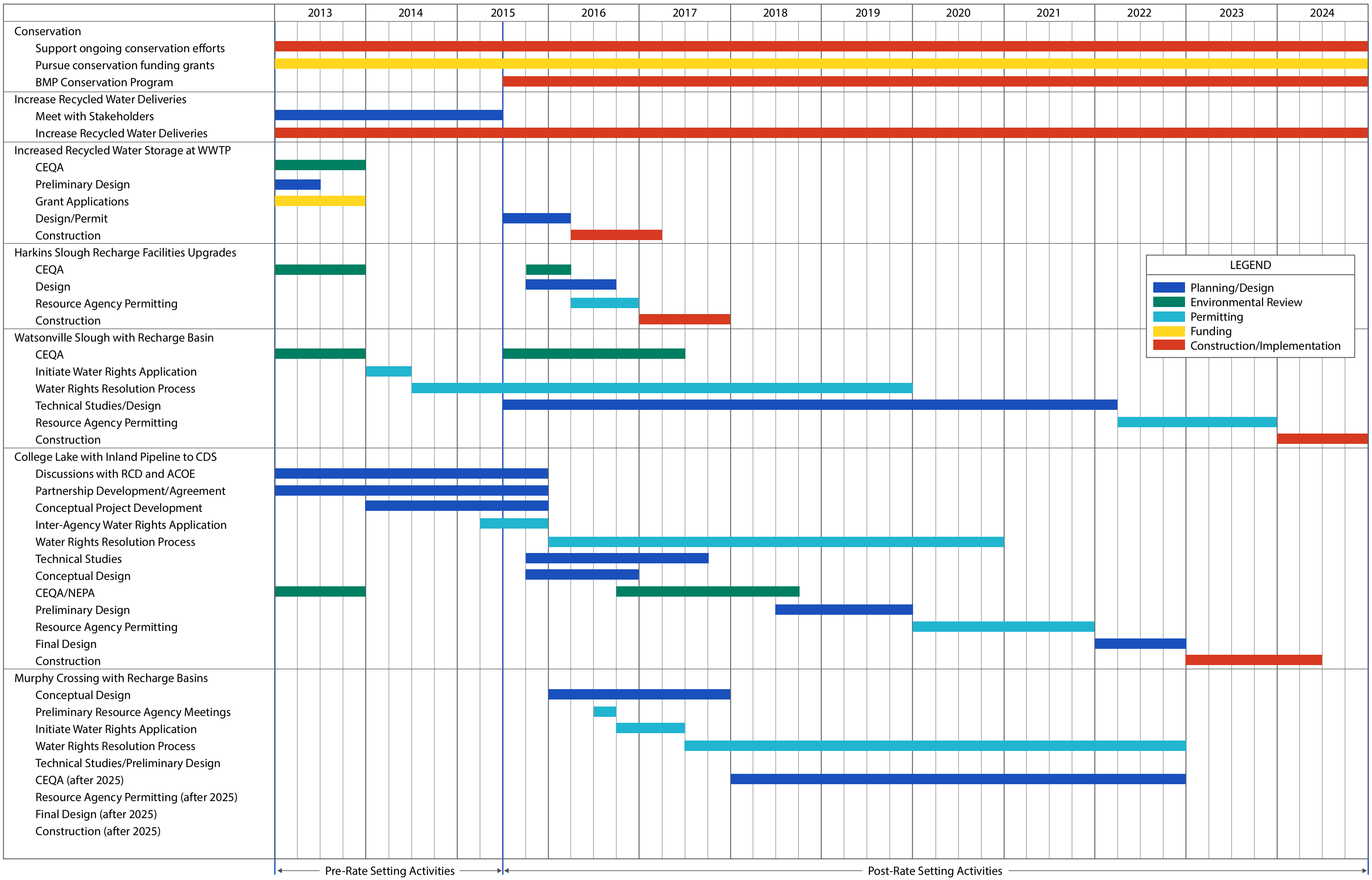

Figure ES-11. Proposed BMP Implementation Schedule.

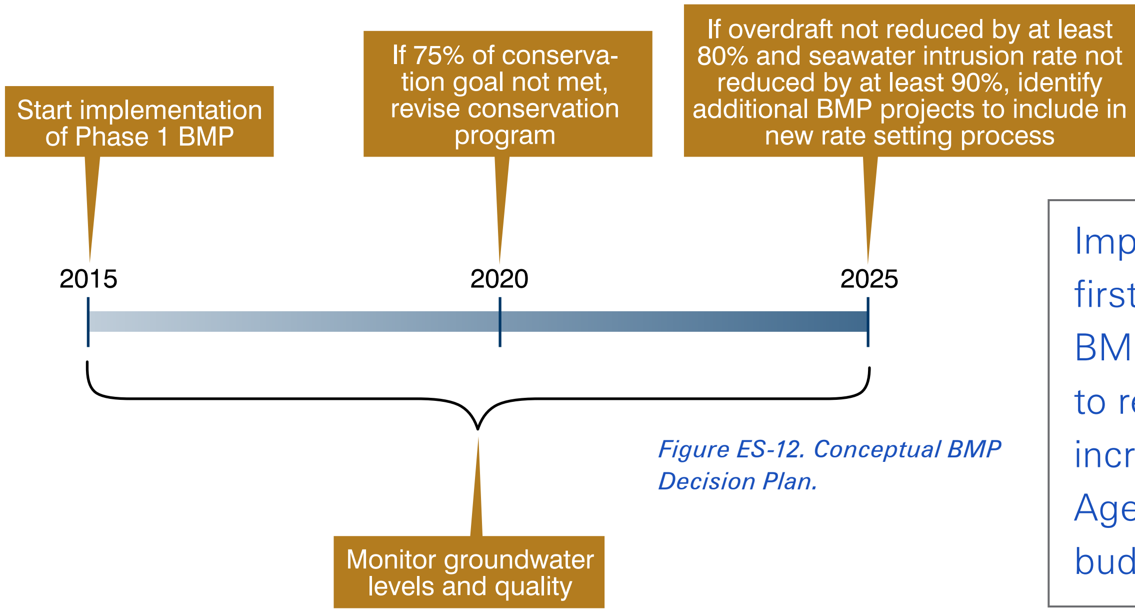

Figure ES-12. Conceptual BMP Decision Plan.

Implementing the first phase of the BMP is estimated to require a 30% increase in the Agency's current budget.

For conservation, it is anticipated that the BMP conservation program would be initiated in 2015 and that it (along with other on-going conservation efforts) would achieve 100% of the savings goal (5,000 AFY) in eight years (by 2023). The PVWMA would continuously monitor basin conditions and, by 2020, determine if a minimum of 75% of the conservation goal (reduced pumping) is being met; if not, the PVWMA would revise the program to increase the levels of conservation and water use efficiency. By 2025, the PVWMA would determine whether overdraft is reduced by at least 80% and seawater intrusion is reduced by at least 90%. If not, the PVWMA would begin the process of identifying new projects to make up the shortfall for solving the basin problem.

For new local surface water projects, the monitoring of the effectiveness of these projects would be determined by measuring the yield of each project, measuring groundwater production, and monitoring water levels in the aquifers and water quality in the delivered water zone. By 2025, the PVWMA would determine if at least 80% of the basin overdraft and 90% of seawater intrusion problems have been addressed, assuming the full portfolio of Phase 1 projects are implemented. If the PVWMA determines the improvements are not on track, it would begin the process of identifying new projects for the eventual prevention of conditions of long-term overdraft, land subsidence, and water quality degradation.

Agency Budget Plan

An analysis conducted of the impact on the PVWMA operating budget of implementing the BMP Phase 1 projects and planning for the Phase 2 project is summarized below.

A cash flow analysis is important to the BMP implementation because it identifies when projects are scheduled to be constructed and funded (likely with bond financing), and confirms a positive balance is maintained in the PVWMA operating budget with the proposed implementation plan. The preliminary cash flow analysis conducted to assist the Ad Hoc BMP Committee in portfolio selection indicates that the BMP programs and projects will require a 30% increase in the PVWMA's budget during Phase 1. A more detailed cash flow analysis will be conducted as part of the PVWMA's rate setting and service charge study, which is being conducted to support BMP implementation.

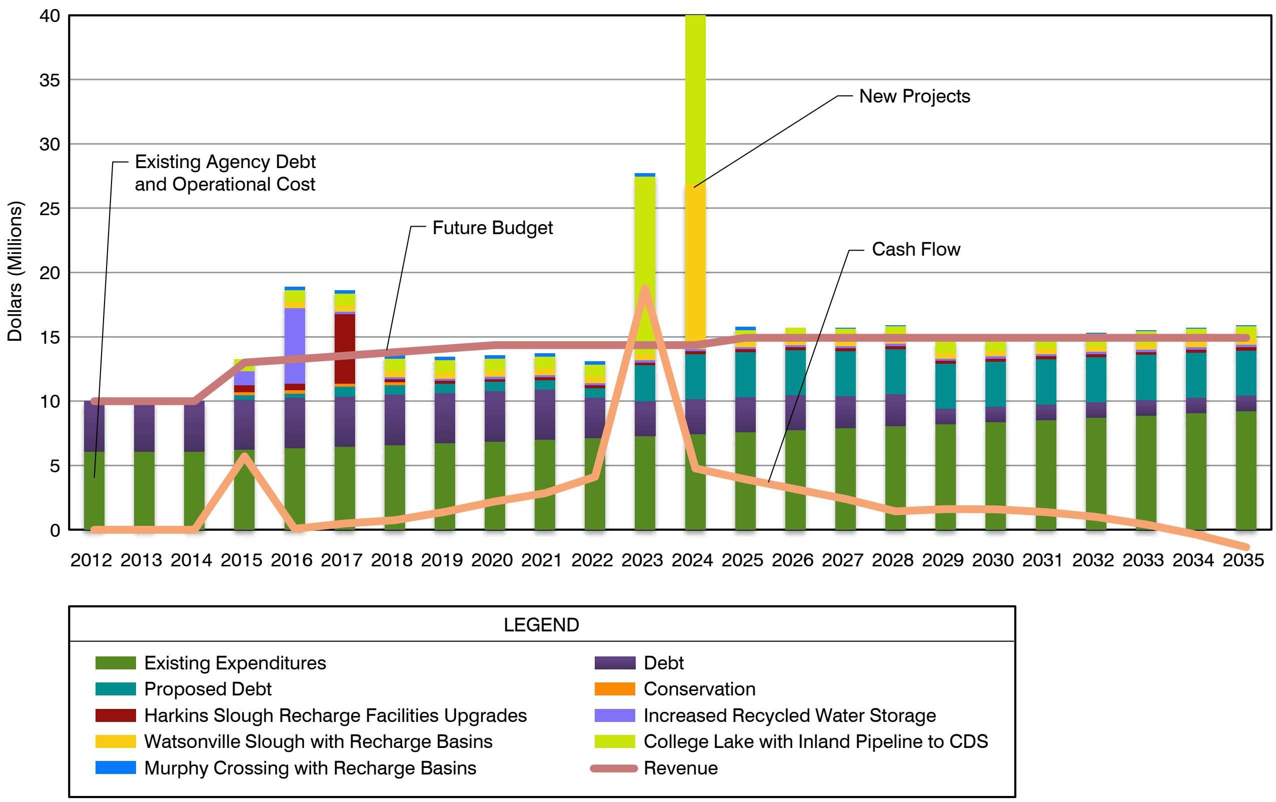

Figure ES-13. Cash Flow Analysis of BMP Phase 1 Implementation.

Chapter 1

INTRODUCTION

BACKGROUND

The Pajaro Valley Water Management Agency (PVWMA) established goals for a Basin Management Plan (BMP) Update as follows:

1. Help achieve the PVWMA charter objective (stated below).
2. Provide an update of previous planning efforts.
3. Define the appropriate course of action toward optimizing the use of available supplies and solving seawater intrusion and overdraft problems.
4. Accomplish these tasks through a community-based process that is inclusive and adaptive.

The BMP Update planning efforts and associated Environmental Impact Report (EIR) present conclusions and recommendations for management of the Pajaro Valley groundwater basin. The BMP Update includes a plan and timeline for implementation of the recommendations, including near-term and long-term actions.

PVWMA Charter

PVWMA is a state-chartered water management district formed to efficiently and economically manage existing and supplemental water supplies. The PVWMA's primary goal is to prevent further increase in, and to accomplish continuing reduction of, long-term overdraft and to provide and ensure sufficient water supplies for present and anticipated needs within its boundaries, as shown in the Figure 1-1.

Section 102 of the PVWMA charter states: "Water resource management activities carried out under this act in the public interest shall recognize the following objectives:

a. Local groundwater resources should be managed toward the avoidance and eventual prevention of conditions of long-term overdraft, land subsidence, and water quality degradation.
b. Local economies should be built and sustained on reliable, long-term supplies and not long-term overdraft as a source of water supply.
c. Water management programs should include reasonable measures to prevent further increases in the amount of long-term overdraft and to accomplish continuing reduction in long-term overdraft, realizing that an immediate reduction in long-term overdraft may cause severe economic loss and hardship.

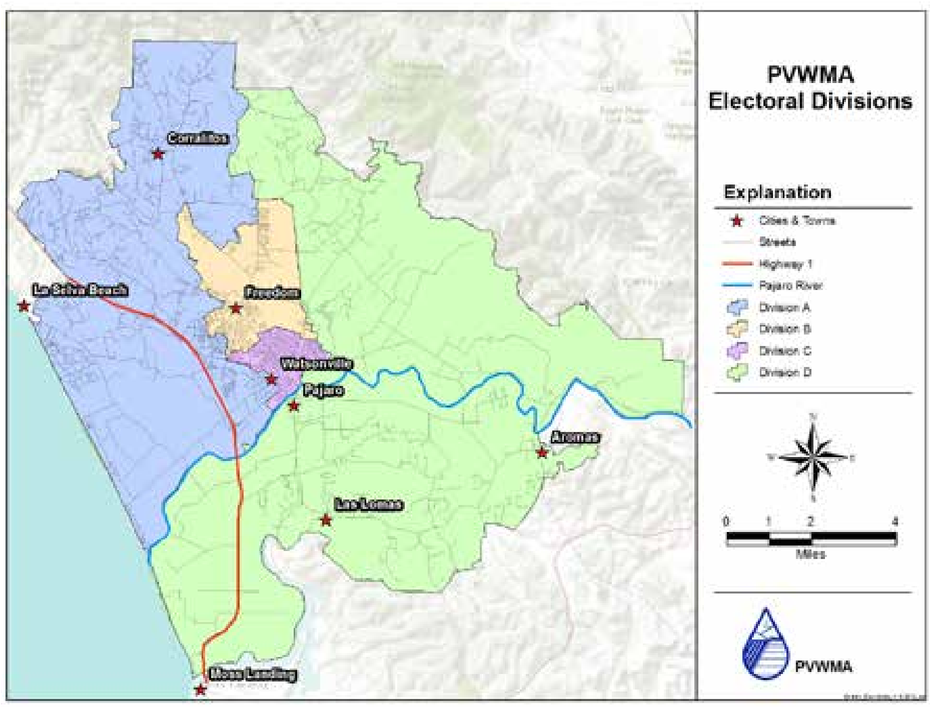

Figure 1-1. PVWMA Boundaries

d. Conservation and economically efficient management of water resources are necessary to meet the needs of agriculture, industry, and urban communities. Economic efficiency requires that water users pay their full proportionate share of the costs of developing and delivering water. Property taxes shall not be used for payment of these costs. Agricultural uses shall have priority over other uses under this act within the constraints of state law.
e. Water conservation programs appropriately include the ability of a water management agency to recognize existing beneficial uses, and to acquire, buy, and transfer water and water rights in the furtherance of its purposes.
f. The purpose of this agency is to efficiently and economically manage existing and supplemental water supplies in order to prevent further increase in, and to accomplish continuing reduction of, long-term overdraft and to provide and insure sufficient water supplies for present and anticipated needs within the boundaries of the agency.
g. It is anticipated that long-term overdraft problems may not be solved unless supplemental water supplies are provided. The water management agency should, in an efficient and economically feasible manner, utilize supplemental water and available underground storage and should manage the groundwater supplies to meet the future needs of the basin."

Governance

PVWMA is governed by a seven-member board of directors, who must live within the agency boundaries and be registered voters. Four directors are directly elected by voters within their division (see Figure 1-1) for overlapping terms of four years each. The remaining three directors are separately appointed by Monterey County, Santa Cruz County and the City of Watsonville. Appointed directors serve two-year terms and must derive at least 51 percent of their net income from agriculture.

Elected

Division A: Dwight Lynn, Treasurer
Division B: Rich Persoff
Division C: Amy Newell
Division D: Paul Faurot

Appointed

City of Watsonville: Rosemarie Imazio, Chair
Santa Cruz County: Dave Cavanaugh, Vice Chair
Monterey County: Javier Zamora

Pajaro Valley Groundwater Basin

Seawater intrusion in the Pajaro Basin, a result of groundwater overdraft, was first documented in 1953 (Bulletin 5, SWRCB). Since then, the problem has become more severe. The Pajaro Valley groundwater basin is in severe overdraft, causing groundwater elevations to drop below sea level and leading to seawater intrusion, as shown in Figure 1-2. Seawater intrusion has caused chloride contamination of groundwater wells up to three miles inland, as shown in Figure 1-3. Seawater intrusion is an immediate and direct threat to the Pajaro Valley economy. The elevated chloride concentrations make the groundwater unusable for irrigating the high value, salt-sensitive crops in the coastal region of the Pajaro Valley. Agricultural production in the Pajaro Valley has an estimated annual value of over $900 million.

2002 Revised BMP

The PVWMA Board of Directors adopted a Revised Basin Management Plan in February 2002. The Revised BMP has been the principal document guiding all of the major projects and programs pursued by the PVWMA in the last decade. The PVWMA adopted its first BMP in 1994. A redraft of the BMP was prepared in 2000 but was delayed so that more analysis of local water supply options could be performed and incorporated into the 2002 Revised BMP.

During the preparation and review of the Revised BMP, the PVWMA analyzed combinations of 14 different project components and five different management strategies. The final strategy adopted by the Board was called the Modified BMP 2000 Alternative and included the following five major projects and programs:

1. Coastal Distribution System pipeline.
2. Recycled Water Project.
3. Harkins Slough Recharge & Recovery Project.
4. Import Water Pipeline Project (11,900 acre-feet per year of imported supply) with aquifer storage and recovery.
5. Water conservation program.

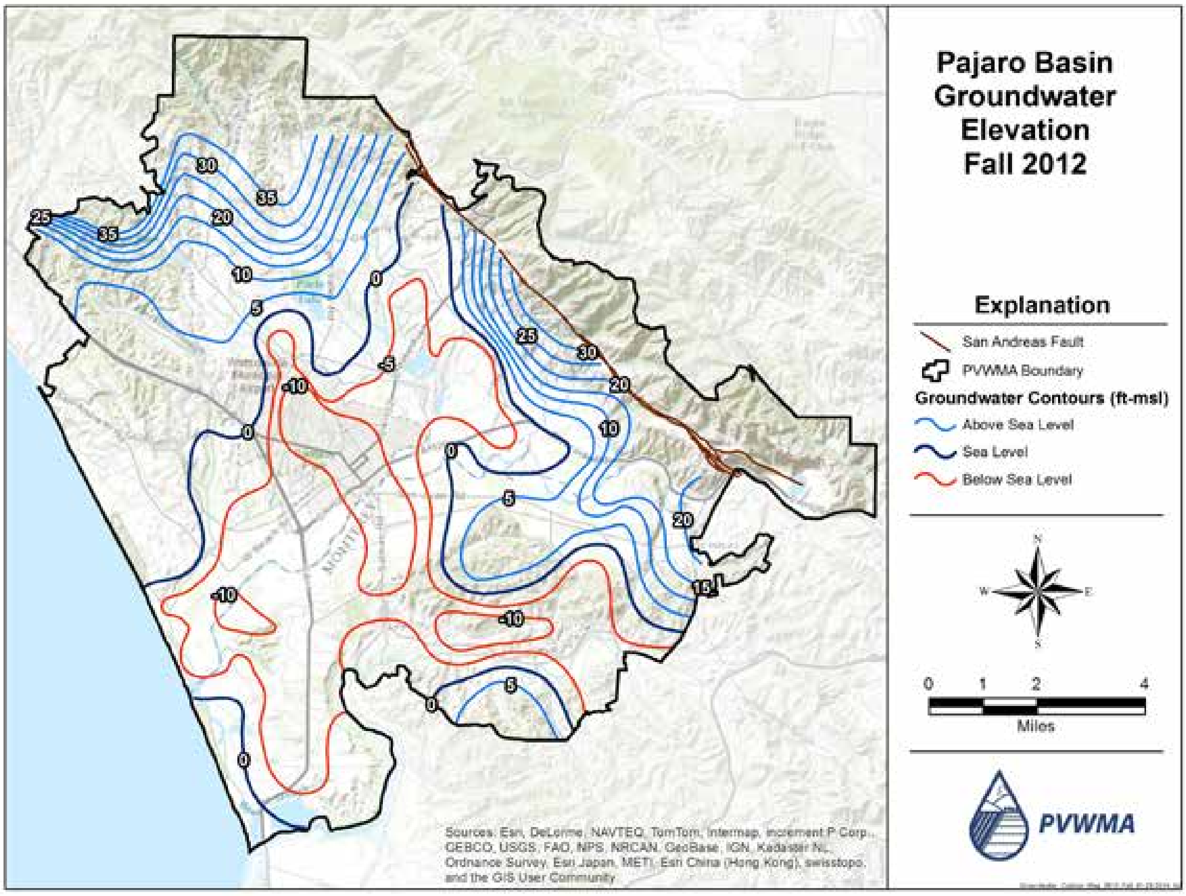

Figure 1-2. Groundwater Levels Below Sea Level in the Pajaro Basin

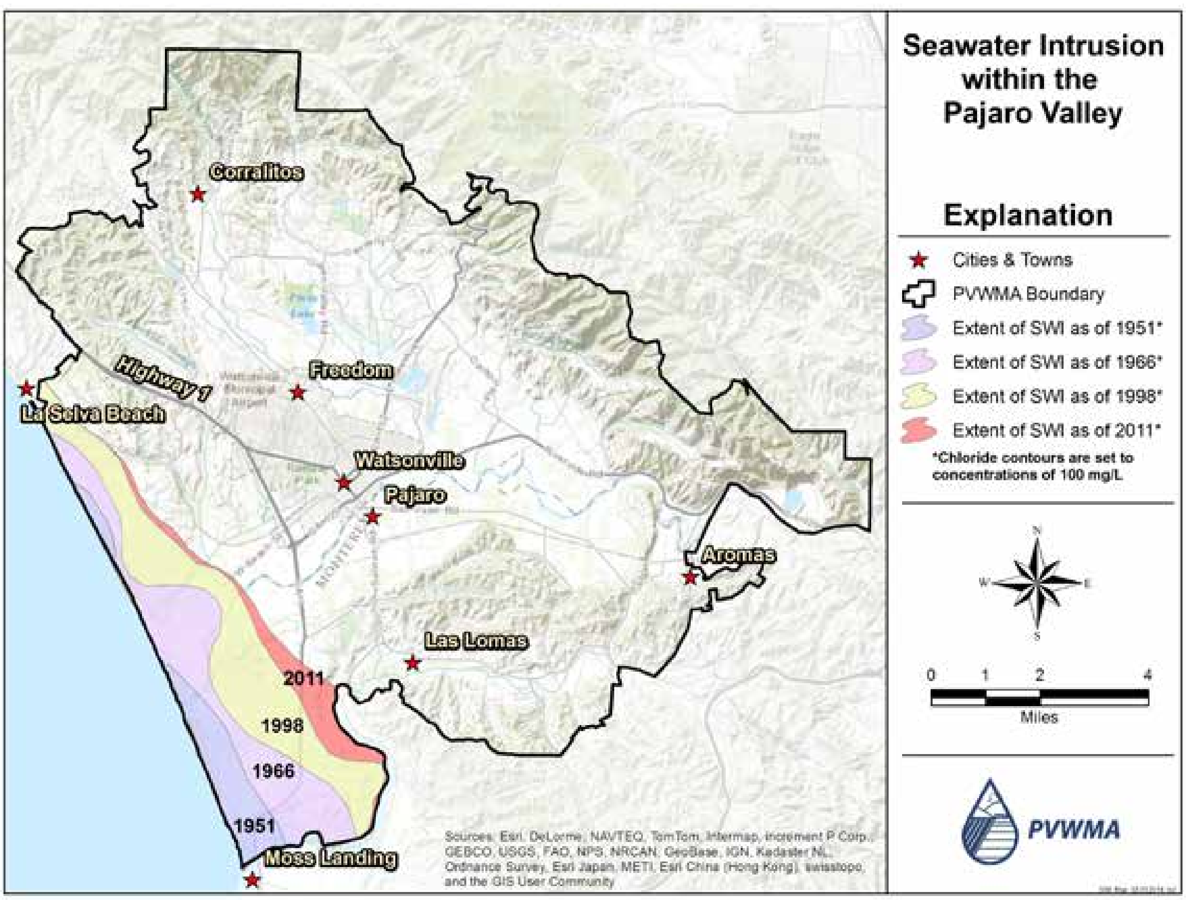

Figure 1-3. Area Impacted by Seawater Intrusion

In addition to providing a plan for the PVWMA to pursue, the BMP is a "basin-wide groundwater management plan" meeting the requirements of California's AB 3030 Groundwater Management Act.

Project Implementation

PVWMA has completed three projects which work together to help reduce overdraft, retard seawater intrusion and improve and protect water quality within the entire basin. PVWMA has constructed the Harkins Slough Recharge Facilities, Recycled Water Facility, and a significant portion of the Coastal Distribution System (CDS) over the past 10 years to partially alleviate groundwater overdraft and seawater intrusion.

The CDS consists of nearly 20 miles of pipeline used to deliver blended recycled water and recovered Harkins Slough water for agricultural use. This project delivers water to the area most impacted by seawater intrusion and reduces groundwater pumping near the coast.

In 2002, the PVWMA commenced operation of the Harkins Slough Recharge Facilities. These facilities divert and filter excess wet-weather flows from Harkins Slough to a recharge basin located about a mile to the west of the slough. The diverted water infiltrates into the ground where it serves to both recharge the groundwater basin and remain in sub-surface storage until it is needed for agricultural use and is extracted and conveyed to growers via the CDS.

In April 2009, the PVWMA began delivering tertiary treated, disinfected recycled water into the CDS from the Watsonville Recycled Water Facility. Expected to produce 4,000 acre-feet per year (AFY) of new water for Pajaro Valley agriculture, the launch of the recycling project came thanks to decades of planning and cooperation between the PVWMA, the City of Watsonville, and key stakeholder groups, as well as significant state and federal grant funding. The recycled water project includes inland wells that are used to provide blend water to improve the water quality for agricultural use.

At full operations, the recycled water, Harkins Slough blend water, and additional groundwater blend supplies will allow the distribution of up to 7,150 AFY to offset groundwater pumping by agricultural water users in the Pajaro Valley coastal area.

However, PVWMA is far from solving the groundwater overdraft problems. In early 2010, the PVWMA Board took formal action to remove the import water pipeline project from current consideration. The Revised BMP anticipated funding the design, construction, and ultimate operation of the import pipeline primarily with augmentation charges and, upon completion, delivered water charges. The Revised BMP contemplated a series of gradual increases in the augmentation charge over the course of several years. However, the legal landscape changed significantly in 2006 with the California Supreme Court's decision in Bighorn Desert View Water Agency v. Verjil, foreshadowing the adverse ruling in PVWMA v. Amrhein. As a result of these decisions, it was clear that the development of a community consensus, demonstrated by a successful Proposition 218-compliant funding process must precede approval of any significant new water supply project. Accordingly, amending the Revised BMP Recommended Alternative to remove the import pipeline aligned the PVWMA's planning objectives with its current fiscal reality.

Without the import pipeline and the potential for Central Valley Project (CVP) supplies, additional surface water supplies and/or reduction in groundwater use were required to effectively balance the groundwater basin and to stop groundwater overdraft and seawater intrusion. The BMP Update was prepared to identify the projects and programs for balancing the basin and replaces previous BMPs.

Pajaro Valley Hydrologic Model

PVWMA contracted with the United States Geology Survey (USGS) to develop a robust, defensible, hydrologic model utilizing public domain code (MODFLOW 2005) and to incorporate current datasets, including new pumpage and land use data now available as a result of the PVWMA's programs. The change in model code from the Integrated Groundwater Surface Water (IGSM) code to MODFLOW 2005 was necessary in part because the IGSM code is proprietary and has been the subject of some criticism within the modeling community. The new model is intended to be a tool used to estimate the water budget of the basin and to evaluate and compare various water management scenarios within the basin.

The Pajaro Valley Hydrologic Model (PVHM) was completed and used to simulate a baseline scenario 34 years into the future to estimate the water budget of the Pajaro Valley basin. The model and its assumptions are summarized in Chapter 2. Projects built and implemented by the PVWMA to date were confirmed to reduce, but not solve, both the seawater intrusion and the groundwater overdraft problems in the future simulation. The basin shortfall was estimated to be approximately 12,000 AFY. Work with the model during the BMP Update included the simulation of projects and programs identified through the BMP process.

Augmentation Charge Refund

In 2007, California's Sixth District Court of Appeal determined that the PVWMA augmentation charge was a property-related service charge under Proposition 218 and that the PVWMA augmentation charge increase from $80 per acre-foot to $160 per acre-foot was invalid. Subsequently, several related lawsuits were concluded by a Superior Court judgment by stipulation of the PVWMA and several interested parties. Under the judgment, all augmentation charges collected over $80 per acre-foot were to be refunded to those who submitted valid claims. According to the Stipulated Settlement, the refunds were made in six equal semiannual payments commencing on July 31, 2008, with the first payout due by January 27, 2009, and subsequent payments at six-month intervals thereafter. All refund payments were made in one of two forms: a credit to the augmentation charge payer for future payments or a direct payment.

Rate Re-establishment

In 2009, following the determination that the augmentation charge is a property-related service, PVWMA initiated a rate reestablishment process, in compliance with Proposition 218. The process would ensure that anyone who benefits from existing facilities are paying their proportionate share of developing and delivering water and increasing the sustainable yield of the basin. The rate reestablishment and proposed service charge adjustments (Augmentation Charges and Delivered Water Charges) were required to pay for the operation and maintenance of the PVWMA supplemental water and delivered water services. The adjustments also would pay for the debt service on water projects already in place for reducing seawater intrusion and water basin overdraft. The service charge revenue is used for PVWMA expenses associated with providing supplemental and delivered water service to the Pajaro Basin. The costs of service include expenses associated with the:

- Operation, maintenance, management, repair, and improvement of the existing facilities and water meters.
- Ongoing debt service related to the design and construction of the facilities.
- Groundwater modeling, water quality monitoring, water resources planning, and groundwater basin management, including an update of the BMP.
- Salaries and benefits and other administration costs of the PVWMA, based on the ratio of direct total costs associated with the supplemental water projects and programs.

The adjusted service charges were calculated based on four identified categories of user groups and the cost of the associated services to each of the individual user classifications:

1. Metered Users Outside Delivered Water Zone (DWZ; Augmentation Charge).
2. Metered Users Inside DWZ (Augmentation Charge).
3. Unmetered Users (Rural Residential; Augmentation Charge).
4. Delivered Water Users (Coastal Distribution System; Delivered Water Charge).

The January 2014 costs of service for the four user groups are:

Unit Cost Per User Class	Cost of Service Rate ($/Acre-Foot)
Augmentation Charge, Metered Users - Outside DWZ	$174
Augmentation Charge, Metered Users - Inside DWZ	210
Augmentation Charge, Unmetered (Rural Residential)	168
Delivered Water Charge	329

BMP Update Approach

With the successful vote approving new service charges in 2010, the PVWMA refocused its efforts to address the groundwater overdraft and seawater intrusion in the Pajaro Basin, to operate and maintain water supply facilities, and to perform critical functions. To guide these efforts, the PVWMA Board approved an approach for updating the BMP.

On October 6, 2010, the Board voted in favor of forming an Ad Hoc BMP Committee to help increase the Pajaro Valley community participation in the development of the BMP Update. This Ad Hoc Committee served as advisors to the PVWMA Board of Directors on matters related to the BMP Update. Throughout the development of the BMP Update, the Committee provided input on the following:

- BMP projects, programs, and policies.
- Basin management strategies.
- Project screening/ranking.
- Project schedule.

To facilitate and encourage diverse stakeholder representation, the Committee was composed of the representatives shown in Table 1-1.

The Committee was chaired by Board member Dave Cavanaugh and was vice chaired by agricultural representative Kirk Schmidt. Technical support and institutional memory was generously provided by Warren Koenig. Committee support was provided by PVWMA staff, the existing modeling and water quality/ops committees, a modeling consultant, and the BMP consultant, as shown on Figure 1-4.

The Board convened an Ad Hoc BMP Committee comprising a wide cross section of the community to develop recommendations for the BMP Update.

SCOPE OF THE BMP UPDATE

PVWMA staff and the Ad Hoc BMP Committee developed a BMP Update scope of work that they felt met the PVWMA's charter objectives, satisfied the groundwater management plan requirements of AB 3030, and satisfied the community involvement

Table 1-1 Ad Hoc BMP Committee Membership

Committee Member	Member Type	Representative Entity
Dave Cavanaugh (Chair)	Appointed	Pajaro Valley Water Management Agency
Kirk Schmidt (Vice Chair)	Appointed	Agricultural
Rosemarie Imazio	Appointed	Pajaro Valley Water Management Agency
Dennis Osmer	Elected	Pajaro Valley Water Management Agency
Rich Persoff	Elected	Pajaro Valley Water Management Agency
John Ricker	Appointed	County of Santa Cruz
Ryan Kelly	Appointed	County of Monterey
Steve Palmisano	Appointed	City of Watsonville
Harry Wiggins	Appointed	Pajaro Sunny Mesa Community Services District
John E. Eiskamp	Elected	Santa Cruz County Farm Bureau
Dave Kegebein	Appointed	Monterey County Farm Bureau
John Martinelli	Appointed	Landowner Group
Chuck Allen	Appointed	Community Dialogue Effort
Vicki Morris	Appointed	Aromas Water District
Ron Duncan	Appointed	At Large
Thomas Karn	Applicant	Rural Residential
Bob Culbertson	Applicant	Environmental
Amy Newell	Applicant	At Large
Skip Fehr	Applicant	Mutual Water Agency
Stuart Kitayama	Appointed	Agricultural
Frank Capurro	Appointed	Agricultural
Tom Rider	Appointed	Agricultural

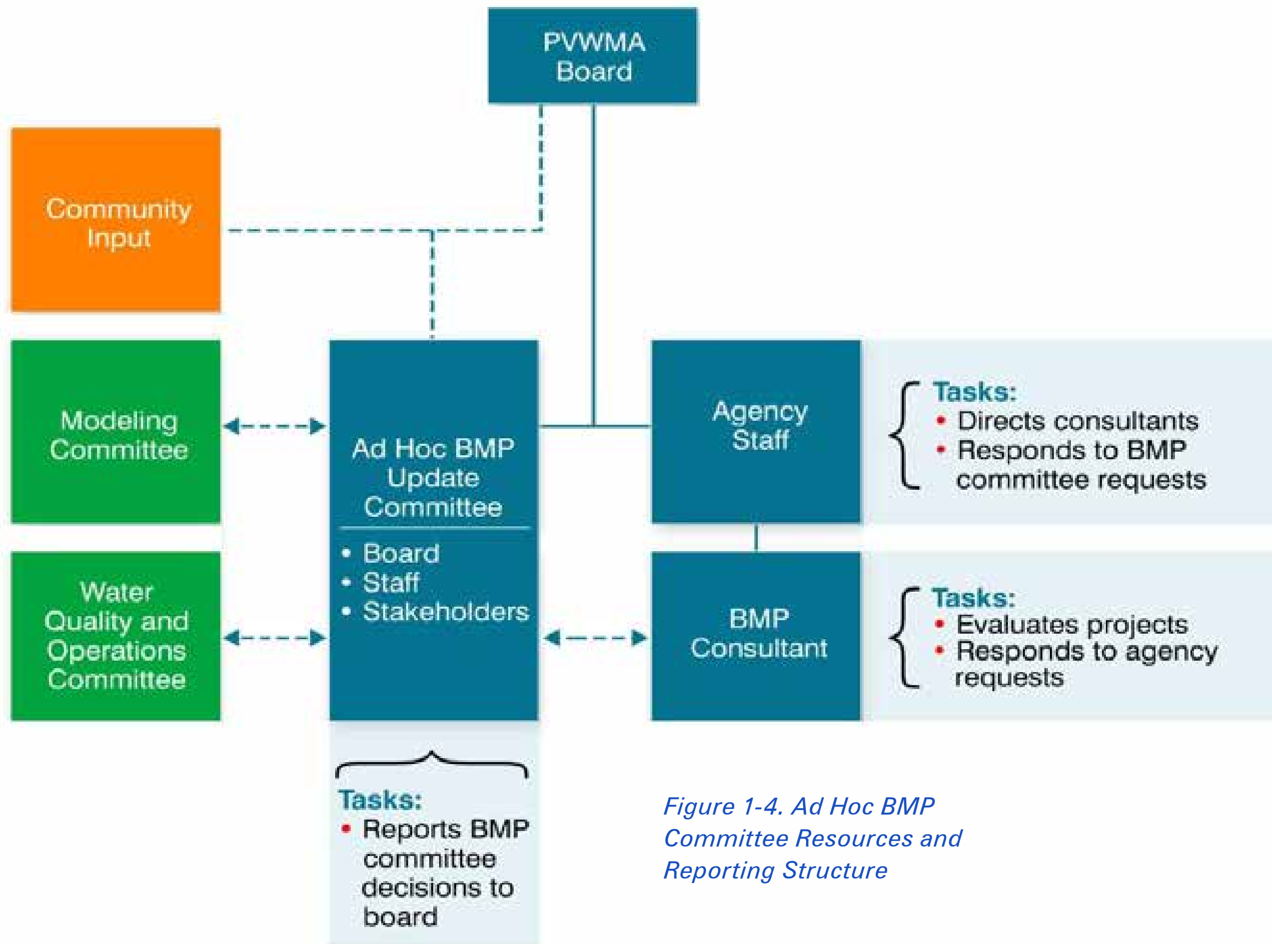

Figure 1-4. Ad Hoc BMP Committee Resources and Reporting Structure

expectations set by the Board. The scope of work established by PVWMA staff and the Committee included the following tasks:

Task 1. Basin Management Plan Meetings, Coordination, and Facilitation

The approach assumed preparation for, attendance at, and facilitation of monthly Ad Hoc BMP Committee meetings throughout the duration of the BMP Update process.

Task 2. Project Development and Screening

The project development and screening was a two-stage project review process, consisting of a fatal flaw screening, followed by a more detailed development of feasible projects. The process began with an extensive list of supplemental water supply projects that could help replenish the basin and bring it back into balance, including projects from the 2002 BMP, committee-developed projects, community group-developed projects, IRWM regional projects, and consultant-developed projects.

Task 3. Basin Management Plan Update

The Final BMP Update (this report) will be presented to the PVWMA Board and the general public at the time the Final EIR is presented (the PVWMA Board accepts the Final BMP Update after it certifies the EIR).

Task 4. Basin Management Plan EIR

This task involved the preparation of an EIR in parallel with the final BMP Update. The approach and schedule allows for concurrent BMP approval and EIR adoption by the PVWMA Board of Directors. Similar to the project development and BMP Update process, the BMP Update EIR was developed through close coordination with and review by the PVWMA Board.

Task 5. General Support Services

This task involved providing general engineering, management, public outreach, and administrative support to PVWMA, as requested by the General Manager of the PVWMA.

BMP Phasing

Figure 1-5 outlines the steps and timeframe required for completing the remaining BMP Update phases. The steps required (by phase) are as follows:

1. The Project Development Phase (completed with endorsement of a preferred BMP portfolio by the BMP Committee and the PVWMA Board of Directors).
2. The BMP Report Phase, including preparation of this BMP Update and initiation of community outreach.
3. The EIR Phase (which began with PVWMA Board approval for issuance of a Notice of Preparation in January 2013).
4. The Financing Phase (Proposition 218 cost of service).
5. The Board Acceptance and Majority Protest Phase.

BMP UPDATE ORGANIZATION

The BMP Update is organized into seven chapters, as follows:

Chapter 1 - Introduction. Summarizes the purpose of the BMP and the role of PVWMA and the Ad Hoc BMP Committee. Chapter 1 also presents the organization of this report.

Chapter 2 - Description of the Basin. Describes the Pajaro Basin, including basin boundaries, geology, hydrology, groundwater levels, modeling approach, groundwater quality, seawater intrusion, land use, and water use.

Chapter 3 - Project Development and Screening. Outlines the potential projects identified by the Ad Hoc Committee and the community, as part of the BMP process, and the project screening process conducted by the Committee.

Chapter 4 - Portfolio and Phasing Evaluation. Describes how the screened projects were analyzed to develop a portfolio of preferred projects and programs and how the portfolio and phasing options were evaluated using hydrologic and cash flow modeling.

Chapter 5 - Basin Management Plan. Describes the projects and programs that form the BMP, with the exception of the conservation program, which is described in Chapter 6.

Chapter 6 - Conservation. Describes the role conservation will play in the BMP, previous conservation studies and efforts, and how conservation efforts will be undertaken and monitored.

Chapter 7 - Implementation Plan. Describes the schedule and tasks involved in implementing the projects and programs that form the BMP.

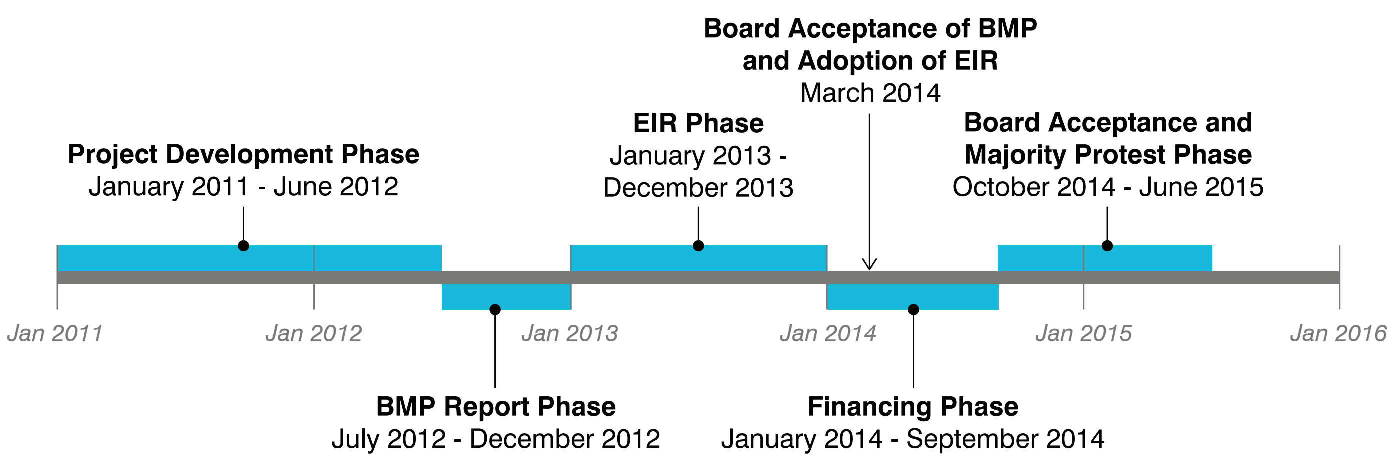

Figure 1-5. BMP Process Phases

Chapter 2

STATE OF THE BASIN

This chapter summarizes the historical and existing conditions of the groundwater basin within the PVWMA service area and summarizes the results of the Pajaro Valley Hydrologic Model (PVHM) baseline simulation. The baseline simulation was used to provide a benchmark to which future scenarios are compared. Much of the information presented in this chapter is from the PVWMA 2002 Basin Management Plan, supplemented with new data and with the results of basin modeling conducted using the PVWMA's new hydrologic model, the PVHM (Hanson et al. in review; HydroMetrics 2012).

BOUNDARIES

The coastal Pajaro Valley straddles southern Santa Cruz County and northern Monterey County (Figure 2-1). The valley covers approximately 120 square miles and is bordered on the northeast by the coastal Santa Cruz Mountains and on the southwest by the Pacific Ocean. The northern boundary of the valley is generally considered to be the drainage divide between the Aptos Creek watershed and the Pajaro River watershed; the southern boundary of the valley is generally considered to be the drainage divide between Elkhorn Slough and Morro Coho Slough (Johnson et al. 1988).

The boundaries of PVWMA and the Pajaro Valley Hydrologic Model are shown in Figure 2-2. The boundaries of the model were generally drawn along the lines of hydrogeologic features and approximate the boundaries of earlier models, such as the Pajaro Valley Integrated Groundwater and Surface Water model (PVIGSM), which was used to simulate projects in the 2002 BMP. The PVHM boundary covers a greater area than the PVWMA boundary. The main differences between the boundaries of the hydrologic model and the boundaries of PVWMA are as follows:

Western Boundary. The western boundary of the Pajaro Valley groundwater basin extends several miles offshore under Monterey Bay. As a result, the boundary of the PVHM also extends offshore. The PVWMA jurisdictional boundary follows the coastline.

Eastern Boundary. The San Andreas Fault trends along the eastern edge of the Pajaro Valley. Impermeable rocks east of the fault act as a barrier to groundwater flow into or out of the Pajaro Valley groundwater basin, creating a well-defined hydrogeologic boundary for the model. Although PVWMA's eastern boundary follows the line dividing Santa Clara and Santa Cruz Counties, it also parallels the fault line and generally follows the eastern boundary of the Pajaro Valley groundwater basin and that of the hydrologic model.

Northern Boundary. The northern boundary of the hydrologic model is set at the divide between the Aptos Creek and Pajaro River watersheds. In general, the northern PVWMA boundary is political, and the groundwater basin is shared with areas outside of PVWMA

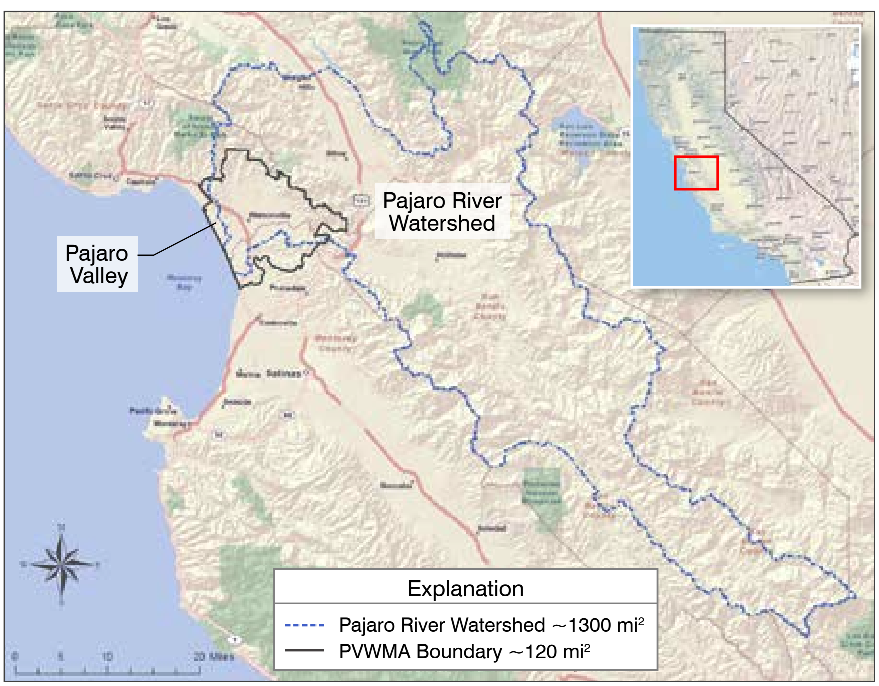

Figure 2-1. Area Map

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jurisdiction. There is no definitive hydrogeologic basis for the northern PVWMA jurisdictional boundary, except where it coincides with the watershed divide.

Southern Boundary. The relatively impermeable clays found in Elkhorn Slough to the south of the Pajaro Valley prevent north-south groundwater flows, creating a well-defined hydrogeologic barrier. Inland of the slough, the groundwater boundary is not well defined; groundwater can move either north or south, depending on the pumping or hydrologic conditions. The PVHM boundary extends south of the PVWMA boundary. The PVWMA jurisdictional boundary has both a physical and political basis, extending from Elkhorn Slough to Carneros Creek. In the Elkhorn Slough area, the PVWMA jurisdictional boundary follows the groundwater divide; inland of the slough, the boundary follows the surface water divide.

GEOLOGY

This section describes the shape and structure of the Pajaro Valley groundwater basin. A basic understanding of the basin geology is necessary to appreciate how the Pajaro Valley groundwater basin, although quite complex and composed of several hydrogeologic units, is geologically interconnected and functions as a single groundwater basin. The basin geohydrology dictates how current groundwater pumping and irrigation practices affect groundwater levels.

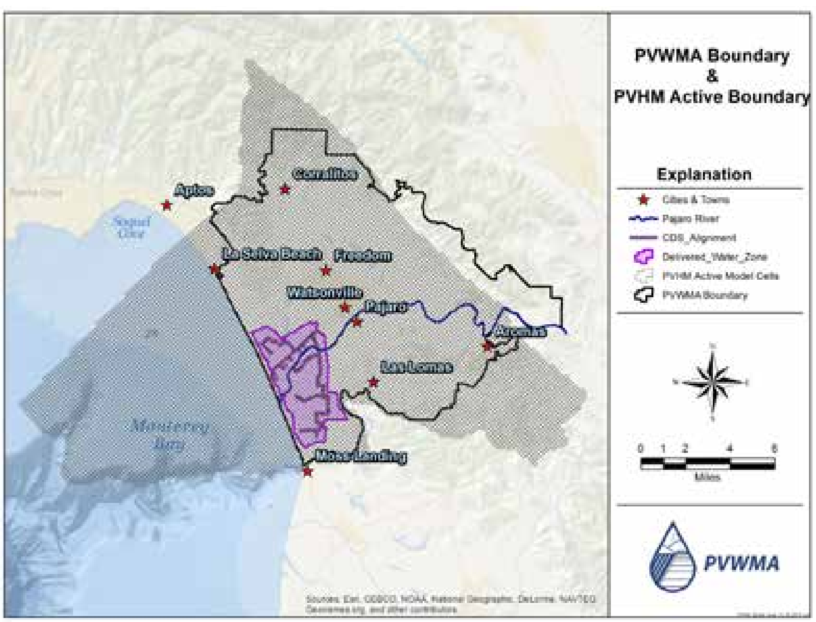


Figure 2-2. PVWMA Boundary and PVHM Active Boundary

Pajaro Valley is underlain by a basement of Cretaceous granitic rocks (Muir 1972). Overlying these consolidated, poorly permeable rocks are a series of westward-dipping strata of late Tertiary and Quaternary age. These strata include the unconsolidated Mio-Pliocene Purisima Formation, the Pleistocene Aromas Red Sands Formation (Allen 1946), Pleistocene terrace deposits, and Holocene alluvium and dune deposits (Muir 1972). The water-bearing units include the dune sand deposits, alluvium and terrace deposits, the Aromas Red Sands Formation, and the Purisima Formation.

The Purisima Formation underlies the valley at depths ranging from at or near land surface along the northern and eastern boundaries, to as much as 900 feet below the land surface near the mouth of the Pajaro River (Johnson et al. 1988). The Purisima Formation consists of layered sandy silts and silts deposited in nearshore and far shore marine environments. It has a maximum thickness that ranges from about 1,000 feet near Watsonville to about 3,500 feet beneath Browns Valley in the Corralitos area, less than ten miles to the north (Muir 1972). **The Purisima Formation is generally penetrated only by a few deeper wells in the Pajaro Valley and provides limited amounts of water.**

The Aromas Red Sands is a major aquifer within the Pajaro Valley. The formation nonconformably overlies the Purisima Formation and has an average thickness of 500 feet and a maximum thickness of about 1,000 feet (Muir 1972). The sands consist of both older fluvial deposits and younger eolian deposits. The Aromas Red Sands are described as well sorted brown to red sands, with interbeds of clay and poorly sorted gravels (Allen 1946; Muir 1972; Hanson et al. 2008; Hanson et al. 2010). **The Aromas Red Sands aquifer provides most of the groundwater pumped by wells in Pajaro Valley.**

Unconsolidated terrace deposits, alluvium and dune deposits, blanket the Aromas Red Sands, to depths of 245 feet, in much of the Pajaro Valley. The alluvium is described as a highly variable mixture of unconsolidated gravel, silt, and sand, with lenses of clay and silty clay. Terrace deposits consist of moderately to poorly sorted silt, sand, silty clay, and gravel, while dune deposits consist of fine- to medium-grained quartz sand (Muir 1972; Johnson et al. 1988).

Table 2-1 summarizes the stratigraphy underlying the Pajaro Valley and briefly describes its water-bearing characteristics. The surface expression of the geologic units within Pajaro Valley is shown in Figure 2-3, and a geologic cross section is shown in Figure 2-4 (Hanson et al., in review).

The aquifers within the groundwater basin are interspersed with clay layers that vary from impermeable to semipermeable and limit the vertical movement of water. A pressurized aquifer located between two clay layers, or aquitards, is considered confined. The primary confining clays are thickest in the middle of the Pajaro Valley and trend roughly parallel to the Pajaro River. The aquitards thin inland toward Watsonville and become discontinuous in the foothills area. However, it should be noted that a perched aquifer, denoted by shallow depths to water, exists in the Corralitos area, indicating the presence of an aquitard effectively separating the perched unit from the underlying aquifer (State Water Resources Board 1953). The perched aquifer overlies the Aromas Red Sands Formation.

Table 2-1 Basin Geology

Formation	General Character	Water-Bearing Properties
Dune Deposits	Unconsolidated, well-sorted, fine- to medium-grained quartzose sand. In part, actively drifting.	Largely unsaturated, but, where saturated, yields water to wells in small quantities, unconfined.
Alluvium	Unconsolidated gravel, sand, silt, and clay. Underlies the alluvial plain and extends into adjoining stream canyons.	Permeable; yields moderate quantities of water to wells.
Terrace and Pleistocene Eolian Deposits	Cross-bedded gravel, sand, silt, and clay. Marine origin near La Selva Beach. Non-marine elsewhere.	Permeable where sufficiently thick; yields moderate quantities of water to wells.
Aromas Red Sands	Semi-consolidated, quartzose, brown to red sand, with some clay layers. Deposited by wind and by meandering and braided streams.	Permeable; yields moderate quantities of water to wells. Main producing aquifer.
Purisima Formation	Poorly indurated sand, silt, clay, and shale; some gravel. Extensive shale beds in lower part of formation. Mostly marine in origin, three subunits locally: upper member is a poorly indurated fine sand with silt and clay layers, some gravel; middle member is a poorly indurated medium to fine sand with silt and clay layers, some gravel; lower member is a poorly indurated sand with shale layers.	Moderately permeable. Lies at considerable depth beneath much of the valley area, although is exposed at the surface in the foothills. Water-bearing properties in the Pajaro Valley are not well known, but upper and middle units probably will yield moderate quantities of water. The Purisima Formation is an important aquifer north of the Pajaro Valley.

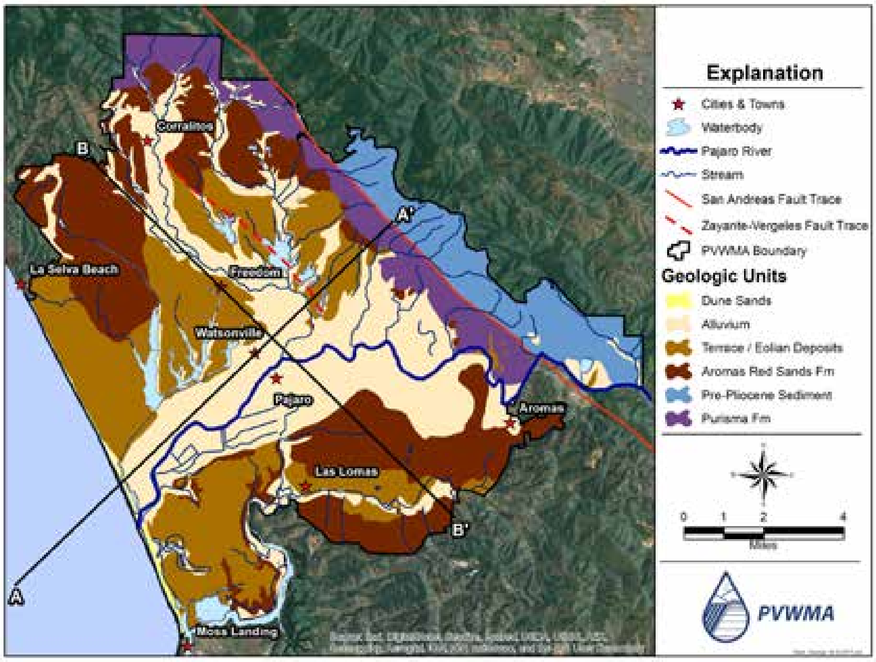


Figure 2-3. Geologic Map of the Pajaro Valley

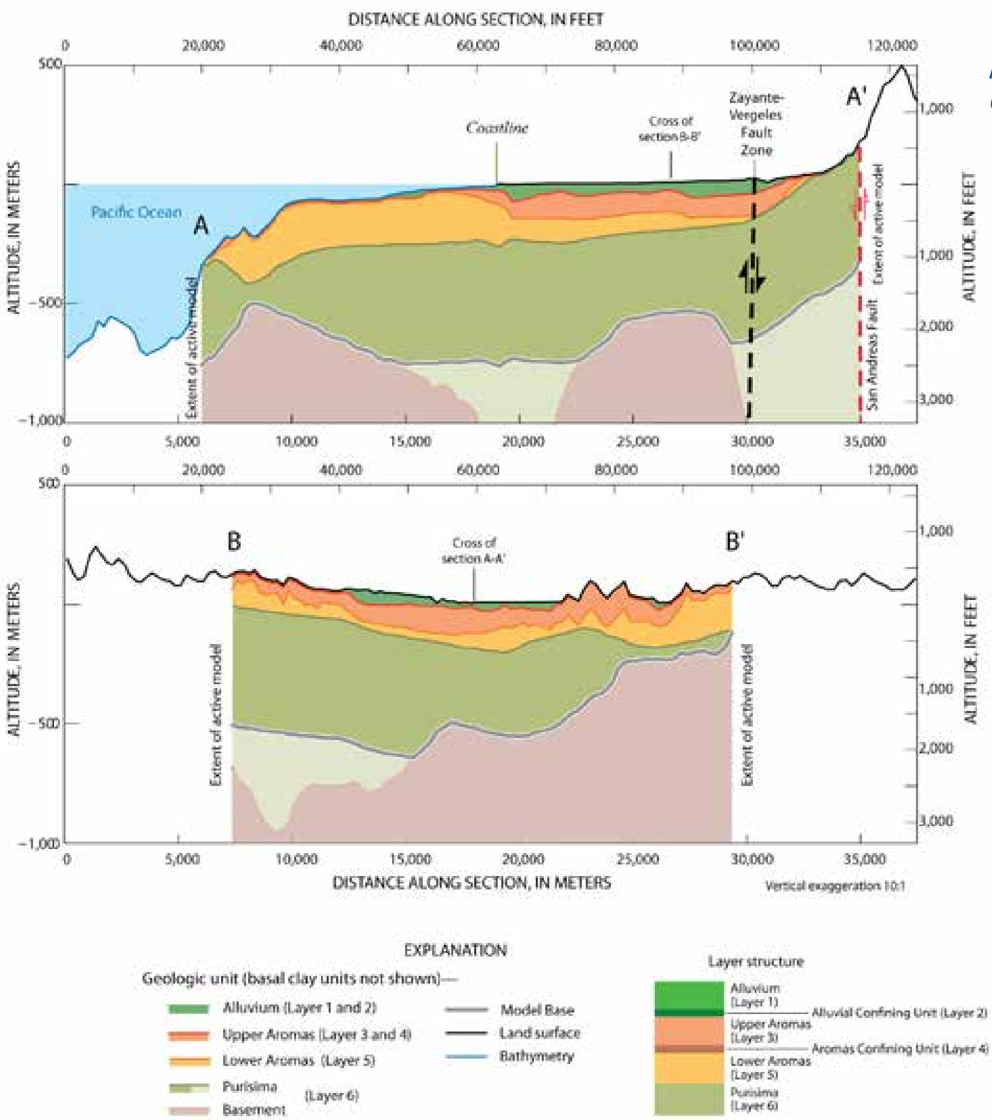


Figure 2-4. Geologic Cross Sections

BASIN HYDROLOGY

Surface Waters

The Pajaro River is the largest coastal stream, measured by annual flows, between San Francisco Bay and the Salinas River. It contributes substantial surface water inflow to the Pajaro Valley groundwater basin. The total drainage area of the Pajaro River above the Chittenden gauging station is approximately 1,200 square miles. Annual stream flow, as recorded by the US Geological Survey (USGS) at the Chittenden gauging station, averaged 163 cubic feet per second (CFS) from 1940 through 2013, with a minimum of 1.06 CFS in 1977 and a maximum of 905 CFS in 1983 (Figure 2-5).[1]

Salsipuedes Creek is the largest tributary of the Pajaro River within the PVWMA. Salsipuedes Creek receives approximately 12,000 acre feet (af) of flow from Corralitos Creek and 4,700 af from the College Lake Watershed (PVWMA 2002). Annual flows from 1956-2005 on Corralitos Creek averaged 16 CFS, with discharge averaging 12,000 acre feet per year (AFY) (PVWMA 2005). Corralitos Creek drains the northern region of PVWMA through a network of streams that includes Browns, West Branch, and Rider Creeks and an unnamed tributary that drains Pleasant Valley and the eastern side of the Calabasas Hills. The College Lake Watershed drains the northeastern region of the PVWMA service area through a network of streams that includes Green Valley, Casserly, and Hughes Creeks. Together the Corralitos Creek and the College Lake Watersheds drain approximately 57 square miles, or roughly half of the PVWMA service area. The other half of the service area is drained in part by the Pajaro River, the Watsonville Slough system, and Carneros Creek.

The small streams that drain the Pajaro Valley have two distinct areas that contribute to flow in the surface water system. In mountainous regions, the streams are underlain by the Purisima Formation, while in the lowlands, streams are underlain by the Aromas Red Sands or younger alluvial material. The Purisima Formation is more consolidated and in general contains finer-grained sediment than the Aromas and the alluvial fill. Therefore, the mountain and lowland reaches of the streams are distinguished by a ten- to twenty-fold difference in mean amounts of runoff, which they contribute to the surface water system (AMBAG July 1984; PVWMA 2002). A single drainage can contain flow in the mountain region and be completely dry in the lowland region. The lowland region does not contribute flow to the surface water system except during large storms or winter storm patterns that deliver frequent precipitation over a short time. The annual average surface runoff through these streams and sloughs, excluding the Pajaro River, is 24,070 af (AMBAG July 1984; PVWMA 2002).

College Lake is a seasonal water body in a natural depression created by the Zayante Fault, located to the north of the intersection of Holohan Road and Highway 152, near the St. Francis Cemetery. The lake captures runoff from an 11,000-acre watershed (CH2M Hill February 1999; PVWMA 2002). The

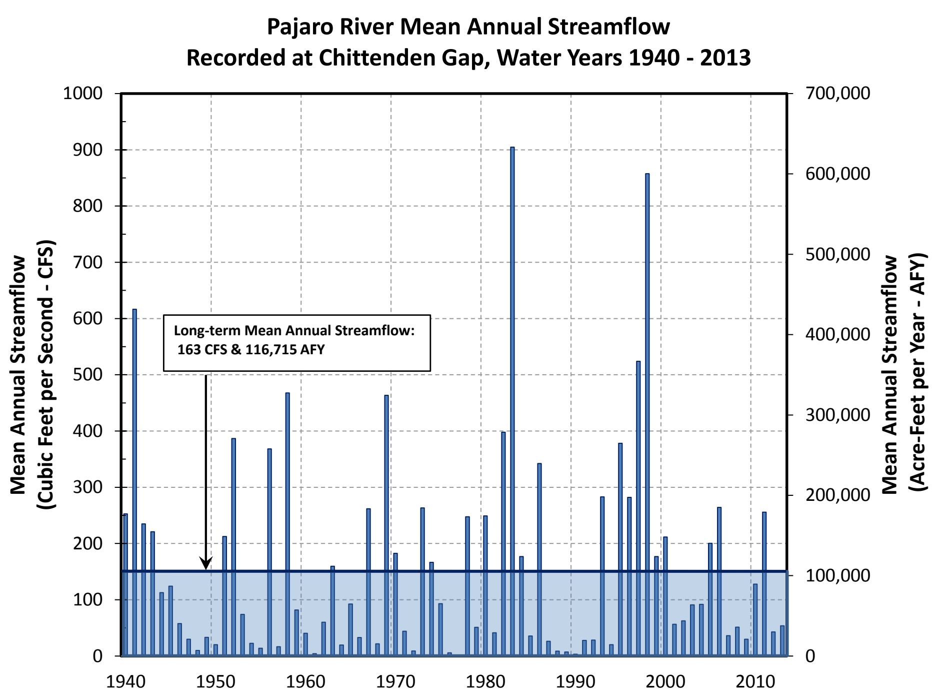


Figure 2-5. Pajaro River Mean Annual Streamflow

[1]Pajaro River at Chittenden Gap – USGS station number: 11159000; http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11159000&PARAmeter_cd=00065,00060

College Lake Reclamation District was formed in the early 1900s by landowners impacted by the flooding of the natural depression. The drained lakebed is used to grow vegetables. The Reclamation District owns and operates the pumps that drain the lake. Under existing conditions, pumping commences between mid-March and May 1st, depending on the amount of spring rains, and is completed by November 1st (Allen Harryman, College Lake Reclamation District, personal communication). The pumped water flows into Salsipuedes Creek and eventually to Monterey Bay via the Pajaro River.

A network of sloughs drains the northwestern region of the PVWMA service area. The Watsonville Slough system includes Harkins, Hansens, West Branch, Galligans, Struve, and Watsonville Sloughs. Harkins Slough has the largest drainage area and the largest annual average flux of 3,000 af. The upper reaches of Harkins Slough originate in Larkin Valley and remain dry throughout most of the year, flowing only during and following storm events. In this region, the slough channel is heavily overgrown and is mostly contained within a ditch along Larkin Valley Road. The lower portions of Harkins Slough are flat, with wide floodplains that are mainly contained in a north-south trending valley located in the western region of the PVWMA service area.

Watsonville Slough has an annual average flux of 2,000 af and receives flow from the Hansens, Struve, and West Branch Sloughs. Just upstream of San Andreas Road, Harkins Slough flows into Watsonville Slough as a tributary. In this area, the sloughs are generally shallow open channels, with broad floodplains that receive, convey, and store runoff from precipitation and irrigation water return flows. Slough bottomlands typically contain water year-round, but the slough system experiences great seasonal variation. Water balance calculations indicate that monthly outflows to the Pajaro River Lagoon may range from 1,800 af in January to less than 100 af in July, with the yearly total averaging 5,000 af (AMBAG June 1999). Carneros Creek enters the southeastern boundary of the PVWMA service area from the south and flows on an east-west trend through the area south of the Pajaro River and discharges into Elkhorn Slough. Carneros Creek has an annual average discharge of 2,800 af and is the largest source of freshwater in the Elkhorn Slough watershed. A Watsonville Slough Hydrologic Study, under the direction of the County of Santa Cruz Resource Conservation District, is underway and is planned to be completed in March 2014. Hydrologic and hydraulic flow models of the lower slough system will be developed as a component of the study. These tools will enable a more complete understanding of flow regimes in the slough.

Rainfall

Rainfall intensity in the Pajaro Valley varies geographically (Figure 2-6). Annual rainfall is 21.9 inches, averaged over 125 years of continuous data collected at the Watsonville Water Works weather station, located near Freedom at an elevation of 95 feet above sea level. Annual precipitation from water years 1940 to 2012 are summarized in Figure 2-7.[2] During the water years 2007 to 2009, annual average precipitation was 62%, 72%, and 74% of normal. During the 2010 and 2011 water years, average annual rainfall was 127% and 126% of normal, thus rebounding from the preceding three consecutive less-than-average years. A similar pattern was observed between the 2001 and 2006 water years, with below

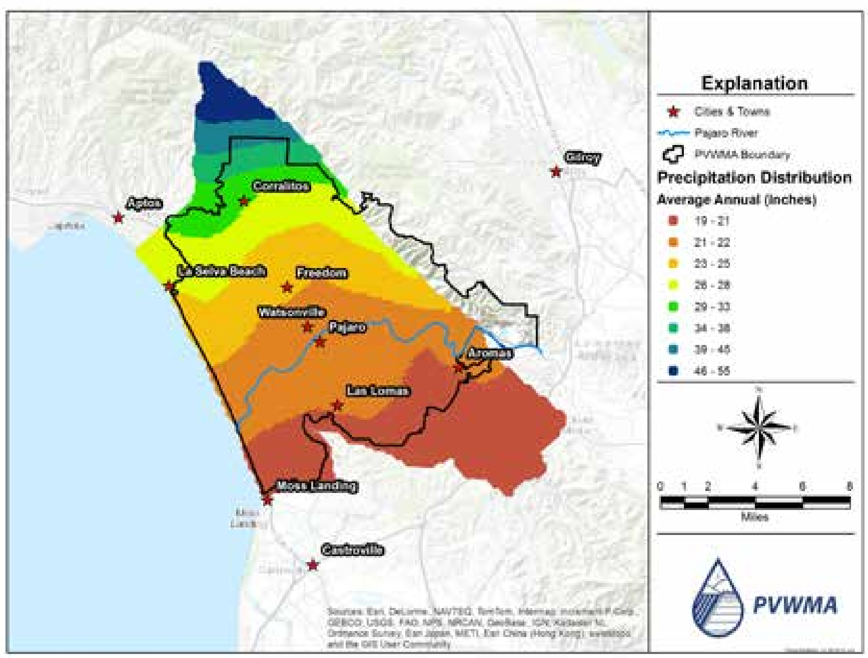


Figure 2-6. Precipitation Variability Map
Source: Modified from Hanson et al., in review

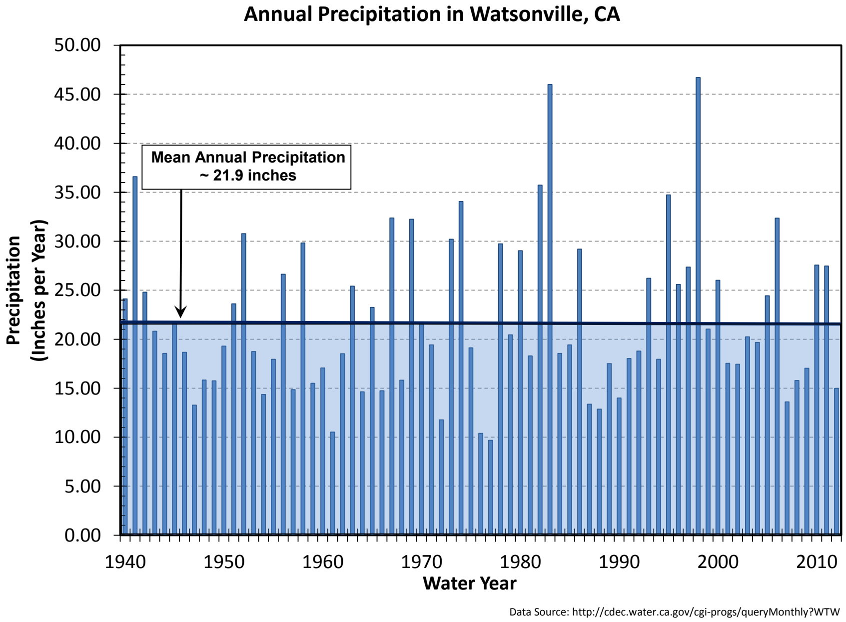


Figure 2-7. Annual Precipitation at Watsonville Water Works

average precipitation from 2001 to 2004 and then greater than average annual precipitation in the 2005 and 2006 water years. Annual average precipitation was well below average during water year 2012, and has been near zero for the first four months of water year 2013 (October 2013 - January 2014).

The Pajaro Valley receives nearly three quarters (72%) of its annual rainfall between December and March. Historically January is the wettest month of the year, receiving 20% of the total rainfall, followed by December (19%) and February (18%). However, recent data suggest this trend may be shifting. From 2000 to 2005, December received the most rainfall (25%), followed closely by February (23%), and January received only 16% of the annual rainfall (PVWMA 2005).

Runoff from rainfall from outside the PVWMA boundary, but otherwise within the Pajaro River Watershed (as denoted on Fig. 2-1) may have the ability to flow into the Pajaro River. Water in the Pajaro River entering the lower Pajaro River Watershed and the PVMWA boundary is measured by a USGS gauging station at Chittenden Gap as previously mentioned. Runoff from rainfall in the Corralitos Creek watershed is measured by a USGS gauging station on Corralitos Creek near Freedom Blvd (Station Number 11159200). Runoff from rainfall in other locations outside the PVWMA boundary flows into creeks that do not drain within the Agency's boundary.

Basin Recharge

Groundwater recharge is the result of complex interactions between land cover and slope, soils, geology, and other physical conditions. The primary sources of recharge to the Pajaro Valley groundwater basin are (1) infiltration of rainfall, (2) seepage of streamflow from the Pajaro River and its tributaries, and (3) percolation of irrigation water. The variation in precipitation and streamflow influences how and when the Pajaro Valley groundwater basin is recharged.

Early season rains and crop irrigation saturate the soil with water, making late-season storms more effective in recharging groundwater supplies. Generally, mild storms of extended duration or relatively frequent storms provide the greatest opportunity for groundwater recharge. Conversely, intense or infrequent storms do little to recharge groundwater. Intense storms typically result in a high percentage of rainfall runoff, while precipitation from infrequent, widely distributed storms is utilized by native vegetation. In the case of infrequent storms, soils do not become saturated and deep percolation into the aquifers does not occur.

Because the Pajaro River and other local streams have unimpeded flows, the majority of groundwater recharge associated with streamflow typically occurs only during the winter or when streams are flowing. Runoff from a large storm event can flow through the Pajaro River and its tributaries relatively quickly, limiting the opportunity for groundwater recharge.

Although there is a large capacity for groundwater storage in the Pajaro Valley groundwater basin, the amount of water that can recharge the aquifer is limited by the valley's hydrogeologic conditions. Even in very wet years, the Pajaro River and creeks such as the Corralitos and Salsipuedes provide only a limited percentage of water to groundwater storage in the basin because of the presence of the impermeable clay layers. Recharge to the aquifers beneath the clay layers generally takes place in the areas where those aquifers are exposed at or near the ground surface, such as in the foothills and the eastern portions of the basin.

[2] A water year is from October 1st to September 30th the following year

Modeling Approach and Results

Hydrologic modeling of the Pajaro Valley groundwater basin was conducted using the PVHM (Hanson et al., in review; HydroMetrics 2012). The model was developed by the USGS and the PVWMA between 2005 and 2010 (Hanson et al. 2008; Hanson et al. 2010) and simulates the natural and human components of the hydrologic system and related climatic factors in the Pajaro Valley (Hanson et al., in review). Groundwater flows are simulated using the widely accepted MODFLOW2005 model (Harbaugh 2005). The model incorporates the most recent version of the USGS's Farm Process (Schmid and Hanson 2009), which allows detailed and realistic simulations of agricultural pumping, based on simulated crop water demand, as well as "non-routed deliveries," which are used to simulate water delivered from PVWMA water supply facilities.

A baseline scenario was simulated to provide a benchmark to which future scenarios are compared. The baseline scenario simulated the effects of the previous 34 years of climate and 2011 delivered water volumes into the future. Assumptions in the baseline simulation included the following:

- The simulation includes 34 years of hydrology, which were based on weather conditions between 1976 and 2009, inclusive. The simulated hydrology was inverted for this simulation: the hydrology of the first year of the baseline simulation reproduces the 2009 hydrology, and the hydrology of the last year of the baseline simulation reproduces the 1976 hydrology.
- Crop distribution is maintained at 2009 levels.
- Municipal pumping is maintained at 2009 levels.
- Irrigation efficiency is maintained at 2009 levels (no increased irrigation efficiency).
- Deliveries through the CDS are maintained at 2011 levels. These deliveries included 1,980 af of recycled water, 520 af of blend water, and 250 af of Harkins Slough water.

Reasonably foreseeable sea level rise was incorporated into the PVHM baseline scenario at all offshore model boundaries. The rate of sea level rise is based on the Intergovernmental Panel on Climate Change's A2 scenario. Between 2000 and 2050, sea levels in Monterey Bay are expected to rise an average of 14 inches (USGS and ESA-PWA, personal communication).

The model was used to assess overdraft and seawater intrusion. **Overdraft was defined in the modeling as a net loss in the amount of groundwater stored in the Pajaro Valley aquifers.** Seawater intrusion was estimated from the model's simulated groundwater flows. **Overdraft and seawater intrusion were calculated only for the Alluvial aquifer and for the Aromas Red Sands aquifer**, which was divided into two hydrogeologic units in the PVHM, the Upper Aromas Sands and Lower Aromas Sands aquifers. These aquifers provide most of the water that is pumped from Pajaro Valley and therefore are of the most concern for overdraft and seawater intrusion.

The approaches to estimating both overdraft and seawater intrusion were devised and refined exclusively for this project. Because the PVHM does not directly provide these values, there is some potential range of variability in estimating both seawater intrusion and overdraft; therefore, **the model results are used as guidance to compare the effect of various projects but not as absolute estimates. Verification of the success of each project will come from ongoing and future monitoring.**

Model results from the baseline simulation indicate the following current conditions:

- Overdraft in the Alluvial aquifer, the Upper Aromas aquifer, and the Lower Aromas aquifer (the aquifers of interest) is approximately 1,400 af per year.
- Seawater intrusion in the Alluvial aquifer, the Upper Aromas aquifer, and the Lower Aromas aquifer (the aquifers of interest) is approximately 1,900 af per year.

The rates are rounded to the nearest 50 af per year.

GROUNDWATER LEVELS

This section describes the historical and current groundwater levels of the Pajaro Valley groundwater basin, building on the discussions of geology and hydrology in the preceding sections. Groundwater levels are used to describe patterns of groundwater flow, changes in groundwater storage, and the potential for seawater intrusion in the Pajaro Valley aquifers. Information on long-term and recent groundwater levels simulated in the PVHM was confirmed by water-level data from the PVWMA database.

Water level contour maps and hydrographs are two common methods of graphically representing water level data through time. These graphical representations are a way of comparing historic water levels to present levels. In the case of a water level contour map, the elevation of the water surface is shown spatially on the map. A hydrograph shows the trend of the water surface elevation in a well through time. Two or more water level contour maps can be compared over time to calculate change in storage of an aquifer and can illustrate when a basin is in overdraft.

Historically, groundwater levels were higher than today in inland areas. In places along the coast, some wells flowed artesian; in other words, groundwater levels were high enough at times in past years that groundwater surfaced in some of the coastal areas. Under such conditions, the pressure and seaward gradient of freshwater in the aquifer was able to prevent intrusion of seawater. By the 1940s, following the major development of groundwater resources to support a growing agricultural industry, some wells would still flow artesian, but only during winter. By the 1970s, water levels west of Watsonville were consistently below sea level from approximately May to December, often never recovering to levels above sea level, providing the conditions necessary for seawater intrusion.

The more recent trend has been for groundwater to move from both the recharge areas near the PVWMA's northern boundary, east of Watsonville, and north Monterey County, and from the coast, toward the large pumping troughs that form in the center of the valley. In the south, water typically moves from north Monterey County northeastward toward Pajaro Valley and westward toward the coast. In the northern part of Pajaro Valley, water moves southeast from the Soquel/Aptos area into the north part of the Pajaro Valley area, then south toward Watsonville and southwest toward Monterey Bay.

Water level data were used to create contour maps of groundwater levels, as shown in Figures 2-8 through 2-13 on the following page. A contour elevation of zero indicates mean sea level. Water level contour maps from the fall of 1947, 1951, 1987, 1992, 1998, and 2013 illustrate the basin's response to drought (1947, 1987-1992) and its recovery (1951, 1998). In 1947, drought resulted in water levels at or below sea level, but by 1951 all areas had recovered to above sea level. In 1992, following six years of drought conditions (an average of 16 inches of precipitation from 1987 to 1992), 63% of the basin had water levels at or below sea level. In the fall of 1998, after four wetter than average years (an average of 34 inches of precipitation from 1995 to 1998), 48% of the basin had water levels at or below sea level, indicating that it still had not recovered from the last drought due to continued overdraft (PVWMA 2002).

Most recently, groundwater levels collected from PVWMA's network of monitoring wells throughout the 2013 water year were used to map the water table elevation in the basin. It is evident that a significant trough below sea level still exists throughout the valley floor, centered around the Pajaro River channel.

The basin's total area with groundwater elevations below sea level has strong implications for drought resistance in terms of the available volume of groundwater in storage and seawater intrusion. In 2005, 52% of the basin's groundwater levels were at or below mean sea level after the rainy season (PVWMA 2005). This indicates that the basin does not have the same groundwater reserves as it once did. Pumping reduces the amount of groundwater stored in the basin. Reducing pumping will allow more of the capacity for groundwater storage to be used. **If drought conditions were to occur again with the basin in its current state, overdraft conditions would worsen and seawater intrusion rates would accelerate beyond what has been measured in the past.** This is because seawater intrudes more rapidly when the aquifer is stressed, due to increased rates of groundwater extraction that typically occur during drought periods.

EXISTING WATER SUPPLY INFRASTRUCTURE

PVWMA has implemented several projects to provide supplemental water supply, as shown in Figure 2-14. These include:

- **The Coastal Distribution System (CDS)**. The CDS is a distribution system used to deliver supplemental water supplies, including recycled water and stored water from the Harkins Slough Recharge Facilities (described below), to farms in coastal Santa Cruz and northern Monterey

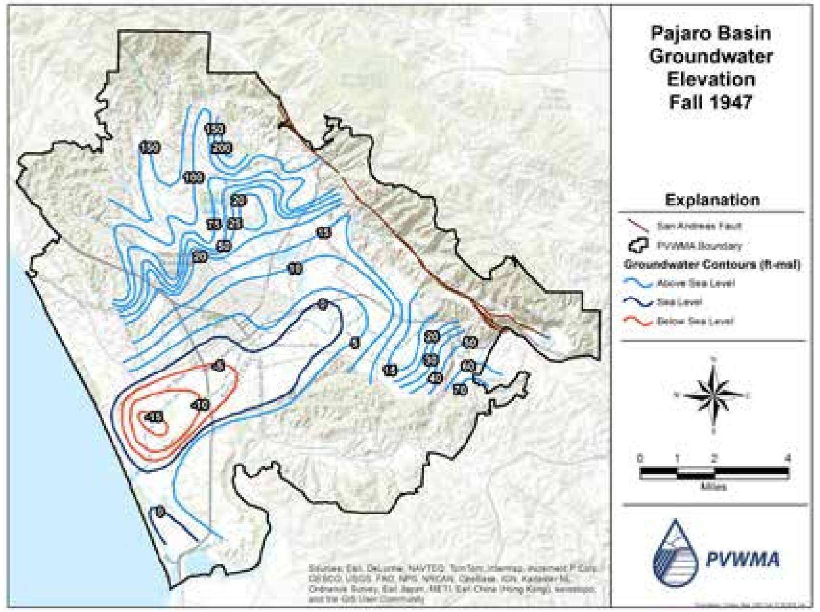


Figure 2-8. 1947 Pajaro Basin Composite Groundwater Contour Map

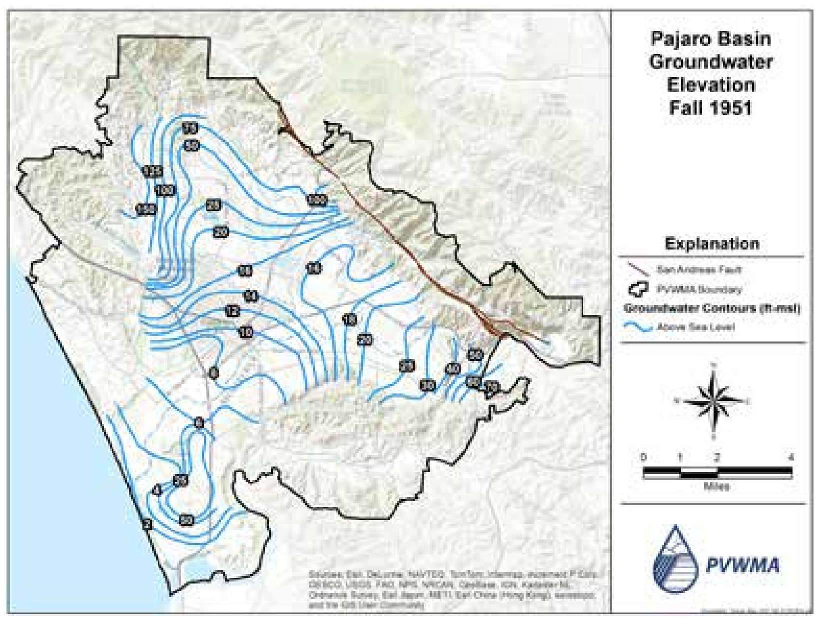


Figure 2-9. 1951 Pajaro Basin Composite Groundwater Contour Map

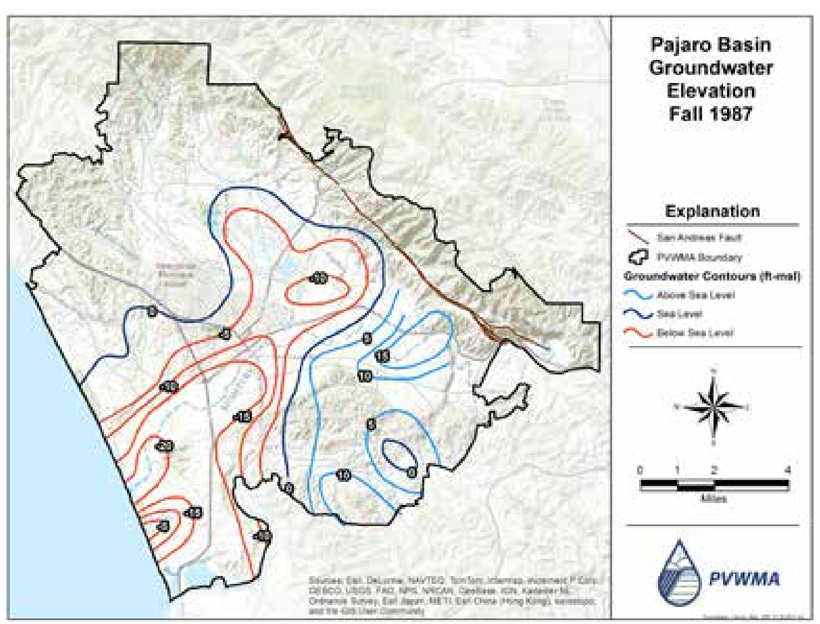


Figure 2-10. 1987 Pajaro Basin Composite Groundwater Contour Map

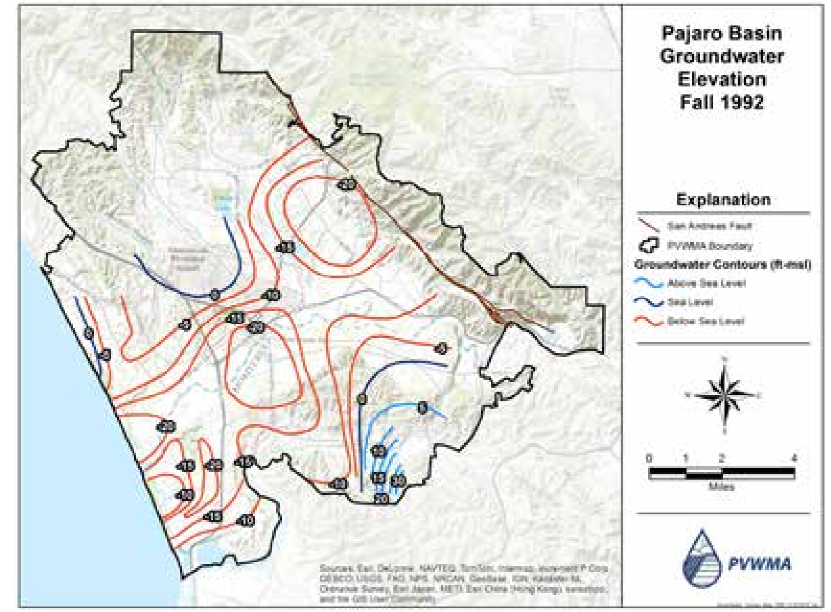


Figure 2-11. 1992 Pajaro Basin Composite Groundwater Contour Map

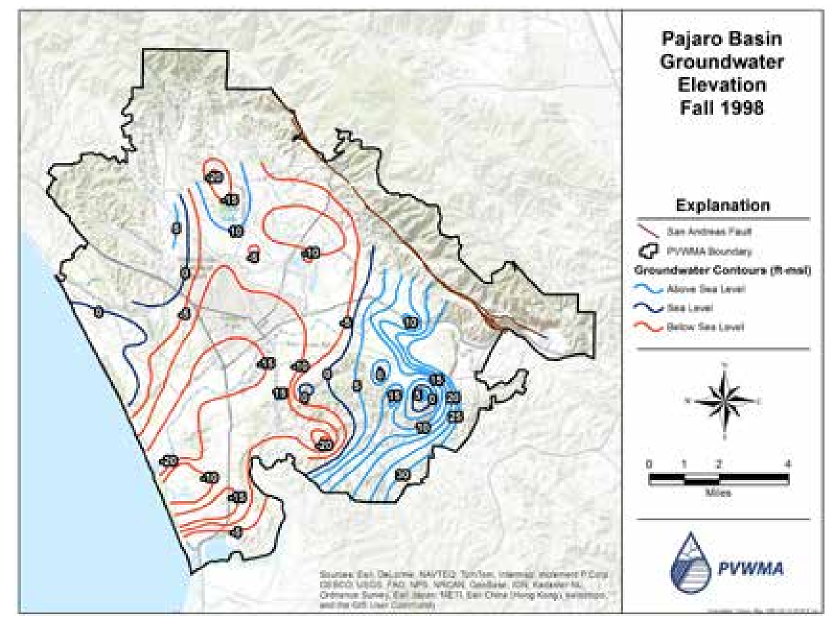


Figure 2-12. 1998 Pajaro Basin Composite Groundwater Contour Map

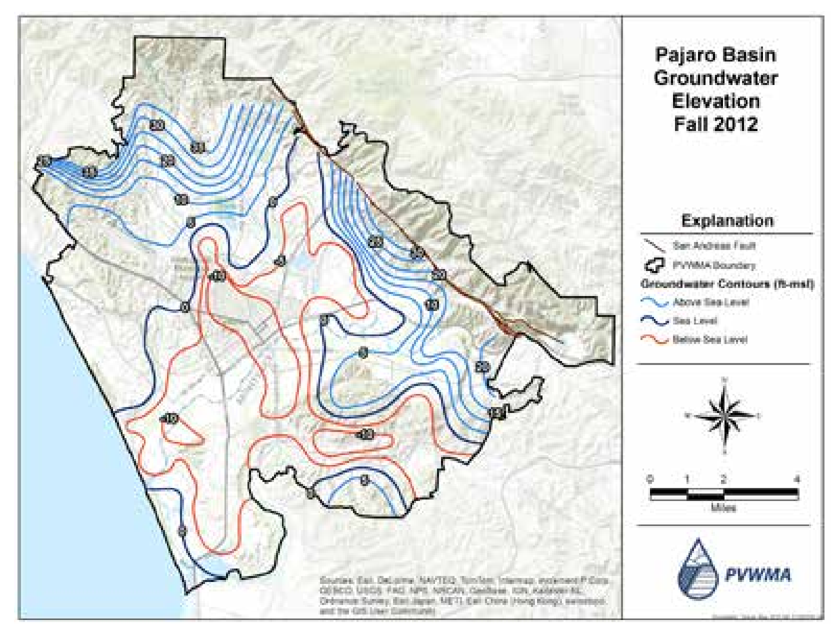


Figure 2-13. 2012 Pajaro Basin Composite Groundwater Contour Map

Counties. Water delivered through the CDS replaces groundwater that would otherwise be pumped from coastal wells to reduce seawater intrusion. In this sense, delivered water provides in lieu recharge to the aquifers.

- **The Recycled Water Treatment Facility**. The PVWMA partnered with the City of Watsonville to build a water recycling plant that can deliver up to 4,000 af per year of tertiary treated, disinfected, recycled water through the CDS during the irrigation season. The plant came online in 2009. In 2013, the plant provided 2,950 af of recycled the CDS. This recycled water was mixed with approximately 1,300 af of blend water from the City of Watsonville potable system, from recovered Harkins Slough water, and from blend water wells operated by PVWMA.
- **The Harkins Slough Recharge Facilities**. The Harkins Slough Recharge Facilities seasonally store wet weather flows from Harkins Slough in the shallow aquifers of the San Andreas Terrace, located near the coast. Stored water is pumped from a series of wells and delivered to coastal farms through the CDS. In its first 12 years of operation, between 2002 and 2013, the facility recharged 7,000 af of diverted Harkins Slough water, roughly 2,200 af of which was recovered for delivery and use by coastal farms; the balance was left in storage. In 2013, the Harkins Slough Recharge Facilities delivered approximately 220 acre-feet of water to the CDS.

The water supplied by PVWMA through the CDS is referred to as delivered water. Table 2-2 summarizes quantities of delivered water supplied by PVWMA from 2009 through 2013.

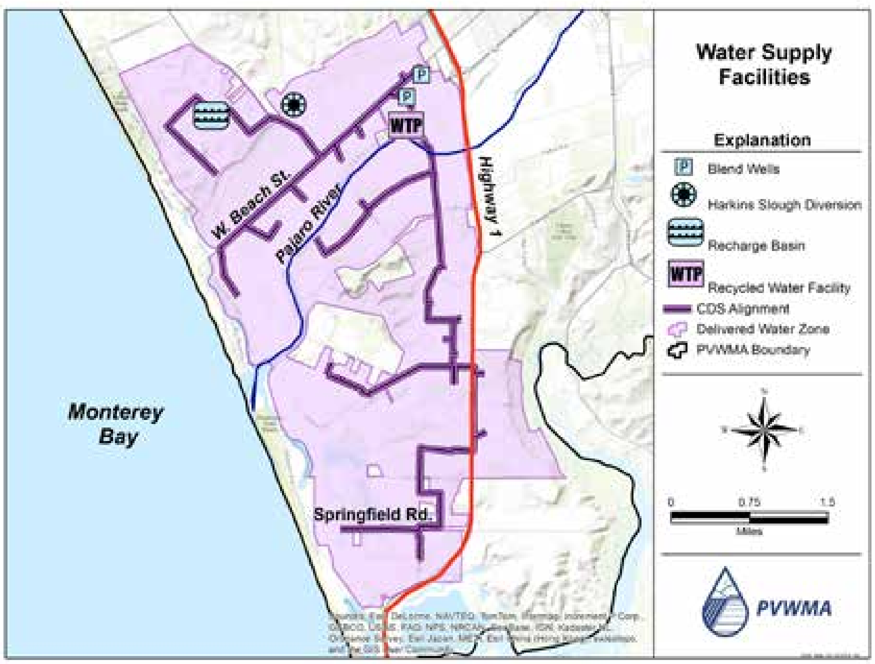


Figure 2-14. Existing PVWMA Water Supply Facilities

Figure 2-15 shows the annual and cumulative volumes of water delivered through the Coastal Distribution System. Figure 2-16 shows the diverted and recovered water by the Harkins Slough Recharge Facilities, respectively, from 2001 through 2013.

Table 2-2 Summary of Delivered Water by Calendar Year

Summary of Delivered Water by Calendar Year	2009	2010	2011	2012	2013
Harkins Slough Project Recovery Wells	159	160	232	239	222
Recycled Water	1,298	1,630	1,958	2,516	2,950
City of Watsonville Potable Blend Supply[1]	517	517	348	792	785
PVWMA Blend Wells[1]	431	374	92	240	318
Total	**2,406**	**2,681**	**2,630**	**3,788**	**4,275**

[1]Blend Wells and City of Watsonville Potable Blend Supply serve to improve the quality of the delivered water product as a whole by reducing the concentration of salts and therefore improving the water quality.

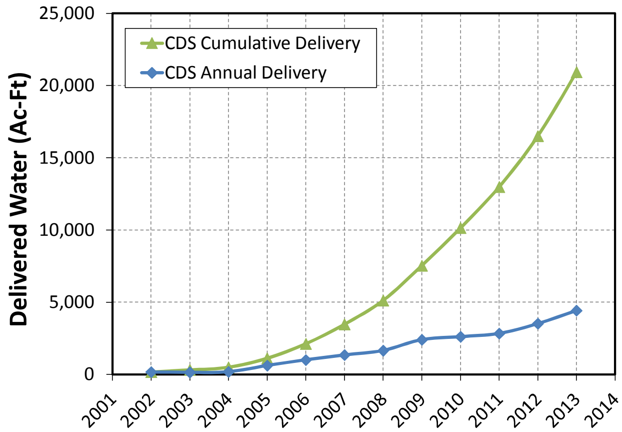


Figure 2-15. Coastal Distribution System Water Deliveries

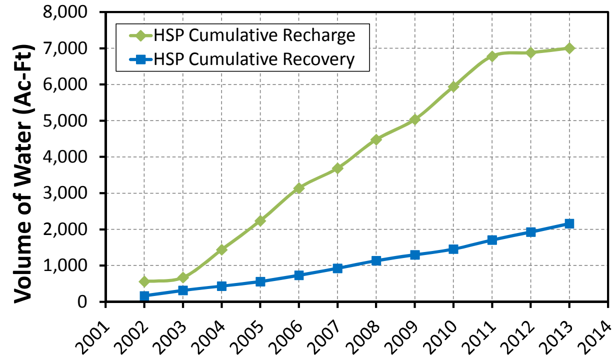


Figure 2-16. Harkins Slough Recharge Facilities Cumulative Diversion and Recovery

SEAWATER INTRUSION

This section presents an introduction to the principles of seawater intrusion and their relevance to the Pajaro Valley.

Principles of Seawater Intrusion

When groundwater levels near the coast fall to near or below mean sea level, there is a natural physical tendency for seawater to flow into the groundwater basin. The higher density seawater flows inland, creating a wedge under the less dense freshwater, until the water table achieves equilibrium with respect to water levels. The lower the groundwater level becomes, the less pressure there is from freshwater within the aquifer to resist the intruding seawater. Groundwater pumping in excess of groundwater recharge enhances this process. Seawater encroaching into the fresh groundwater basin degrades water quality, and wells in affected areas may have to be abandoned. This process is illustrated in Figure 2-17.

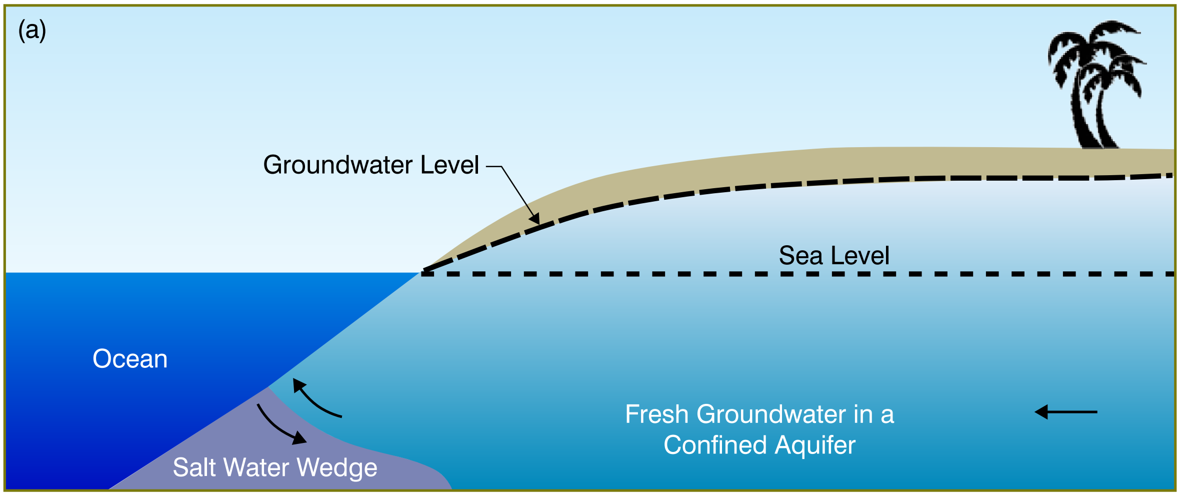
Unlike freshwater levels in the groundwater basin that vary with the season and climatic trends, the ocean is a constant source of recharge, and sea level elevation varies only marginally with the tide and climate change. When inland pumping causes the groundwater level to drop, pressure throughout the aquifer decreases and equilibrium is restored via seawater intrusion. Thus, pumping throughout the basin causes seawater intrusion along the coast, and decreased pumping throughout the basin can allow groundwater levels to recover, restoring an equilibrium point at which seawater does not intrude further.

Seawater intrusion rates are driven by the amount of cumulative overdraft in the groundwater basin. Overdraft is defined as the net negative balance in the annual groundwater budget (i.e., the combination of outflows and inflows) for the basin. The largest outflow from the groundwater system is annual groundwater extractions, and the largest input to the system is recharge from rainfall and streamflow. Analysis of the difference between the inputs and outputs to the system through time yields the rate of overdraft accumulation.

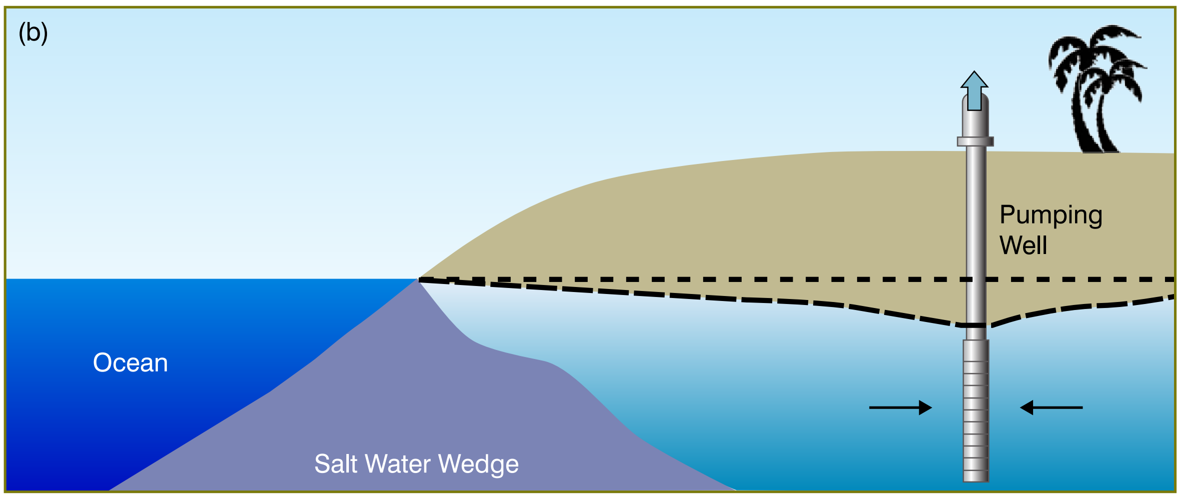
Seawater Intrusion in the Pajaro Valley

The Alluvium, Aromas Red Sands, and Purisima Formations are hydrogeologically connected to the ocean through a number of outcrops in Monterey Bay. The southernmost outcrop of the Aromas Red Sands Formation occurs between 350 and 500 feet below sea level three miles offshore in the northern wall of the Monterey Submarine Canyon. The northernmost outcrop occurs just offshore of La Selva Beach. Longstanding and continued overdraft of the Aromas Red Sands has allowed seawater to intrude via these outcrops into the freshwater aquifer system.

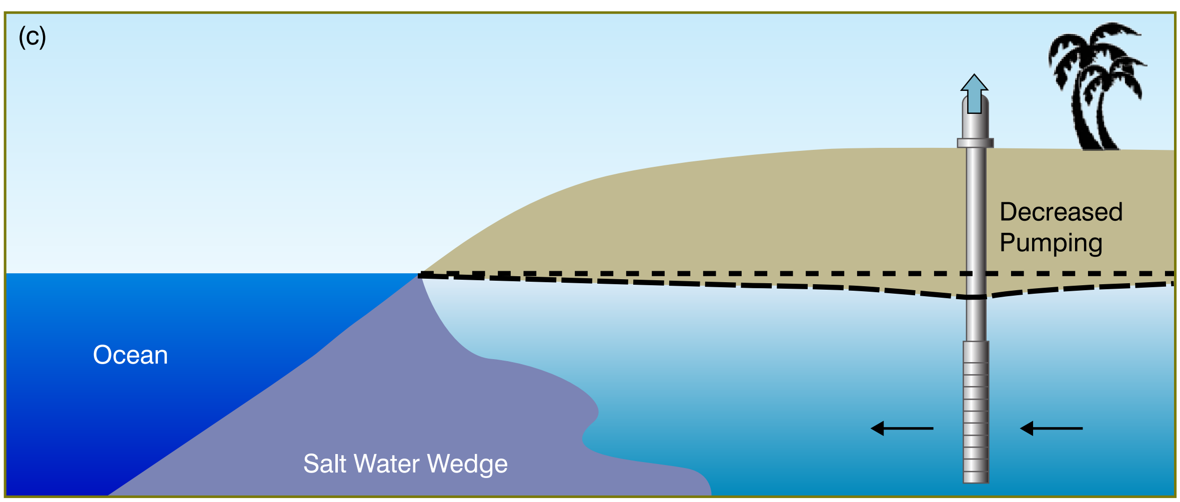
Figure 2-17. Seawater Intrusion and Mitigation Process



a) *Historic condition—Groundwater levels above sea level equilibrium level. No wells and no seawater intrusion.*



b) *Current stage—Excessive pumping results in long-term decreases in groundwater levels, pushing the salt water wedge closer to the pumping well trying to reach equilibrium.*



c) *Mitigation—Decreased pumping replenishes groundwater levels, increasing equilibrium pressure and pushing salt water wedge away from wells.*

The average concentration of chloride in seawater is 19,000 milligrams per liter (mg/L). Chloride levels exceeding 140 mg/L will likely result in increasing problems for agricultural irrigation (California Regional Water Quality Control Board 1995). Increasing chloride concentrations in groundwater well samples is an indication of seawater intrusion. Chloride is useful for monitoring seawater intrusion because it is chemically stable and moves at the same rate as the intruding water. The horizontal migration of seawater occurs slowly over time as seawater mixes with the freshwater as it moves inland. Initially, chloride concentrations increase gradually. However, as the bulk of the seawater plume moves inland, chloride concentrations can rise rapidly.

The extent of landward seawater intrusion has increased over time along the coastal region of the basin, as shown in Figure 2-18. The area south of the Pajaro River has experienced the highest extent of intrusion since 1998, and the intruded area continues to expand. Comparing the total intruded area between the analyzed datasets (1951-2011) shows there was a 218% increase in intruded area between 1955 and 1966, an 88% increase between 1966 and 1998, and a 12% increase between 1998 and 2011. The total intruded area has increased almost sevenfold since 1951.

A number of coastal wells have shown substantial increases in chloride concentrations over the last couple of decades, indicating that the volume of freshwater displaced in the intruded area is continuing to increase. Chloride levels are generally highest in the deeper confined aquifers consisting of Aromas Red Sands and the Purisima Formation. The concentration of chloride in the groundwater basin has been measured, with values ranging from less than 5 mg/L to 14,600 mg/L. Historically, an increase in agricultural acreage, a switch to more water-intensive crops, and urban population growth has driven the rise in demand for water. Given that roughly 90% of the water used in the Pajaro Valley is pumped groundwater, these trends have led to a greater cumulative overdraft in the Pajaro Valley basin. Seawater intrusion rates accelerate in response to growing cumulative overdraft. The largest increases in landward seawater intrusion rates in the Pajaro Basin correspond with periods of drought and the concomitant rise in demand for water and reductions in natural recharge.

LAND USE

Historical Land Use

Land use within the Pajaro Valley is dominated by the following categories: native vegetation, agriculture, and urban/rural residential areas. Department of Water Resources land use datasets documenting historical land use within the valley were compiled in the 2002 BMP. At that time, for the previous hydrologic flow model (the PVIGSM), land use was summarized by the model area, which, as for the current model, was greater than the PVWMA service area. In 1997, for example, approximately 30,200 acres of irrigated agricultural land were within the PVWMA service

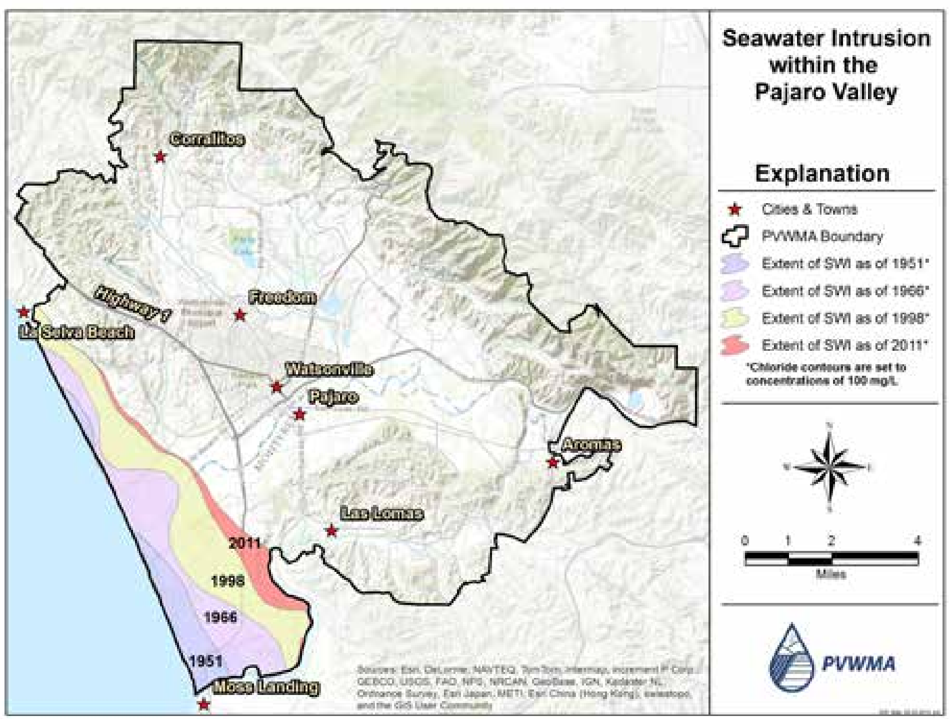


Figure 2-18. Seawater Intrusion within the Pajaro Valley

area and approximately 34,650 acres were in the model area. For this BMP Update, these data have been supplemented to include land use data within the PVWMA service area collected by PVWMA in 2011, 2012, and 2013. The total acreages for general land use type within the PVWMA boundaries are presented in Table 2-3 below. Due to the different areas analyzed (model area and service area), only trends are discussed.

Urban and rural residential land use has been steadily increasing, from approximately 5% of the total service area in 1966 to 17% of the total service area in 2006 (PVWMA, personal communication). DWR land use data were analyzed to determine historical agricultural land use changes in the basin. As shown in Table 2-3 between 1966 and 1975, agricultural land use increased by approximately 3,000 acres (about 10%) in the Pajaro Basin. From 1975 to 1989, agricultural land use in the basin increased by approximately 1,100 acres (3%). However, from 1989 to 1997, agricultural land use in the Pajaro Basin increased by approximately 200 acres (0.5%; Montgomery Watson/AT Associates 1999-2000). From 2011 to 2013, agricultural acreage has stayed stable, with less than a 500-acre increase.

An understanding of the historical land use conditions and cropping patterns is necessary to develop an understanding of the historic water use patterns. These data are also utilized by the PVHM's Farm Process (Schmid and Hanson 2009), which allows detailed simulations of agricultural pumping based on simulated crop water demand. Table 2-4 shows the relative breakdown by crop type and the changes in crop types planted in the Pajaro Valley Model Area over the last 47 years.

Table 2-3 Summary of Land Use

Land Use Type	Acreage							
	1966	1975	1982	1989	1997	2011	2012	2013
Total Agricultural Acreage	30,450	33,410	31,520	34,460	34,650	28,270	28,380	28,700
Urban Acreage	4,760	6,690	8,020	8,380	12,860	NA	NA	NA
Native Vegetation	61,300	56,410	56,970	53,660	49,000	NA	NA	NA

Values from 1966-1997 are for the model area; acreages from 2011-2013 are for PVWMA service area; data are rounded to the nearest 10 acres; NA = not available.
Sources: PVWMA 2002, and PVWMA data, 2013

Table 2-4 Historical Agricultural Land Use

Land Use Type	Historic Land Use: % of Surveyed Land							
	1966	1975	1982	1989	1997	2011	2012	2013
Strawberry	6	13	19	19	20	33	26	25
Irrigated Fallow	14	12	10	11	12	8	9	8
Caneberries, Bushberries, & Vines	0	0	2	4	5	16	18	19
Vegetable Row Crops	48	39	33	38	40	26	31	31
Field Crops	2	4	6	3	2	NA	NA	NA
Deciduous (apple orchards)	25	26	24	17	11	8	8	7
Pasture	4	5	3	3	4	NA	NA	NA
Nursery	1	2	4	6	6	5	5	7
Other/Unknown	NA	NA	NA	NA	NA	3	3	3

Values from 1966-1997 are for the model area; acreages from 2011-2013 are for the PVWMA service area and represent consolidated land use categories. For example, Field Crops were mapped as Vegetable Row Crops. Data are rounded to the nearest percentage point and may not sum to 100% due to rounding. NA = Not Available.
Sources: PVWMA 2002, and PVWMA data, 2013

Current Land Use

Land use within the Pajaro Valley is primarily agricultural. Figure 2-19 shows the 2013 breakdown for the land uses within the PVWMA service area. Table 2-5 shows current land use acreages and estimated crop values. Most notably there has been a steady increase in caneberries, with raspberries and blackberries currently accounting for over 19% of the crops grown within the PVWMA service area. As these types of crops are more water intensive than some of the crops that have been replaced, such as apples, this trend has increased water use.

Future Land Use

Urban

As shown in Table 2-3 (previous page), urban land use in the Pajaro Valley increased from approximately 4,800 acres in 1966 to 12,900 acres in 1997 and 13,373 acres in 2006 (PVWMA, personal communication). Urban population growth will affect the Pajaro Valley by causing the conversion of undeveloped areas or potentially agricultural land to urban land (expansion of urban areas for new development) and/or by increasing population density within existing urban areas (infill development and redevelopment). Table 2-6 projects future population growth for urban water users within the City of Watsonville as an example for projected population growth within the Pajaro Valley.

Agricultural

Based on the historical data in Table 2-3, the total agricultural land area has remained relatively constant from 1989 onward. Though crop rotation creates annual shifts in crop related land use, there have been significant shifts in the types of crops grown in the valley, as shown in Table 2-4 (previous page). The trend of replacing low-water-use crops with higher value, more-water-intensive crops may continue.

Table 2-5 Current Agricultural Land Use and Crop Value[1]

Land Use Type	2011	2012	2013	$ value per acre	2013 crop $ value
Fallow	2,364	2,600	2,300	-	-
Vegetable Row Crops (Lettuce, Celery, Zucchini, Artichokes, etc.)	7,420	8,810	8,900	$8,367	$74,466,300
Strawberries	9,380	7,350	7,160	$49,921	$357,434,360
Caneberries	4,300	4,890	5,200	$51,149	$265,974,800
Blueberries	40	40	70	$32,333	$2,263,310
Vines/Grapes	150	130	120	$8,532	$1,023,840
Deciduous (Apple Orchards)	2,320	2,130	2,120	$5,384	$11,414,080
Nurseries/Flower/Subtropical Plants	1,380	1,400	1,860	$97,930	$182,149,800
Other (Irrigated Turf, Grazing Land, Unknown Ag, etc.)	920	930	970	-	-
Total Acreage	**28,270**	**28,280**	**28,700**		**$894,726,490**

Source: PVWMA 2013 land use data and crop values from the Santa Cruz County Ag Commissioner 2012 Crop Report

[1]Although the Pajaro Valley includes portions of both Santa Cruz and Monterey Counties, Santa Cruz County crop values were assumed to be more reflective of the Pajaro Valley since Monterey County crop values may be heavily influenced by those of the Salinas Valley.

Table 2-6 Watsonville Estimated Population Growth

	2010	2015	2020	2025	2030	2035
Watsonville Population	65,739	66,826	68,759	71,318	73,691	75,073

Source: Watsonville Urban Water Management Plan 2010

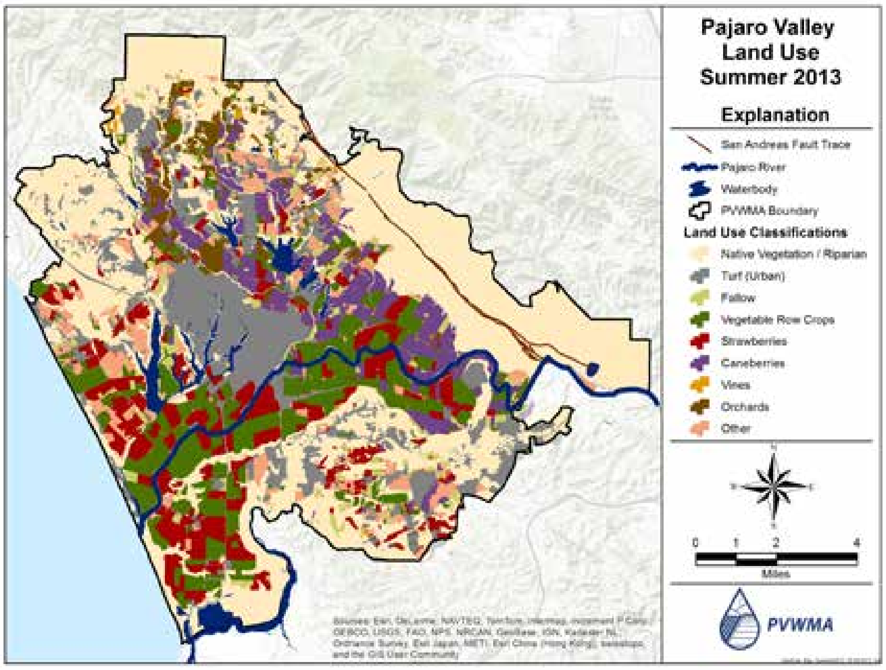


Figure 2-19. Pajaro Valley Land Use Summer 2013
Source: *PVWMA Data*

2012). As shown in Figure 2-21 below, although population growth has continued to increase over the past fifteen years, urban water use has remained relatively constant, due to water conservation programs. **The City plans to continue to achieve no net increase in groundwater use in the future through a combination of expanded water conservation and increased surface water supply.**

Table 2-7 (following page) presents a detailed breakdown of water use within the Pajaro Valley from 2001-2013. The table identifies groundwater, surface water, and delivered water separately. The metered wells category represents 95% of agricultural wells, with the remaining wells including mutual wells and a number of wells used for non-agricultural purposes.

WATER USE

Pajaro Valley water use for 2000 to 2013 is shown in Figure 2-20 . The five-year average for groundwater use from 2009-2013 is approximately 52,000 af. The five-year average from 2009-2013 for total water use, including delivered water and City of Watsonville surface water use, is approximately 55,000 afy.

The City of Watsonville's stated goal regarding water demand is to have no net increase in groundwater use (Steve Palmisano, BMP Joint Meeting, August

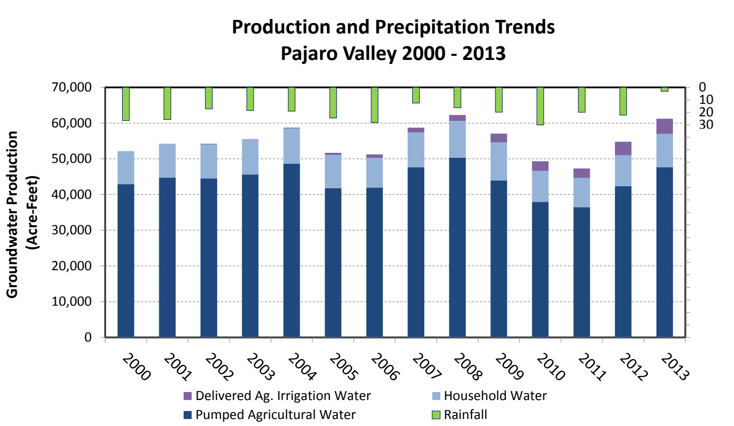


Figure 2-20. Pajaro Valley Groundwater and Delivered Water Use

WATER QUALITY

Water resources in the Pajaro Valley include both surface water and groundwater. Currently, groundwater is the predominant source of supply. However, since surface water represents potential sources for the future, it is important to understand the current state of both groundwater and surface water quality in the basin. The main water quality standards that apply are outlined in the Basin Plan for the Central Coastal Basin, prepared by the California Regional Water Quality Control Board, Central Coast Region (2011).

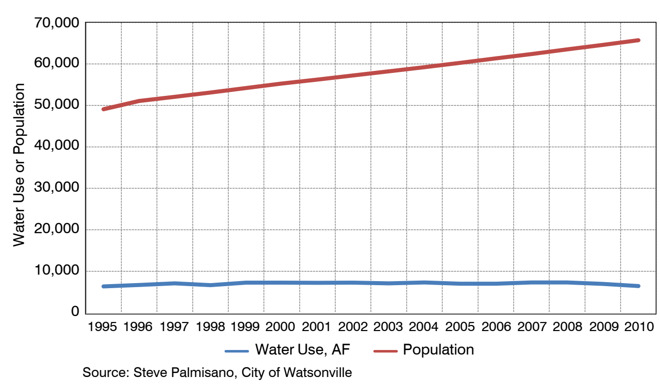


Figure 2-21. Historical City of Watsonville Water Use

Table 2-7 Pajaro Valley Water Use

Groundwater Usage by Calendar Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Metered Wells	44,189	43,896	45,010	48,024	41,177	41,482	47,275	50,015	43,620	37,642	36,129	42,026	47,360
Non-metered Wells (Estimated)	568	595	600	574	606	490	331	309	344	302	290	331	251
Delivered Water	0	158	139	207	603	990	1,337	1,665	2,405	2,680	2,751	3,788	4,275
City of Watsonville (Groundwater)	6,527	6,617	6,796	7,055	6,575	7,002	6,936	7,654	6,934	6,223	6,000	6,383	7,033
City of Watsonville (Surface Water)	1,093	1,066	843	752	1,002	913	991	340	372	733	905	633	368
Other Municipal	1,245	1,256	1,261	1,289	1,226	572	1,285	1,223	2,167	1,034	1,058	1,104	1,171
Rural Residential (Estimated)	1,691	1,695	1,695	1,577	1,492	1,466	1,494	1,495	1,486	1,474	1,127	1,133	1,139
Sum of Groundwater Usage (af)	**54,220**	**54,059**	**55,363**	**58,639**	**51,555**	**51,826**	**58,467**	**62,149**	**55,452**	**47,600**	**45,123**	**52,009**	**58,057**
Sum of Water Usage (af)	**55,313**	**55,283**	**56,344**	**59,478**	**52,682**	**52,916**	**59,648**	**62,702**	**57,329**	**50,088**	**48,259**	**55,397**	**61,596**

Sources: PVWMA Data

This plan, as mandated by the California Porter-Cologne Water Quality Control Act (1969), outlines water quality objectives that apply to the PVWMA service area. In addition, the PVWMA is developing a Salt and Nutrient Management Plan that is scheduled to be adopted by 2015, in accordance with the State Water Resources Control Board's Recycled Water Policy.[3]

Constituents of Concern

Previous studies and surveys have identified the following as primary parameters of concern for irrigation water quality in the Pajaro Valley (RMC, May 2001):

- Nitrates
- Salinity
- Sodium
- Toxicity from chloride and sodium
- Crop pathogens, primarily phytophthora

The Central Coast Regional Water Quality Control Board (CCRWQCB) Basin Plan has developed water quality objectives for irrigation supplies. The guidelines for the parameters of concern are shown in Table 2-8 at right. The largest source of nutrients is likely from applied fertilizer. The largest source of salts in the valley is from seawater intrusion, followed by water flowing into the basin from outside the agency's boundary (i.e. – the Pajaro River). The following sections summarize the identified parameters of concern and associated adverse impacts as related to the Pajaro Valley.

Nitrates. Nitrate contamination is a major concern in drinking water in the Pajaro Valley groundwater basin. Water high in nitrates is a threat to human health, particularly for infants. Nitrate is generally expressed as NO_3 (nitrate) or NO_3-N (nitrate-nitrogen). The EPA has set a Maximum Contaminant Level (MCL) at 10 mg/L NO_3-N. Because nitrates are contained in fertilizers in relatively high quantities and agriculture is the main source of livelihood in the Pajaro Valley, nitrates are routinely added to basin soils. Nitrates are highly soluble and can easily leach into groundwater. They may also be found in surface waters due to agricultural runoff. The transport of nitrates in groundwater is generally limited by aquitards that separate the various aquifers.

Salinity. Electrical conductivity (EC) and total dissolved solids (TDS) are measures of the total salt content of the irrigation water. The salt tolerance of an agricultural crop is normally expressed as the decrease in yield associated with a given level of soil salinity. The University of California and others have studied crop salt tolerance and developed general relationships between irrigation water salinity, soil salinity, and crop yield. In general, irrigation water with a salinity value of less than 500 mg/L TDS is the objective for delivery to local farmers. Some crops, such as strawberries, have a lower salt tolerance and may require additional onsite water management measures to reduce salinity-related crop impacts.

Sodium. The adjusted Sodium Adsorption Ratio (SAR) is a measure of the sodium hazard to crops and soils due to irrigation water. In addition to sodium concentrations, the adjusted SAR considers the impact of irrigation water salinity and bicarbonates. Bicarbonates in irrigation water are potentially harmful to the soils because they may precipitate calcium from

[3] http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/recycledwaterpolicy_approved.pdf

Table 2-8 CCRWQCB Irrigation Water Quality Guidelines

Problem and Related Constituent	Water Quality Guidelines Units	No Problem	Increasing Problems	Severe
Salinity				
EC of irrigation water	mmho/cm	<0.75	0.75 - 3.0	>3.0
Permeability				
EC of irrigation water	mmho/cm	>0.5	<0.5	<0.2
SAR, adjusted	-	<6.0	6.0 – 9.0	>9.0
Specific ion toxicity from root absorption				
Sodium (evaluate by adjusted SAR)	-	<3	3.0 – 9.0	>9.0
Chloride	mg/L	<142	142 - 355	>355
Boron	mg/L	<0.5	0.5 – 2.0	2.0 – 10.0
Specific ion toxicity from foliar absorption (sprinklers)				
Sodium	mg/L	<69	>69	-
Chloride	mg/L	<106	>106	-
Miscellaneous				
Ammonia as Nitrogen	mg/L	<5	5 – 30	>30
Nitrate as Nitrogen	mg/L	<5	5 – 30	>30
Bicarbonate (only with overhead sprinklers)	mg/L	<90	90 – 520	>520
pH	-	Normal range	6.5 – 8.4	-

Source: CCRWQCB 2011

the cation exchange complex in the form of relatively insoluble calcium carbonate. As exchangeable calcium is lost from the soil, the relative proportion of sodium is increased, with a corresponding increase in the sodium hazard.

Irrigation water that is high in sodium may lead to a reduction in soil permeability, especially when applied to fine-textured (clayey) soils that already experience drainage problems. Soils of this type are found along the Pajaro River near the ocean. Applying irrigation water with an adjusted SAR below 6.0 does not usually affect the permeability of a soil.

Chloride and Sodium Toxicity. Irrigation water supplied with high levels of chloride and sodium can cause root and foliar absorption. Crop yield may be impacted from root absorption when the adjusted SAR exceeds 3.0 or when the chloride concentration exceeds approximately 140 mg/L. The toxic affects from these constituents usually occur on woody perennial plants. Annual crops are usually tolerant to these constituents, except for strawberries, which, based on limited data, are considered to be relatively sensitive. Soil conditions and irrigation management may affect these threshold levels. Even though few data exist to fully assess the potential impact, these threshold levels should be considered when considering the potential hazard to crop production from root absorption of these constituents.

Crop damage can occur from foliar absorption of sodium and chloride associated with sprinkler irrigation. Impact heads allow the irrigation water to come into contact with the crop foliage, whereas drip irrigation applies water directly to the soil. As with root absorption, annual crops are generally tolerant to foliar absorption, but strawberries would be considered somewhat sensitive. Because drip irrigation is the prevalent method of irrigating strawberries in the Pajaro Valley, potential crop damage from foliar absorption is not expected to be an issue. Additionally, the water quality guidelines to minimize potential root absorption impacts are similar to the guidelines that minimize foliar absorption; therefore, any measures implemented to protect crops from root absorption will simultaneously reduce the potential for foliar absorption.

Pathogens. Current agricultural practices in the Pajaro Valley include the use of the soil fumigant methyl bromide to control weeds and pathogens, including phytophthora. Phytophthora is of concern because it can cause crown and root rot, which greatly reduce the plants' ability to absorb water and nutrients (CH2M Hill, April 1999). Phytophthora can be readily controlled by crop cultural/management approaches, such as:

- Planting crops on well-drained soils and using raised beds to facilitate drainage.
- Periodically leveling the land to avoid low areas within the field where drainage may become a problem.
- Using resistant varieties/rootstocks.
- Planting disease-free nursery stock.
- Carefully managing irrigation to avoid excessively wet soil conditions and plant moisture stress.
- Maintaining soil pH above 7.0.

Vegetable row crops produced in the Pajaro Valley do not seem to be impacted by phytophthora-related production problems, and PVWMA vegetable crop growers have not identified phytophthora contamination as a concern.

Current Water Quality in the Pajaro Valley

The PVWMA monitors surface water quality at thirty sites throughout the basin, including the Pajaro River, Corralitos Creek, Carneros Creek, College Lake, Pinto Lake Outflow, Corncob Canyon, and the Harkins/Watsonville Slough system. Water samples are collected at each site monthly; the locations are shown on Figure 2-22. This section describes water quality in the Pajaro Valley as it relates to the parameters of concern discussed in the previous section. The surface waters described below are generally of usable quality for irrigation and, in some instances, are of higher quality than groundwater supplies. However, most of the surface water within the Pajaro Valley presents seasonal water quality concerns.

The Pajaro River. The PVWMA collects water samples from the Pajaro River at three locations: Rogge Lane in Aromas (PR1), Murphy Crossing upstream of Watsonville (PR2), and Thurwachter Road (PR3) downstream of Watsonville and closest to the ocean. TDS data collected at PR1, PR2, and PR3 between November 1994 and May 2013 show PR1 and PR2 are similar, while PR3, which is closest to the ocean and is affected by the tides, is significantly higher (Figure 2-23). The minimum and maximum TDS measured at PR1 and PR2 are 200 mg/L and 1,400 mg/L. The minimum and maximum TDS measured at PR3 are 275 mg/L and nearly 20,000 mg/L; the high TDS at PR3 is likely the result of seawater mixing with river water during high tide. Nitrate as NO_3 at PR1 and PR2 has a range of less than 10 mg/L to 77 mg/L, while at PR3 the minimum nitrate level is less than the detectable limit, and maximum recorded nitrate level was 54 mg/L in 2001. Salinity levels upstream can be high at periods of low flow, with a direct linear correlation between flow and TDS.

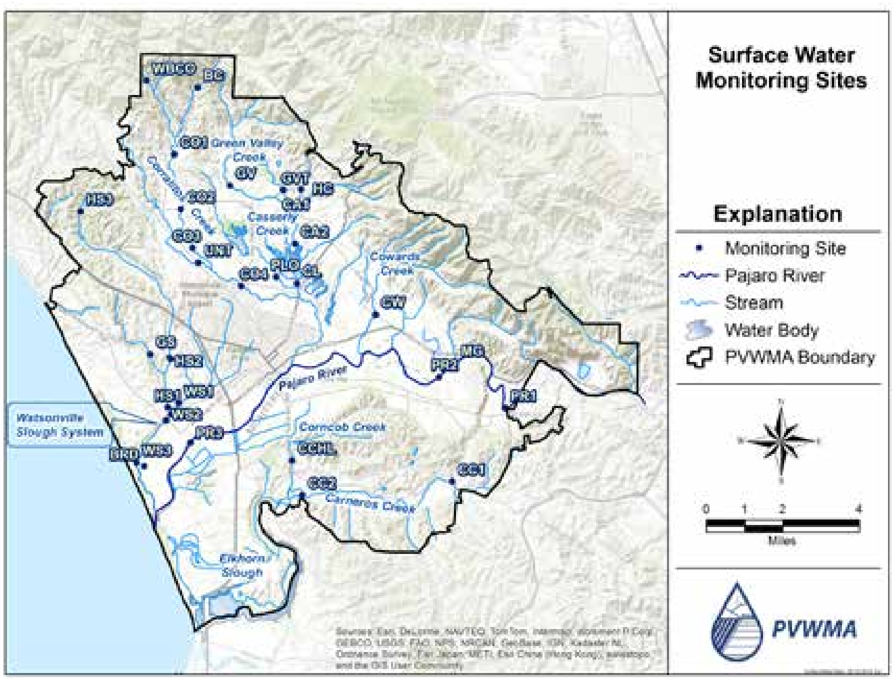


Figure 2-22. Surface Water Sampling Locations

Corralitos Creek. Corralitos Creek water is a usable water supply that has some seasonal water quality concerns. Surface water samples are collected on Corralitos Creek at four locations: Brown's Valley Road (CO1), Varni Road (CO2), Scurich Lane (CO3), and Green Valley Road (CO4). Figure 2-24 shows TDS measured at each Corralitos Creek site between 2003 and 2013. CO1 and CO2 have TDS values that range from 150 to 380 mg/L through time. The highest measured values are found at CO3, where TDS has been as high as 755 mg/L. CO4 ranges from 135 to 560 mg/L.

Nitrate samples for Corralitos Creek sites CO1 and CO2 are very similar, with most nitrate samples between zero and ten mg/L, aside from two anomalous points at CO1. Water samples from CO3 tested low for nitrates from 1995 to 1999 but more recently has had nitrate concentrations as high as 45 mg/L. The Green Valley site, CO4, has seen fluctuations in the concentration of nitrate since 1995, but only recently has nitrate spiked to over 40 mg/L. This may be a result of excess fertilizer runoff upstream of CO4. Land upstream of CO1 and to a lesser extent CO2, is on the whole more rural and forested and contains fewer farms.

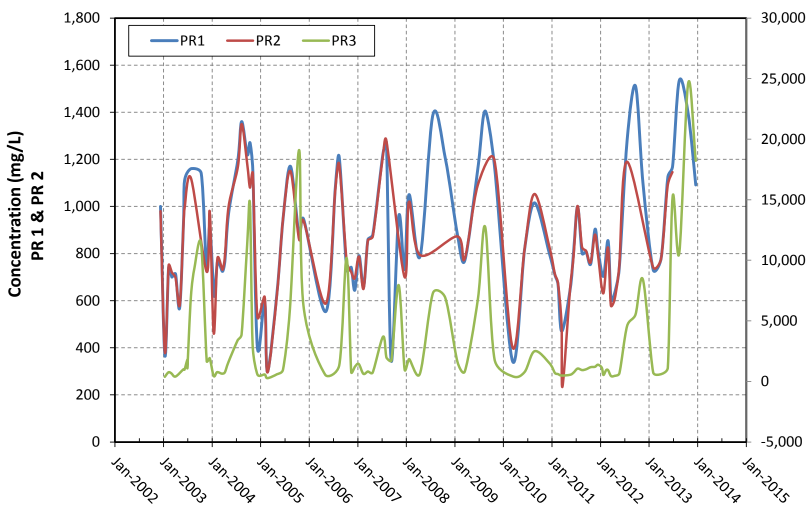


Figure 2-23. Pajaro River Total Dissolved Solids

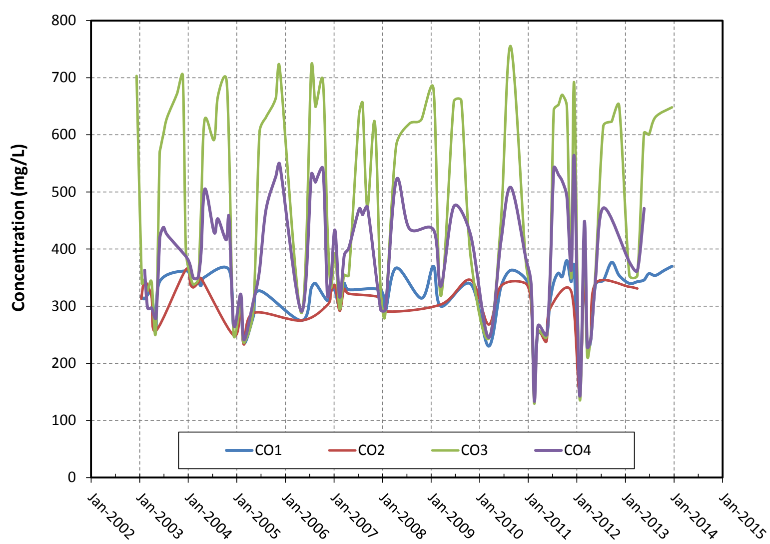


Figure 2-24. Corralitos Creek Total Dissolved Solids

Harkins Slough/Watsonville Slough. Three sites along Watsonville Slough and Harkins Slough are sampled monthly for water quality. TDS data are summarized in Figures 2-25 and 2-26 on the following page. TDS data collected at the most upstream site, WS1 (located at the railroad trestle above Harkins Slough), ranges from 200 to 1,650 mg/L, with an average of 667 mg/L for data collected between 2002 and 2011. Just downstream, WS2 (at the confluence with Harkins Slough) experiences higher ranges in the data of 260 to 6,710 mg/L, with average TDS values of 896 mg/L. The site located closest to the ocean, WS3 (at Shell Road), has much higher TDS values than the other two sites combined. One reason for this is the brackish mixture of slough water and seawater that develops during high tides. Another cause of high TDS values at WS3 is that the Pajaro River annually becomes sealed off from the ocean by a sand berm. This turns the immediate upstream reach of the river and Watsonville Slough into a brackish lagoon, where water levels are controlled by tidal fluctuations and seepage through the berm. The concentration of TDS at WS3 has been as high as 14,900 mg/L, although it averages closer to 2,400 mg/L. Nitrate concentrations measured at the Watsonville Slough sites are similar to concentrations measured at sites along the Pajaro River. Concentrations may be as high as 170 mg/L but in general are lowest at WS1, with an average of 25 mg/L between 2002 and 2013. Average TDS values collected from Harkins Slough range between 222 mg/L and 864 mg/L at the farthest point downstream. Similar to Watsonville Slough, high TDS values are associated with proximity to the ocean of the testing site. Nitrate values at the two upstream sites (HS2 and HS3) are minimal.

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College Lake. Water quality at College Lake varies seasonally. During the first storm events of the season, the runoff collected in College Lake exhibits high values of TDS, nitrates, and other pollutants. High nitrate concentrations are typically observed during the beginning of the rainy season, with dilution during the rainy season improving water quality (RMC 2001). TDS and nitrate concentrations collected at the College Lake outlet fluctuate seasonally. TDS concentrations range from 700 mg/L down to approximately 100 mg/L, as shown in Figure 2-27, and nitrate concentrations range from undetectable to approximately 40 mg/L.

Delivered Water Quality. Delivered water quality depends on the amounts of recycled water, City of Watsonville potable water, PVWMA blend water wells, and Harkins Slough Recharge Facilities recovery well water. A strict monitoring program is in place that includes irrigation suitability monitoring and health and safety monitoring. This includes sampling by PVWMA staff at all CDS water sources and active turnouts, as well as continuous turbidity monitoring at the Recycled Water Facility and a soil monitoring program. Health and safety monitoring is conducted twice a month by the Monterey County Environmental Health Department. Monitoring is conducted for total coliform, fecal coliform, *e. coli*, and *clostridium perfringens*. Delivered water quality for TDS, chloride, sodium, nitrate, and SAR are summarized in Figures 2-28 through 2-32 on the following page.

Pajaro Valley Groundwater. Groundwater quality within the major aquifers of the Pajaro Valley is influenced by factors related to hydrology, geochemistry, well construction, groundwater pumping, and land use. Seawater intrusion leads to high levels of salinity within some of the coastal groundwater aquifers. Well data generally indicate that regions of high salinity have been expanding over the past decades. High chloride levels are found in all the aquifers at the coast. Also of concern is groundwater quality in the Murphy Crossing area, which is of relatively poor water quality with TDS concentrations and other constituents exceeding irrigation water quality objectives. Nitrate contamination has been identified as a problem in areas of high residential septic tank density and in some areas that are

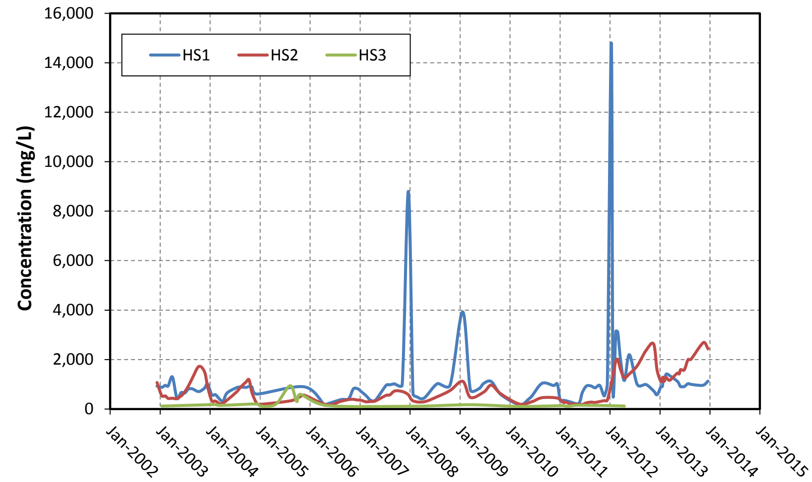

Figure 2-25. Watsonville Slough Total Dissolved Solids

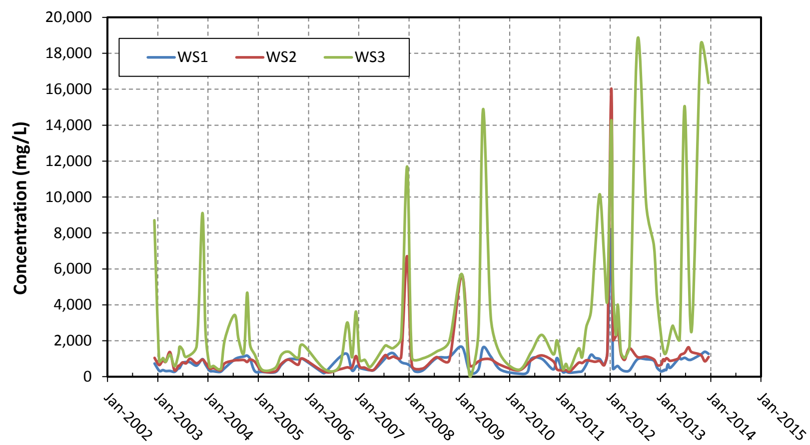

Figure 2-26. Harkins Slough Total Dissolved Solids

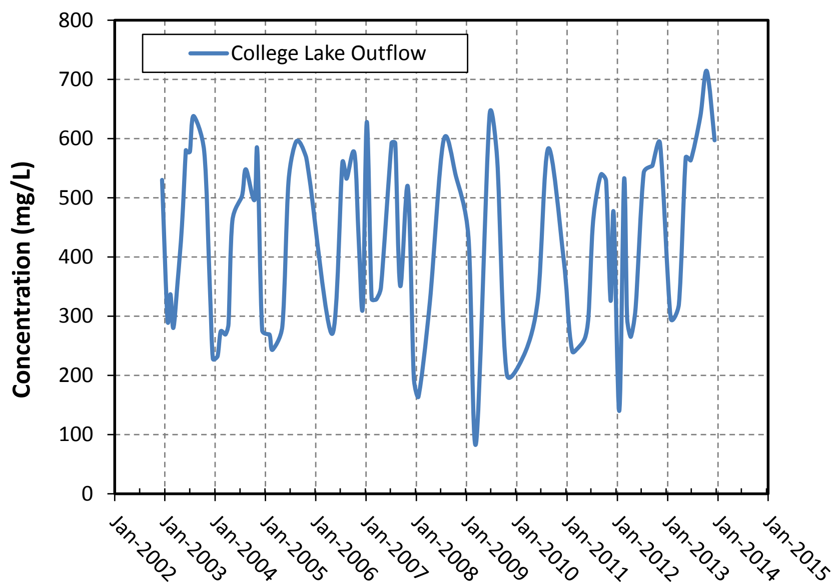

Figure 2-27. College Lake Total Dissolved Solids

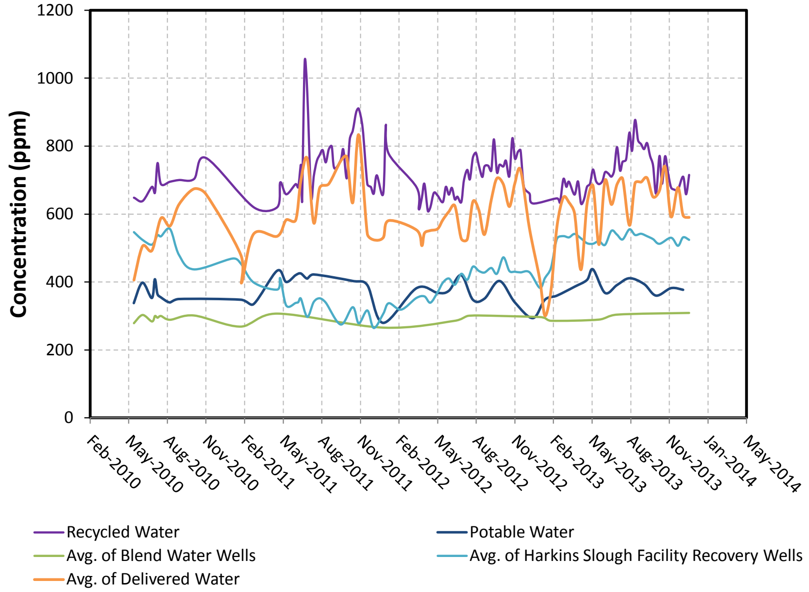

Figure 2-28. Delivered Water Total Dissolved Solids

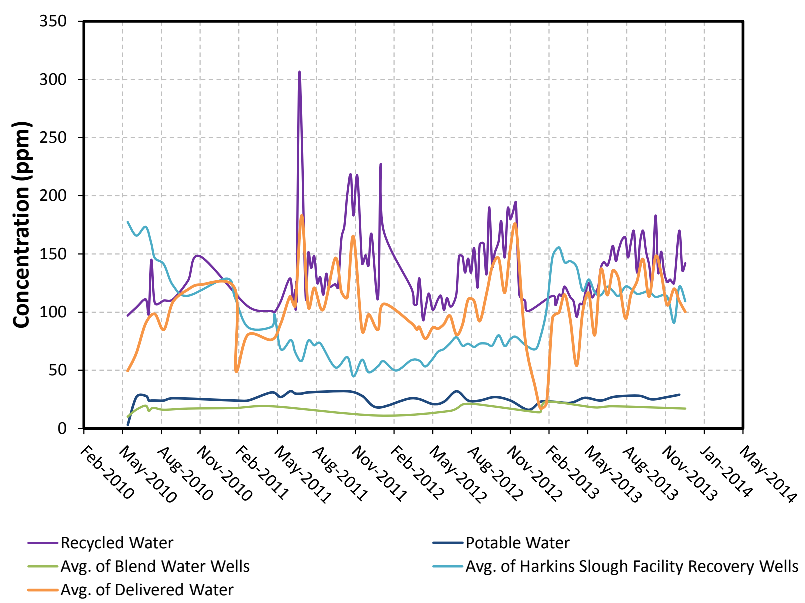

Figure 2-29. Delivered Water Chloride

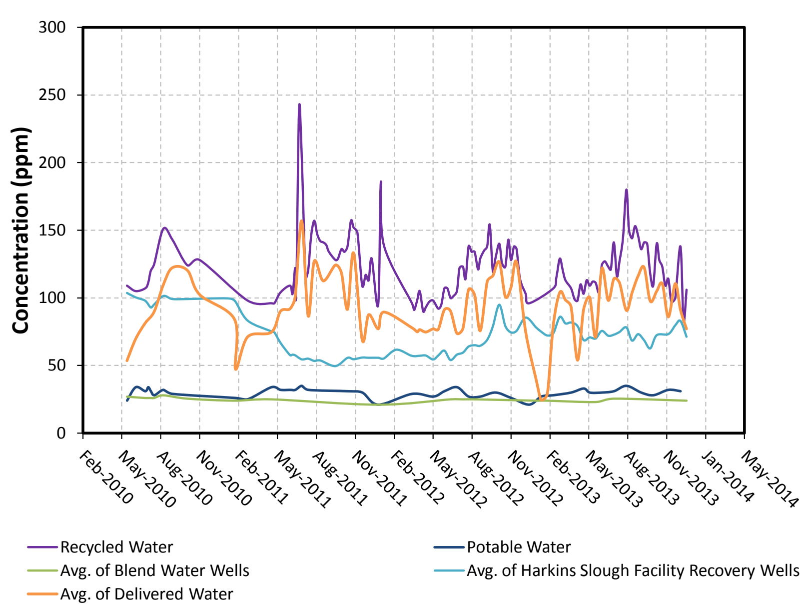

Figure 2-30. Delivered Water Sodium

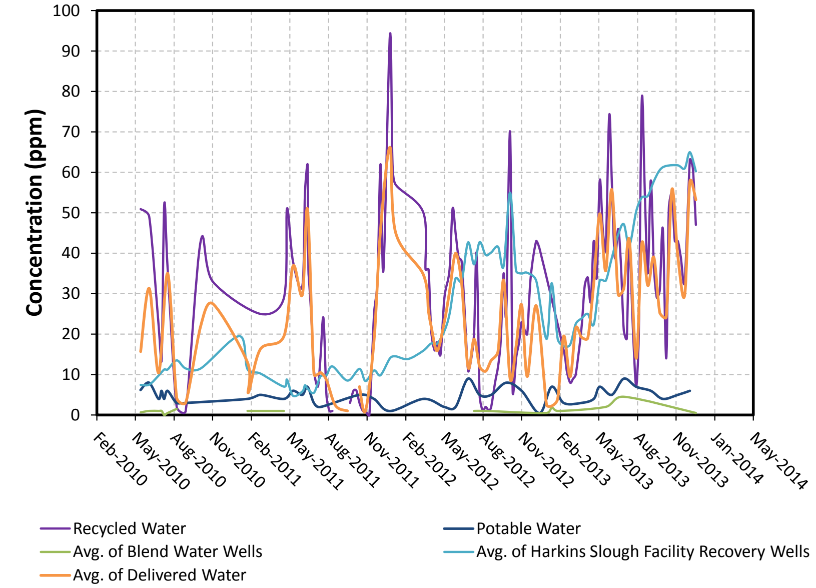

Figure 2-31. Delivered Water Nitrate as NO_3

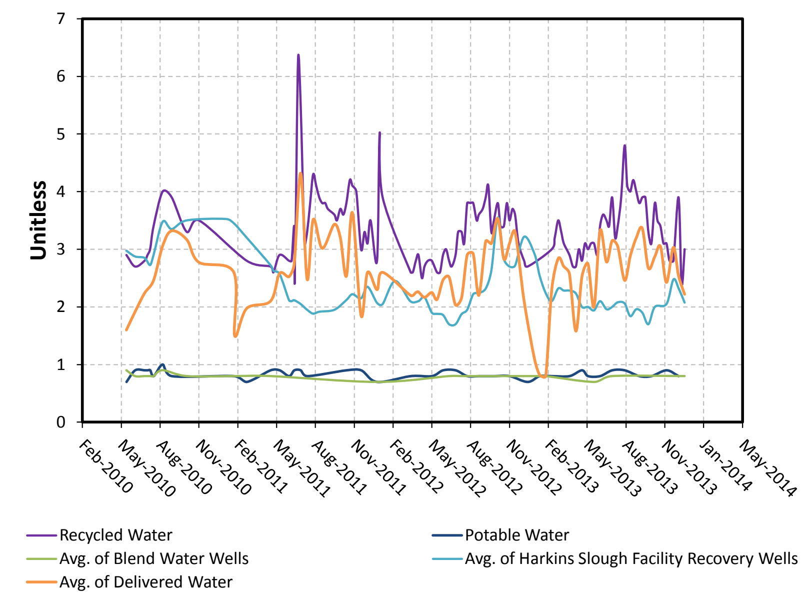

Figure 2-32. Delivered Water Sodium Adsorption Ratio (SAR)

recharged by the Pajaro River. In addition, since nitrate contamination is generally associated with surface sources of pollutants, areas with shallow perched water table aquifers or unconfined aquifers are generally more susceptible to long-term increases in nitrate levels. Nitrate concentrations in excess of drinking water standards have been measured in certain areas throughout the Pajaro Valley. A Salt and Nutrient Management Plan, in accordance with the State Water Resources Control Board's Recycled Water Policy, is presently under development and will identify at-risk areas and mitigation strategies.

Phytophthora is not present in the groundwater. Infiltration testing suggests that percolation of water into the groundwater basin is an efficient phytophthora removal mechanism (CH2M Hill, April 1999).

Poor quality water is not necessarily contained within boundaries; often, water is the mechanism through which pollutants are transported. Hydrologic processes cycle water through various media, from precipitation to surface water to groundwater. Applied irrigation water may be transported as runoff to surface waters or may percolate to groundwater. A source of often poor water quality to the lower Pajaro River Watershed is the Upper Pajaro River Watershed. As shown in Figure 2-1, the Pajaro River Watershed includes approximately 1,200 square miles before it enters the lower Pajaro Valley. The river drains 1,200 square miles of rural and agricultural land, which creates an opportunity for salts and nutrients to run off the land and into the river, where they are transported into the Pajaro River which flows to Monterey Bay. The reach of the river between Chittenden Gap and Murphy Crossing is favorable to groundwater recharge. As a result, groundwater quality in that area represents the quality of the water in the river, which varies from quite good during high flows, to salt and nutrient rich during lower flows. Groundwater may move into surface water bodies, and seawater may intrude into the fresh groundwater aquifers. Water is rarely confined to a single location. Thus, water quality issues that affect one water body may also become a threat to neighboring water bodies.

Although the Pajaro Valley groundwater basin contains numerous aquifer layers that are generally separated by clay layers, water transport between these layers is possible. Groundwater in different confined aquifer layers is under varying amounts of pressure, and groundwater will move from areas of high pressure to areas of lower pressure. Water can move vertically between aquifers, through naturally occurring gaps in intervening clays, along the casings of improperly constructed wells that penetrate more than one aquifer zone, or through well bore flow. Additionally, abandoned wells with perforations at multiple aquifer elevations provide a transport channel through which water can move. Thus, poor quality water may migrate between formations, contaminating other water-bearing units within the groundwater basin. This increases the concerns associated with seawater intrusion, as aquifers that underlie intruded aquifers can be affected.

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Chapter 3
PROJECT DEVELOPMENT AND SCREENING

BMP UPDATE DEVELOPMENT PROCESS

As described in Chapter 1, the PVWMA Board voted in October of 2010 to form an Ad Hoc BMP Committee to help increase the Pajaro community's participation in developing the BMP Update. This Committee advised the PVWMA Board of Directors with matters related to the BMP Update. The Committee met regularly over an 18-month period to discuss potential solutions aimed at fulfilling its mission. The primary focus of the Committee over this time was to work with PVWMA staff and project consultants to identify, analyze, short-list, and ultimately recommend a portfolio of projects and programs to "solve" the basin problem, i.e., solve seawater intrusion and basin overdraft. Figure 3-1 provides an overview of the process developed and utilized by the Committee to prepare the BMP Update.

- Prioritize new supply projects to balance the groundwater basin and prevent long-term overdraft.

The Ad Hoc BMP Committee addressed these priorities by first developing a list of potential BMP projects and then conducting a screening analysis, as illustrated in Figure 3-2.

DEVELOPMENT OF INDIVIDUAL PROJECTS

The Ad Hoc BMP Committee solicited ideas for BMP projects from its members and from the community at large. The Committee identified a total of 44 projects, including those from the 2002 BMP, BMP Committee-developed projects, community group-developed projects, integrated regional water management (IRWM) projects, and consultant-developed projects. The complete list of projects is included in Table 3-1 on the following page.

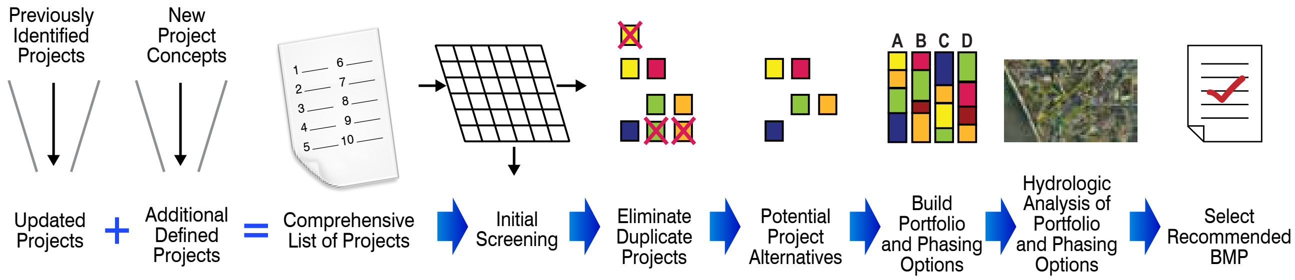


Figure 3-1. The BMP Update was developed utilizing a community-based multi-phased process.

As described in Chapter 2, overdraft of the Pajaro Valley groundwater basin and continuing seawater intrusion remain serious threats to the viability of the valley's groundwater supply. The BMP Update included an approach for identifying individual projects that, combined with other projects, would address these basin problems. The priorities for identifying individual BMP projects were as follows:

- Prioritize water use efficiency and water demand reduction alternatives that have the potential to reduce basin demands.
- Prioritize improvements to existing infrastructure to maximize supply.

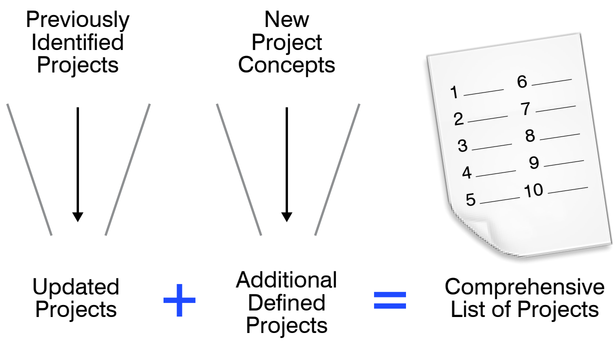


Figure 3-2. The Ad Hoc BMP Committee identified and evaluated a total of 44 alternatives.

Table 3-1 Projects Identified by the Ad Hoc BMP Committee

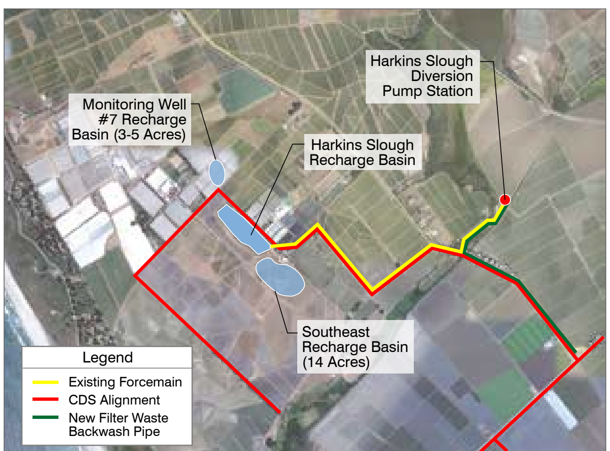
Project Type	Name
GROUNDWATER	
G-1	San Benito County Wells to Aromas Water District
G-2	San Benito County Groundwater Demineralization
G-3	San Benito County Groundwater Demineralization at Watsonville Wastewater Treatment Plant (WWTP)
SURFACE WATER	
S-1	Murphy Crossing with Recharge Basins
S-2	Watsonville Slough with Recharge Basins
S-3	College Lake with Inland Pipeline to Coastal Distribution System
S-4	Expanded College Lake, Pinto Lake, Corralitos Creek, Watsonville Slough, and Aquifer Storage and Recovery
S-5	Bolsa de San Cayetano Dam with Pajaro River Diversion
S-6	Imported Central Valley Project (CVP) Water
S-7	River Conveyance of Mercy Springs CVP Water and Rubber Dam at Murphy Crossing
S-8	Freedom Lake/Corralitos Lagoon
S-9	College Lake Aquifer Storage and Recovery (ASR) in Winter
S-10	Dams at Bolsa and Strawberry Hills with Pajaro Diversion
S-11	River Conveyance of Mercy Springs CVP Water for Recharge at Murphy Crossing
S-12	College Lake to Recycled Water Treatment Plant in Summer
S-13	Groundwater Recharge Upstream of Murphy Crossing with Water from Soap Lake and San Benito Floodplains
S-14	Partial College Lake to Recycled Water Treatment Plant in Summer
S-15	Protection of Natural Recharge Areas and Small-Scale Managed Aquifer Recharge
S-16	Zayante Creek Reservoir and Pipeline
S-17	Series of Small Dams on Pescadero Creek
S-18	Pipeline from Lexington Reservoir
S-19	Warner Lake
S-20	College Lake with Pipeline to Adjacent Farmland
S-21	Imported Water Supply from Uvas Reservoir
S-22	Harkins Slough Recharge Facilities Upgrades
RECYCLED WATER	
R-1	Recycled Water to Harkins Slough Recharge Basin
R-2	Recycled Water to Harkins Slough and Watsonville Slough Recharge Basins
R-3	Pipeline from Santa Cruz WWTP
R-4	Pajaro Dunes North Diurnal Recycled Water Storage
R-5	Bolsa Dam for Winter Recycled Water Storage
R-6	Increased Recycled Water Storage at Treatment Plant
R-7	Increased Recycled Water Storage via Grower Ponds
R-8	Seasonal Recycled Water Storage South of PVWMA
R-9	Recycled Water from the South County Regional Wastewater Authority (SCRWA)
R-10	Winter Recycled Water Advanced Treatment and Injection

Table 3-1 Projects Identified by the Ad Hoc BMP Committee

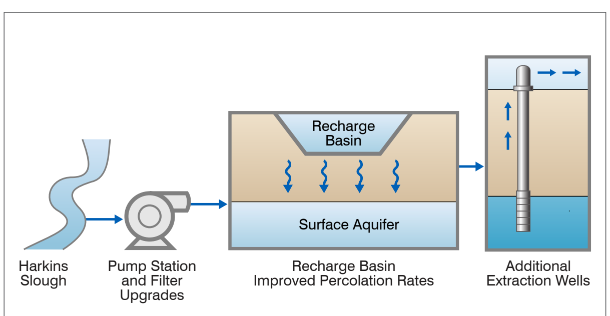
Project Type	Name
R-11	Winter Recycled Water Deep Aquifer ASR
R-12	Dams at Bolsa and Strawberry Hills for Recycled Water Storage
DEMAND MANAGEMENT	
D-1	Increased Irrigation Efficiency with Soil Tensiometers
D-2	Fallow 10% of Farmland
D-3	Fallow 8,000 Acres of Coastal Land
D-4	Irrigation Efficiency Training
D-5	Performance-based Water Conservation Incentives
SEAWATER	
SEA-1	Desalination of Seawater
INFRASTRUCTURE	
I-1	CDS Expansion

Following initial identification, each project was defined to a planning level of detail that included a project description, site plan, project schematic, and conceptual-level cost estimate. A one-page summary sheet was then developed for each project (Appendix B); Figure 3-3 shows an example of a project summary sheet.

S-22: Harkins Slough Recharge Facilities Upgrades



PROJECT PLAN



PROJECT SCHEMATIC

Background:
The Harkins Slough Recharge Project was constructed in 2002 and was included in the 2002 BMP. The project is permitted to divert water between November and May. The water is filtered and pumped to the Harkins Slough Recharge Basin for storage in the shallow groundwater aquifer. Extraction wells located around the recharge basin extract water and supply the CDS during the irrigation season. The water rights permit from the SWRCB limits the maximum diversion from Harkins Slough and Watsonville Slough to 2,000 AFY. The average annual yield of the project was estimated to be 1,100 AFY from the extraction wells in the 2002 BMP. Since 2002, the Harkins Slough recovery wells have only produced 180 AFY on average and just over 2,100 AF since 2002. This project will provide improved infrastructure to help maximize the project yield. The proposed project includes new shallow extraction wells at the recharge basin, pump station upgrades at the slough diversion, additional filters to reduce the loading rate per filter, coagulant addition facilities to improve filtration, approximately 4,000 feet of filter waste backwash discharge pipeline from the filters to Beach Road, and a sump and sumps pumps at the filters to pump waste backwash to the existing sewer on Beach Road. The USDA Natural Resources Conservation Service (NRCS) is planning to construct a wetlands on land between Harkins Slough and Watsonville Slough and divert water from the sloughs into it, which would improve the water quality diverted to the recharge basin. The Agency is coordinating this project with the NRCS project.

Yield:
1,000 AFY

Capital Cost:
$5.8 Million

Operations & Maintenance:
$90,000

Annualized Capital and O&M Cost:
$510,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:
Total suspended solids and turbidity

Implementation Issues:
The Agency has gained a better understanding of recharge basin hydrogeology through various studies, which should allow improved recovery well design and yields. However, increased recovery well yields cannot be confirmed until the new wells are proven.

Implementation Timeline:
Near-Term*

*Timelines:
Near-Term = 0 - 10 years Mid-Term = 10 - 20 years Long-Term = 20 - 30 years

Figure 3-3. A one-page summary sheet was developed for each of the 44 alternatives.

SCREENING OF ALTERNATIVES

The Committee then conducted a multistage screening process to select the most promising projects to include in the BMP. The Committee evaluated the viability of each of the 44 projects based on cost and/or implementation issues and whether projects had the same location or water source. This process is illustrated in Figure 3-4.

As a result of this screening process, projects were placed in one of three categories:

A= The project remained on the list for further consideration.

B= The project required more definition and reconsideration.

C= The project was eliminated from further consideration.

Category B projects were reconsidered by the Committee after additional information was developed (typically information requested by the Committee to complete its evaluation). Eventually, all projects were placed in either the A or C categories as a result of the screening process. A total of 30 of the 44 projects were screened out or combined into other projects, with 14 projects progressing to the portfolio development phase. The projects that were screened out and the primary reason for their elimination are summarized in Table 3-2.

The 14 projects that passed the screening process are listed in Table 3-3. These projects were used by the Committee to develop a portfolio of projects to halt basin overdraft and stop seawater intrusion.

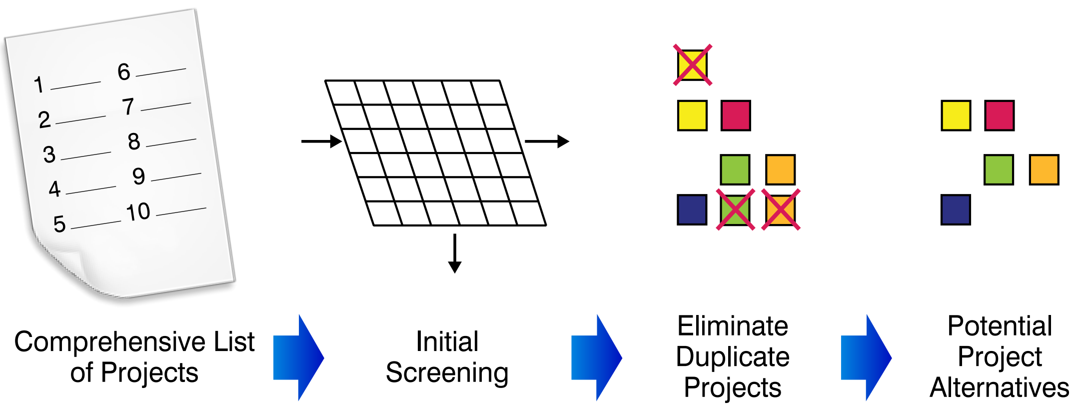


Figure 3-4. The multistage screening process focused the BMP on 14 project alternatives.

Table 3-2 Projects Eliminated from Further Consideration

Project Type	Name	Reason Committee Screened Out
GROUNDWATER		
G-1	San Benito County Wells to Aromas Water District	Small yield, potential export ordinance issues, compensation requirements
G-2	San Benito County Groundwater Demineralization	Export ordinance, cost
SURFACE WATER		
S-6	Imported CVP Water	Politically unacceptable
S-7	River Conveyance of Mercy Springs CVP Water and Rubber Dam at Murphy Crossing	S-11 River Conveyance of Water for Recharge at Murphy Crossing is more cost effective
S-8	Freedom Lake/Corralitos Lagoon	Insignificant yield
S-9	College Lake ASR in Winter	Cost, regulatory uncertainty
S-10	Dams at Bolsa and Strawberry Hills with Pajaro Diversion	Cost prohibitive

Table 3-2 Projects Eliminated from Further Consideration

Project Type	Name	Reason Committee Screened Out
S-12	College Lake to Recycled Water Treatment Plant in Summer	Less cost effective than sending water to CDS
S-13	Groundwater Recharge Upstream of Murphy Crossing with Water from Soap Lake and San Benito Floodplains	Not effective for Pajaro Basin recharge
S-14	Partial College Lake to Recycled Water Treatment Plant in Summer	Cost prohibitive
S-15	Protection of Natural Recharge Areas and Small-Scale Managed Aquifer Recharge	PVWMA is better suited to support others' efforts rather than to manage decentralized program
S-16	Zayante Creek Reservoir and Pipeline	Cost prohibitive
S-17	Series of Small Dams on Pescadero Creek	Insignificant yield
S-18	Pipeline from Lexington Reservoir	Cost prohibitive
S-19	Warner Lake	Insignificant yield
S-20	College Lake with Pipeline to Adjacent Farmland	S-3 (College Lake with Inland Pipeline to Coastal Distribution System) would allow College Lake water to be used at both the coast and inland
S-21	Imported Water Supply from Uvas Reservoir	Water not available
RECYCLED WATER		
R-1	Recycled Water to Harkins Slough Recharge Basin	Would preclude the use of the recovery wells for S-22 (Harkins Slough Recharge Facilities Upgrades)
R-2	Recycled Water to Harkins Slough and Watsonville Slough Recharge Basins	Would preclude the use of the recovery wells for S-2 (Watsonville Slough with Recharge Basins)
R-3	Pipeline from Santa Cruz Wastewater Treatment Plant	Cost prohibitive
R-4	Pajaro Dunes North Diurnal Recycled Water Storage	Cost, permitting
R-5	Bolsa Dam for Winter Recycled Water Storage	Cost prohibitive
R-7	Increased Recycled Water Storage via Grower Ponds	Complex to implement with grower/ agency coordination
R-8	Seasonal Recycled Water Storage South of PVWMA	Cost, small yield
R-9	Recycled Water From SCRWA	Cost
R-10	Winter Recycled Water Advanced Treatment and Injection	Cost
R-12	Dams at Bolsa and Strawberry Hills for Recycled Water Storage	Cost, small yield
DEMAND MANAGEMENT		
D-2	Fallow 10% of Farmland	Politically and economically unacceptable
D-3	Fallow 8,000 Acres of Coastal Land	Politically and economically unacceptable

Table 3-3 Projects that Passed Screening Process

Project Type	Name
GROUNDWATER	
G-3	San Benito County Groundwater Demineralization at Watsonville WWTP
SURFACE WATER	
S-1	Murphy Crossing with Recharge Basins
S-2	Watsonville Slough with Recharge Basins
S-3	College Lake with Inland Pipeline to CDS
S-4	Expanded College Lake, Pinto Lake, Corralitos Creek, Watsonville Slough, and Aquifer Storage and Recovery
S-5	Bolsa de San Cayetano Dam with Pajaro River Diversion
S-11	River Conveyance of Water for Recharge at Murphy Crossing[1]
S-22	Harkins Slough Recharge Facilities Upgrades
RECYCLED WATER	
R-6	Increased Recycled Water Storage at Treatment Plant
R-11	Winter Recycled Water Deep Aquifer ASR
DEMAND MANAGEMENT	
D-6	Increased Recycled Water Deliveries[2]
D-7	Conservation[3]
SEAWATER	
SEA-1	Desalination of Seawater
INFRASTRUCTURE	
I-1	CDS Expansion

[1]Alternative S-11 was modified to include water from an unidentified source due to the uncertainty of Mercy Springs CVP water as a source.
[2]Alternative D-6 was split off from Alternative R-6 as a critical component of maximizing use of the existing recycled water treatment facilities.
[3]Alternative D-7 was created by combining elements of Alternatives D-1, D-4, and D-5.

Chapter 4

PORTFOLIO AND PHASING EVALUATION

The BMP Committee evaluated the 14 projects that passed the initial screening process to (1) develop a portfolio of projects that together could achieve the dual goals of balancing the basin and halting seawater intrusion and (2) recommend which of the projects to include in the first phase of the BMP. The process is shown in Figure 4-1.

PORTFOLIO SELECTION AND ANALYSIS

Ranking of Projects

The 14 projects were first listed by unit cost per project yield ($/af), from least costly to most costly. The list was then divided into projects that could be implemented in the first phase (first 10 years) of the BMP, referred to as "green projects," and projects that could be implemented beyond the first phase (10 to 30 years out), referred to as "orange projects." Table 4-1 summarizes the ranking of green and orange projects by cost per acre-foot. As indicated, the green projects tended to be those that were generally less costly and were anticipated to have fewer potential permitting, public acceptance, and environmental issues associated with their implementation.

Following the initial ranking of projects, and after considerable analysis and discussion, the BMP Committee selected the seven lowest cost per af projects for inclusion in a BMP portfolio. As described in the paragraphs below, the inclusion of these seven projects, if implemented and operated as anticipated, were determined to be adequate to solve 90% of the seawater intrusion and 100% of the basin overdraft problems. The remaining seven projects are included as potential future projects in the BMP should the yield or the measured results on overdraft and seawater intrusion of the first seven projects not meet the expectations of the planning level estimates.

Hydrologic Modeling

The seven projects included in the selected BMP portfolio were simulated using the Pajaro Valley Hydrologic Model to determine if, as a group, they could achieve the dual goals of balancing the basin and stopping seawater intrusion (HydroMetrics, 2012). Assumptions in the portfolio simulation were as follows:

- The simulation includes 34 years of hydrology, based on weather conditions between 1976 and 2009.
- Crop distribution is maintained at 2009 levels.
- Municipal pumping is maintained at 2009 levels.
- Irrigation efficiency is improved by 10%, distributed evenly across the basin, representing a reduction in groundwater pumping of approximately 5,000 AFY.
- The CDS supplies 8,600 acre-feet of water annually to coastal farms that are currently capable of receiving delivered water. This delivered water is used by farms preferentially, before pumping groundwater.
- The Harkins Slough Recharge Facilities Upgrades and the Watsonville Slough with Recharge Basins projects were not explicitly simulated; rather the desired amount of water provided by those projects was included in the total available supplemental supply.
- No blending water from the City of Watsonville or PVWMA blend wells was needed in this scenario because the water supply projects mentioned above met the demand target.

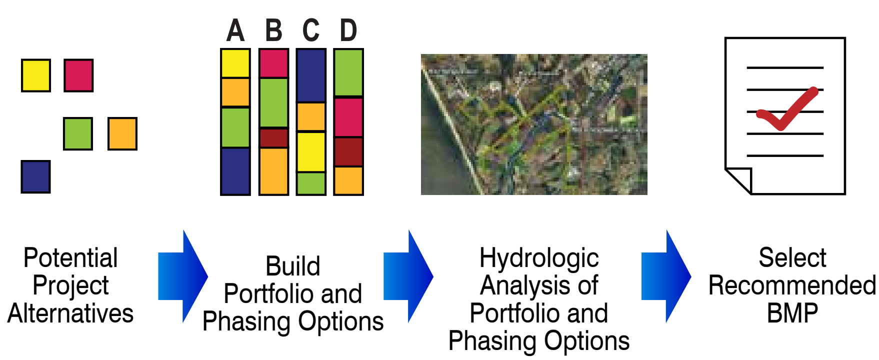


Figure 4-1. Screened alternatives were grouped to form a portfolio that could balance the basin and halt seawater intrusion.

Table 4-1 Ranking of Screened Projects

	Project or Program	Estimated Yield, AFY	Planning Level Cost Estimate, $/af
D-6	**Increased Recycled Water Deliveries**	**1,250**	**[1]**
D-7	**Conservation**	**5,000**	**200[2]**
S-22	**Harkins Slough Recharge Facilities Upgrades**	**1,000**	**500**
R-6	**Increased Recycled Water Storage at Treatment Plant**	**750**	**700**
S-2	**Watsonville Slough with Recharge Basins**	**1,200**	**1,000**
S-3	**College Lake with Inland Pipeline to CDS**	**2,400[3]**	**1,100**
S-1	**Murphy Crossing with Recharge Basins**	**500**	**1,400**
I-1	CDS expansion	[4]	[4]
R-11	Winter Recycled Water Deep Aquifer ASR	3,200	1,500
S-11	River Conveyance of Water for Recharge at Murphy Crossing	2,000	1,500
G-3	San Benito County Groundwater Demineralization at Watsonville WWTP	3,000	2,500
S-4	Expanded College Lake, Pinto Lake, Corralitos Creek, Watsonville Slough, and Aquifer Storage and Recovery	2,000	2,900
SEA-1	Seawater Desalination	7,500	3,400
S-5	Bolsa de San Cayetano with Pajaro River Diversion	3,500	3,500

Key:
Green = Could be implemented within the first 10 years of the BMP (by 2025)
Orange = Could be implemented after 2025
Bold = Seven projects included in BMP portfolio
Not bold = Seven projects potentially added in the future if needed

[1]No cost is associated with increased recycled water deliveries.
[2]Cost does not include 3- to 5-year program cost of approximately $250,000-300,000 annually.
[3]College Lake with Inland Pipeline to CDS yield changed to a range of 2,100 to 2,400 AFY based on 2014 RCD College Lake Study (see College Lake project description in Chapter 5).
[4]The estimated capital cost of CDS expansion is $13 million. Since the project conveys water from other projects, it does not have a yield.

The hydrologic modeling showed that, based on likely future hydrologic conditions, implementing the selected portfolio will eliminate overdraft in the Alluvial Aquifer, Upper Aromas Aquifer, and Lower Aromas Aquifer, the most productive aquifers in the Pajaro Valley. The simulations also indicated that seawater intrusion in the Alluvial Aquifer, Upper Aromas Aquifer, and Lower Aromas Aquifer would be reduced to a rate of 200 AFY, which is within the accuracy of the model (HydroMetrics 2012).

PHASING ANALYSIS

The BMP is envisioned as a 30-year plan to be implemented in three phases. Phase 1 would begin with Board adoption of the BMP and BMP EIR in 2014 and public approval of a new rate structure in 2015, followed by project implementation and operation through 2024. Phase 2 would begin in 2025 and would continue through 2034. Phase 3, if required, would begin in 2035 and would go through 2044.

The plan implementation will include planning, design, construction, and monitoring of programs and project effects on the basin. It is anticipated that the majority of selected portfolio projects would be constructed and operational in the first 20 years (first two phases of the plan). The number of projects and the schedule for implementation of those projects was a key recommendation decision to be made by the BMP Committee, as described in more detail below. It was also anticipated that careful basin monitoring would continue throughout the 30-year BMP as a critical component of the plan implementation.

Definition of Options

The Committee developed phasing options from the projects within the selected portfolio that could potentially be implemented in Phase 1 of the BMP, from 2015 to 2024. The options evaluated are as follows:

- **Option 1:** Include only projects in Phase 1 that maximize use of existing facilities.
- **Option 2:** Include all projects in Phase 1 except S-2.
- **Option 3:** Include all "green" projects in Phase 1 (i.e., all projects that could be implemented in Phase 1 would be implemented).

The options are summarized in Table 4-2.

The challenge for the Committee in weighing these three phasing options was to find the appropriate balance between the rate of solving the basin problems and managing the cost of the BMP program. To understand this balance, two models were used: the hydrologic model previously described and a cash flow model that analyzed the impact of implementing and funding projects on the PVWMA's annual budget. The cash flow model is described below.

Cash Flow Model

Cash flow analyses were generated for each phasing option to provide an estimate of how implemented projects would affect the PVWMA operating budget. The analysis provided information on what revenue adjustments and/or financing needs would be necessary to generate a positive fund balance in the future.

Existing Revenue and Expenditures

The cash flow model was built upon the existing PVWMA budget. The PVWMA currently generates approximately $10 million annually to support operations and debt service. Annual expenditures for operations are roughly $6.1 million, with existing debt service obligations of $3.9 million. Five bond issuances, having maturities ranging from 2022 to 2037, comprise current debt. Table 4.3 outlines the debt payment schedule.

In order to account for inflation, beginning in 2015 annual operating expenditures in the cash flow model were increased each year by 2%. The cash flow model also took into account when the existing debt service reaches maturity.

Table 4-2 Summary of Phase 1 Options Evaluated

Project or Program		Option 1: Maximize Use of Existing Facilities	Option 2: Exclude S-2	Option 3: Include All Green Projects
D-6	Increased Recycled Water Deliveries	√	√	√
D-7	Conservation	√	√	√
S-22	Harkins Slough Recharge Facilities Upgrades	√	√	√
R-6	Increased Recycled Water Storage at Treatment Plant	√	√	√
S-2	Watsonville Slough with Recharge Basins			√
S-3	College Lake with Inland Pipeline to CDS		√	√
S-1	Murphy Crossing with Recharge Basins			

Key:
Green = Could be implemented within the first 10-years of the BMP (by 2025)
Orange = Could be implemented after 2025
The Murphy Crossing project (S-1; it was an orange project), by definition, could not be implemented in Phase 1.

Table 4-3 PVWMA Debt Payment Schedule

Debt	Amount	Maturity	Annual Payment
SWRCB #1	$11,650,000	December 17, 2022	$763,600
SWRCB #2	6,215,000	November 21, 2023	414,500
DWR City	3,510,000	September 30, 2027	222,100
1999 Bond	19,725,000	March 1, 2029	1,300,000
City	27,345,000	May 1, 2037	1,200,000
Total Debt Service	**$68,445,000**		**$3,900,200**

Figure 4-2 provides a summary of the existing revenues and expenditures. It illustrates the financial baseline without future capital projects. As demonstrated by the diminishing purple bars, as existing debt reaches maturity, the cost is no longer included in the expenditure analysis. In addition, the green bars, representing existing expenditures, increase annually by 2% to account for inflation.

Future Capital Projects and Programs

New project and program expenditures were added onto the foundation of existing expenditures and debt service built into the cash flow model for each of the three phasing options. Projects were added to the model, with planning, design, construction, and operations and maintenance (O&M) costs placed where they would most likely fall in the timeline.

Whenever a new project was projected to go into construction, new debt was added in the model. Similarly, when existing debt was identified to be retired, it was taken off the annual debt requirement.

To determine future expenditures, the cash flow analysis utilized assumptions of capital costs, escalation, and payment method. The conservative assumption was that all new projects would be paid by taking new loans or issuing new bonds (i.e., new debt) and not by grants. While it is highly unlikely that some costs would not be offset by grants, it is not currently known when and for which projects grants will be awarded. An annual escalation of 4% was applied to all projects.

Project schedules were developed and project costs were spread between non-construction (permitting, environmental, and engineering time) and construction; the project costs, implementation schedule, and funding options (cash, reserves, or debt) were analyzed. The project schedules used for the cash flow modeling are summarized in Figure 4-3.

Each of the three phasing options was modeled against the existing baseline. The resulting expenditure forecasts were analyzed to determine the sufficiency

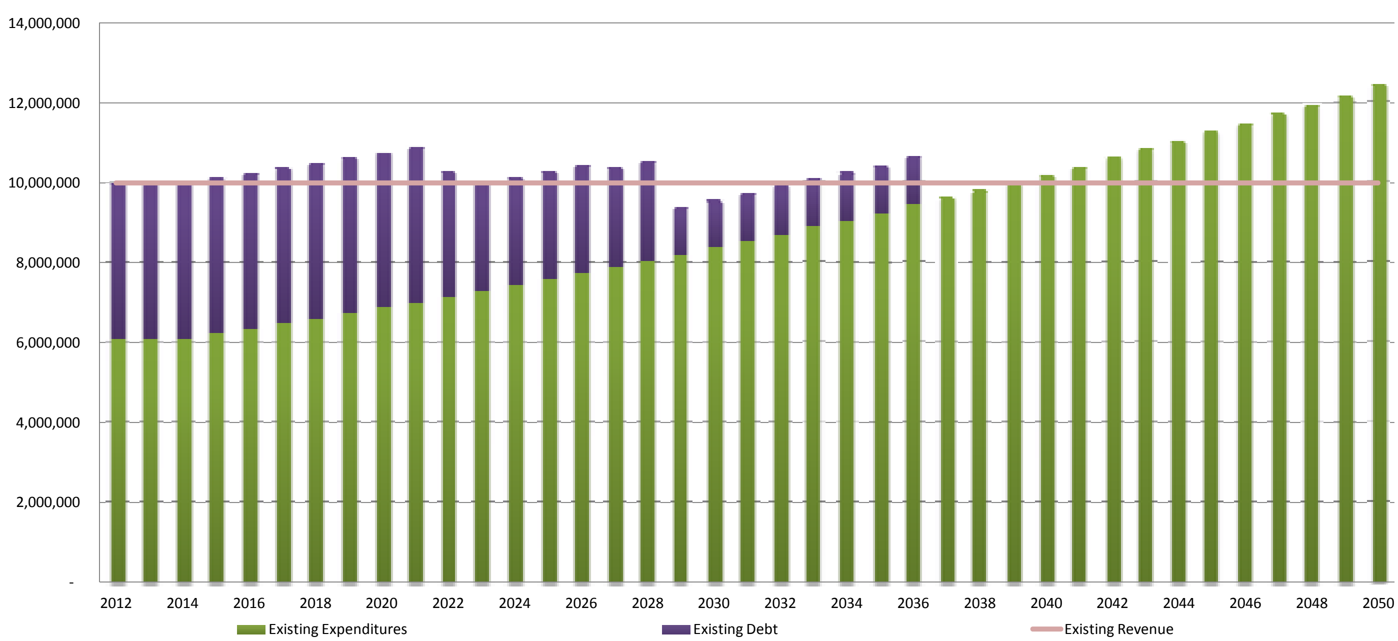


Figure 4-2. Cash Flow Model Revenue and Expenditure Baseline

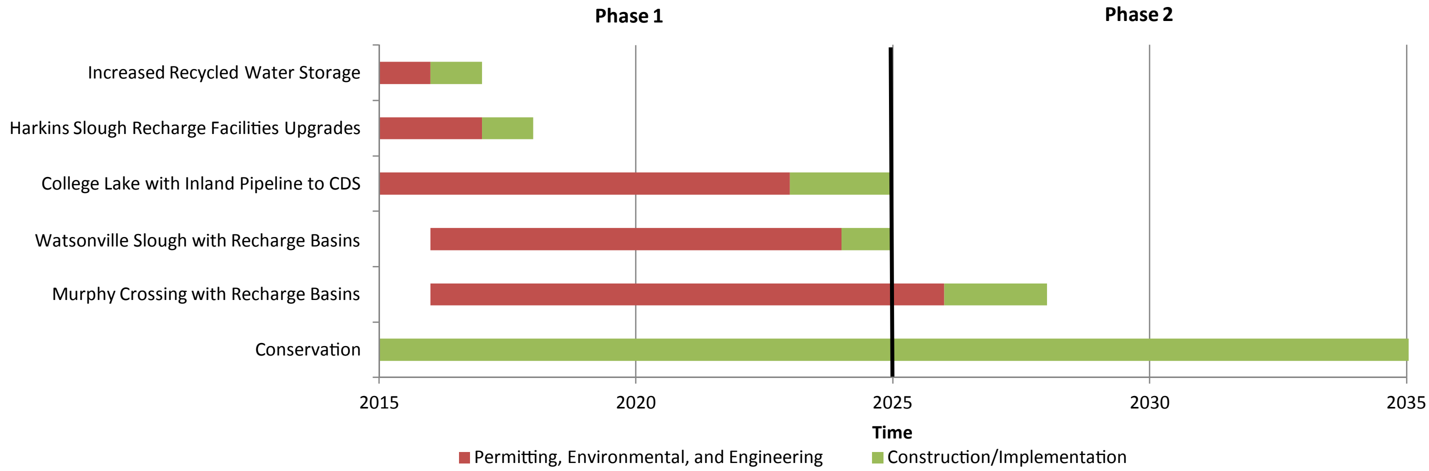


Figure 4-3. Project Scheduling Used in Cash Flow Model

of revenues to generate positive cash flow and to maintain a positive fund balance. Figure 4-4 provides a cash flow summary of Option 3 with proposed revenue adjustments. As shown, the PVWMA's existing cash flow stream will require revenue adjustments (illustrated as upticks on the cash flow curve) to adequately fund new capital projects (to keep the cash flow line from dipping below zero).

As the figure demonstrates, the existing cash flow (revenue) needs to be adjusted to support the proposed projects. For each option, multiple cash flow and financial projections were analyzed to determine the most appropriate financing mechanism. Beyond adjusting the proposed implementation schedule, various financing options were analyzed to provide sufficient revenue in the short term and long term without building excessive reserves.

Some projects, typically smaller in value, were assumed to be financed with cash or existing reserves. On the other hand, projects with large costs were debt financed to mitigate short-term impact on the PVWMA's cash flow or revenue needs. The cost of the debt issuance is illustrated by the purple bars (Debt). An increase in the bars' heights represents a new debt issuance in that year, whereas a decrease indicates that the debt cost has reached full maturity.

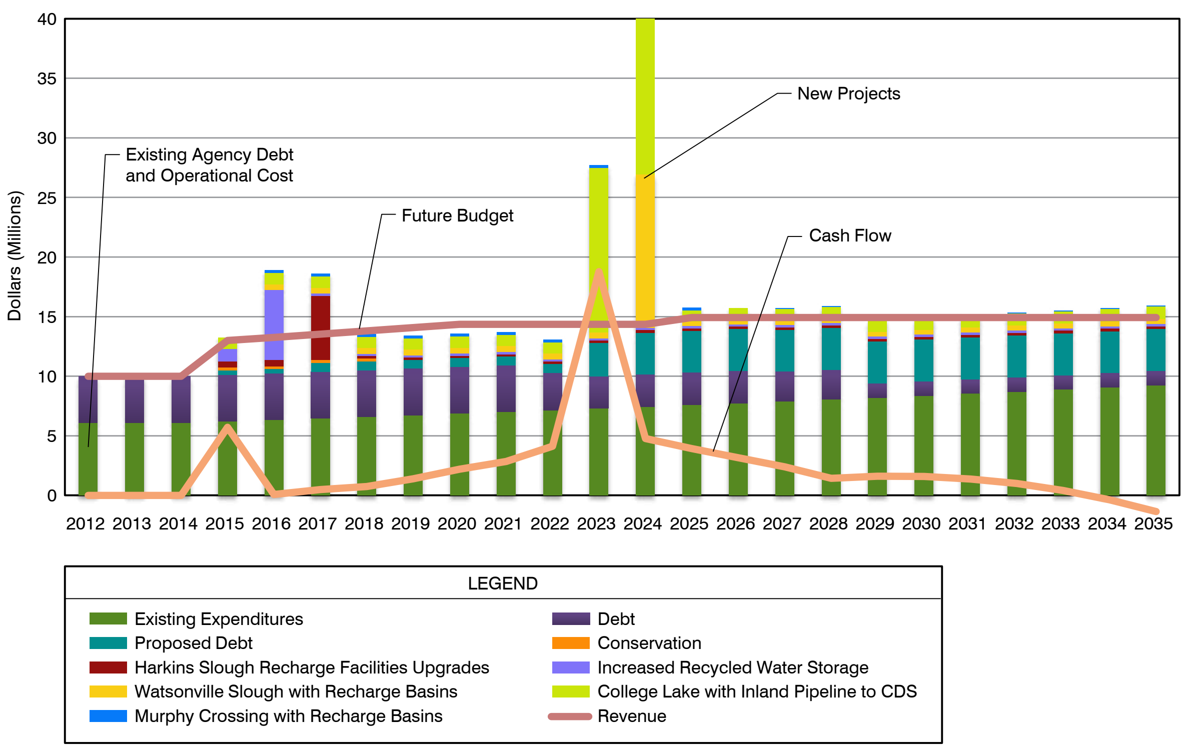


Figure 4-4. Cash Flow Summary Example - Option 3

Results of Cash Flow and Hydrologic Modeling

The results of the cash flow and hydrologic modeling for the three phasing options are summarized in Table 4-4.

Option 1 has the lowest cost, with an estimated increase to the current PVWMA budget of 15%; however, it also provides the least benefit, solving approximately 45% of basin overdraft and 15% of seawater intrusion in Phase 1.

Option 2 has a somewhat higher cost, with an estimated increase to the current PVWMA budget of 25%; however, it also provides increased benefit, solving approximately 65% of both basin overdraft and seawater intrusion in Phase 1.

Option 3 has the highest cost of the three options, with an estimated increase to the current PVWMA budget of 30%; however, it provides the most benefit, solving approximately 80% of basin overdraft and 85% of seawater intrusion in Phase 1.

Again note that this analyses was to identify phasing options for Phase 1 (the first 10-years) of the BMP. It will take implementation of all of the projects identified in Table 4-2 to solve 90% of the seawater intrusion and 100% of the basin overdraft problems.

Recommended Phasing Option

The Committee reviewed and discussed the analysis of the phasing options and voted to recommend Option 3, Implementation of all green projects, to the PVWMA Board. A large majority of the Committee felt that the urgency of the issues facing the Pajaro Valley required that projects be implemented sooner rather than later, and that the additional revenue requirement of 30% identified for this phasing option would be less costly than delaying the implementation of projects to solve the basin overdraft and seawater intrusion problems.

This recommendation was presented to the PVWMA Board in a workshop setting with the Committee and the public on August 15, 2012. At that meeting, the Board accepted the Committee's recommendation. The acceptance of the recommended portfolio and phasing plan provided the basis for the Draft BMP Update and the Notice of Preparation required to initiate the CEQA review process. The list of projects recommended by the BMP Committee will also become the basis for developing a BMP cost of service report and ultimately the Proposition 218 (revenue adjustment) vote required for implementation of the BMP Update.

COMMUNITY OUTREACH

While the Committee's endorsed portfolio of projects and programs was designed to solve the basin overdraft and seawater intrusion problem, the Committee also recognized that significant work remained. This work will involve the growers, the City of Watsonville, and other members of the Pajaro Valley community to ensure that the conservation and delivered water goals assumed in the development phase of the plan can be met.

Future phases of the BMP will include considerable outreach to begin updating the community on components and issues associated with the BMP Update. Outreach will focus on how the community may go about achieving the BMPs targeted conservation and delivered water goals.

REFERENCES

HydroMetrics. October 2012. *Hydrologic Model Analysis of Basin Management Plan Alternatives.*

Table 4-4 Phasing Options

Project or Program	Option 1: Maximize Use of Existing Facilities	Option 2: Exclude S-2	Option 3: Include All Green Projects
Percentage of basin overdraft solved in Phase 1	45%	65%	80%
Percentage of seawater intrusion solved in Phase 1	15%	65%	85%
Total Phase 1 capital costs	$12,000,000	$43,500,000	$58,200,000
Total annualized costs, capital + O&M	$2,000,000	$4,600,000	$5,800,000
Current PVWMA operations budget	$10,000,000	$10,000,000	$10,000,000
Approximate increase to current PVWMA budget	15%	25%	30%
Increased Recycled Water Deliveries	√	√	√
Conservation	√	√	√
Harkins Slough Recharge Facilities Upgrades	√	√	√
Increased Recycled Water Storage at Treatment Plant	√	√	√
Watsonville Slough with Recharge Basins			√
College Lake with inland Pipeline to CDS		√	√

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BASIN MANAGEMENT PLAN

OVERVIEW

The BMP includes implementing the following seven projects and programs:

- Conservation.
- Increased Recycled Water Storage at Treatment Plant.
- Increased Recycled Water Deliveries.
- Harkins Slough Recharge Facilities Upgrades.
- Watsonville Slough with Recharge Basins.
- College Lake with Inland Pipeline to Coastal Distribution System (CDS).
- Murphy Crossing with Recharge Basins.

The following seven additional projects are included as potential future projects for consideration, if the BMP projects and programs do not provide the projected yields, or if these yields are not sufficient to balance the basin and halt seawater intrusion:

- CDS expansion.
- Winter Recycled Water Deep Aquifer Storage & Recovery (ASR).
- River Conveyance of Water for Recharge at Murphy Crossing.
- San Benito County Groundwater Demineralization at Watsonville WWTP.
- Expanded College Lake, Pinto Lake, Corralitos Creek, Watsonville Slough, and ASR.
- Seawater Desalination.
- Bolsa de San Cayetano Dam with Pajaro River Diversion.

DESCRIPTION OF BMP PROJECTS AND PROGRAMS

The projects and programs that form the BMP are described below, with the exception of Conservation, which is discussed in Chapter 6.

Increased Recycled Water Storage at Treatment Plant

Project Background

The Watsonville Recycled Water Treatment Facility was completed in 2008. The facility was constructed in partnership with the City of Watsonville and was designed to deliver 4,000 AFY of recycled water during the irrigation season. The recycled water is blended with other water supplies to lower chloride levels and to provide an SAR value of less than four. The blend water supplies are from groundwater wells owned and leased by PVWMA, the City's potable supply, and the Harkins Slough Recharge Facilities extraction wells.

The volume of recycled water delivered to growers has increased each year that the recycled water facility has been in operation, from 1,298 af in 2009 to 2,950 af in 2013. A substantial portion of the supply, however, is not being used because:

1. It is not available during the daytime when demand is the highest
2. There is insufficient nighttime demand to utilize the nighttime supplies
3. There is insufficient demand in the "shoulder" periods before and after the peak irrigation season, particularly March to mid-April and October to mid-November

Currently, recycled water is not produced at night unless there is a demand (water order) by a grower or group of growers. Water that has received secondary treatment is sent through the City of Watsonville's ocean outfall when there is no demand for delivered water at night. A goal of the BMP Update was to develop projects and programs that would increase demand and deliveries during the irrigation season to fully utilize the 4,000 AFY available from the facility. This project, Increased Recycled Water Storage at Treatment Plant, addresses Item 1 above, insufficient supplies during the daytime. Items 2 and 3, insufficient nighttime and shoulder period demand, are addressed in the following section, Increased Recycled Water Deliveries.

Project Description

The most cost-effective way to provide additional supplies of disinfected, tertiary treated water during the day is to treat and store recycled water that can be produced at night. This project was developed to provide that additional recycled water storage for daytime deliveries.

The recycled water treatment facilities currently include approximately one million gallons (MG) of water storage. Space is available south of the existing storage tank to add up to approximately two MG of storage. This project would add up to two one-million-gallon storage tanks at the treatment plant and additional pumps at the distribution pump station to allow more recycled water to be sent to the CDS during the daytime over the peak demand months (May through September). The project also includes installation of approximately 500 feet of parallel 24" diameter CDS pipe adjacent to the treatment plant. The proposed location of the storage tanks, pumps, and parallel 24" pipe is shown in Figure 5-1. A schematic of the project is shown in Figure 5-2.

Water Quality and Yield

Two million gallons of additional storage is estimated to allow an additional 750 AFY of recycled water to be supplied to meet daytime demand in the CDS. The additional storage will need to be designed to minimize the potential for dead zones in the tanks, which could affect water quality.

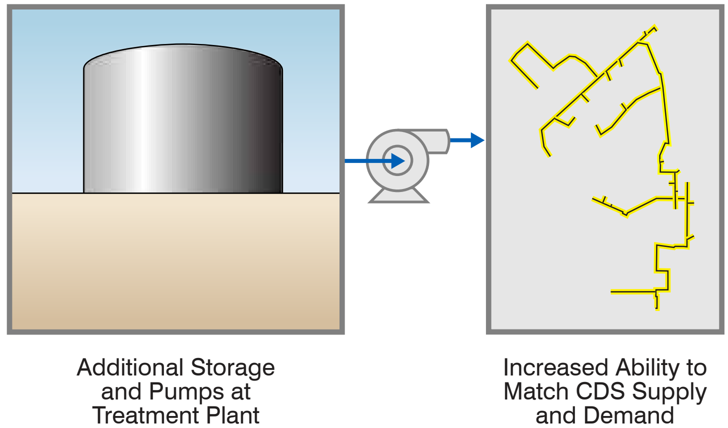

Figure 5-2. Increased Recycled Water Storage at Treatment Plant Project Schematic

Implementation Issues

PVWMA staff is reviewing funding opportunities, and the project may be able to be completed prior to 2015 if funding is available. Space next to the existing 0.5-MG clear well is limited and includes a stormwater detention basin. The storage tanks will likely need to be designed to allow stormwater detention in the vicinity of the tanks.

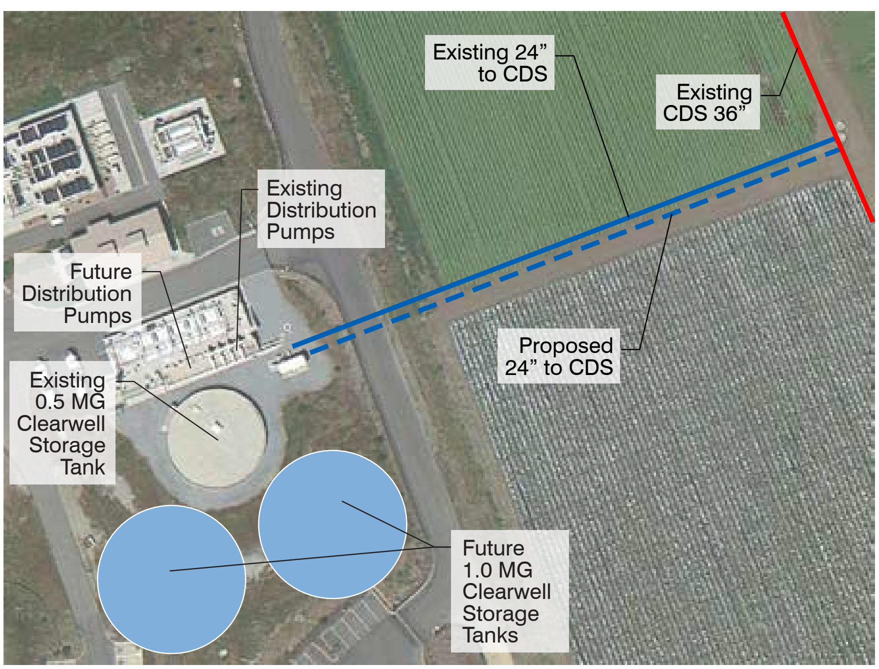

Figure 5-1. Increased Recycled Water Storage at Treatment Plant Project Plan

Planning Level Cost Estimate

The estimated total implementation cost for Increased Recycled Water Storage at Treatment Plant is $6.2 million. Project costs are summarized in Table 5-1.

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Increased Recycled Water Deliveries

Project Background

As described in the previous section, a substantial portion of recycled water supplies are not being used due in part to insufficient nighttime and shoulder period demand. Figure 5-3 shows a typical peak irrigation system recycled water demand and supply pattern. As the figure indicates, during the daytime the irrigation demand is greater than the supply. At night, the pattern is reversed, with the flow to the wastewater treatment plant typically well in excess of the irrigation demand. The increased storage project, presented above, is estimated to deliver approximately 750 AFY, and the remaining additional recycled water will need to be delivered at night and during the shoulder periods to fully utilize the 4,000 AFY available. The purpose of this project is to increase nighttime irrigation season recycled water deliveries by approximately 1,000 AFY and shoulder period recycled water deliveries by approximately 250 AFY, for a total of 1,250 AFY increased deliveries from 2011 levels.

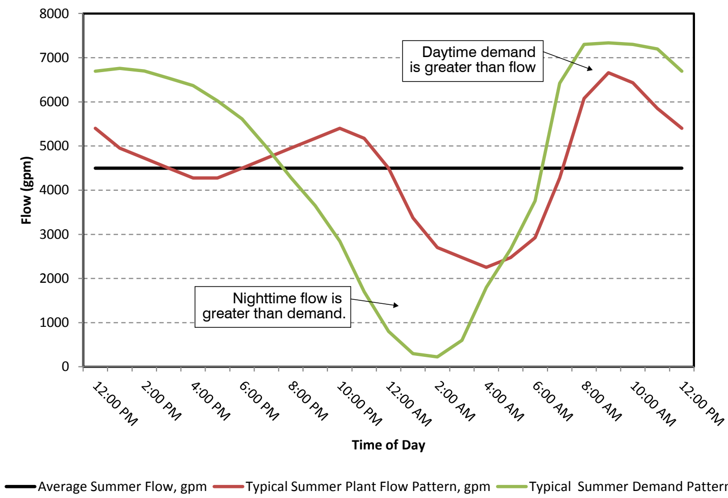


Figure 5-3. Typical Summer Recycled Water Demand and Supply Pattern

As of January 2014, Agency operations staff have made substantial progress towards these goals working with the grower community.

Project Description

A schematic of Increased Recycled Water Deliveries is shown in Figure 5-4 on the following page.

The BMP Committee identified strategies to increase recycled water deliveries that included the following:

- Pricing of delivered water.
- Peer encouragement.
- Lease or producer requirements.
- Mandatory use ordinance.

Pricing of Delivered Water

Financial incentives could be used to increase nighttime recycled water demand. Due to electrical energy time-of-use pricing, electricity used to run the recycled water treatment facilities (primarily pumping and UV disinfection) costs approximately $50/af less during the night, compared to the average daily cost. Financial incentives could include providing a credit or rate reduction of $50/af to users with a flow of at least 800 gallons per minute (gpm) who irrigate for a minimum of ten hours at night.

Peer Encouragement

Peer encouragement could potentially increase delivered water use by encouraging coastal growers who do not use delivered water, or use limited amounts, to be "part of the solution." PVWMA staff has, however, done considerable public outreach through growers meetings, newsletters, and other means to make sure current and potential customers know about the benefits of taking delivered water. It is unclear that peer encouragement could have further significant impact in increasing delivered water use.

Lease or Producer Requirements

Some landowners limit the amount of well water that a tenant can use to 15% to 20% of total annual use. Others are considering requiring growers from whom they purchase products to use delivered water, if available. Such requirements have the potential to significantly reduce pumping and increase delivered water use. To encourage this, additional education and outreach to landowners as to the basin-wide benefits of reduced coastal pumping would be implemented.

Mandatory Use Ordinance

PVWMA could put in place a mandatory use ordinance requiring all growers with access to delivered water to use delivered water and stop pumping from their wells. Such an ordinance is in place in the northern Salinas Valley. A PVWMA mandatory use ordinance would require that the PVWMA be able to reliably supply sufficient water to meet the irrigation needs of all growers in the delivered water zone. It would constitute a major shift from the current voluntary and cooperative nature of efforts to solve basin overdraft.

Water Quality and Yield. The goal of this program is to increase recycled water use by approximately 1,250 AFY from 2011 levels, in addition to the approximately 750 AFY estimated to be supplied during the day when Increased Recycled Water Storage at Treatment Plant is in operation.

Water quality at nighttime could be worse than during the day since nighttime supplies to the CDS have historically included less blend water and therefore has had a higher TDS. This is due to limited demand and the minimum flow the recycled water facility can produce, which is about 2,000 gpm. The PVWMA Water Quality Project and Operations Committee has recommended that the Board consider setting a policy to provide similar water quality at night and during the day by blending the recycled water with roughly the same percentage of potable or supplemental well water at all times.

Implementation Issues. Much success is being realized by current efforts to encourage more deliveries. Since 2011, deliveries have increased by an average of 20 percent per year. This is likely due to the increased grower acceptance of the new supply, the outreach and education efforts having a positive impact, the deterioration of pumped groundwater quality at the coast, and a lack of precipitation. The BMP Committee did not make a recommendation as to how best encourage growers to increase recycled water deliveries. It was the Committee's belief that this was a policy decision that rests at the Board level. On October 24, 2012, the PVWMA Water Quality Project and Operations Committee recommended to the Board that it evaluate a reduction in nighttime delivered water rates as a mean to encourage increased use. On December 19, 2012, the Board approved the concept of reduced rates for nighttime delivered water for large users with long sets, with the details of the reduced rates to be determined in the future.

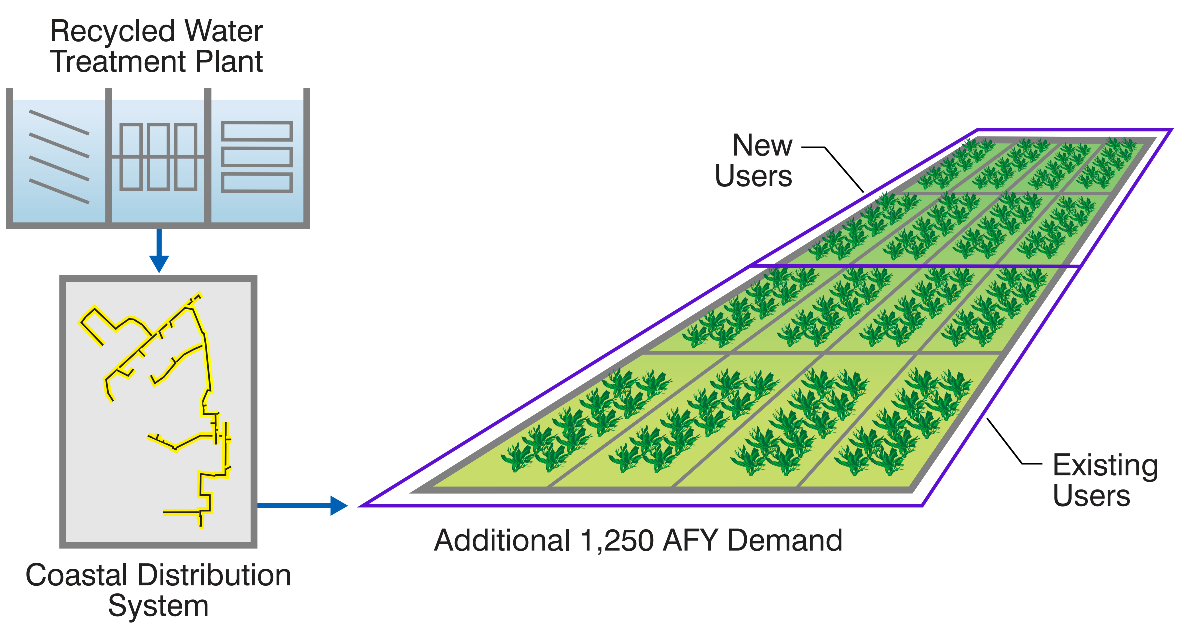


Figure 5-4. Increased Recycled Water Deliveries Project Schematic

Impediments to increased delivered water use identified to date include the price of delivered water compared to pumping and the convenience of pumping groundwater at any time of day.

Planning Level Cost Estimate. The cost of increasing deliveries of recycled water will depend on the methods selected by the Board to encourage increased deliveries. It is anticipated that financial incentives to increase nighttime recycled water use will not decrease net revenue because more water will be sold at a lower average production cost. Financial analysis would be needed to confirm this.

Table 5-1 Cost Estimate for Increased Recycled Water Storage at Treatment Plant

Project Element	Planning Level Cost Estimate[1]
Site work	$500,000
Reservoirs	$2,300,000
Tank appurtenances	$60,000
Additional pumps	$120,000
Electrical, instrumentation & controls	$260,000
Total Direct Cost	**$3,200,000**
Construction contingency (30%)	$960,000
General conditions (20%)	$640,000
Contractor overhead and profit (10%)	$320,000
Sales tax (8.25% of 25% of direct cost)	$70,000
Total Construction Cost	**$5,200,000**
Engineering, legal, administration, permits (20%)	$1,040,000
Total Estimated Project Capital Cost	**$6,200,000**
Annualized capital costs[2]	$450,000
Reservoir O&M (0.15%)	$4,000
O&M pumps (2.5%)	$10,000
Power costs (3000 gpm for 250 AFY, for 450 hours at $0.15/kW-h)	$50,000
Total Annualized Cost	**$510,000**
Annual Yield (af)	**750**
Unit Cost ($/af)	**$700**

[1]Costs are expressed in 2011 dollars. Inflation, which will occur between 2011 and actual project construction, will increase these costs.

[2]Annualized costs are based on a 30-year capital recovery period at 6% interest.

Harkins Slough Recharge Facilities Upgrades

Project Background

The Harkins Slough Recharge Facilities were constructed in 2002 and seasonally store wet weather flows from Harkins Slough in the shallow aquifers near the coast. The wet weather flows are pumped through pressure sand filters and then to a recharge basin where the water percolates into the ground. Stored water is pumped from a series of recovery wells and is delivered to coastal farms through the CDS during the irrigation season. The location of the Harkins Slough Recharge Facilities is shown in Figure 5-5.

On June 8, 2000, PVWMA received Permit for Diversion and Use of Water #21039 from the State Water Resources Control Board (SWRCB), which allows the use of up to 2,000 AFY of Harkins and Watsonville Slough water from November 1 to May 31.

The project has diverted a total of 7,000 af (an average of approximately 580 AFY) from Harkins Slough from 2002 through 2013, with a maximum of 904 af in 2010. The average annual yield from the extraction wells to the CDS was estimated to be 1,100 AFY at the time the project was constructed. The project has delivered an average of 180 AFY of water to the CDS from 2002 through 2013, with a maximum of 252 af in 2011.

Diversions from the slough have historically been limited by inadequate water quality in the slough and the diversion pump intakes being clogged with mud. Water supplied to the CDS from the extraction wells has been limited by low yields from the wells. The low yields are partly due to the presence of fine grained sediment lenses (silt and clay) located above the screened interval of several recovery wells, which restricts the flow of water in the subsurface.

In early 2001, when the facility was still under construction, ten extraction wells were installed around the recharge basin. These ten wells were constructed with a 40-foot perforated interval, with perforations averaging 36 feet above sea level to about 5 feet below sea level. As noted above, yield from the wells has been much lower than anticipated. In 2008, the PVWMA was awarded a Local Groundwater Assistance Grant (AB303) from the California Department of Water Resources for a proposal called the Harkins Slough Project Re-Operation Feasibility Study. As part of that study, three new monitoring wells were installed around the recharge basin in an effort to detect diverted slough water leaking into the surficial aquifer. The study led to a detailed review of existing recovery well construction data and analysis of associated SCADA data, and eventually to the construction of three new recovery wells in 2012.

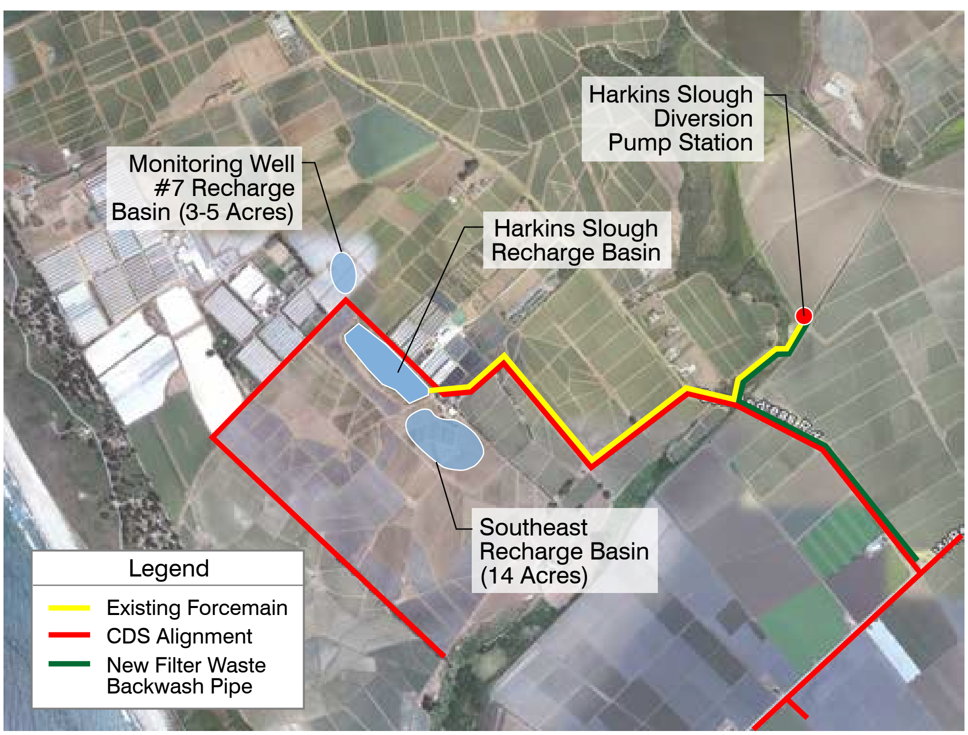


Figure 5-5. Harkins Slough Recharge Facilities Upgrades Project Plan

Collaborative studies with the University of California Santa Cruz and Stanford University were taking place at the recharge basin concurrently. The UC Santa Cruz group was studying the spatial and temporal dynamics of recharge (Racz et al. 2012) and the effects of recharge on denitrification (Schmidt et al. 2011). The Stanford team was testing and continues to test geophysical methods to learn about the infiltration and deeper percolation of recharged water (Haines et al. 2008; Pidliseky et al. 2010). The Racz et al. 2012 study of the Harkins Slough Recharge Basin found there was high spatial and temporal variability in point-specific infiltration rates, with the mean of measured values generally lower than rates indicated by whole-pond calculations. Infiltration rates at the Harkins Slough Recharge Basin varied between 3 feet/day to less than 0.3 feet/day.

As described above, PVWMA's existing water rights permit for Harkins and Watsonville Slough diversions was received in 2000. A water rights permit may be finalized or "licensed" as a water right by the SWRCB after 10 years of putting the water to beneficial use. However, the SWRCB will typically grant a license only for the maximum annual amount of water utilized during the permit period, and 904 af is the maximum annual amount diverted to date. In order to realize the full benefits of the original Harkins Slough Project, the PVWMA applied to the SWRCB in December 2011 for a 10-year extension to put the 2,000 AFY to beneficial use. On July 13, 2012, the PVWMA received a draft amended permit from the SWRCB that extends the date for putting the water to beneficial use until December 31, 2021. The PVWMA commented on the draft permit in October 2012.

Facility improvements are needed to accomplish three goals:

1. Maximize diversions from the slough.
2. Maximize infiltration of diverted water.
3. Maximize water extracted from the recovery wells and supplied to the CDS.

The Harkins Slough Recharge Facilities Upgrades are designed to accomplish these goals through the construction of new infrastructure and upgrades to existing infrastructure.

Project Description

The project includes installation of new shallow extraction wells at the recharge basin, upgrading the pump station and filters at the slough diversion to improve system operation and recharge percolation rates, and construction of a new recharge basin. Potential recharge basin locations identified to date include the Southeast Recharge Basin and Monitoring Well #7 Recharge Basin sites, as shown in Figure 5-5. A project schematic is shown in Figure 5-6.

In 2011, PVWMA removed the invasive vegetation and accumulated mud that had prohibited the pump station from operating at full capacity. This project includes replacing the pumps to allow the PVWMA to better control the amount of flow sent to the pressure filters, construction of coagulant addition facilities and additional filters to reduce the amount of solids sent to the recharge basin, and construction of an additional recharge basin. The pump station upgrades may also include upgrades to the pump house, controls, and intake to improve facility reliability and minimize future clogging issues.

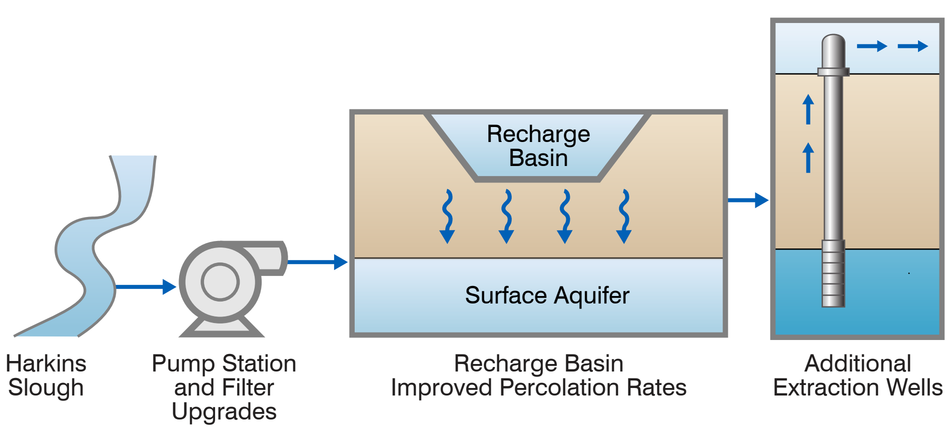


Figure 5-6. Harkins Slough Recharge Project Upgrades Project Schematic

The USDA Natural Resources Conservation Service (NRCS) is planning to construct a wetland on land between Harkins Slough and Watsonville Slough and to divert water from the sloughs into it. This may improve the water quality diverted to the recharge basin. The proposed diversion from the sloughs into the wetlands would be upstream of the confluence of Watsonville and Harkins Sloughs and the Harkins Slough Pump Station. The PVWMA will coordinate with the NRCS when implementing the Harkins Slough Recharge Facilities Upgrades component of the BMP Update.

New extraction wells near the existing recharge basin will be built sequentially so that each well location and screened depth can be based on information from the previous wells. The number of wells required depends on the yield of individual wells. Horizontal drilling and additional new site(s) for recharge will also be considered.

Table 5-2 Cost Estimate for Harkins Slough Recharge Basin Facilities Upgrades

Project Element	Cost Estimate[1]
Additional shallow extraction wells	$1,000,000
Pump station upgrades	$500,000
Coagulant addition facilities and additional filters	$800,000
Filter waste backwash discharge line and pump station	$600,000
Total Direct Cost	**$2,900,000**
Construction Contingency (30%)	$870,000
General Conditions (20%)	$580,000
Contractor Overhead and Profit (10%)	$290,000
Sales Tax (8.25% of 50% of Direct Cost)	$120,000
Total Construction Cost	**$4,800,000**
Engineering, Legal, Admin, Permits (20%)	$1,000,000
Total Estimated Project Capital Cost	**$5,800,000**
Annualized Capital Cost[2]	$420,000
O & M Pump and Treatment (3%)	$90,000
Total Annualized Cost	**$510,000**
Annual Yield (af)	**1,000**
Unit Cost ($/af)	**$500**

[1]Costs are expressed in 2011 dollars. Inflation, which will occur between 2011 and actual project construction, will increase these costs.

[2]Annualized costs are based on a 30-year capital recovery period at 6% interest.

Water Quality and Yield

The goal of the upgrades is to increase the project's yield of recovered water by approximately 1,000 AFY on average, in addition to the current recovered water yield of approximately 200 AFY. The average projected yield is lower than the maximum diversion of 2,000 AFY. This is because some years the maximum diversion is not possible due to high suspended solids affecting filtration and percolation rates, and high TDS. With the diversion limitation of 2,000 AFY, the average yield of the project cannot be increased beyond approximately 1,200 AFY without a new water rights permit application. However, a new diversion from the sloughs is the basis for the Watsonville Slough with Recharge Basins Project described in the following section.

Diversions from Harkins Slough are permitted to occur from November through May. In practice, diversions have occurred no earlier than December, when the quality of slough water becomes acceptable for recharge. Diversions occur when the turbidity level is less than 50 NTU so that the filters do not get clogged. Elevated chloride concentrations, a result of the 2012 brackish water flood, greatly reduced the period of diversion in 2012 and 2013. This could become a greater problem in the future due to a rising sea level and the types of storms we may see with climate change. The planned wetland construction by the NRCS could improve the water quality at the diversion point by (1) bringing higher quality water from the Watsonville Slough to Harkins Slough and by (2) reducing turbidity by settling solids in the wetland.

Implementation Issues

CEQA review is required for the Harkins Slough Recharge Facilities Upgrades. The pump station upgrades may involve construction in Harkins Slough, depending on the need to modify the existing pump station foundation and intake, which would lengthen the implementation process due to required in-stream construction permits. In addition, facility improvements are complicated by diversion pump ownership and maintenance responsibilities. The pumps are owned by Santa Cruz County, and any maintenance or improvements to the pumping facility must be coordinated with the County.

The PVWMA has gained a better understanding of Harkins Slough Recharge Basin hydrogeology through the studies noted above, which should allow improved recovery well design and yields. However, increased recovery well yields cannot be confirmed until new wells are tested and operated over time.

Planning Level Cost Estimate

The estimated total capital cost for the Harkins Slough Recharge Facilities Upgrades is $5.8 million. Project costs are summarized in Table 5-2. The costs for an additional recharge basin are included in the Watsonville Slough with Recharge Basins Project.

Watsonville Slough with Recharge Basins

Project Background

The Watsonville Slough system consists of six major branch sloughs: Watsonville, Harkins, Hanson, Struve, West Branch of Struve, and Gallighan. The slough system is a network of approximately 800 acres of coastal salt marsh, seasonal wetlands, brackish and freshwater emergent marsh and riparian communities. It receives runoff from a 13,000-acre watershed area. The Resource Conservation District of Santa Cruz County is conducting a hydrologic study of Watsonville Slough which is planned to be completed in March 2014. The results of the study should increase the understanding of the Watsonville Slough system.

This project is designed to utilize the available freshwater surface supply. The project approach and design are similar to the Harkins Slough Recharge Facilities, including diversion, treatment, and recharge facilities as described below. Permitting for the project is similar to the permitting for the Harkins Slough Recharge Facilities, including a water rights permit from the SWRCB.

The NRCS is planning to construct a wetlands between Harkins Slough and Watsonville Slough, upstream of the existing Harkins Slough diversion. The wetlands would be operated by diverting water from the sloughs into the constructed wetlands, which would allow Watsonville Slough water to be fed to the Harkins Slough pump station. The PVWMA would coordinate this project with the NRCS project.

Project Description

The Watsonville Slough with Recharge Basins Project would divert Watsonville Slough water during winter high flows from December to May. The water would be stored in the surficial groundwater aquifer at the proposed North Dunes Recharge Basin (PVWMA 2002) and/or at alternative locations near the existing Harkins Slough Recharge Basin (the Southeast Recharge Basin and the Monitoring Well #7 Recharge Basin). The location of these sites is shown in Figure 5-7 on the following page.

Water would be diverted directly from the Watsonville Slough within the yellow area shown on Figure 5-7 (specifically, from just south of the Harkins Slough to approximately 2,000 feet upstream of Harkins Slough). If the NRCS wetland is constructed on the land between the Harkins/Watsonville prior to project design, the diversion location for the project may be located within, or downstream of the constructed wetland area. A pump station at the diversion point would pump the water in a pipeline to a new or expanded filtration facility located at the site of the existing Harkins Slough filter plant. The filtered water would be pumped to the recharge site through the Harkins Slough Recharge Facilities pipeline and through a new connecting pipeline, and then stored in the surficial aquifer. A schematic of the proposed component is shown in Figure 5-8.

The proposed North Dunes Recharge Basin would require a 25-acre percolation area, assuming a percolation rate of 0.3 feet/day (RMC 2001), based on a maximum diversion rate of 2,000 AFY from Watsonville Slough between December and May. The Southeast Recharge Basin would require a smaller percolation area of 14 acres based on a faster infiltration rate of 0.6 feet/day (PVWMA 2002), but it would require further evaluation to determine storage and recovery characteristics. Percolation tests have not been performed at Monitoring Well #7 Recharge Basin site. A recent study of the Harkins Slough Recharge Basin found that there was high spatial and temporal variability in point-specific infiltration rates, with the mean of measured values generally lower than rates indicated by whole-pond calculations (Racz et al. 2012). Infiltration rates at the Harkins Slough Recharge Basin varied between 3 feet/day and less than 0.3 feet/day. Future studies would be needed to better determine infiltration rates in the proposed basins in order to design corresponding basin size.

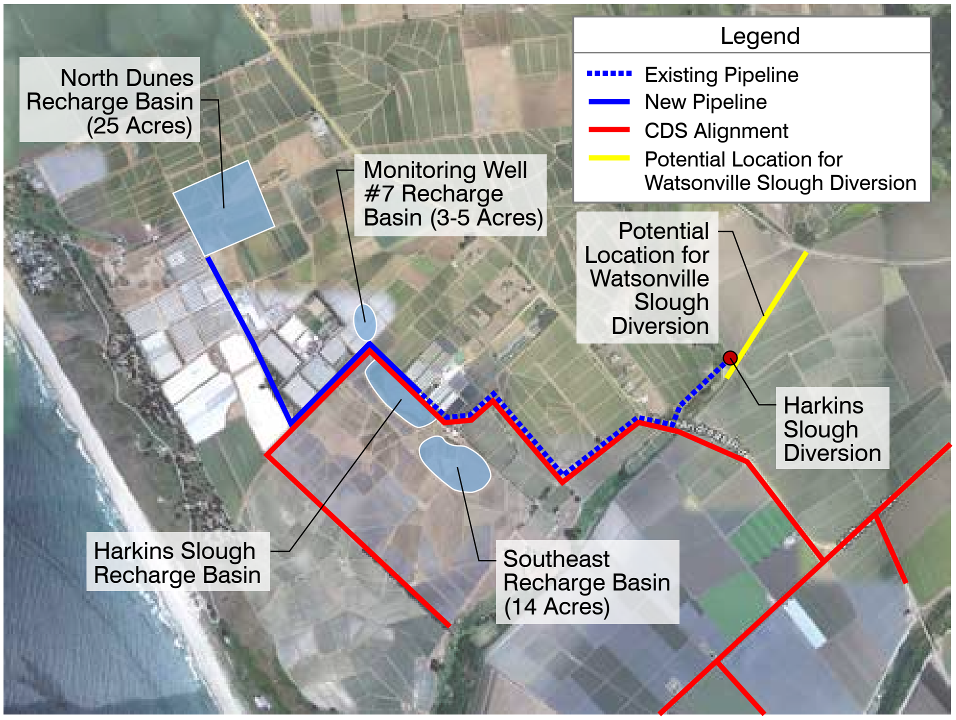


Figure 5-7. Watsonville Slough with Recharge Basins Project Plan.

Recovery wells constructed around the recharge basin(s) would extract water during the irrigation season. Horizontal drilling will be considered. As planned, this project would require construction of a diversion structure, inlet pump station, filtration facility, booster pump station, recharge basins, recovery wells, and up to approximately 8,000 feet of connecting pipelines. The pipeline routing could be modified if the CDS Expansion Project were built, allowing for a shared pipeline leading to the Harkins Slough Recharge Basin and additional piping leading to the North Dunes Recharge Basin. The pipeline could also potentially be routed to the recycled water plant as an alternative source of blend water.

Water Quality and Yield

The proposed project would yield approximately 1,200 AFY. The yield is lower than the maximum diversion of 2,000 AFY due to years when the maximum diversion is not possible because of water quality and flows.

Diversions would occur from December through May when the quality of slough water is acceptable for recharge. As stated in the 2002 BMP, raw water from the slough typically exhibits TSS and turbidity concentrations higher than those generally required for percolation. To avoid clogging the recharge basin, filtration would need to reduce the TSS to acceptable levels.

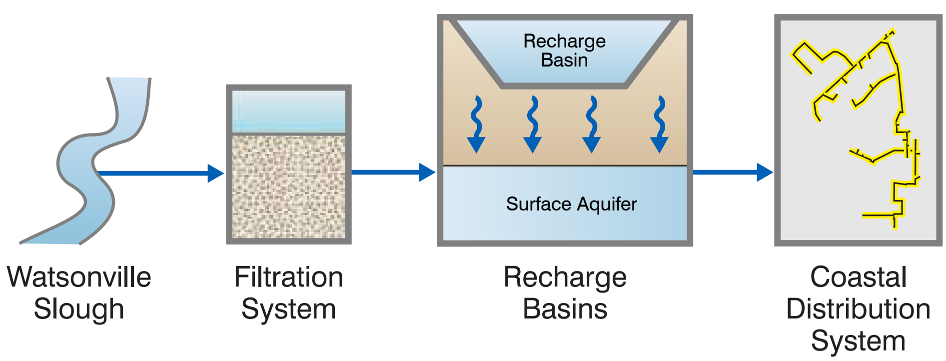


Figure 5-8. Watsonville Slough with Recharge Basins Project Schematic

Implementation Issues

CEQA review is required for the Watsonville Slough with Recharge Basins Project. Implementation issues include water rights, hydrogeology, and permitting. The PVWMA currently has a right to withdraw a maximum of 2,000 AFY from Harkins Slough and Watsonville Slough, with withdrawals limited to much less than 2,000 AFY in some years due to water quality and flows. Therefore, the PVWMA would need to obtain a new water rights permit from the SWRCB in order to achieve an average yield of 1,200 AFY from this project, in addition to the planned yield of 1,200 AFY from the upgraded Harkins Slough Recharge Facilities. Additionally, water diversion, sedimentation, and water recovery issues which have occurred at the Harkins Slough Project, could be areas of concern for this project. Hydrogeologic and engineering studies would be conducted to optimize the design of the facilities. The PVWMA is also evaluating ways to address these issues by speaking with representatives of other water districts who operate recharge basins, and by collaborating with local universities.

The diversion point for Watsonville Slough water may be influenced by the final design of the proposed NRCS wetlands. A possible diversion alternative that could expedite the environmental permitting process and water rights acquisition is to locate the diversion point on Harkins Slough at the outlet of the proposed wetland. The PVWMA would coordinate the proposed diversion location with the NRCS project.

This project is planned to store and recover water in a degraded perched aquifer and would need to be permitted similarly to the existing Harkins Slough Recharge Facilities. Technical Memorandum No. 2 The Dunes Recharge Project (CH2MHILL 1997) indicated that recharge sites in the area of the North Dunes Recharge Basin may have the potential to directly recharge the Aromas Formation aquifer. Water perched above the clay layer may be percolating into the Aromas aquifer in areas where the clay is noncontinuous. Additional studies may be required to demonstrate that the project is improving the quality of water in a degraded perched aquifer and not impairing groundwater quality, or additional treatment may be required before discharging water to the proposed recharge basin.

Planning Level Cost Estimate

The estimated total implementation cost for the Watsonville Slough with Recharge Basins Project is $14.7 million. Project costs are summarized in Table 5-3.

Table 5-3 Cost Estimate for Watsonville Slough with Recharge Basins

Project Element	Planning Level Cost Estimate[1]
Watsonville Slough Diversion, Pumps, and Piping	$600,000
7,500 gpm pump and filters	$1,100,000
Recharge basin with recovery wells, monitoring wells	$3,000,000
24-inch Pipeline to/from Harkins Slough pipeline	$1,800,000
Fittings, valves, etc.	$100,000
Total Direct Cost[2]	**$6,600,000**
Construction contingency (30%)	$2,000,000
General conditions (20%)	$1,300,000
Contractor overhead and profit (10%)	$700,000
Sales tax (8.25% of 50% of direct cost)	$300,000
Total Construction Cost	**$11,000,000**
Engineering, legal, administration, permits (20%)	$2,200,000
Technical studies	$500,000
Land acquisition and right-of-way easements[2]	$1,000,000
Total Estimated Project Capital Cost	**$14,700,000**
Annualized capital cost[3]	$1,070,000
O&M pump and treatment[2]	$130,000
Total Annualized Cost	**$1,200,000**
Annual Yield (af)	**1,200**
Unit Cost ($/af)	**$1,000**

[1]Costs are expressed in 2011 dollars. Inflation, which will occur between 2011 and actual project construction, will increase these costs.
[2]Cost based on 2002 BMP adjusted to 2011 dollars (ENR-CCI 1.296)
[3]Annualized costs are based on a 30-year capital recovery period at 6% interest.

College Lake with Inland Pipeline to CDS

Project Background

College Lake is located approximately one mile northeast of the Watsonville city limits. It is a naturally occurring seasonal lake that receives water inflows from the Green Valley, Casserly, and Hughes Creek subwatersheds. These streams drain approximately 11,000 acres of range, rural residential, and crop lands. Casserly Creek and two of its tributaries, Banks Creek and Gaffey Creek, are known to support the state and federally listed south-central California coast steelhead (*Onchorhynchus mykiss*). Outflows from the lake naturally flow downstream to Salsipuedes Creek (mixing with overflow from Pinto Lake) in the winter. A low flashboard dam, operated by the College Lake Reclamation District Number 2049 on the south side of the lake, causes inundation of approximately 234 acres of the basin (DDA 2013) and helps prevent water from Salsipuedes Creek from entering College Lake. In the spring, usually beginning mid-March to May 1st, depending on the amount of spring rains, the lake basin is pumped dry to allow farming to take place during the summer. Pumping generally continues intermittently throughout the summer until mid-October or November, depending on early rains and crops that may need to be harvested (Allen Harryman, College Lake Reclamation District, personal communication, September 2012). The majority of the lakebed is used for row crops. The College Lake Project was included in the PVWMA Local Water Supply and Distribution Projects Environmental Impact Report (ESA 1999).

The US Army Corps of Engineers is studying how to optimize College Lake for flood control. It is developing plans for levee reconstruction along Salsipuedes Creek, which includes relocating a stretch of Pinto Creek near College Lake (USACE 2012).

There is an opportunity to increase the storage capacity of the lake, allowing water to be captured, stored, and delivered for irrigation. This project includes the development of the facilities required to store, treat, and deliver the water.

The Resource Conservation District of Santa Cruz County (RCD) is conducting a study of College Lake water flows, usage, and resource management to be completed in 2014. The study will increase the understanding of the hydrology of College Lake to inform and support collaboration in developing a multi-benefit alternative for College Lake. This will involve developing a set of management measures for the lake that maximizes benefits for water supply and flood management, while preserving steelhead migration. It also will support other environmental and community benefits. Results of the study will play a major role in PVWMA's development of this project.

Project Description

This project includes construction of a new adjustable weir downstream of the existing low dam. The new outlet weir would raise the College Lake outlet elevation by 2.3 feet to 62.5 feet. This would increase the total storage capacity of the lake from approximately 1,000 af to approximately 1,700 af (USACE 2007). It also would increase the total inundated area from approximately 234 acres to 272 acres (DDA 2013). The water pumped out of College Lake would be filtered and disinfected at College Lake prior to distribution. Construction would include approximately 5.8 miles of a new water main, a new pump station, and a filtration plant with disinfection. A project plan is shown in Figure 5-9, and a project schematic in Figure 5-10.

The project would send water from College Lake during the summer through a new pipeline either to the Recycled Water Facility (RWF) storage tank to supply the CDS or directly to the CDS, with provisions to supply inland users along the new water main pipeline. Sending College Lake water to the RWF storage tank would allow blending with recycled water before distribution to provide more uniform water quality to CDS users; however, it would reduce the amount of storage available for recycled water. Conversely, sending College Lake water directly to the CDS preserves the amount of storage available for recycled water at the RWF; however, it would result in varying water quality in the CDS, depending on the timing of College Lake and recycled water being pumped to the CDS. The facilities would be constructed to allow College Lake water to be supplied to either location and to allow the PVWMA flexibility in balancing water quality and storage.

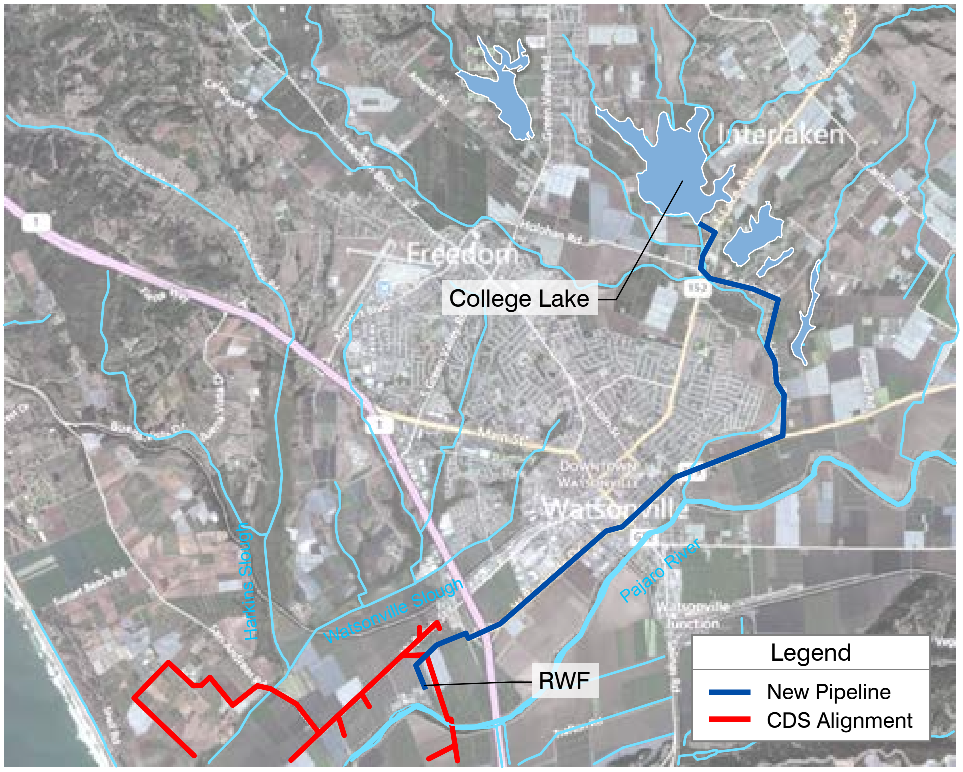


Figure 5-9. College Lake with Inland Pipeline to CDS Project Plan

outflow requirement is based on a minimum flow requirement of 7.5 cfs in Salsipuedes Creek immediately downstream of the Corralitos Creek confluence. This flow includes an estimated minimum of 300 af (2 cfs) coming from College Lake over the weir from March 15 to May 31 for steelhead smolt outmigration (ESA 2002). These minimum flow estimates were derived from a 1997 channel configuration (critical riffle) assessment that will need to be confirmed. Moreover, the existing College Lake dam is typically fully inundated during the winter adult steelhead upmigration period (approximately January through March) under current conditions; therefore, it does not present an adult migration impediment at this time. However, depending on existing hydrology, the proposed raising of the dam by 2.3 feet may delay its overtopping. This could impede adult upmigration and necessitate an adult passage structure and adult bypass flows that were not evaluated during the 1997 investigations.

Water quality at College Lake varies seasonally. During the first storms of the season, the runoff collected in College Lake exhibits high values of TDS, nitrates, and other constituents. High nitrate concentrations are typically observed during the beginning of the rainy season, with dilution occurring through the rainy season and improving water quality (RMC 2001).

The results of the RCD study will help further define how College Lake can be developed as a water supply source, while preserving habitat for steelhead and other wetland/riparian species. It also will support other environmental and community benefits and will help reduce implementation issues for the project.

Water Quality and Yield

The proposed project would provide a yield of approximately 2,100 to 2,400 AFY. The estimated yield includes the volume of the lake of 1,700 af, plus an estimated inflow of 700 to 1,000 af during the irrigation season, minus an estimated outflow of 300 af to satisfy minimum flow requirements downstream for steelhead habitat. The estimated College Lake

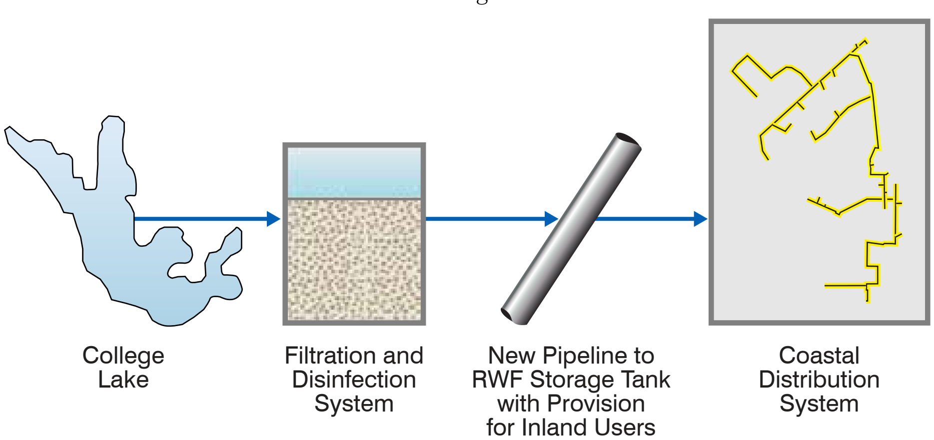


Figure 5-10. College Lake with Inland Pipeline to CDS Schematic

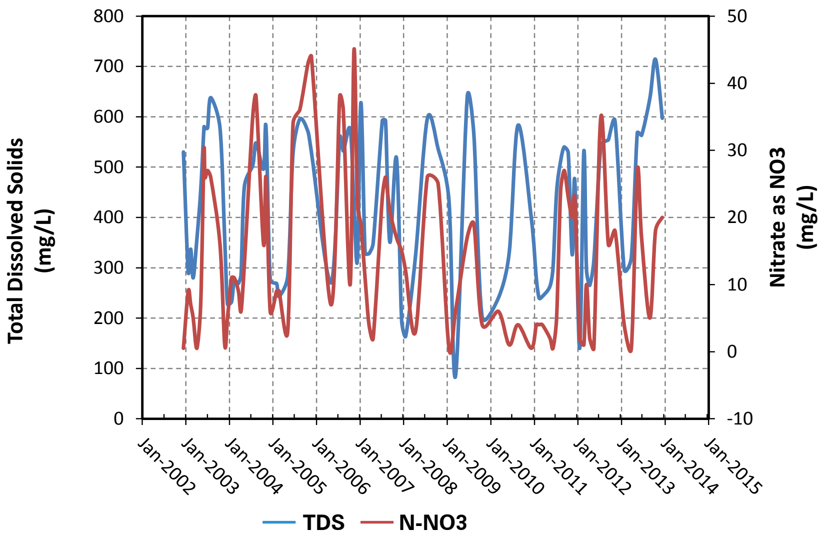


Figure 5-11. College Lake Outflow Water Quality 2002-2013

Figure 5-11 is a chart of average TDS and nitrate concentrations collected at the College Lake outlet from 2002-2013 and showing annual TDS and nitrate fluctuations. It is assumed that diversions from College Lake would occur after the initial runoff has occurred and sufficient dilution has taken place.

Implementation Issues

CEQA review is required for the College Lake with Inland Pipeline to CDS Project. Environmental habitat is a major issue of concern for implementation of the project. Casserly Creek and two of its tributaries, Banks Creek and Gaffey Creek, are known to support the state and federally listed south-central California coast steelhead (*Onchorhynchus mykiss*). It has been unclear whether College Lake simply constitutes a migratory corridor for adult and smolt steelhead, or whether juvenile steelhead are actually utilizing the lake as seasonal rearing habitat in late winter/early spring prior to outmigration in late spring. A steelhead smolt outmigration study was conducted in the spring of 2011 at the outlet of College Lake (Podlech 2011). While the data for this study were not conclusive, due to the small sample size of collected fish, scale analysis of smolts demonstrated that these fish were rearing in the lake and exhibited substantial recent growth rates. Therefore, College Lake appears to function as a productive rearing habitat for juvenile steelhead prior to their outmigration to the ocean and needs to be managed as such. Also, as a downstream refuge from high winter flows in the small upper watershed creeks, College Lake contributes to an increase in juvenile winter survival and may aid in overall salmonid population stability and persistence. Typically, steelhead passage into Corralitos Creek, Salsipuedes Creek, College Lake, and upstream tributary streams takes place between January and April (CH2MHILL 1999). According to the 2002 EIR, a minimum of 2 cfs would need to be provided from College Lake through May 31st (ESA 2002); however, this 1997 bypass flow estimate would likely be considered outdated for permitting purposes and would need to be reevaluated.

PVWMA submitted a water rights application to the SWRCB in 1995 for diversion and storage at College Lake. The water rights application would need to be re-initiated and a water right received to allow this project to be implemented.

Planning Level Cost Estimate

The estimated total implementation cost for the College Lake with Inland Pipeline to CDS Project is $31.5 million, as summarized in Table 5-4.

Table 5-4 Cost Estimate for College Lake with Inland Pipeline to CDS

Project Element	Planning Level Cost Estimate[1]
New conveyance pipeline	$8,300,000
College Lake headgate and diversion pumps[2]	$1,300,000
Pump station (three 200-horsepower pumps)	$800,000
Environmental habitat and mitigation	$1,000,000
Filtration (6,000-gpm system)	$2,500,000
Disinfection and clearwell	$1,000,000
Total Direct Cost	**$14,900,000**
Construction contingency (30%)	$4,500,000
General conditions (20%)	$3,000,000
Contractor overhead and profit (10%)	$1,500,000
Sales tax (8.25% of 50% of direct cost)	$600,000
Total Construction Cost	**$24,500,000**
Engineering, legal, administration, permits (20%)	$4,900,000
Technical studies	$1,000,000
Land rights	$1,100,000
Total Estimated Project Capital Cost	**$31,500,000**
Annualized construction cost[3]	$2,300,000
O&M pipeline (1%)	$80,000
O&M pump and filters (2.5%)	$120,000
Disinfection	$20,000
Pump power	$120,000
Total Annualized Cost	**$2,600,000**
Annual Yield af	**2,400**
Unit Cost ($/af)	**$1,100**

[1]Costs are expressed in 2011 dollars. Inflation, which will occur between 2011 and actual project construction, will increase these costs.

[2]Cost based on 2002 BMP adjusted to 2011 dollars (ENR-CCI 1.2961).

[3]Annualized costs are based on a 30-year capital recovery period at 6% interest.

Murphy Crossing with Recharge Basins

Project Background

Murphy Crossing with Recharge Basins was included in the PVWMA Local Water Supply and Distribution Projects Environmental Impact Report (ESA 1999). The Pajaro River is the largest stream in the Pajaro Valley, draining approximately 1,190 square miles above the gauge at Chittenden. Streams tributary to the Pajaro River include the Corralitos, Salsipuedes, Brown's Valley, Green Valley, Casserly, and Pescadero Creeks, which drain the southern slopes of the Santa Cruz Mountains in the area. Annual stream flow, as recorded by the US Geological Survey at the Chittenden gauging station, averaged 164 cfs from 1940 through 2011, with a minimum of 1 cfs in 1977 and a maximum of 905 cfs in 1983. Peak flows in the Pajaro River, available between December and May, are a potential water source for diversion and groundwater infiltration.

Project Description

The Murphy Crossing with Recharge Basins Project would divert water from the Pajaro River between December and May. This is when the Pajaro River water quality is within an acceptable range and streamflows are above the required minimum necessary to maintain steelhead habitat. The project includes the construction of an infiltration gallery, pump station, monitoring wells, recharge basins, and a connector pipeline from pump station to recharge basins.

Figure 5-12 shows the proposed project plan, and Figure 5-13 is a schematic of the project. An infiltration gallery located upstream of the Murphy Crossing bridge would capture water and transport it to four recharge basins.

The recharge basins would be located just north of the intersection of Highway 129 and Murphy Road. The site covers approximately 20 acres. The designated area for the recharge basins functions largely as a natural drainage collection area for the farm fields and foothill watersheds to the east of the site.

The recharge basins would have a total area of approximately 9 acres. The basin layout uses as much of the existing natural depressions as possible. The site would be divided into four separate basins, separated by earthen berms, with percolation rates for the basins ranging from 1.7 feet/day for Basins 1, 2, and 3 to 0.6 feet/day for Basin 4 (CH2MHILL 2000). The portion of the proposed recharge basins adjacent to the proposed pipeline (Ortega Basin) was dug out by a local grower in 2011 for collection of

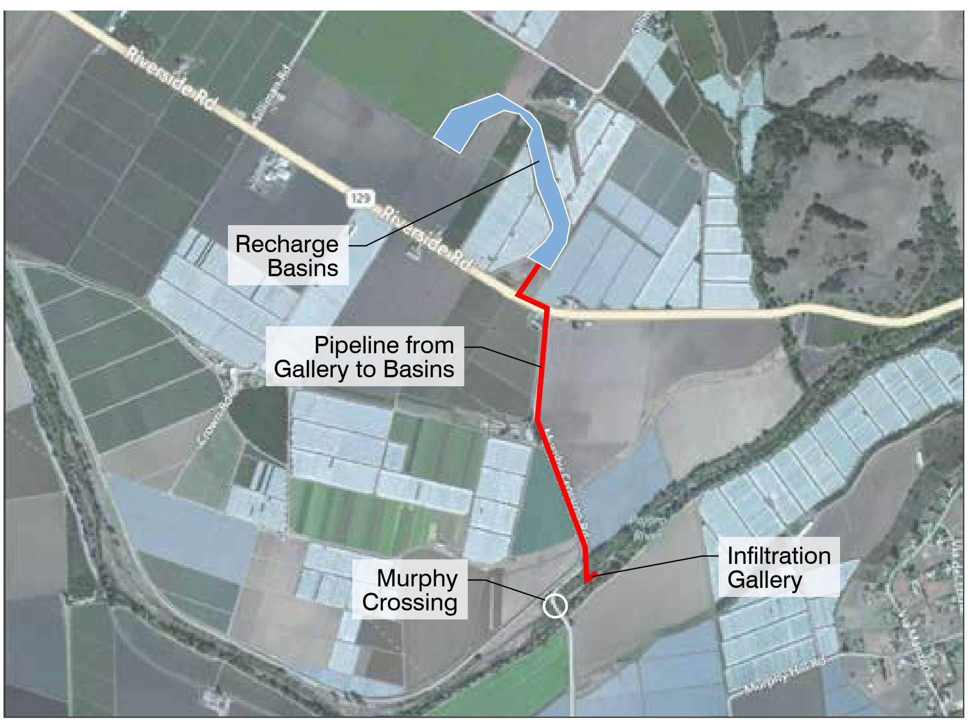


Figure 5-12. Murphy Crossing with Recharge Basins Project Plan

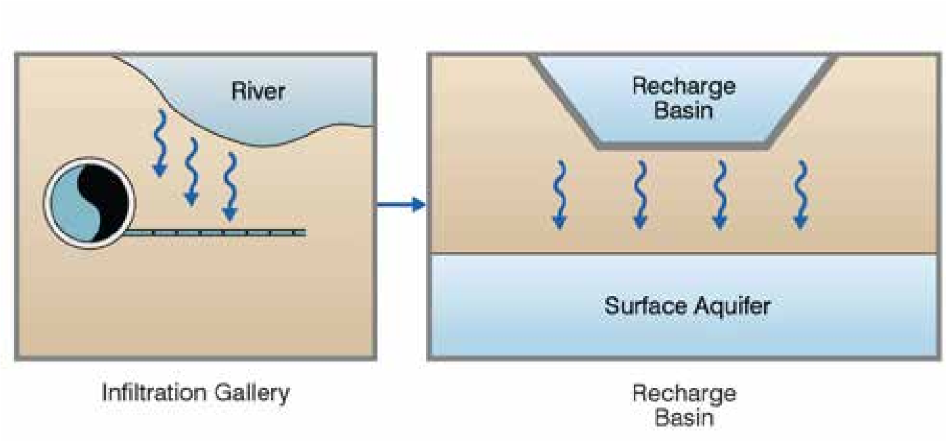


Figure 5-13. Murphy Crossing with Recharge Basins Project Schematic

drainage and groundwater recharge. The portion of the proposed recharge basins farthest from the Ortega Basin, known as the Bokariza-Drobac site, was tested for infiltration capacity in 2011 (Russo 2011). The 2002 BMP estimated that the project's average annual available yield from the river could be up to 1600 AFY; 620 af of this would be available for recharge, and the remaining 980 af would be diverted for irrigation via an inland irrigation pipeline. This scenario was based on 54 diversion days at 15 cfs (CH2MHILL 1999). The current version of the Murphy Crossing Project is for recharge only. Accounting for years of low precipitation volumes and consequently lower flows in the Pajaro River, a conservative yield of 500 AFY is estimated.

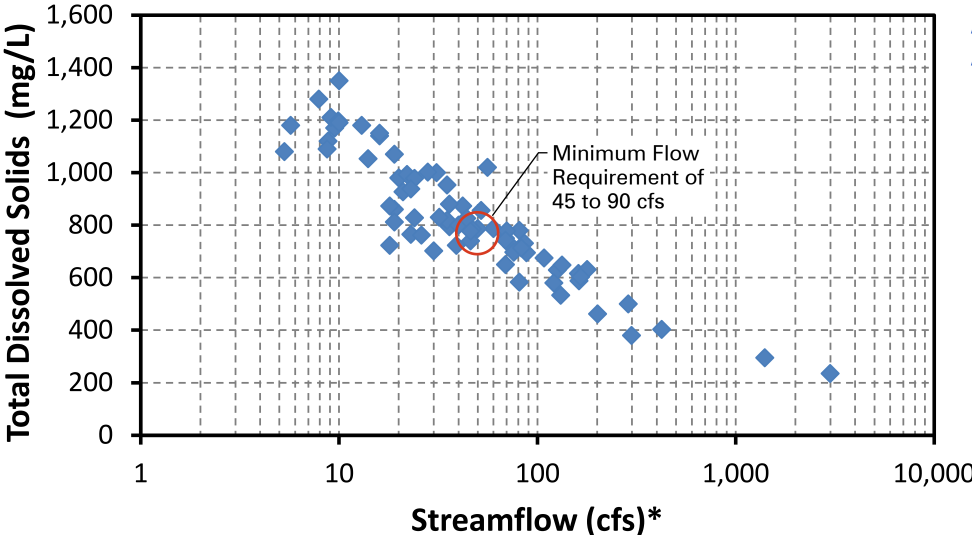
The Murphy Crossing infiltration gallery would generally divert Pajaro River water from late December through mid-May, when flows are highest in the Pajaro River. A variety of numbers, ranging from 35 cfs to 90 cfs, have been used in the past regarding minimal flows needed to avoid impact on steelhead smolt passage. A 1997 report by Habitat Restoration Group (Appendix C in the 2002 BMP EIR) identified a minimum flow rate of 45 cfs for steelhead passage. CH2MHILL (1999) reported that at minimum flow values of 90 cfs, there would be approximately 52 days during which 7,000 gpm could be extracted from the Pajaro River. This extraction volume far exceeds the current proposed extraction volumes. An infiltration gallery would consist of 18-inch-diameter perforated pipe placed approximately 5-6 feet below the river bottom, forming a water collection grid. The infiltration gallery would cover approximately 2 acres of the riverbed just upstream of the Murphy Crossing bridge. River water collected in the perforated pipe would flow by gravity into a sump on the north side of the river. Pumps would convey the water from the sump into the conveyance pipeline to the recharge basins.

Water Quality and Yield

The proposed Murphy Crossing Project would provide approximately 500 AFY. The key water quality parameter of concern is TDS. TDS concentrations of water in the Pajaro River are below 800 mg/L at flows between 45 cfs and 90 cfs, with TDS concentrations decreasing with increasing flows, as shown in Figure 5-14 on the following page. The RWQCB recommends irrigation water to be less than 500 mg/L, with high TDS concentrations affecting growth and crop production of sensitive crops such as strawberries and raspberries. However, two nearby monitoring wells, MW54 and MW238, exhibit average TDS levels of 818 mg/L and 1430 mg/L for data collected by PVWMA between 2007 and 2011. The proposed project could help decrease current groundwater TDS levels, thus improving current irrigation water quality from local wells. Figure 5-15 on the following page shows TDS values measured at Murphy Crossing from 2002-2011.

Implementation Issues

CEQA review is required for the Murphy Crossing with Recharge Basins Project. The main challenges for implementation of the project concern fisheries and water rights. The Murphy Crossing Project was evaluated as a part of the *Pajaro Valley Water Management Agency Local Water Supply and Distribution Projects Environmental Impact Report* (ESA 1999). An application for a water right was submitted to the SWRCB in 1995. The National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW) requested that additional investigations be undertaken to evaluate the sediment disruption characteristics of the proposed infiltration gallery. The reduced diversions associated with the updated version of the project may help alleviate the concerns of the NMFS and CDFW.



*Flow data from USGS Gauging Station at Chittenden Gap

Figure 5-14. Flow Rates in Pajaro River vs. TDS at Murphy Crossing 2002-2013

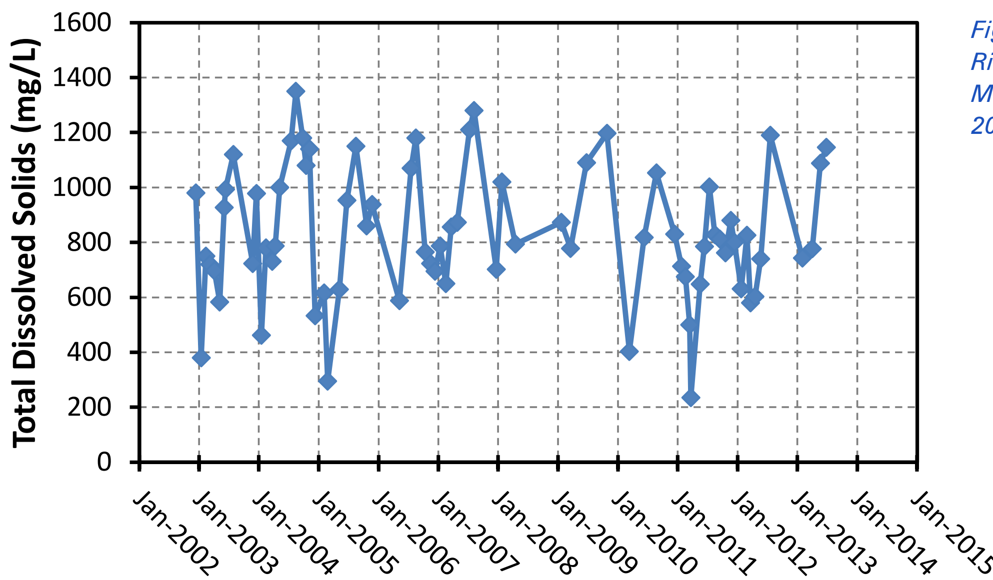


Figure 5-15. Pajaro River TDS Levels at Murphy Crossing 2002-2013

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Planning Level Cost Estimate

The estimated total implementation cost for the Murphy Crossing Project is $8.7 million. Project costs are summarized in Table 5-5.

Table 5-5 Cost Estimate for Murphy Crossing with Recharge Basins

Project Element	Planning Level Cost Estimate[1]
Infiltration gallery and pump station	$1,400,000
Recharge basin and basin piping	$1,200,000
Monitoring wells	$500,000
Connecting pipeline from gallery to recharge basin[2]	$800,000
Total Direct Cost[3]	**$3,900,000**
Construction contingency (30%)	$1,200,000
General conditions (20%)	$800,000
Contractor overhead and profit (10%)	$400,000
Sales tax (8.25% of 50% of direct cost)	$200,000
Total Construction Cost	**$6,500,000**
Engineering, legal, administration, permits (20%)	$1,300,000
Technical studies	$500,000
Land acquisition (20 acres)[4]	$400,000
Total Estimated Project Capital Cost	**$8,700,000**
Annualized capital cost[5]	$630,000
O&M pipeline (1%)	$8,000
O&M pumps (2.5%)	$40,000
Annual basin maintenance (sediment removal)	$8,000
Total Annualized Cost	**$690,000**
Annual Yield (af)	**500**
Unit Cost ($/af)	**$1,400**

[1]Costs are expressed in 2011 dollars. Inflation, which will occur between 2011 and actual project construction, will increase these costs.

[2]Diversion flow = 16 feet/second (7,200 gpm)

[3]Cost based on 2002 BMP adjusted to 2011 dollars (ENR-CCI 1.2961)

[4]Property values are per correspondence with Chuck Allen, July 18, 2011 (inland rolling hills = $20,000/acre)

[5]Annualized costs are based on a 30-year capital recovery period at 6% interest.

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Other agencies and companies are also providing support to assist growers in calculating crop water and fertilizer needs. UC Cooperative Extension (UCCE) offers the CropManage program, which uses CIMIS, and a UCCE-developed program to calculate ET and crop needs on a customized basis. Similarly, Hortau Inc. offers a Wireless Irrigation Network (WIN) that builds on CIMIS by adding wireless soil tension meters and a network of wireless transmitters to provide real-time irrigation information. Several local growers are currently employing these systems.

Several companies make hand-held, portable soil moisture meters that can be used by growers as an alternative to using a wireless system. While less precise than permanently installed systems, these meters can provide a low cost, simple indication of soil moisture. They are particularly useful to check that all parts of the field are getting a relatively uniform amount of irrigation. They are also useful for the irrigation person or farm manager who wants to check if his system is working as anticipated.

The Resource Conservation District (RCD) of Santa Cruz County, the RCD of Monterey County, and the Central Coast Agricultural Water Quality Coalition all provide on-farm irrigation efficiency evaluations through a United States Department of Agriculture (USDA) grant that draws to a close in December of 2012.

Three entities, the RCD of Santa Cruz County, Sustainable Conservation (a state-wide non-profit supporting economically sustainable solutions to ecological challenges), and a local grower/shipper are working together to develop stakeholder-supported solutions for water supply and water quality issues. This loosely-associated group, called the Community Dialog Group, is working on the development of potential performance indicators, measurement methods, targets and incentives for water conservation.

These and similar collaborative efforts among industry practitioners will continue to inform the development and implementation of the BMP Update conservation program.

AGRICULTURAL CONSERVATION

Potential Pajaro Basin Conservation Savings

Using crop and well pumping data, Dr. Samuel Sandoval Solis, UC Davis, working with Dr. Michael Cahn, UCCE, has identified a range of potential agricultural water savings specifically for the Pajaro Valley. The savings are based on comparing applied water with the optimal amount of water (based on the ET for each crop type). **Calculated potential savings range from 4,600 AFY to 5,100 AFY[1].** Based on the current crop distribution, these savings tend to be greater for the inland area. Current average water use and the calculated range of savings for coastal and inland areas are shown in Table 6-1.

Table 6-1 Potential Agricultural Water Savings

Target Area	Average Water Use from 2006-2010	Lower End Savings	Higher End Savings
Coastal	15,900	1,600	1,800
Inland	30,300	3,000	3,300
Total	46,200	4,600	5,100

All numbers in AFY
Average water use rounded to nearest hundred
Water use does not include rural residential use

While the coastal area requires a greater reduction in pumped water to address seawater intrusion, lowering inland water use also benefits the Basin, since it reduces the gradient caused by the groundwater depression, which increases saltwater intrusion.

The pumping reductions that could be achieved based on these calculations represent approximately 10 percent savings in current agricultural water use for the basin as a whole, a number consistent with the previous studies described above. It is unlikely that all growers will achieve the same level of savings. However, the current implementation of some irrigation efficiency practices on some fields has been reported to achieve savings higher than 10 percent[2]; and the goal of this plan is an overall average of at least 10 percent savings across the Basin.

[1]The range is a function of assumptions made for 1,480 acres of "Unknown Agricultural Use." The lower end assumes no water savings from these acres, while the upper range assumes a savings of 500 AFY.

[2]For example, some users of the CropManage and WIN/Hortau system have reported that their individual records indicate higher savings, in the range of 15 percent to 20 percent are achievable, which suggests these tools could help achieve the 10 percent average reduction goal.

Conservation through Irrigation Efficiency

The BMPs conservation component focuses on the potential conservation savings gained by improving agricultural irrigation efficiencies. Irrigation efficiencies are realized by delivering the optimal amount of water to a particular crop. **An efficient irrigation system is characterized by highly uniform distribution, water application rates that are consistent with soil conditions, minimization of evaporation and runoff, and accurate scheduling to apply the right amount of water at the right time.** Other factors to be considered in an efficient system include crop type, soil type and atmospheric conditions.

Factors that contribute to inefficient water use include the high value of some crops such as cool season vegetables and berries. Farm managers may over-water to assure that crop water needs are met because, for all crops in the basin, water costs are a small part of the overall expenses especially compared to the revenue loss from a poor crop. In addition, many farm managers have multiple plantings to manage simultaneously, leading to a tendency to manage all fields in a similar manner, resulting in over-irrigating and/or irrigating under sub-optimum conditions (e.g., during the day, in the wind, etc.). Poor irrigation system design and operation also creates uncertainty about the rate and uniformity of water application, leading to over-watering as a means to compensate for this uncertainty and assure that crop water needs are met. These practices negatively impact water supply, basin overdraft and the efficiency of growers' operations.

While there are many opportunities for increased efficiencies in the irrigation infrastructure, management practices that optimize water use are much more cost effective than wholesale equipment replacement. There are both high and low tech management practices available. It is not necessary to expend a lot to get started. Rather, it is useful and practical to start with the simplest tests and then do more if the over irrigation cannot be easily resolved. For example, to test if the irrigation system is distributing water evenly throughout a field, a field manager could go through some or all of the following steps at the end of an irrigation set. Note that the steps are in order of increasing cost and effort:

1. Drive around the field to make sure that there are no puddles or particularly wet spots. If there are, the irrigation system needs adjustment.
2. Go to endpoints and center of the irrigation system, take a hand shovel and dig down 6 inches, and scoop up and squeeze a handful of soil to make sure it is moist but not mud. Compare the level of wetness at the various endpoints to the wetness at the center. All should be about the same. If they are not, the irrigation system needs adjustment.
3. Use a soil moisture probe (they cost ~ $4-500) to test the moisture in the soil at the endpoints of the irrigation system and compare to the moisture at the center. All should be relatively the same.
4. Do a distribution uniformity test by putting buckets under emitters in a uniform pattern around the field. All should be about the same. If they are not, the irrigation system needs adjustment.
5. Request UCCE or one of the mobile lab services to do a distribution uniformity test. There are often grants to offset part of the cost. NRCS will pay part of the cost if the test is done as part of a planned upgrade of the irrigation system.
6. Install permanent soil moisture monitors in the field. This can be done in conjunction with a remote reporting device so that the readings are automatically relayed to the growers' computer or cell phone.

Other effective irrigation efficiency practices include the following:

- Increasing distribution uniformity (ensuring that the water within the irrigation system is reaching plants in all sections of the field with uniform amounts of water during the irrigation period) by encouraging uniform nozzles/sprinkler heads, pressure regulators, and proper maintenance (to avoid system loss from the pump to the point of application through leaks or clogs);
- Eliminating tailwater to the maximum extent (and recapturing and reusing remaining water for non-food crop use);
- Matching water used for irrigation to plant needs;
- Scheduling applications to minimize water loss due to evaporation, wind, or watering below the plant root zone;
- Using irrigation calculation tools such as CIMIS (there is a CIMIS station near the coast and one in the middle of the valley as well as the spatial CIMIS system), wireless information networks (e.g., those offered by Hortau Inc.), soil moisture sensors to test

CONSERVATION

INTRODUCTION

Agricultural water conservation plays a major role in this Basin Management Plan (BMP) Update, providing over 40 percent [5,000 acre feet per year (AFY)] of the approximately 12,000 AFY estimated yield or reduction in pumping to be achieved by the seven projects and programs that constitute the BMP Update. By reducing demand, a conservation program may eliminate the need for one or more expensive capital improvement water supply projects. Conservation also provides water quality and financial benefits to growers. Increased efficiency reduces excess watering, which, in turn, reduces the amount of agricultural runoff entering the Basin's surface and ground water. Increased efficiency also reduces the cost of pumping water and the loss of fertilizer and other amendments that are moved out of the root zone due to overwatering.

Approximately 80% of total water use in the basin is attributed to agriculture. Of the remaining uses, the City of Watsonville represents about 13 percent, rural residential about 3 percent, non-agricultural metered wells account for about 2 percent and other municipal uses about 2 percent (PVWMA data from 2006-2010, data on delivered water from 2011). The City of Watsonville has an active conservation plan directed at its urban users. **The conservation component of the BMP Update therefore, focuses on agriculture, where most water is used and the potential for savings is greatest.** This section, which was written by the Central Coast Agricultural Water Quality Coalition, provides an overview of previous conservation studies and efforts and the approach that will be taken as part of the BMP Update to identify and implement an effective conservation program within PVWMA's service area.

PAST AND CURRENT CONSERVATION EFFORTS

Previous Studies

Water conservation is not a new concept in the Pajaro Basin. Numerous organizations and agencies have studied the overdraft problem and undertaken efforts to implement workable and effective conservation programs as part of the basin management solution. These efforts provide the basis for the BMP Update conservation plan and PVWMA will continue to work with these groups to develop and implement responsive conservation strategies.

Previous studies and plans that have examined opportunities for agricultural water conservation in the Basin include:

- Water Conservation 2000, prepared for PVWMA by CH2MHill (2000);
- PVWMA's 2002 Basin Management Plan;
- The 2010 City of Watsonville Urban Water Management Plan (UWMP);
- Approaches to Water Conservation: Pajaro Valley, by Catherine Carlton and Tiffani Jarnigan (2011).

Ongoing Conservation Efforts

Significant agricultural water conservation efforts are ongoing in the Pajaro Basin including:

- California Irrigation Management Information Systems.
- CropManage Program.
- On-Farm Irrigation Efficiency support.
- Grower education and outreach.

Among the actions PVWMA has undertaken to promote conservation, consistent with the above plans, was the installation of two California Irrigation Management Information Systems (CIMIS) weather stations; a third is to be installed in the near future. CIMIS collects weather data and uses this data to calculate the amount of evaporation from the soil and the amount of water used by crops (transpiration). The resulting factor, evapotranspiration (ET), can be used by growers to calculate the efficient use of irrigation water. CIMIS information can be accessed independently and free of charge through the CIMIS website www.cimis.water.ca.gov. The website provides information from the station nearest to the farm's location as well as access to ET information generated by satellite imagery through the website's spatial CIMIS program. Growers can also request daily, weekly and seasonal email updates of CIMIS data.

- soil moisture, and water meters on the well and sub-mains; and
- Reducing germination and transplant irrigation.

Irrigation infrastructure improvements may involve switching to a more efficient irrigation systems (e.g., from sprinkler or furrow methods to micro-irrigation or drip systems).

Designing the Conservation Program

PVWMA, as part of the BMP Update, is working with partners and stakeholders to develop an effective water conservation program for the Basin designed to accomplish a 5,000 AFY reduction in water use through improved irrigation efficiencies. This section describes the approach that would be taken and steps involved in developing and implementing a viable water conservation program. The program will continue to be honed as the studies discussed below are completed and the discussions with the grower community and local technical providers continue over the next few years. Implementation of the program would also entail the identification of funding, as discussed below.

The goal of the conservation program would be to reduce annual irrigation water use by 5,000 AFY by the end of 2023, when compared to the 2006-2010 Basin wide five-year average (46,200 AFY), which represents a savings of about 10 percent. The overall success in reaching the conservation goal would be measured on a basin-wide scale, not farm-by-farm, so growers who have already invested in conservation would not be penalized. The steps envisioned in the program design are summarized in Figure 6-1.

Designing the Conservation Program	
Step 1.	Collect Data and Fill Information Gaps
Step 2.	Incorporate Data into the Program; Develop Plan
Step 3.	Develop Outreach Strategy to Maximize Program Effectiveness
Step 4.	Develop Pricing and Other Potential Conservation Strategies

Figure 6-1. Conservation Program Design

Task 1. Collect Data and Fill Information Gaps

To effectively identify areas of greatest potential for conservation and to track implementation results, the conservation plan should be informed with current and appropriate data. This would involve determining data needs, collecting available data, evaluating and packaging the existing data into a useful format, identifying remaining knowledge gaps, and gathering the additional data to fill those gaps. Collected information may be perceived as potentially sensitive and will not be disclosed to the public. If it is not possible for PVWMA to keep such information confidential due to Freedom of Information Act (FOIA) requirements, it would be maintained by a third party that is not bound by FOIA and is experienced in working with confidential information.

Once the PVWMA Board has approved the conceptual conservation program, the following steps would be implemented:

- Determination of actual water use by crop type, by using existing PVWMA well meter data and collecting crop data for the fields served by each well. This will require the evaluation and synthesis of numerous information sources including reviews of existing satellite photos, GIS data bases, climatic zone data, Agricultural Commissioner ranch maps, and various water survey results.
- Establishment of irrigation targets for specific crops. Irrigation targets will be based on the ideal amount of water to meet crop needs without reducing yield or quality. The difference between this target and actual water use by crop type is the measure of potential conservation savings.
- Identifying and addressing water use variables that may distort or contribute to the margin of error when making baseline and conservation estimates. These variables, the ways they are addressed, and any assumptions that are made about them, will be tracked. These variables, which affect the total water use for a farm or ranch include (but are not limited to) rotational change in crop type, location, soil type, and/or number of crops per acre.

Task 2. Incorporate Data into the Program

Using the information described above, the data would be analyzed and used to design an effective outreach program. Development of the outreach program would involve determining crop acreage profiles, water usage, climate zones, soil data and ultimately designing a demonstration project (pilot project) for irrigation efficiency.

Task 3. Develop outreach strategy to maximize program effectiveness

Outreach efforts would target growers who could benefit from additional training and technical assistance. Included would be owners and operators of high-water use crops and growers who have not participated in education and training programs to date. Achieving the 5,000 AFY reduction goal will require the identification of and connecting with those growers who have not participated in water conservation strategies and are not reducing water usage. **By targeting growers who have been identified (by the process described above) as using water above the median for a crop type, the program's resources would be focused on the growers who have the most to gain from implementing irrigation best practices, and would yield the greatest progress toward meeting the program goals.**

Task 4. Develop Pricing and Other Potential Conservation Strategies

In addition to improving irrigation efficiency by using technology to match water applications with crop needs, the conservation program would investigate and consider implementation of other possible conservation strategies. Pricing strategies are commonly used conservation tools, based on the assumption that increases in the price of water will reduce water use. **The two main approaches to conservation pricing are tiered rates, where the price per unit of water increases as more water is used, and increases in the flat rate.** Both approaches face potential economic limitations. The effectiveness of conservation pricing depends in part on the "elasticity," or sensitivity of water demand to price. Although the elasticity of agricultural water demand has been found to be fairly low, the 2011 conservation study cited above notes that growers may be more responsive to increases in price (the price elasticity can be increased) when they are aware of ways to increase efficiency. (In other words, growers are more receptive to reducing water usage in response to price when knowledge and tools to do so are available.) To be implemented, either of these pricing strategies would need to meet the legal requirements of California law, including Proposition 218 (Cal. Constitution, Article XIIID), which requires that the revenues from property-related fees or charges not exceed the proportionate cost of the property-related service attributable to the parcel being charged.

Rotational land fallowing, where agricultural land is taken out of production for a period of time, has been identified in previous studies as effective in reducing water use. However, land fallowing has negative economic side effects[3] and is not being considered as a conservation tool for the Basin, although many growers individually practice this technique.

Implementing the Conservation Program

The steps envisioned for **program implementation** are summarized in Figure 6-2. While reductions in water usage achieved by some growers are not universal, there is considerable room for improving water use efficiency in the Basin. **Preliminary studies indicate that berries and vegetables are two crops with significant water savings potential.** Dr. Michael Cahn of the UCCE has completed trials with raspberry growers in the Salinas Valley, indicating that annual irrigation water consumption could be reduced to about 18 acre-inches per season, compared to the average water use of between 36 and 48 acre-inches per season (suggesting a possible 1.5 to 2 AF reduction per season). However, no control fields were used in his research, so this is an estimated number.

Implementing the Conservation Program

Step 1. Implement Targeted Outreach
Step 2. Coordination with Stakeholders
Step 3. Measure Performance and Adapt if Needed
Step 4. Report Progress and Communicate Changes

Figure 6-2. Conservation Program Implementation

[3]Even in cases where the loss of income to the farmer is compensated (through subsidies, for example), the indirect effects of fallowing, including losses to businesses and labor that rely on the farming operation, are not offset and can adversely affect a community.

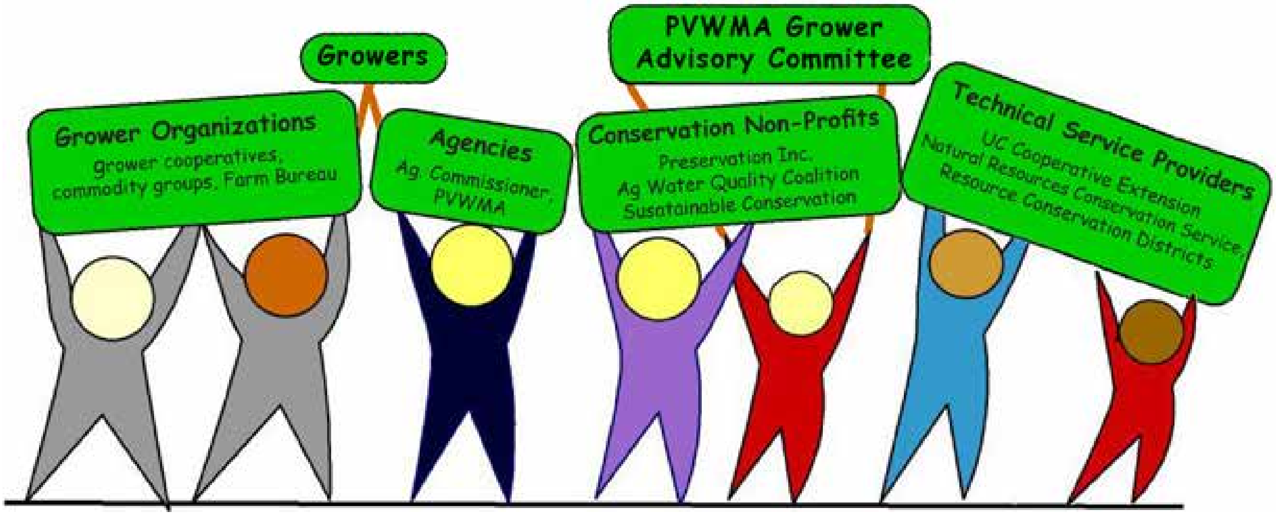

Figure 6-3. Coordination with Stakeholders

Research of irrigation needs for various crops conducted by Drs. Michael Cahn, Richard Smith, and Tim Hartz indicates that many vegetable growers may overwater by 200 to 300 percent, which provides clear room for improvement in practice and reduction in water use. But vegetables may be the hardest crop with which to achieve effective reductions in irrigation use since most vegetables are sprinkler irrigated, fieldworkers are not in the fields on a daily basis as they are with berries and, therefore, are not present to see if crops are suffering from inadequate water application. Also, each vegetable crop is only in the field for 30 to 90 days between planting and harvesting.

Task 1. Implement targeted outreach

On-farm conservation program outreach, education, training, and technical assistance for growers and farm managers in the PVWMA district would begin once funding is identified and secured. As described above, in-field program implementation would focus on those growers who have been identified as using more water than is optimal for a given crop, who grow high water use crops, and those who have not evaluated their irrigation systems or participated in previous education efforts and would implement the program elements described above.

Task 2. Coordination with Stakeholders

In addition to outreach programs described above to solicit grower participation in the BMP Update conservation program, the continuing involvement of partner organizations and diverse members of the agriculture industry (Figure 6-3) in ongoing discussions will be needed to:

- review progress;
- suggest next steps; and
- identify, engage with, and understand the needs of growers in the area.

Necessary partners include the Central Coast Agricultural Water Quality Coalition, grower organizations, commodity groups and cooperatives, the Farm Bureaus, Agricultural Commissioners, the various technical providers (including UCCE, NRCS, and RCDs), the PVWMA Board and staff, as well as a-proposed Ag Conservation Technical Advisory Committee (described below). Publicizing and discussing the program's short term and the long term success would be important elements of the program. Ensuring stakeholder involvement would involve soliciting, processing, and incorporating stakeholder feedback into the various plan components; and then effectively conveying both successes and challenges back to the stakeholders in a clean communication loop. In addition, the program would include continued and expanded coordination with partner organizations such as the RCD of Santa Cruz County, NRCS, Preservation Inc., and Sustainable Conservation, to assess and account for other previous and ongoing irrigation efficiency work, to leverage each other's stakeholder lists and contacts, and to ensure that a unified and coherent message about conservation goals, objectives and implementation strategies is presented.

Establishment by PVWMA of an Ag Conservation Technical Advisory Committee would be an asset to the program's success. This group could include members of the former PVWMA Grower Advisory Committee and representatives of a complete range of interest groups, and could assist the PVWMA, the Coalition and partners in reviewing progress, adjusting priorities, focusing the need for specific research, adapting the workplan to meet changing conditions, and fostering support from committee members' respective constituents.

Task 3. Measure performance and adapt if needed

The goal of achieving 5,000 AFY in reduced pumping across the basin begins in 2013 with the continued support by PVWMA of other ongoing efforts, with a goal of achieving 100 percent of its targeted savings by 2023 (10-years).

Program success would be measured using a statistical approach to quantify the level of conservation savings. **The formula would compare actual annual water use (based on PVWMA extraction data) to a baseline equal to the average metered water use for the five-year period from 2006 through 2010.** This approach would recognize, account for and acknowledge today's conservation practices, implemented during the years 2011-2012, after the Ad Hoc BMP Committee and the Community Dialog Group meetings started. This methodology would provide an objective measure of the change in water use over time and minimize confounding factors such as droughts, above/below average rainfall/temperatures, and years when rainfall occurs in an unusual pattern affecting irrigation (e.g., years when rain occurs late in the spring and replaces normal early plant irrigation).

Performance measurements may indicate a need to adapt the conservation program. Adaptive management (Figure 6-4) would be part of every component of the conservation program, and semi-annual input from the proposed Ag Conservation Technical Advisory Committee should be considered essential to the effectiveness of the program. A strong evaluation and adaptive management component

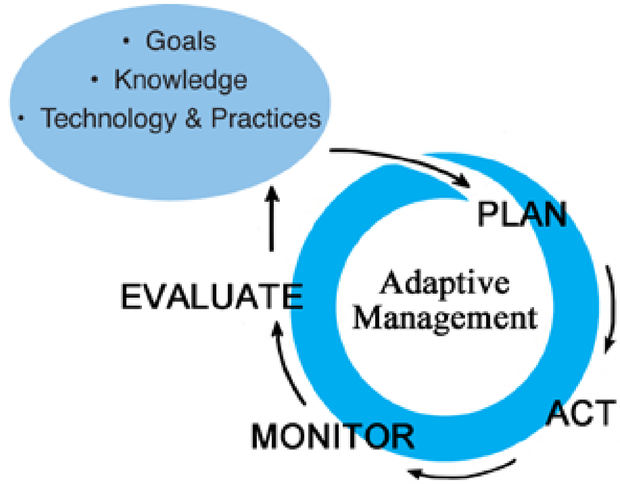

Figure 6-4. Adaptive Management Schematic

assures that the conservation program will provide the expected benefits and that stakeholders receive the full value for their investment in this work.

Task 4. Report progress and communicate changes

Regular progress reports would be prepared to track program implementation and facilitate effective adaptive management when program components do not work as envisioned. Progress reports would include semi-annual reports to the Board and stakeholders to summarize overall trends, changes implemented, measurements of success for the various tools implemented, and water conservation evaluation results, with adaptive management adjustments proposed for the next year's work.

CONSERVATION PROGRAM FUNDING

PVWMA has limited conservation program funding opportunities due to the restrictions in the Agency Act on the use of augmentation funds. Since conservation is not specifically called out in PVWMA's enabling legislation as an activity that may be funded with augmentation charges, only Management Fees which are collected as a per parcel charge on the tax rolls, have been used to fund conservation. The available Management Fees are not adequate to fund a meaningful program.

Given these current limitations, PVWMA can implement a three-pronged approach for continuing conservation efforts and working towards full implementation of a conservation strategy:

- Continuing coordination with other conservation activities and organizations;
- Securing outside funding (grants) to support implementation of a conservation strategy; and
- Working towards Agency Act modifications to allow appropriate funding of a conservation strategy.

The BMP Committee and the Board recognize that conservation activities by others, occurring outside of Agency efforts, are ongoing and have a lot of momentum to continue. Supporting these ongoing efforts by the Basin communities (growers and landowners) is essential to addressing the basin's overdraft and seawater intrusion problems today. In Phase 1 of the BMP Update (after 2015) there will be additional opportunities to increase irrigation efficiency and community awareness of water use that will be a key component of the BMP Update.

Given the restrictions of the Agency Act, any significant funding of the conservation strategy in advance of an Agency Act amendment would have to occur through grants. PVWMA will identify and pursue conservation funding opportunities that would support the implementation of the conservation strategy. Funding opportunities include the U.S. Bureau of Reclamation Water Use Efficiency Grant, CA Department of Water Resources Water Use Efficiency Grant, CA Department of Water Resources Integrated Regional Water Management Program Implementation Grant, and others.

OTHER CONSERVATION EFFORTS IN THE BASIN

City of Watsonville

The City of Watsonville is committed to conservation efforts that are described in their Urban Water Management Plan (UWMP), both as a partner of the PVWMA and as a domestic water supplier required by state law to reduce per capita water use. The UWMP identifies 1,000 AFY as an achievable objective for urban conservation within the city. **Conservation efforts to meet this objective are an important factor in meeting the City Council's goal of not increasing groundwater pumping in the future as the city's population grows.**

One way the city will avoid increasing groundwater pumping will be by implementing conservation measures and constructing the Corralitos Creek Water Supply and Fisheries Project[4]. No net increase in the City's groundwater pumping is, in turn, a key assumption in the hydrologic modeling of the BMP Update.

City conservation programs include the following:

- Water survey programs for single-family residential and multifamily residential customers;
- Residential plumbing retrofit including ultra-low flush toilet replacement programs.
- System water audits, leak detection, and repair;
- Metering with commodity rates for all new connections and retrofit of existing connections;
- Large landscape conservation programs and incentives;
- High-efficiency washing machine rebate programs;
- Public information programs;
- School education programs;
- Conservation programs for commercial, industrial, and institutional accounts;
- Conservation pricing;
- Water conservation coordinator; and
- Water waste prohibition.

The City spends approximately $290,000/year on water conservation, of which $180,000/year funds toilet and washing machine rebate and retrofit programs, about $50,000/year funds landscape water audit programs, and $60,000/year is spent to educate the public on water conservation through the nature center, targeted adult education programs, and school tours.

Rural Residential Units

When maximum conservation is achieved from large acreages (i.e., the agricultural water users, where the largest conservation gains can be realized), PVWMA would extend the conservation implementation efforts to the approximately 2,300 *unmetered rural residential* users within the PVWMA service area. Likely strategies would include support for low-flow toilet retrofits, irrigation efficiency evaluation and system design support, and other water-saving home retrofits, such as low flow shower heads, faucet adaptors and hose nozzles.

[4]This project, which will increase year-round water availability and fish passage, is funded through a U.S. Bureau of Reclamation grant awarded in 2011.

BMP IMPLEMENTATION

IMPLEMENTATION PLAN

The proposed phasing for the BMP projects and programs is shown in Figure 7-1. The BMP includes a three-part plan, as follows:

1. Conservation (water use efficiency).
2. A recycled water program to increase nighttime recycled water deliveries and a recycled water storage project (additional tanks at the treatment plant) to maximize daytime recycled water deliveries.
3. Four local surface water projects (Harkins Slough Recharge Facilities Upgrades, College Lake with Inland Pipeline to CDS, Watsonville Slough with Recharge Basins, and Murphy Crossing with Recharge Basins) for implementation in the BMP.

The trigger for initiating the BMP implementation will be a successful rate setting process scheduled for mid-2015. However, there are project-related activities that will take place prior to mid-2015 that are required to (1) build on the momentum created by the community-driven BMP development process and (2) prepare the BMP to be "planning ready" immediately following a successful rate setting process. The proposed schedule for activities prior to and following adoption of a new rate structure are summarized in Figure 7-2.

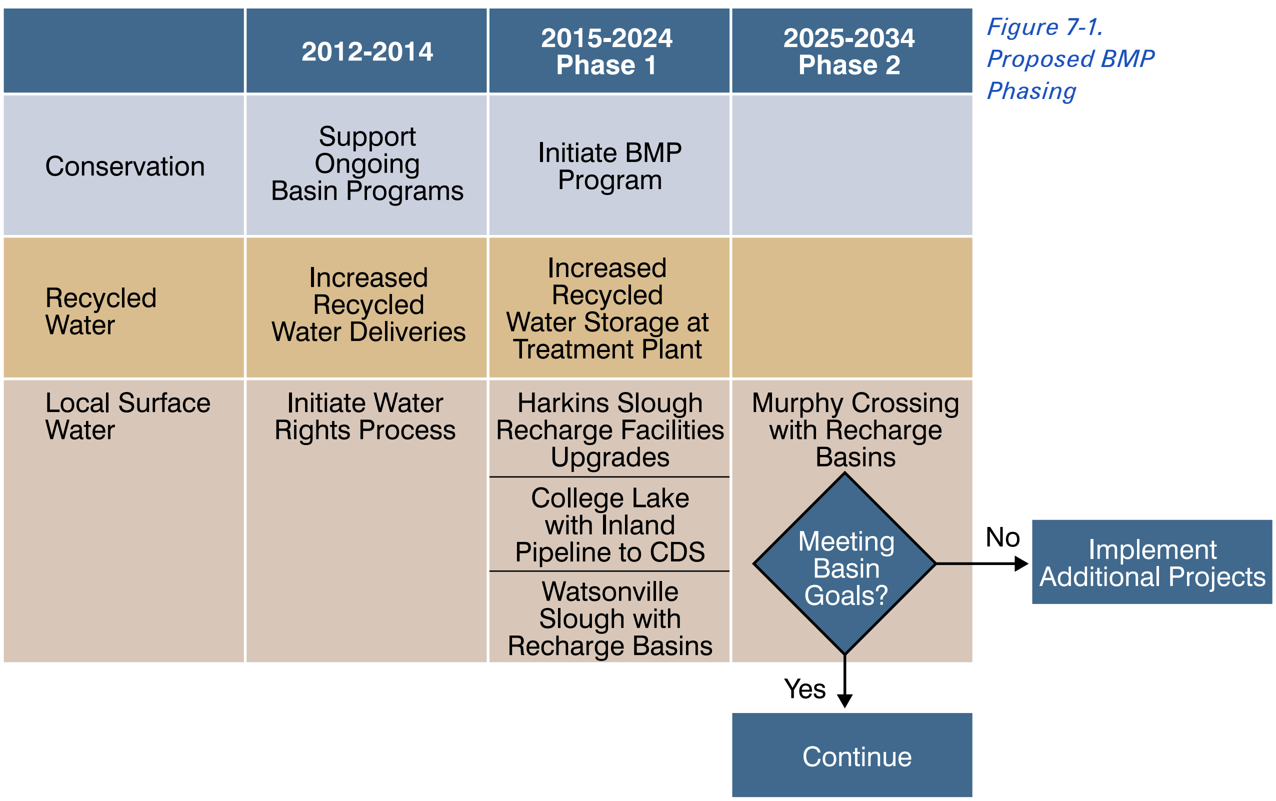

Figure 7-1. Proposed BMP Phasing

PROJECT IMPLEMENTATION ISSUES

The schedule for implementation of the BMP Update is shown in Figure 7-2 on the following page.

The implementation schedule is largely driven by environmental, permitting, and water rights-related issues required for the implementation of each project. In particular, the environmental and permitting issues are related to in-stream construction, aquatic habitat/ fisheries mitigation, and groundwater recharge or ASR; water rights are required for implementation of College Lake with Inland Pipeline to CDS, Watsonville Slough with Recharge Basins, and Murphy Crossing with Recharge Basins Projects. The implementation issues associated with each project are discussed in Chapter 5 and are summarized in Table 7-1.

Increased Recycled Water Deliveries and Conservation could be initiated immediately, as shown in Figure 7-2.

Increased Recycled Water Storage at Treatment Plant has minimal implementation hurdles, and design and construction of those facilities can begin as soon as funding is available. It is anticipated that design and construction of recycled water storage could be completed in two years.

Harkins Slough Recharge Facilities Upgrades planning and design could begin immediately. The facilities associated with this project include the pump station, filters, waste filter backwash pipeline and wells. Work on upgrading the filters and adding new wells can begin any time project funding is available. Work on upgrading the pump station could involve construction in the slough if foundation upgrades are needed. Work in the slough would require the following permits:

- Streambed Alteration Agreement (from the CDFW).
- Section 404 Clean Water Act Nationwide Permit (from the US Army Corps of Engineers).
- Section 401 Water Quality Certification (from the Regional Water Quality Control Board).

If sensitive species, sensitive habitats, or cultural resources are present within the project footprint, additional coordination with and/or permits from the CDFW, the US Fish and Wildlife Service, NMFS, and the State Historic Preservation Office may also be required. Obtaining these regulatory permits and resource agency approvals could be a six-month to two-year process, depending upon the resources present and the level of anticipated impact. Once permits are obtained it is estimated that construction could be completed within a year.

The College Lake with Inland Pipeline to CDS, Watsonville Slough with Recharge Basins, and Murphy Crossing with Recharge Basins Projects will require generally the same permits described above but will require a significantly longer period to complete the planning and permitting processes. All three projects require that PVWMA obtain new water rights. It is recommended that the PVWMA begin the water rights application process as soon as possible. Working with the regulatory agencies during project definition,

Table 7-1 Summary of Main Potential Implementation Issues

Project	Water Rights	In-Stream Construction	Aquatic Habitat/ Fisheries Mitigation	Groundwater Recharge or ASR Permitting
Increased Recycled Water Deliveries				
Conservation				
Increased Recycled Water Storage at Treatment Plant				
Harkins Slough Recharge Facilities Upgrades		√		
College Lake with Inland Pipeline to CDS	√	√	√	
Watsonville Slough with Recharge Basins	√	√	√	√
Murphy Crossing with Recharge Basins	√	√	√	√

Key:
Green = Could be implemented within the first 10 years of the BMP (by 2025)
Orange = Could be implemented after 2025

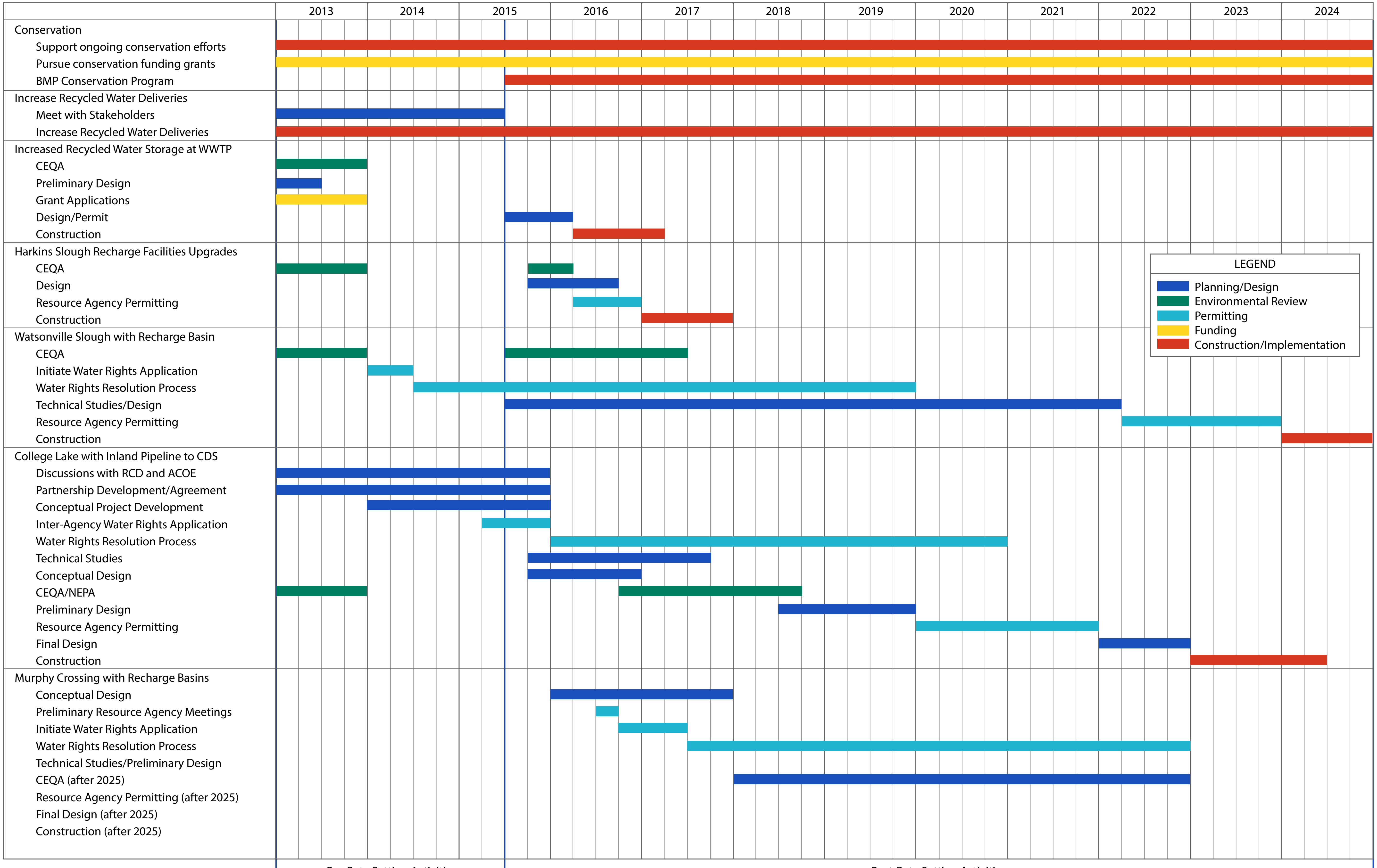

Figure 7-2. Proposed BMP Implementation Schedule

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as is currently occurring with the College Lake Project, has the potential to expedite the granting of water rights by addressing regulatory and environmental concerns up front.

MEASURING BASIN IMPROVEMENT

Figure 7-3 is a conceptual timeline for determining when decisions may be required to consider implementation of the more expensive capital projects (orange projects) identified in the BMP. The basis for such decisions will be the measurement of basin groundwater improvement (basin groundwater levels and seawater intrusion).

The PVWMA regularly measures groundwater levels, water quality, groundwater production, and delivered water use. Continued monitoring of these parameters will be an important component of the BMP implementation. The purpose of the monitoring as part of the BMP Update implementation will be as follows:

- To understand the impact of conservation (is pumping basin-wide reduced over a given period of time? are groundwater levels improving?).
- To understand the impact of delivered water use (has groundwater production declined in the delivered water zone? how is the decline in groundwater production affecting water levels and water quality?).
- To measure the yield of capital projects (are capital projects producing the anticipated yield?).
- To determine if new projects need to be considered to solve the remaining basin overdraft and/or seawater intrusion (are existing facilities, in combination with increased water use efficiency programs, stopping groundwater overdraft and halting seawater intrusion?).

For conservation, it is anticipated that the BMP conservation program would be initiated in 2015 and that it (along with other on-going conservation efforts) would achieve 100% of the savings goal (5,000 AFY) in eight years (by 2023). The PVWMA would continuously monitor basin conditions and by 2020 determine if a minimum of 75% of the conservation goal (reduced pumping) is being met; if not, the PVWMA would revise the program to increase the levels of conservation and water use efficiency. By 2025 the PVWMA would determine whether overdraft is reduced by at least 80% and seawater intrusion is reduced by at least 90%; if not, the PVWMA would begin the process of identifying new (orange) projects to make up the shortfall for solving the basin problem. The new project(s) would be identified prior to a Phase 2 rate setting process after 2025 (required to pay for the construction of Phase 2 projects) and would be implemented in Phase 2.

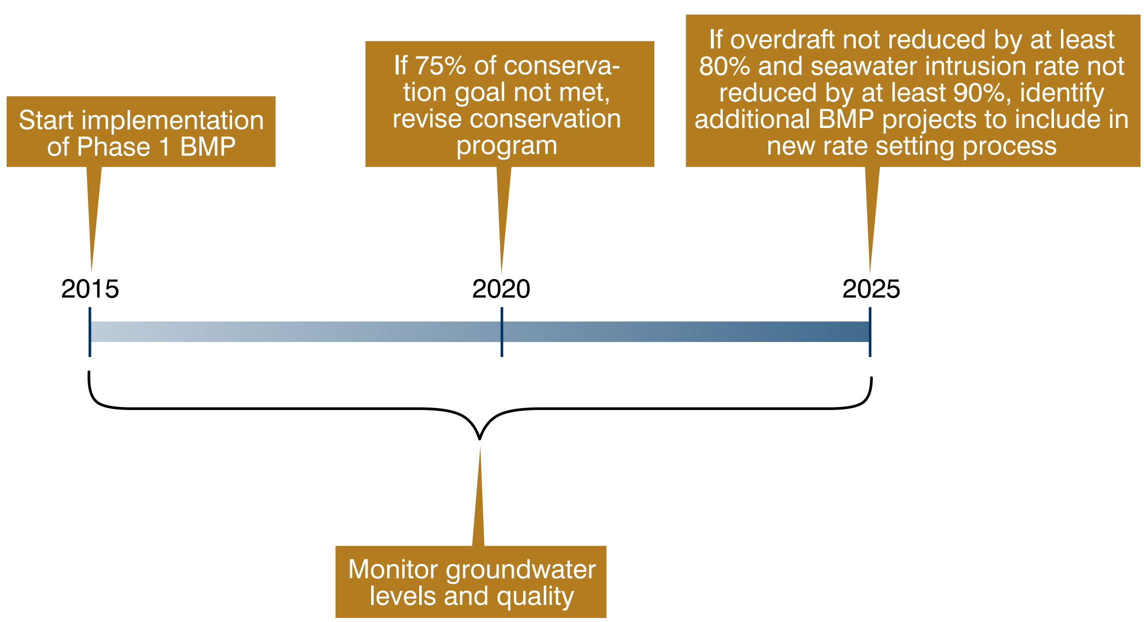


Figure 7-3. Conceptual BMP Decision Plan

For maximizing recycled water use (from 2011 use of approximately 2,000 AFY to 4,000 AFY), it is anticipated that an ongoing program would be required to encourage growers and landowners to use delivered water at night, on weekends, and on irrigation shoulder months (March to mid-April and October to mid-November) to optimize this resource. Pricing, outreach, and education are proposed to achieve maximum usage. Mandatory use requirements could be considered if these initial approaches were not effective. There are no alternative projects for maximizing recycled water deliveries.

For new local surface water projects, the monitoring of the effectiveness of these projects would be determined by measuring yield of each project, measuring groundwater production, and monitoring water levels in the aquifers and water quality in the delivered water zone. The process for then determining whether additional, more expensive projects are still required to solve the basin problem would follow a process similar to that identified above for conservation. By 2025 the PVWMA would determine if at least 80% of the basin overdraft and 90% of seawater intrusion problems have been addressed, assuming the full portfolio of Phase 1 projects are implemented. If the PVWMA determines the improvements are not on track, it would begin the process of identifying new (orange) projects to make up the shortfall for solving the basin problem. The new project(s) would be identified prior to a Phase 2 rate setting process after 2025, and would be implemented in Phase 2.

AGENCY BUDGET PLAN

Figure 7-4 shows an analysis of the impact on the PVWMA operating budget for implementing the BMP Update Phase 1 projects and planning for Murphy Crossing with Recharge Basins. The cash flow analysis (discussed in detail in Section 4.2) is important to the BMP implementation because it (1) identifies when projects are scheduled to be constructed and therefore funded (likely with bond financing), and (2) confirms a positive balance is maintained in the PVWMA operating budget with the implementation plan proposed.

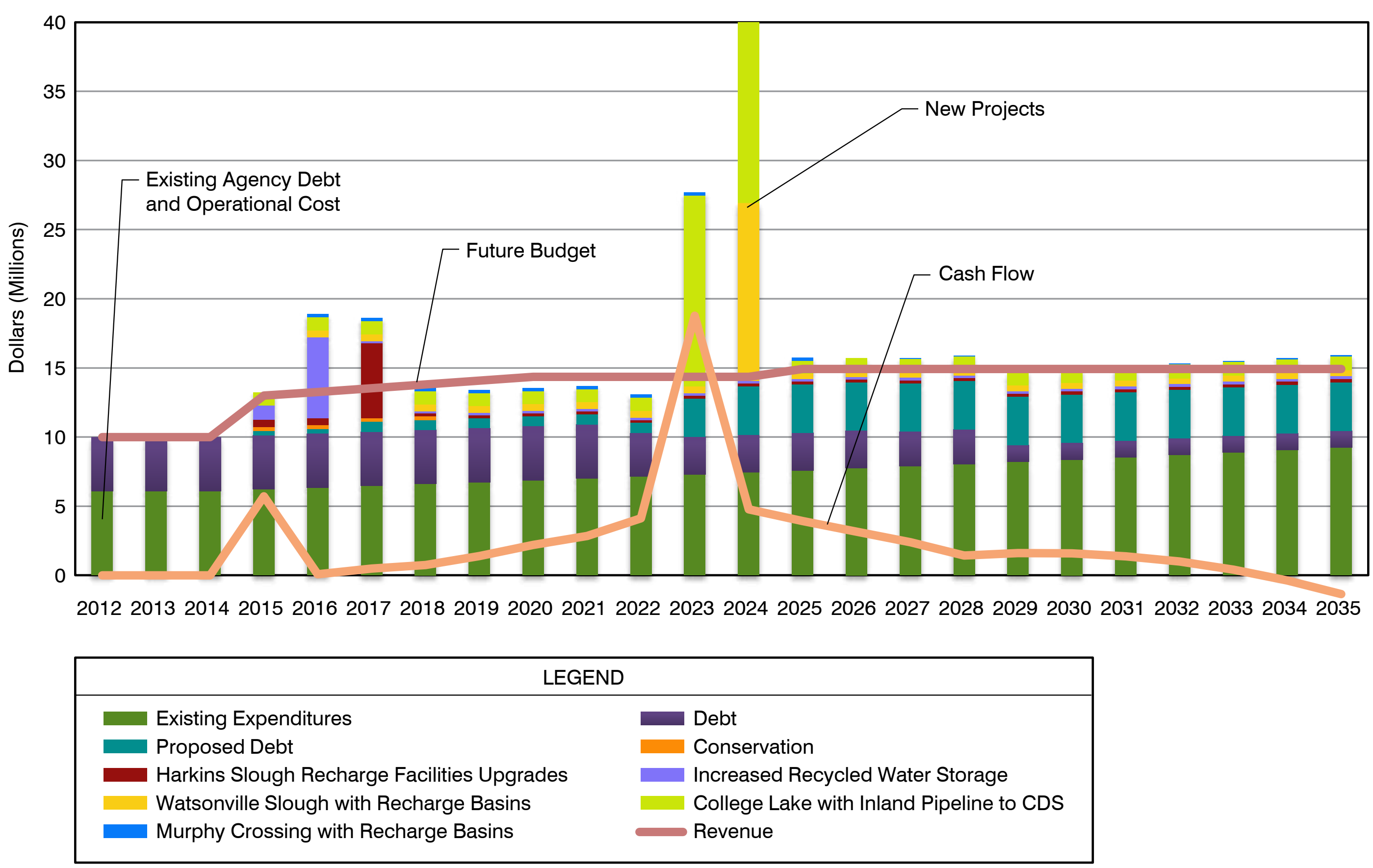


Figure 7-4. Cash Flow Analysis of BMP Phase 1 Implementation

To determine if new (orange) projects are required to make up the shortfall for solving the basin problem, it will be critical to confirm by 2025 that the goals are being met for the following:

- Conservation savings.
- Recycled water deliveries.
- Local surface water project yields and deliveries.
- Reduced pumping
- Basin levels.
- Seawater intrusion.

This determination will then dictate the funding needs required for implementation of Phase 2 of the BMP and the requirements for the second rate setting process after 2025.

GRANT FUNDING

The PVWMA has been very successful in obtaining outside grant funding to help fund capital projects identified in previous BMPs. To date, the PVWMA has received nearly $50 million of state and federal grant funding that has been applied to the planning, design and construction of the Watsonville Water Recycling Facility, the Coastal Distribution System, Supplemental Wells, and Harkins Slough Recharge Facilities. Continuing the effort to obtain additional grant funding will be a key component of the BMP Update implementation plan.

Funding programs likely to be considered include:

- US Bureau of Reclamation WaterSMART Title XVI Recycled Water Grants
- US Bureau of Reclamation WaterSMART Water and Energy Grants
- California Department of Water Resources Water Use Efficiency Grants
- California Department of Water Resources Integrated Regional Water Management Grants

In October 2012, PVWMA in cooperation with the Resources Conservation District of Santa Cruz County, the Central Coast Agricultural Water Quality Coalition, and the Santa Clara County Farm Bureau, submitted the following project and program applications for consideration in the Pajaro River Watershed IRWM Plan, positioning for future funding eligibility:

- Agricultural Water Quality Program
- Conservation Planning and On-Farm Irrigation Efficiency Support
- On-Farm Meter Education, Installation and Implementation
- Regional Mobile Lab for the Pajaro Basin.
- Integrated Aquifer Enhancement Program for the Pajaro Valley
- College Lake Management Plan
- Harkins Slough Facility Recovery Optimization Study
- Increased Watsonville Recycled Water Storage and Deliveries Project
- Watsonville Slough with Recharge Basins Project
- Murphy Crossing with Recharge Basins Project

There are numerous state and federal grant and loan programs that are available to PVWMA. PVWMA will continue to identify funding opportunities and pursue those opportunities that are considered to have the maximum potential for success.

The cash flow analysis discussed previously does not include the assumption of grant funding being obtained. Any grant funding that can be obtained and applied to funding BMP capital projects in the future will reduce the overall impact of the BMP on the PVWMA's operating budget.

Appendix A: Conservation Program Strategy

Appendix A: Conservation Program Strategy

Goal

The objective of the Conservation Program is to achieve the water conservation goal defined in the Basin Management Plan (BMP), 5000AFY basin-wide. This program will maximize the financial and human resources to achieve the goal. This document, which was written by the Central Coast Agricultural Water Quality Coalition, outlines the phases, tasks, and strategies to implement the Conservation Program (Figure 1). The Conservation Program will focus on improving agricultural irrigation efficiency and thus, reducing pumping across the Basin.

Rationale

One of the foundational programs that came out of the Basin Management Plan process was increased conservation through agricultural irrigation efficiency because it:

1. Is the lowest cost alternative to solving the Basin problem;
2. Avoids expensive capital projects;
3. Improves water quality by reducing return flows;
4. Assists in meeting Regional Water Board Ag Waiver requirements; and
5. Reduces the cost of crop production, improving growers' bottom lines.

Agriculture accounts for approximately 80% of total Basin water use and has the greatest potential for improvement. Some Pajaro Valley growers have implemented water conservation programs with positive outcomes. Irrigation efficiency provides water demand reduction, contributing to sustainable use of the resource and benefiting growers through regulatory compliance and improved crop yield; in summary, a win-win outcome.

Components of the Conservation Program

The table below shows the major components of the Conservation Program. The tasks are described on page 7.

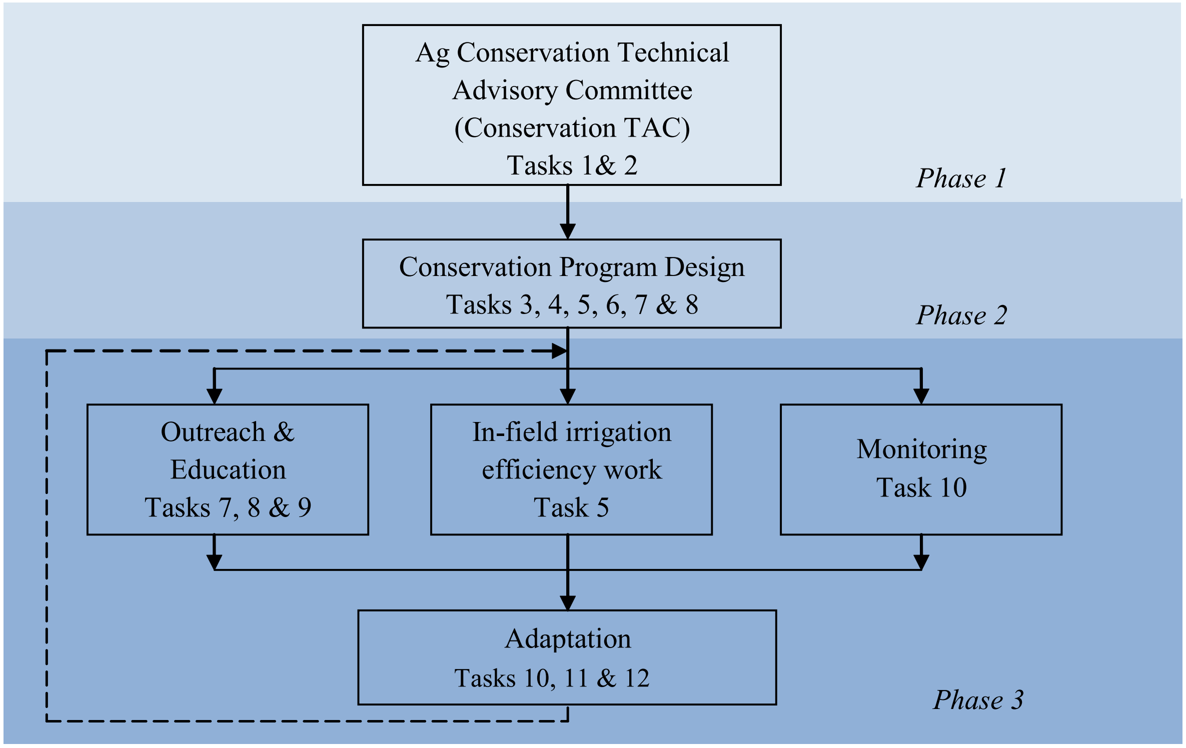


Figure 2 – Main Components of the Conservation Program

Phase 1: Ag Conservation Technical Advisory Committee. If established, the objective of this committee will be to involve all stakeholders and knowledgeable advisors, represent and communicate the interests of Basin growers, and oversee and review progress and implementation of a Conservation Program.

Phase 2: Conservation Program Design. The objective of this process will be to design the implementation program. This would be achieved by collecting all available data and information, and doing a strategic data analysis to identify places with highest potential for water conservation, and creating a list of agricultural irrigation efficiency practices. This phase will also include developing a comprehensive outreach and education program to share program developments with the agricultural community, solicit their feedback to maximize buy-in, and define strategies to incentivize water conservation.

Phase 3: Implementation. The objective of this process will be to implement the Conservation Program. The main components are: outreach and education, in-field irrigation efficiency work, and monitoring.

Phase 3: Adaptation. The objective of this process would be to regularly evaluate Conservation Program progress, receive feedback from stakeholders and advisors, and adjust the strategies used to achieve program goals.

Conservation Program Design

The objective of this phase will be to design a detailed conservation program. This design must identify and then focus on the opportunities with the greatest potential for improvement in irrigation efficiency and water conservation. The product of this process will be an implementation program.

Data Collection and Strategic Analysis

The first step on the conservation program design would be a comprehensive analysis of the available (and updated) data to gain knowledge about areas where there is greatest potential for improving water use efficiency. This process is also referred to as *strategic analysis.* Much of the first year of plan implementation would be spent analyzing the available data to identify areas of greatest potential for conservation, as well as collecting new data. These data may include sensitive information and will be maintained by the Ag Water Quality Coalition, who has experience managing confidential information, and as a non-profit entity, is not bound by FOIA laws. These data would only be presented publicly in aggregate form with no disclosure of identifying information.

Identification of growers who are using more water than is optimal for their crop will be accomplished by comparing actual *applied water* (in acre-feet, AF) and the *optimal water application* determined by crop Evapotranspiration (ET_C). The methods and data sources involved in this process are explained below:

A. Establish the optimal water application for specific crops, based on the ideal amount of water that meets crop needs without reducing crop yield or quality. The difference between this target and actual water use is the measure of potential conservation savings.
    a. Data sources include CIMIS and research by Dr. Cahn and Dr. Caron.
B. When possible, develop a crop spatial distribution for each farm. Data sources include spatial land use data, satellite imagery, Ag Waiver enrollment information (eNOI data) and Ag Commissioner maps.
C. Examine spatial metered well data (from PVWMA) in combination with the spatial crop distribution and determine which well (or water turnout) serves each farm, or group of farms.
D. Determine the annual applied water (AF/acre) for each farm and crop for individual wells. Data will be presented anonymously using graphs.
    a. Determining crop acreage served by shared wells may require growers or landowners to voluntarily provide that information. These people may be persuaded to collaborate with the program by the communication and education campaign (explained below).

E. For each of the three climate zones in the Basin, the optimal water application (CIMIS-based and experimentally-based) will be compared with the applied water (See Table 1. for an example). This data can then be presented in public forums without farm disclosure.

F. Track assumptions that are made about other variables that may influence irrigation management. Examples include rotational change in crop type, location, soil type, seasonal ETo, number of crops per acre, irrigators, farm managers, and production managers.

Table 1. Proposed comparison of Optimal Water Application versus Applied Water by crop and climate zone

	Climate Zone 1	*Climate Zone 2*	*Climate Zone 3*	*Climate Zone 1*	*Climate Zone 2*	*Climate Zone 3*
Crop	**Optimal Water Application**			**Applied Water**		
strawberries						
raspberries						
apples						
celery						
lettuce						

Note: Ideal is based on crop need, soil, and ET

Through this strategic data analysis, additional strategies for maximizing program effectiveness may be revealed, such as targeting growers who have not participated in previous education programs, or growers of the most frequently grown crop types. The Conservation Program will be managed adaptively, and therefore strategies will be developed as needed to focus on additional groups of people.

Outreach and Education Campaign

Multiple techniques can be used to communicate why the conservation measures are important for the agricultural community and the sustainability of the Basin. The means of communication will be based on the preferences of the community members. Communications with grower organizations like the Farm Bureau, commodity and grower-shipper groups can be achieved though presentations, web and newsletter content, and through our Technical Advisory Committee members.

Individual growers can be engaged through electronic or hard copy media, and group or individual meetings. Growers will also be engaged during in-field irrigation efficiency education and training events, during workshops, and while working with growers to identify financial support, to establish demonstration sites, and to coordinate peer to peer information sharing opportunities. Technical service providers and agency personnel will be engaged through membership on the Technical Advisory Committee and during efforts to coordinate programs.

Some of the main messages include:

A. The Basin overdraft is everybody's problem, and solving it requires a collective solution.

B. The proposed program provides growers with tools to both reduce their water demands and improve their bottom lines.

C. Proactive strategies can help to avoid top down fixes, such as Basin adjudication. We are converting challenges into ground-up solutions.

Lastly, community buy-in for conservation goals and objectives will be fostered to ensure that the Conservation work creates lasting changes both in practice and in philosophy. Stakeholders will be meaningfully involved throughout the process, with assurance that their concerns are addressed while receiving consistent, tangible evidence of the value of the programs we are promoting to their bottom lines and the Basin's long-term sustainability.

Incentives

There are several incentives to encourage participation in the Conservation Program; these incentives can be grouped as financial and regulatory incentives. In summary, economic benefits of irrigation efficiency include improved quality of the product, higher crop yield, reduction in operation cost due to water use and pumping reductions. Regulatory benefits include improved water quality from reduced runoff and nutrient leaching to groundwater, consistent with requirements of the Regional Water Board's Ag Waiver Program.

Carrots		Sticks
	Financial Incentives	
Avoided project costs	⟷	Capital cost of new projects
Increase profitability due to increase in product quality and crop yield	⟷	Not generating as much revenues as market competitors
Seawater intrusion mitigation	⟷	Complete loss of Ag. business due to poor water quality
Balancing water overdraft	⟷	Unsustainable water resources leading towards complete loss of local economy
Economic benefits for those implementing conservation measures	⟷	Losing competiveness due to higher operation costs
	Regulatory Incentives	
Compliance with the Ag. waiver	⟷	Hassle to deal with Ag. waiver
Maintaining local control of water resources	⟷	Basin Adjudication

Program Implementation

The objective of this phase will be to implement the Conservation Program to achieve the water conservation goal of the Basin Management Plan, 5000AFY basin-wide.

In-Field Irrigation Efficiency Work

Once funding is provided, on-farm outreach and conservation work could begin. The outreach program will focus on those growers who have been identified with the strategy described above as using more water than is optimal for a given crop, who grow high water use crops, and those who have not evaluated their irrigation systems or participated in previous education efforts. The primary elements of the conservation program will include:

A. Workshops about irrigation best practices to owners and operators of high-water use crops, and growers who have not participated in these programs before, utilizing letters, phone calls, and workshops. In addition to practices, the outreach program will provide discussion about:

   a. Communicating the economic and operational benefits of water conservation, with an emphasis on the value of conservation as a tool to increase profitability and meet regulatory compliance. Speakers will include technical consultants, representatives of financial assistance programs (e.g., NRCS EQIP) and growers who have benefited from increased irrigation efficiency.

   b. Raising awareness of assistance programs available to growers, encouraging them to sign up for more intensive support, and referring growers who need financial and additional technical support for structural changes to the appropriate party (e.g.; NRCS, RCDs, CAFF, etc.). These referrals will be made during workshops, one-on-one conversations, and discussion of field evaluation results. Guest speakers from assistance programs will be invited to speak at workshops.

B. Training sessions and on-farm at-the-site (tailgate) irrigation efficiency training to focus on practice implementation, effectiveness, and evaluation. It is important that growers learn how to track their own progress.

C. Consultation services to help growers improve irrigation efficiency will be provided at various levels of service. Growers need accurate data demonstrating how well their irrigation systems are performing summarized in a clear report with follow up consultation. They also need data to be able to determine how well their irrigation scheduling is meeting crop water needs. For growers with potential room for improvement, this consultation can help them take the next steps to improving irrigation efficiency. To achieve and maintain these goals, ongoing education programming will help growers, farm managers, and irrigators develop and maintain expertise in farm water management.

D. Training for field managers and irrigation staff, as well as farm owners, to:
    a. Provide custom trainings for a specific farm crew (add-on cost to the grower).
    b. Provide technical consultants to work with farm owners and operators to create and implement a plan for training based on results of field evaluations.
E. One-time on-farm evaluation of existing irrigation systems for selected growers by evaluating factors including:
    a. Distribution uniformity of the irrigation system
    b. Design efficiency review of the irrigation system
    c. Evaluating and reviewing data, producing summary reports, and meeting with growers individually to explain results in a report and plan/recommend next steps.
F. More intensive on-farm work with a selected group of growers (identified as likely to benefit from more assistance by the growers' one-time evaluation results) collecting and analyzing field level data with tools including:
    a. Installing flow meters on mains and sub-mains for growers who do not have them for tracking irrigation volumes and schedules
    b. Establishing and tracking crop ET
    c. Monitoring soil moisture
    d. Irrigation scheduling of crop cycles
    e. Evaluating and reviewing the data, producing summary report, and meeting with growers individually to explain report results and plan/recommend next steps.

Monitoring

The monitoring component will be composed of two parts: (1) monitoring the basin-wide water savings and (2) monitoring the effectiveness of the Conservation Program.

Monitoring Basin-wide Water Savings

To evaluate the overall success of both the Conservation Program and other conservation efforts in the Basin, the annual agricultural well production data for the upcoming years will be compared to the average well production data from 2006-2010, using 2009 as an average year. This comparison will provide an estimate of the water savings and trends related to the Conservation Program.

Monitoring Program Effectiveness

The success of this program will be evaluated by quantifying the changes in well production data in locations where the outreach program has provided in-field support. Individual grower results will be confidential, as this procedure will merely provide an indication about the effectiveness of the program in solving the overdraft and saltwater intrusion problems.

Adaptive management

Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of those previously employed. Using feedback from project monitoring, from the Conservation Technical Advisory Committee, and from the agricultural community, we will improves outcomes of the Conservation Program by making critical adjustments throughout the process.

Tasks (see Figure 1)

1. Integrating an Ag Conservation Technical Advisory Committee to provide stakeholder input and oversight for the program (including growers, technical service providers, agency staff, agricultural NGOs, Universities, etc.)
2. Building on the successes and short-comings of the Conservation Program established in the 2002 Basin Management Plan
3. Looking at all available data and literature to identify and fill information gaps
4. Develop a *strategic data analysis* to identify growers and places with the highest potential for water conservation through improving irrigation efficiency practices
5. Develop an in-field program of conservation practices to assist growers in conserving water through various irrigation efficiency practices, including:
    - Irrigation system efficiency evaluations
    - On farm “tailgate” trainings
    - Access to and training on irrigation management tools, e.g., a meter demo program
    - A gasket and nozzle exchange program
    - Specialized trainings on irrigation management and tools, such as real time monitoring data
    - Supplemented costs for equipment
    - Assistance with finding additional financial support (through NRCS, grant funding, other cost-share opportunities)
6. Working with specialists and local partners to propose strategies and methods to incentivize conservation efforts building on existing work in this area. This strategies may include:

- Financial incentives: such as improving crop yield and economic revenue through the use of real time monitoring tools and/or increase of economic benefits for those farmers implementing water conservation practices
- Regulatory incentives: through the compliance of regulation by not leaching nutrients to surface water and groundwater sources

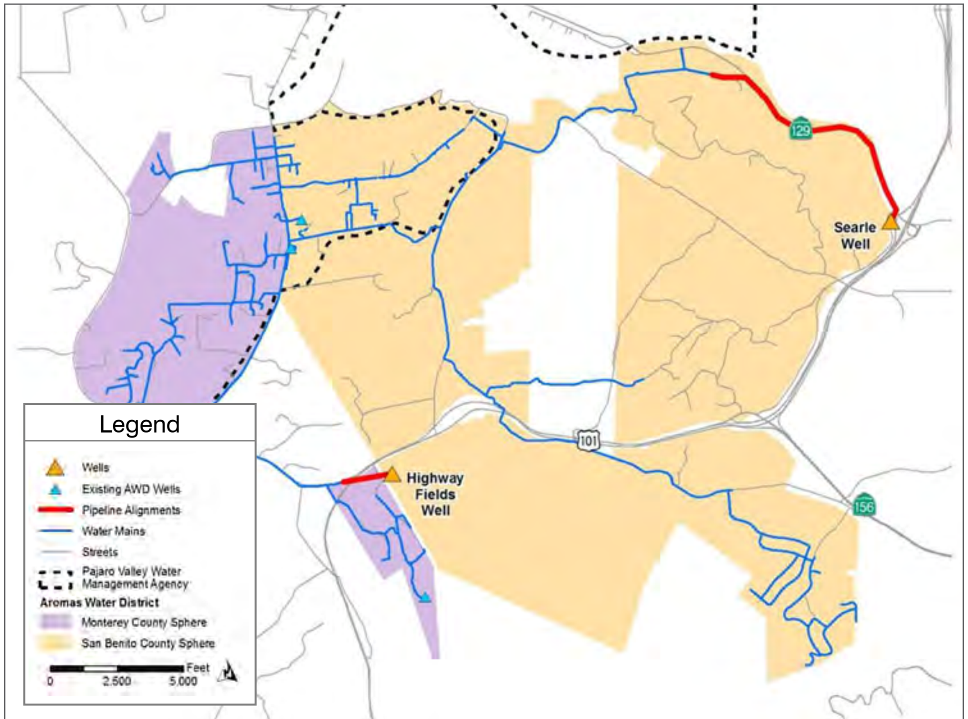
7. Creating an outreach strategy that connects growers to irrigation efficiency support services, focusing on growers working with crops that can benefit from improved irrigation efficiency (high water-need crops and crops irrigated in excess of crop demand); and growers who have not participated in previous evaluations or programs. Identifying growers (by crop type and past meter records) who could most benefit from irrigation efficiency support.
8. Implementing an *Outreach and Education Campaign* to clearly communicate the "Why" message:
   - The Basin overdraft is everybody's problem, and solving it requires a collective solution
   - The proposed program provides growers with tools to both reduce their water demands and improve their bottom lines
   - Proactive strategies can help to avoid top down fixes. We are converting challenges into ground-up solutions.
9. Effectively outreaching to targeted growers
   - Solving the 'multiple crop types irrigated by one well' problem, likely by communicating directly with growers who are interested in participating - with the assurance that the information will be kept confidential
   - Using a third-party who is experienced working with confidential grower information
10. Perform monitoring data analysis to make sure:
    - Irrigation efficiency practices function appropriately for growers and their goals (Dr. Michael Cahn, UC Cooperative Extension, Dr. Jean Caron and Guillaume Létourneau, University of Laval)
    - Conservation efforts are achieving water pumping and usage reductions (Dr. Samuel Sandoval Solis, UC Davis)
11. Regular briefings and reports to keep Board Members, Conservation Advisory Committee members, and stakeholders aware of program constraints, progress and adaptations.
12. Ongoing development of funding to support grower conservation efforts, including identifying and seeking grant funding opportunities.

Appendix B: Project Summary Sheets and Cost Estimates

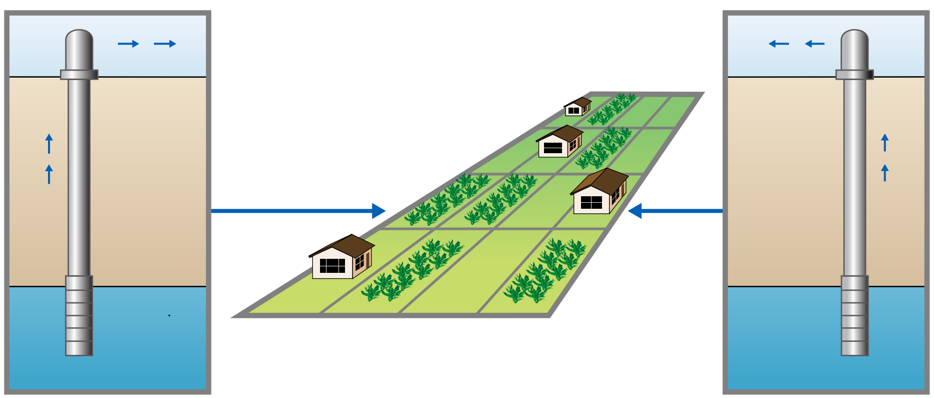
APPENDIX B -
PROJECT SUMMARY SHEETS AND COST ESTIMATES

TABLE OF CONTENTS

G-1: San Benito County Wells to Aromas Water District



PROJECT PLAN



Searle and/or Highway Fields Wells

Distribution to AWD San Benito County Customers

Less Pumping from Monterey County AWD Wells

PROJECT SCHEMATIC

Background:

The Aromas Water District (AWD) currently supplies approximately 400 AFY of potable water to its customers, including approximately 200 AFY to customers in Monterey County and approximately 200 AFY to customers in San Benito County. All of the water currently comes from wells in Monterey County. This project involves AWD obtaining the rights to draw water from one of two private wells in San Benito County to replace some or all of the water from the Monterey County wells. The two wells are the Searle well and the Highway Fields well, which have tested capacities of 2000 and 300 gpm, respectively. Cost would include construction of approximately 2.5 miles of new conveyance pipeline for the Searle Well and 0.28 miles for the Highway Fields Well, new pumps at wellhead, and iron and manganese treatment. SBCWD has indicated some form of compensation would be required. This is not included in the costs outlined below.

Yield:

Searle Well: 400 AFY

Highway Fields Well: 200 AFY

Capital Cost:

Searle Well: $5.7 Million

Highway Fields Well: $1.3 Million

Operations & Maintenance:

Searle Well: $100,000/Year

Highway Fields Well: $60,000/Year

Annualized Capital and O&M Costs:

Searle Well: $520,000

Highway Fields Well: $150,000

Water Quality Considerations:

Water quality appears adequate with iron and manganese removal.

Implementation Issues:

Compensation to SBCWD. Need to verify that drawing water from Searle or Highway Fields well does not draw down groundwater in Pajaro basin.

Implementation Timeline:

Near-Term*

***Timelines:**

Near-Term = 0 - 10 years

Mid-Term = 10 - 20 years

Long-Term = 20 - 30 years

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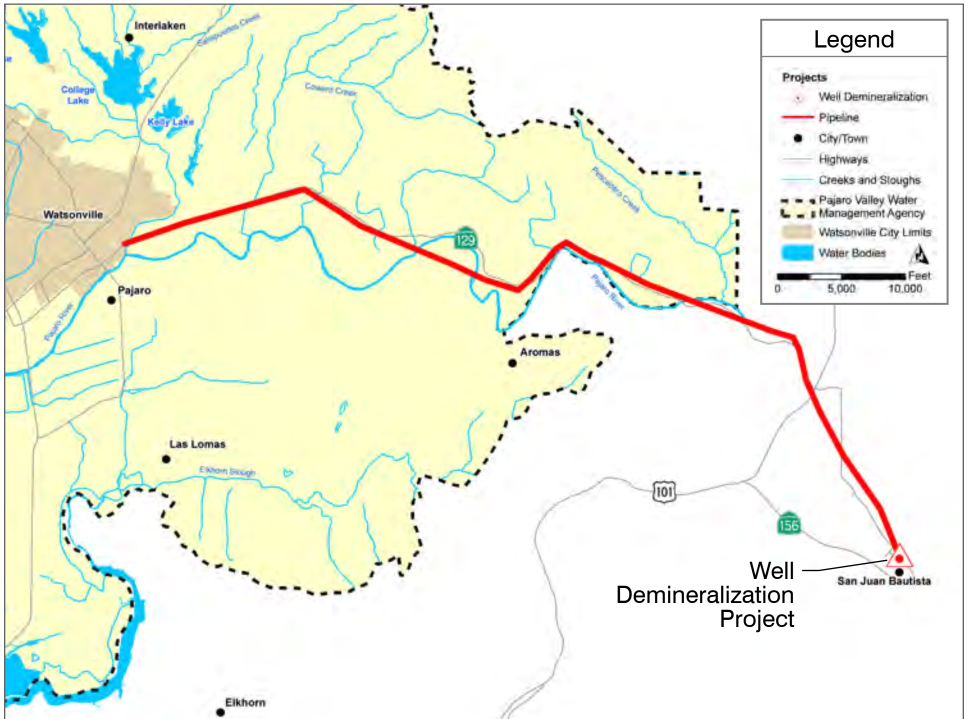
Cost:

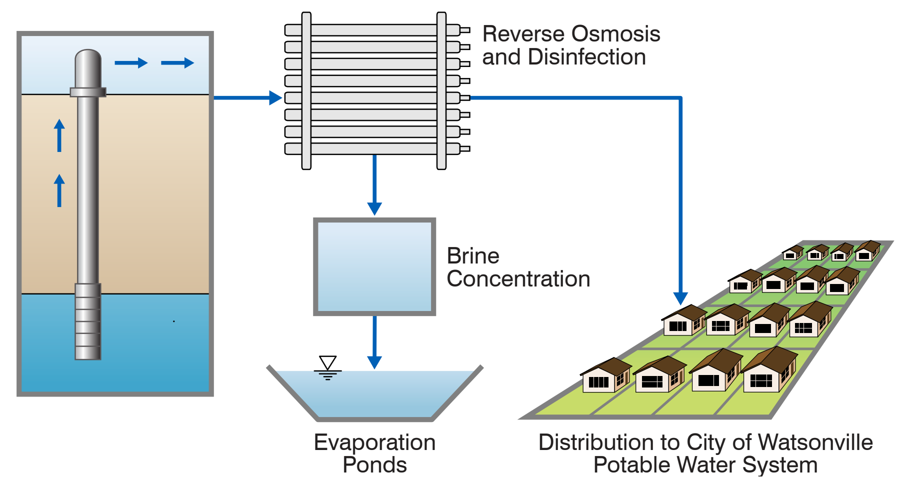
G-1: San Benito County Wells to Aromas Water District 2012 Basin Management Plan Update Pajaro Valley Water Management Agency		
Project Element	**Searle Well Cost Estimate**	**Highway Fields Well Cost Estimate**
Filtration & Treatment (Iron & Manganese)[1]	$700,000	$350,000
Chlorination	$50,000	$50,000
SCADA System Connection	$30,000	$30,000
New Well Pumps (if well pump insufficient)	$100,000	$50,000
Pipeline [2]	$1,800,000	$140,000
Appurtenances (Valves, fittings, AVAR, blowoff, etc)	$180,000	$14,000
Total Direct Cost	**$2,860,000**	**$640,000**
Construction Contingency (30%)	$900,000	$200,000
General Conditions (20%)	$570,000	$130,000
Contractor Overhead and Profit (10%)	$300,000	$60,000
Sales Tax (8.25% of 50% of Direct Cost)	$100,000	$30,000
Total Construction Cost	**$4,730,000**	**$1,060,000**
Engineering, Legal, Admin, Permits (20%)	$950,000	$210,000
Total Estimated Project Implementation Cost	**$5,700,000**	**$1,300,000**
Annualized Construction Cost[3]	$410,000	$90,000
O&M Pipeline	$20,000	$10,000
O & M Pump and Treatment	$25,000	$20,000
Pump Power (300gpm for 200AFY, for 3600 hours at $0.15/kW-h)		$30,000
Pump Power (2000gpm for 400AFY, for 1100 hours at $0.15/kW-h)	$60,000	
Total Annualized Cost	**$520,000**	**$150,000**
Annual Yield AF	**400**	**200**
Unit Cost ($/AF)	**$1,300**	**$800**

Notes:
(1) Cost for Searle Well Treatment has been estimated from Highway Fields, assumed approximately double cost
(2) Pipeline 8" PVC C900 for Searle Well and 6" PVC C900 for Highway Fields Well
(3) Annualized costs are based on a 30-year capital recovery period at 6% interest.

G-2: San Benito County Groundwater Demineralization



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Santa Clara Valley Water District (SCVWD) and the San Benito County Water District (SBCWD) performed a feasibility study of desalinating groundwater within the San Juan Valley. The groundwater contains high total dissolved solids (TDS) and would require treatment to reduce TDS. The project would provide up to 3,000 AFY of desalinated groundwater from the San Juan groundwater sub-basin. The project includes building seven new groundwater wells, a centralized reverse osmosis treatment with disinfection system, a brine concentrate system, brine evaporation ponds, and storage and transmission system piping to convey water to the City of Watsonville's potable water system.

Yield:

3,000 AFY

Capital Cost:

$85.8 Million

Operations & Maintenance:

$2.1 Million/Year

Annualized Capital and O&M Costs:

$8.3 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

RO treated water would be blended with raw groundwater to meet TDS objectives of <500 ppm, and hardness < 120 MG/L CaCO3

Implementation Issues:

Pilot testing, environmental and CDPH permitting, concentrate management and disposal.

Implementation Timeline:

Mid- to Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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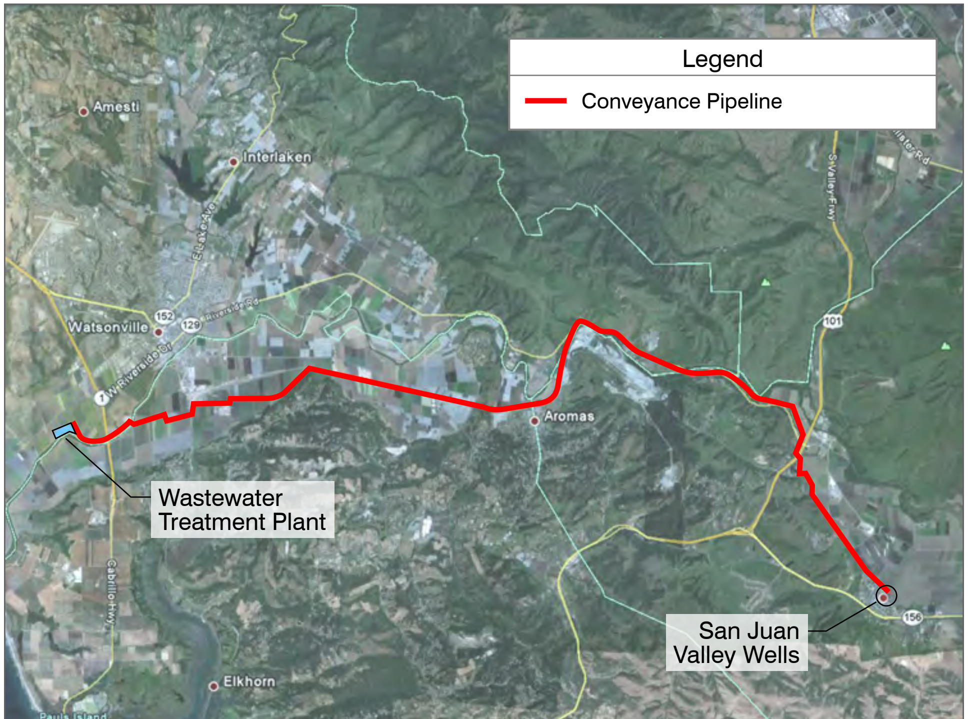
Cost:

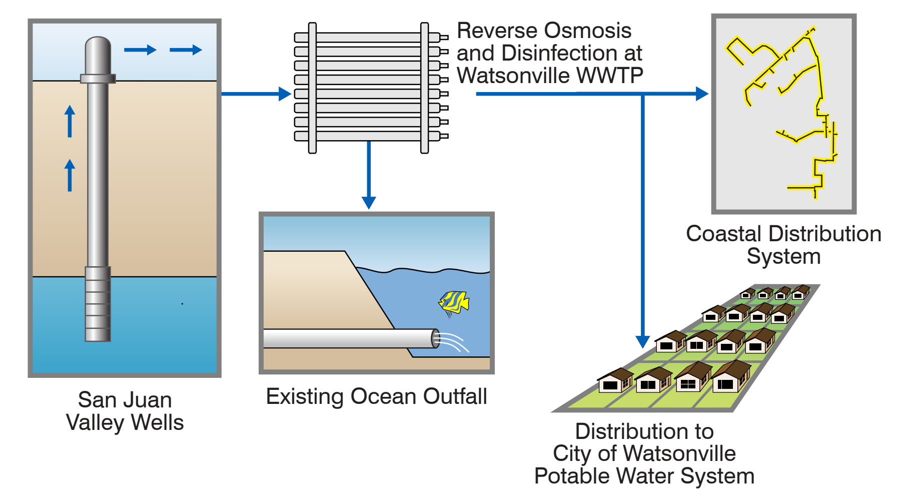
G-2: San Benito Groundwater County Demineralization **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
Transmission Pipeline	$25,000,000
Pump Station	$1,500,000
Groundwater Extraction, Desal Treatment(1)	$7,000,000
Concentrate Management (1)	$10,000,000
Total Direct Cost	**$43,500,000**
Construction Contingency (30%)	$13,100,000
General Conditions (20%)	$8,700,000
Contractor Overhead and Profit (10%)	$4,400,000
Sales Tax (8.25% of 50% of Direct Cost)	$1,800,000
Total Construction Cost	**$71,500,000**
Engineering, Legal, Admin, Permits (20%)	$14,300,000
Total Estimated Project Implementation Cost	**$85,800,000**
Annualized Construction Cost(2)	$6,200,000
O&M Pipeline (1.5%)	$400,000
O & M Demineralization Treatment & Concentrate Manag.(1)	$1,200,000
Power Cost (5,200 gpm for 6,700 hours)(3)	$500,000
Total Annualized Cost	**$8,300,000**
Annual Yield AF	**3,000**
Unit Cost ($/AF)	**$2,800**

Notes:
(1) Costs from RMC "Pajaro River Watershed Groundwater Desalinization Study DRAFT Volume 1 - Report"
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.
(3) Actual pump volume would be approximately 3,450 AF for a yield of 3,000 AF; treatment is ~85% efficient

G-3: San Benito County Groundwater Demineralization at Watsonville WWTP



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Santa Clara Valley Water District (SCVWD) and the San Benito County Water District (SBCWD) performed a feasibility study of desalinating groundwater within the San Juan Valley. The groundwater contains high levels of total dissolved solids (TDS) and would require treatment to reduce these levels. This alternative differs from that outlined in the feasibility study in that the desalination would occur at the Watsonville WWTP to facilitate brine management and disposal. Approximately 3,000 AFY of groundwater would be pumped from the San Juan groundwater sub-basin to the Watsonville Wastewater Treatment Plant (WWTP) for treatment. The project includes building seven new groundwater wells, a pump station, approximately 19-miles of conveyance pipeline, and a reverse osmosis treatment and disinfection system at the Watsonville WWTP. Treated water would be discharged directly to the City of Watsonville through an existing water line running to the plant, to agricultural users through the CDS, and potentially inland agricultural users if the College Lake pipeline is constructed. The waste brine would be discharged through the WWTP's existing outfall.

Yield:

3,000 AFY

Capital Cost:

$76.1 Million

Operations & Maintenance:

$1.6 Million

Annualized Capital and O&M Costs:

$7.1 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

RO treated water will be blended with raw groundwater to meet TDS objectives of < 500 ppm, and hardness < 120 mg/L CaCO3.

Implementation Issues:

Pilot testing, environmental and CDPH permitting, and disposal.

Implementation Timeline:

Mid- to Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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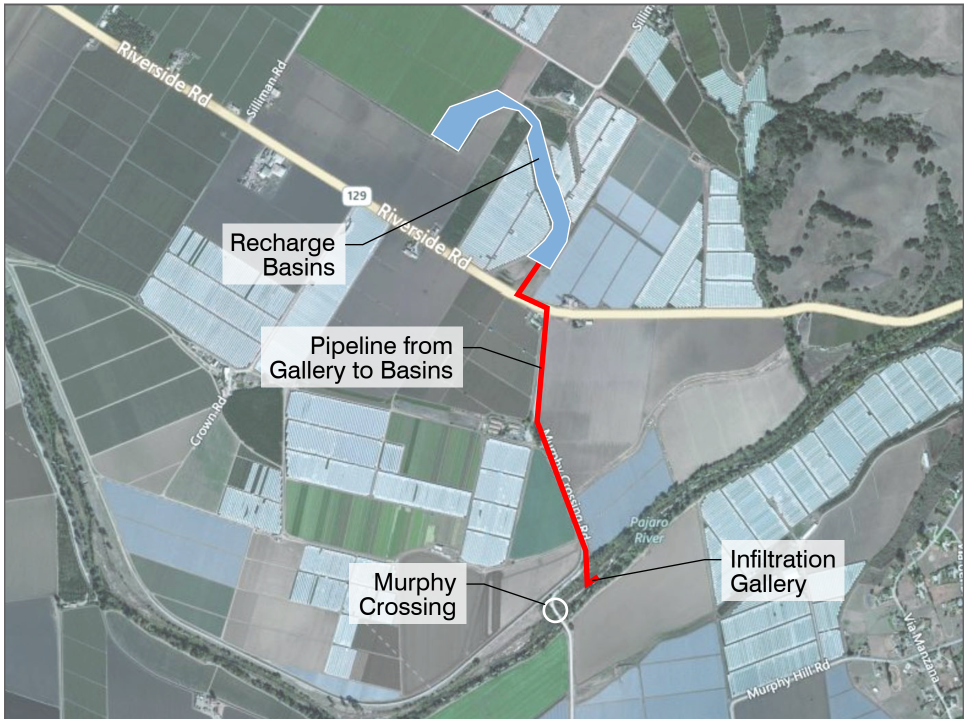
Cost:

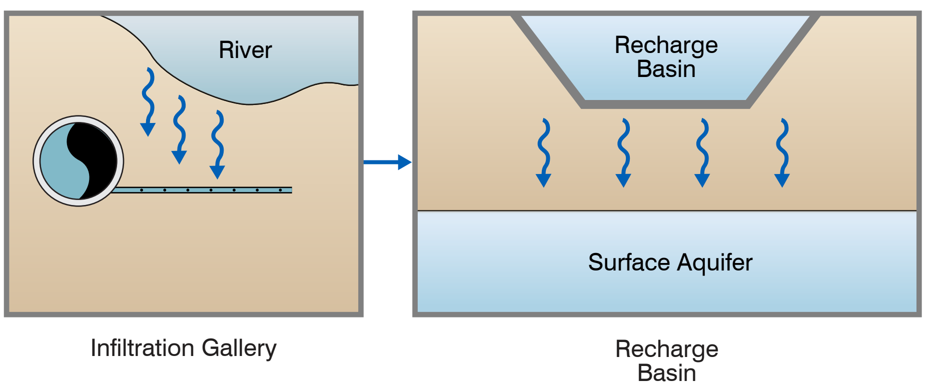
G-3: San Benito Groundwater Demineralization at Watsonville WWTP 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Transmission Pipeline	$30,100,000
Pump Station	$1,500,000
Groundwater Extraction, Desal Treatment[(1)]	$7,000,000
Total Direct Cost	**$38,600,000**
Construction Contingency (30%)	$11,600,000
General Conditions (20%)	$7,700,000
Contractor Overhead and Profit (10%)	$3,900,000
Sales Tax (8.25% of 50% of Direct Cost)	$1,600,000
Total Construction Cost	**$63,400,000**
Engineering, Legal, Admin, Permits (20%)	$12,700,000
Total Estimated Project Implementation Cost	**$76,100,000**
Annualized Construction Cost[(2)]	$5,500,000
O&M Pipeline (1.5%)	$500,000
O & M Demineralization Treatment & Concentrate Manag.[(1)]	$600,000
Power Cost (5,200 gpm for 6,700 hours)[(3)]	$500,000
Total Annualized Cost	**$7,100,000**
Annual Yield AF	**3,000**
Unit Cost ($/AF)	**$2,400**

Notes:
(1) Costs from RMC "Pajaro River Watershed Groundwater Desalinization Study DRAFT Volume 1 - Report"
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.
(3) Actual pump volume would be approximately 3,450 AF for a yield of 3,000 AF; treatment is ~85% efficient

S-1: Murphy Crossing with Recharge Basins



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Murphy Crossing project would divert water from the Pajaro River between December and May, when the Pajaro River water quality is within an acceptable range and streamflows are above the required minimum necessary to maintain steelhead habitat. The project includes the construction of an infiltration gallery pump station, monitoring wells, recharge basins, and a connector pipeline from pump station to recharge basins.

The infiltration gallery would consist of 18-inch-diameter perforated pipe placed approximately 5-6 feet below the river bottom, forming a water collection grid, and would cover approximately 2 acres of the riverbed just upstream of the Murphy Crossing bridge. River water collected in the perforated pipe would flow by gravity into a sump on the north side of the river. Pumps would convey the water from the sump into the conveyance pipeline to the recharge basins.

Yield:

500 AF of groundwater recharge

Capital Cost:

$8.7 Million

Operations & Maintenance:

$56,000/Year

Annualized Capital and O&M Cost:

$690,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

TDS levels from Pajaro River water.

Implementation Issues:

Permitting issues related to steelhead habitat and recharge water quality, sediment characteristics related to infiltration gallery, availability of sufficient Pajaro River flows.

Implementation Timeline:

Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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COST:

S-1: Murphy Crossing with Recharge Basins 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Planning Level Cost Estimate**
Infiltration Gallery & Pump Station	$1,400,000
Recharge Basin & Basin Piping	$1,200,000
Monitoring Wells	$500,000
Connecting Pipeline from Gallery to Recharge Basin (1)	$800,000
Total Direct Cost(2)	**$3,900,000**
Construction Contingency (30%)	$1,200,000
General Conditions (20%)	$800,000
Contractor Overhead and Profit (10%)	$400,000
Sales Tax (8.25% of 50% of Direct Cost)	$200,000
Total Construction Cost	**$6,500,000**
Engineering, Legal, Admin, Permits (20%)	$1,300,000
Technical Studies	$500,000
Land Acquisition (20 Acres)(3)	$400,000
Total Estimated Project Capital Cost	**$8,700,000**
Annualized Capital Cost(4)	$630,000
O&M Pipeline (1%)	$8,000
O&M Pumps (2.5%)	$40,000
Annual Basin Maintenance (sediment removal)	$8,000
Total Annualized Cost	**$690,000**
Annual Yield (AF)	**500**
Unit Cost ($/AF)	**$1,400**

Notes:

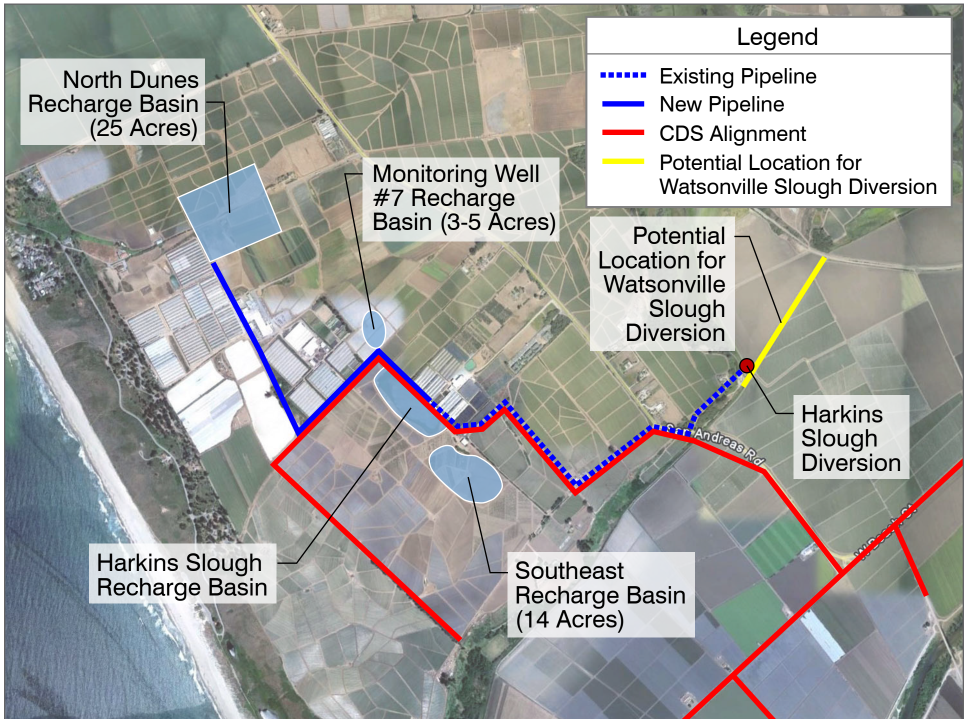
(1) Diversion Flow = 16 ft/s [7200 gpm].

(2) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)

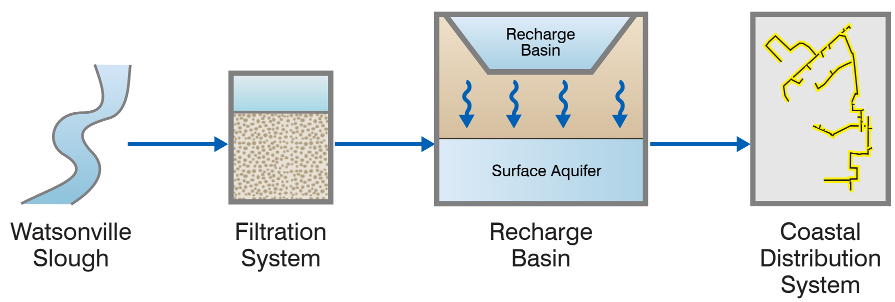
(3) Property Values are per correspondence with Chuck Allen, July 18, 2011 [inland rolling hills = $20,000/acre]

(4) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-2: Watsonville Slough with Recharge Basins



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This project would divert Watsonville Slough water from December to May for storage in the surficial groundwater aquifer at the proposed North Dunes Recharge Basin, Southeast Recharge Basin, and/or Monitoring Well #7 Recharge Basin. Water would be diverted from Watsonville Slough north of the Harkins Slough diversion or through the proposed constructed wetlands on an adjacent property and would be filtered, pumped to the recharge site through the Harkins Slough Recharge Facilities pipeline and through a new connecting pipeline, and then stored in the aquifer. Recovery wells constructed around the recharge basin would extract water during the irrigation season. As currently planned, this project would require construction of a diversion structure, inlet pump station, filtration facility, booster pump station, recharge basins, recovery wells, and up to approximately 8,000 feet of connecting pipelines. The USDA Natural Resources Conservation Service (NRCS) is planning to construct a wetlands on land between Harkins Slough and Watsonville Slough and divert water from the sloughs into it, which would allow Watsonville Slough water to be fed to the Harkins Slough pump station. The Agency will coordinate this project with the NRCS project.

Yield:

1,200 AFY

Capital Cost:

$14.7 Million

Cost includes construction of a diversion structure, inlet pump station, wet well, filtration facility, booster pump station, recharge basin, and connecting pipelines.

Operations & Maintenance:

$130,000/Year

Annualized Capital and O&M Cost:

$1,200,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

As with the existing Harkins Slough project, water quality concerns would include high slough water turbidity and high filtered water turbidity. In addition, TDS may be a concern since Watsonville Slough is tidally influenced.

Implementation Issues:

The PVWMA will need to obtain a water rights permit from the SWRCB. Additionally, water recovery issues which occur at the Harkins Slough project may occur at the proposed diversion project.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years Mid-Term = 10 - 20 years Long-Term = 20 - 30 years

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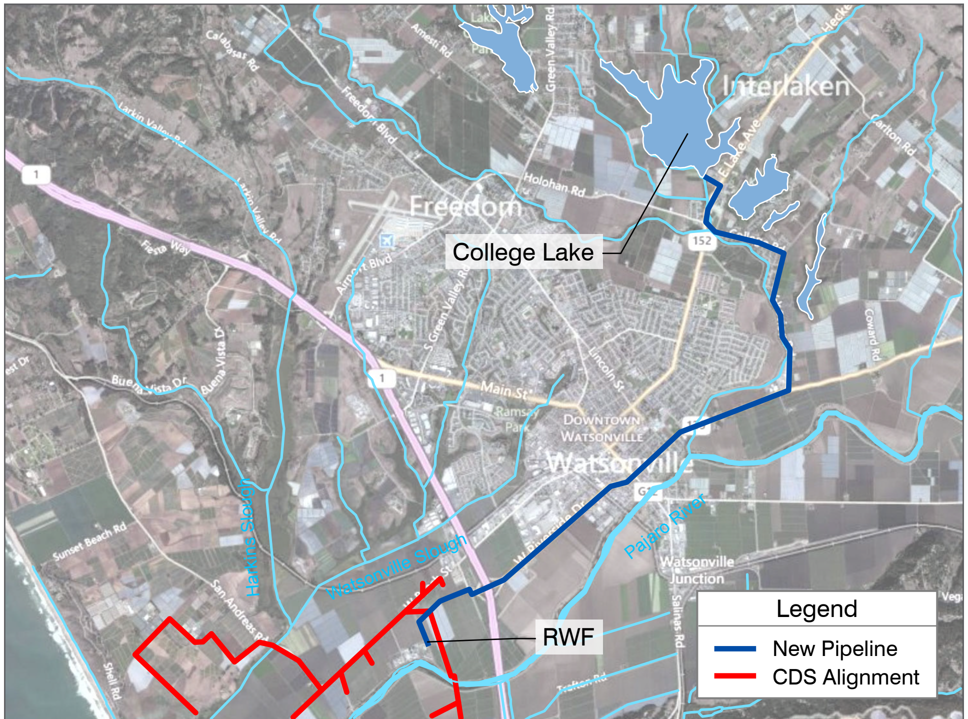
COST:

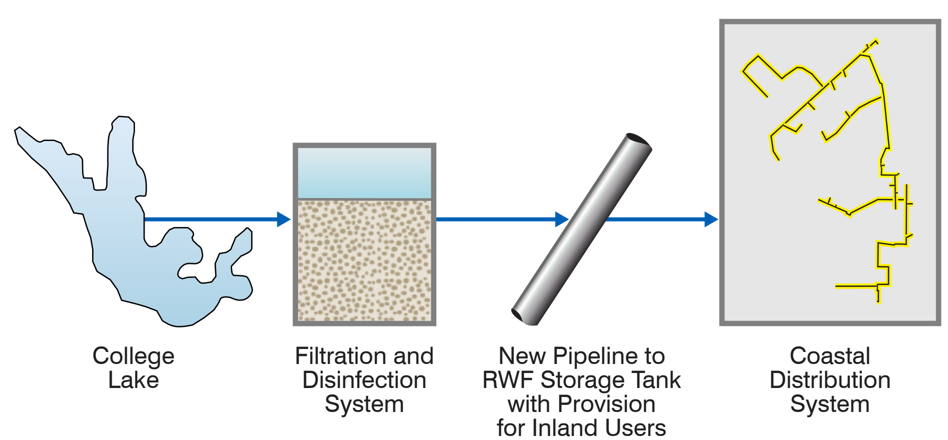
S-2: Watsonville Slough with Recharge Basins 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Planning Level Cost Estimate**
Watsonville Slough Diversion, Pumps, & Piping	$600,000
7,500 gpm Pump & Filters	$1,100,000
Recharge Basin with Recovery Wells, Monitoring Wells	$3,000,000
24-inch Pipeline to/from HS pipeline	$1,800,000
Fittings, Valves, etc.	$100,000
Total Direct Cost (1)	**$6,600,000**
Construction Contingency (30%)	$2,000,000
General Conditions (20%)	$1,300,000
Contractor Overhead and Profit (10%)	$700,000
Sales Tax (8.25% of 50% of Direct Cost)	$300,000
Total Construction Cost	**$11,000,000**
Engineering, Legal, Admin, Permits (20%)	$2,200,000
Technical Studies	$500,000
Land Acquisition & Right of Way Easements(1)	$1,000,000
Total Estimated Project Capital Cost	**$14,700,000**
Annualized Capital Cost(2)	$1,070,000
O & M Pump and Treatment(1)	$130,000
Total Annualized Cost	$1,200,000
Annual Yield (AF)	1,200
Unit Cost ($/AF)	**$1, 000**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-3: College Lake with Inland Pipeline to CDS



PROJECT PLAN



PROJECT SCHEMATIC

Background:

College Lake is located approximately one mile north of the Watsonville City limits and is a naturally occurring seasonal lake that receives water inflows from the Green Valley, Casserly and Hughes Creek subwatersheds. These streams drain approximately 11,000 acres of range, rural residential, and crop lands. Outflows from the lake naturally flow downstream to Salsipuedes Creek (mixing with overflow from Pinto Lake) in the winter months. An existing low dam on the south side of the lake causes inundation of approximately 234 acres of the basin, and helps prevent water from Salsipuedes Creek from entering College Lake. In the spring, the lake basin is pumped dry to allow farming to take place during the summer months.

This project includes construction of a new adjustable weir structure downstream of the existing low dam to increase the total storage capacity of the lake to approximately 300 acres. The project would send water from College Lake during the summer through a new pipeline to the recycled water facility (RWF) storage tank to supply the Coastal Distribution System, with provision to supply inland users along the pipeline. The water pumped out of College Lake would be filtered and disinfected at College Lake prior to entering the pipeline. Construction would include approximately 5.8 miles of new water main, a new pump station, and a filtration plant with disinfection.

The Resource Conservation District of Santa Cruz County is currently (2014) conducting a study of College Lake water flows, usage, and resource management. The results of this study will help further define how College Lake can be developed as a water supply source while preserving habitat for steelhead and other wetland/riparian species, and supporting other environmental and community benefits, and help reduce implementation issues for the project.

Yield:

2,100 to 2,400 AFY

Capital Cost:

$31.5 Million

Operations & Maintenance:

$340,000/Year

Annualized Capital and O&M Cost:

$2.6 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Phytophthora, algae, and pesticides.

Implementation Issues:

Water rights and permitting issues related to steelhead and bird habitat.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years Mid-Term = 10 - 20 years Long-Term = 20 - 30 years

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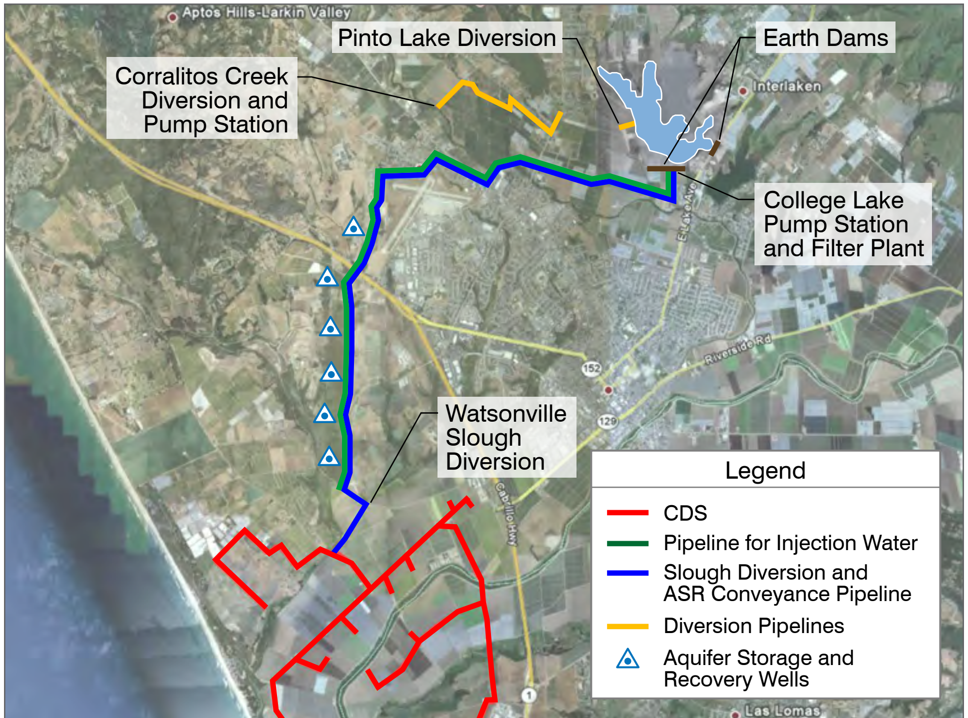
Cost:

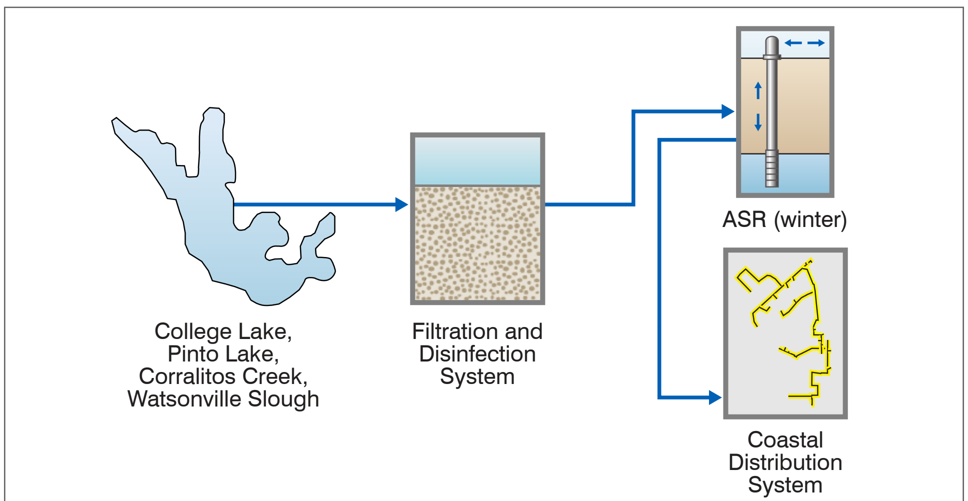
S-3: College Lake with Inland Pipeline to CDS **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Planning Level Cost Estimate**
New conveyance pipeline	$8,300,000
College Lake headgate and diversion pumps [1]	$1,300,000
Pump station (3-200 HP Pumps)	$800,000
Environmental habitat and mitigation	$1,000,000
Filtration (6000-gpm system)	$2,500,000
Disinfection and clearwell	$1,000,000
Total Direct Cost	**$14,900,000**
Construction contingency (30%)	$4,500,000
General conditions (20%)	$3,000,000
Contractor overhead and profit (10%)	$1,500,000
Sales tax (8.25% of 50% of Direct Cost)	$600,000
Total Construction Cost	**$24,500,000**
Engineering, legal, administration, permits (20%)	$4,900,000
Technical studies	$1,000,000
Land rights	$1,100,000
Total Estimated Project Capital Cost	**$31,500,000**
Annualized construction cost[2]	$2,300,000
O&Mpipeline (1%)	$80,000
O&M pump and filters (2.5%)	$120,000
Disinfection	$20,000
Pump power	$120,000
Total Annualized Cost	**$2,600,000**
Annual Yield AF	**2,400**
Unit Cost ($/AF)	**$1,100**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-4: Expanded College Lake Project with Pinto Lake, Corralitos Creek, Watsonville Slough, and Aquifer Storage and Recovery



PROJECT PLAN



PROJECT SCHEMATIC

Background:

College Lake is a seasonal water body in a fault-controlled depression located to the north of Holohan Road west of Highway 152, near St. Francis Cemetery. The lake captures runoff from an 11,000-acre watershed during the winter. The Expended College Lake Project would increase the total storage capacity of College Lake to 4,600 AF, increase the water supplies to College Lake, and add a seasonal storage component. This project diverts water from Corralitos Creek, Pinto Lake, and Watsonville Slough and provides ASR injection during the winter and recovery during the summer. A filtration and disinfection system would treat water from College Lake prior to entering the distribution pipeline. Two pipelines would be required; one to convey filtered water to the injection system wells, and a second to convey water from the slough to College Lake in the winter and also to convey College Lake and well water to the CDS during the irrigation season. This project would include the construction of College Lake main dam and saddle dam, filtration and disinfection facilities, pump stations, ASR wells, and approximately 15 miles of new conveyance pipeline. Harkin Slough yield (1100 AF) was included in the 2002 BMP; it is not included with this alternative.

Yield:

Total: 5,600 AFY

Not included in S-2 & S-3: 2,000 AFY

Capital Cost:

Total: $111 Million

Not included in S-2 & S-3: $71 Million

Operations & Maintenance:

Total: $1 Million/Year

Not included in S-2 & S-3: $560,000/Year

Annualized Capital and O&M Cost:

$9 Million (30-year capital recovery at 6% interest)

Not included in S-2 & S-3: $5.6 Million

Water Quality Considerations:

Removal of phytophthora and algae. Slough and lake water may require advanced treatment before injection to ground aquifer.

Implementation Issues:

Significant environmental, water rights and permitting issues.

Implementation Timeline:

Mid- to Long-Term*

***Timelines:**

Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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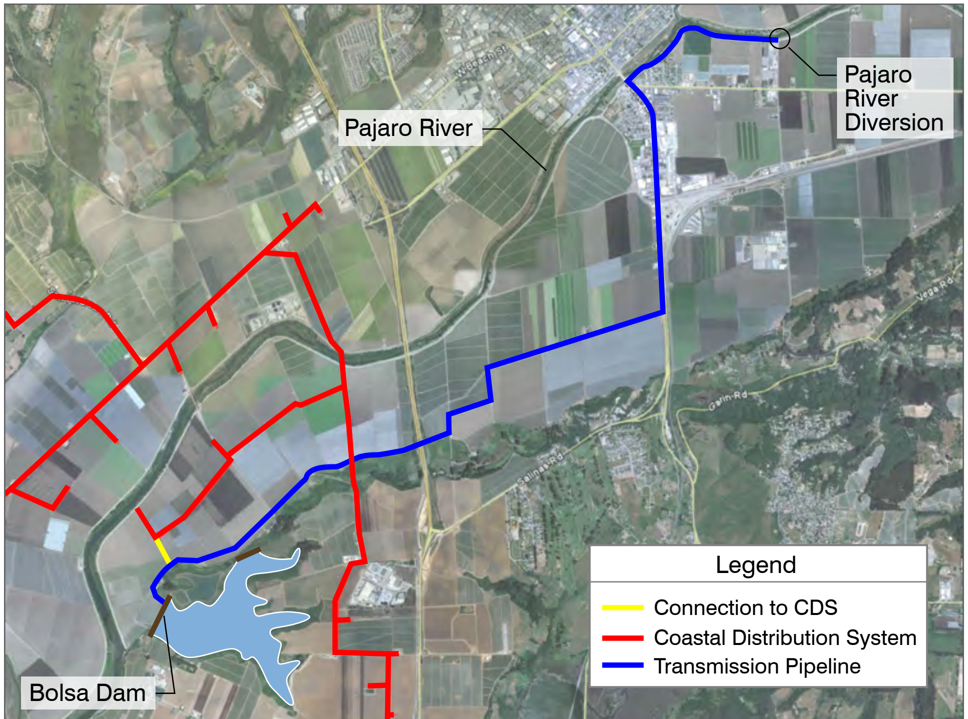
Cost:

S-4: Expanded College Lake Project with Pinto Lake, Corralitos Creek, Watsonville Slough and ASR **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
College Lake Dam, Dike, Spillway, Outlet Works	$10,100,000
College Lake Filter Facilities & Pump Station	$3,900,000
College Lake Pretreatment Facilities	$2,600,000
Membrane filtration or full conventional treatment (for injection only)	$5,400,000
Road & Utility Relocation	$1,400,000
Watsonville Slough Diversion, Filter, & Pump Station	$1,600,000
Pinto Lake Diversion	$500,000
Carrolitos Creek Diversion	$3,400,000
ASR - Injection & Extraction	
Injection/Extraction Wells(2) (6 wells, 600/1000 gpm inject/extract)	$5,700,000
Monitoring Wells	$400,000
Pipeline for Injection	$7,000,000
Pipeline Sloughs to College Lake Pretreatment	$10,700,000
Total Direct Cost	**$52,700,000**
Construction Contingency (30%)	$15,800,000
General Conditions (20%)	$10,500,000
Contractor Overhead and Profit (10%)	$5,300,000
Sales Tax (8.25% of 50% of Direct Cost)	$2,200,000
Total Construction Cost	**$86,500,000**
Engineering, Legal, Admin, Permits (20%)	$17,300,000
Land Acquisition (380 acres @ $20,000/acre) (3)	$7,600,000
Land Acquisition (40 acres @ $5,000/acre) (3)	$200,000
Total Estimated Project Implementation Cost	**$111,400,000**
Annualized Construction Cost(4)	$8,100,000
O & M Dam	$15,000
O & M Pipeline (1%)	$220,000
O & M Pump and Filters (2.5%)	$350,000
Power Cost - Watsonville Slough Pump *(1200 AF, 200 HP at 200' ~ 2000 gpm)*	$60,000
Power Cost - ASR Wells to CDS *(2400 AF, 300 HP at 200' ~ 3000 gpm)*	$120,000
Power Cost - College Lake to CDS *(3200 AF, 400 HP at 200' 4800 gpm)*	$160,000
Total Annualized Cost	**$9,000,000**
Annual Yield (AF)	**5,600**
Unit Cost ($/AF)	**$1,600**

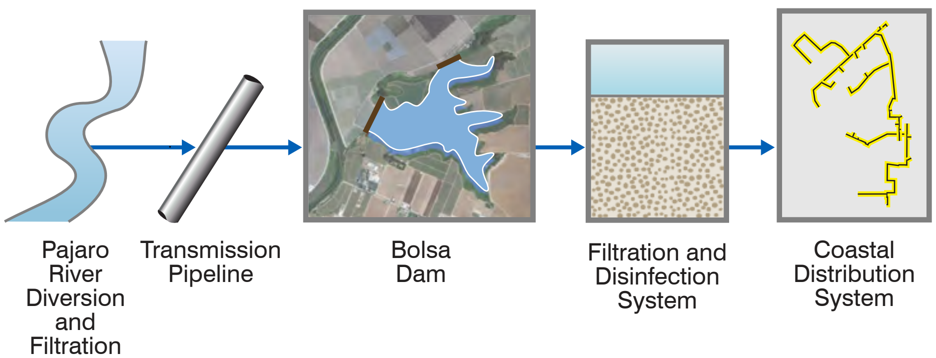
Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) ASR Component has been modified from 2002 BMP - Alternatively 3,200 AF will be stored in College Lake and only 2400 AF will be used for ASR in winter. This is due to the higher cost of ASR wells. 2400 AF over 5 month would be 3600 gpm requiring 6 wells at 600 gpm injection.
(3) Property Values are per correspondence with Chuck Allen, July 18, 2011 (inland rolling hills farmland = $20,000/acre)

(4) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-5: Bolsa de San Cayetano with Pajaro River Diversion



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This project consists of two options, one involving surface water only and one involving both surface and recycled water. Option 1 involves construction of the Bolsa De San Cayetano Dam and Reservoir for seasonal surface water storage to allow up to 5,000 AF in peak years of Pajaro River water to be diverted and pumped to the reservoir in the winter and used to meet irrigation demand in the summer. The dam and reservoir would be located in Monterey County on the south side of the Pajaro River and adjacent to Trafton Road. The reservoir site is surrounded by 100 to 150 feet high terrace upland that has been eroded from a canyon. The earth fill dam would be located across the mouth of the canyon to form the reservoir. A small saddle dam would also be constructed on the north ridge. The Pajaro River diversion would consist of an infiltration gallery, filtration system, and pump station facilities. The diversion would be located approximately 0.5 miles upstream of the confluence of Salsipudes Creek and Pajaro River. It is assumed the water would need to be filtered and disinfected after storage to meet user requirements. Option 2 involves using the reservoir for both surface water and recycled water storage. Option 2 uses the same infrastructure as Option 1 and also includes lining the reservoir as has been required by other Regional Water Quality Control Boards for surface storage of recycled water. Having the availability to store recycled water increases the average project yield since some years sufficient surface water is not available for diversion.

Yield:

3,500 AFY (Option 1), **4,500 AFY** (Option 2)

Capital Cost:

$150 Million (Option 1), **$197.3 Million** (Option 2)
Cost includes approximately six miles of new conveyance pipeline.

Operations & Maintenance:

$900,000/Year

Annualized Capital and O&M Cost:

$11.8 Million (Option 1), **$15.2 Million** (Option 2)
(30-year capital recovery at 6% interest)

Water Quality Considerations:

TDS and phytophthora are the water quality concerns for water diverted from the Pajaro River.

Implementation Issues:

Permitting issues related to steelhead habitat and water rights.

Implementation Timeline:

Long-Term

***Timelines:**
Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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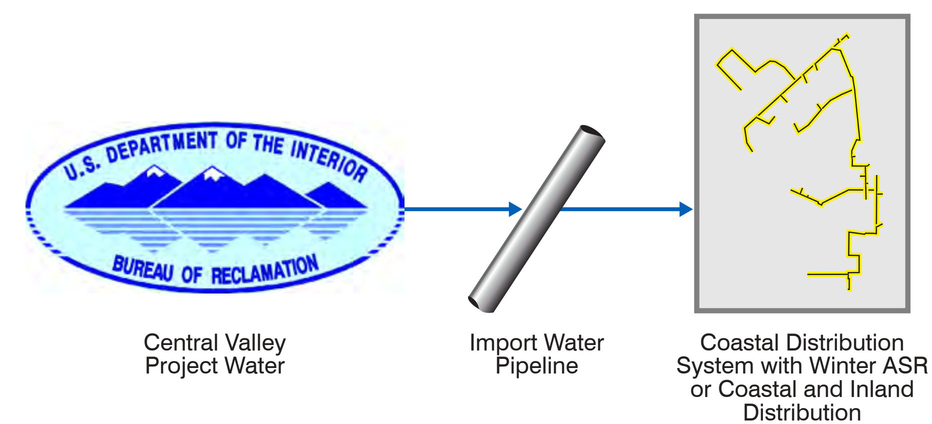
S-5: Bolsa De San Cayetano for River Diversion and Recycled Water
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

Project Element	**Option 1**	**Option 2**
Bolsa Main Dam, Saddle Dam Spillway, Outlet Works[1]	$31,800,000	$31,800,000
Road Relocation[1]	$500,000	$500,000
Diversion Pump Station and Filtration[1]	$16,800,000	$16,800,000
Pump Station Diversion [1]	$10,500,000	$10,500,000
Pump Station and Filtration (back into CDS)	$2,300,000	$2,300,000
Transmission Pipeline[1]	$10,900,000	$10,900,000
Connection to CDS Pipeline[1]	$800,000	$800,000
Reservoir Lining		$18,000,000
Linning Clean Soil Fill/Cover		$6,000,000
Total Direct Cost [4]	**$73,600,000**	**$97,600,000**
Construction Contingency (30%)	$22,100,000	$29,300,000
General Conditions (20%)	$14,700,000	$19,500,000
Contractor Overhead and Profit (10%)	$7,400,000	$9,800,000
Sales Tax (8.25% of 50% of Direct Cost)	$3,000,000	$4,000,000
Total Construction Cost	**$120,800,000**	**$160,200,000**
Engineering, Legal, Admin, Permits (20%)	$24,200,000	$32,000,000
Land Acquisition (170 Acres, half of this is farm land) [2]	$5,100,000	$5,100,000
Total Estimated Project Implementation Cost	**$150,100,000**	**$197,300,000**
Annualized Construction Cost[3]	$10,900,000	$14,300,000
O & M Pipeline (1%)	$100,000	$100,000
O & M Pump and Treatment (2.5%)	$700,000	$700,000
O & M Dam	$50,000	$50,000
Total Annualized Cost	**$11,800,000**	**$15,200,000**
Annual Yield AF	**3,500**	**4,500**
Unit Cost ($/AF)	**$3,400**	**$3,400**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Cost estimate does not include evronmental mitigation related to steelhead habitat in the Pajaro River.
(3) Property Values are per correspondence with Chuck Allen', July 18, 2011 (coastal flat = $45,000/acre) 85 acres @ $45K and 85 acres of non-agriculture @ $15K.
(4) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-6: Imported CVP Water

PROJECT PLAN



PROJECT SCHEMATIC

Background:

Central Valley Project (CVP) water is conveyed from the Delta of the San Joaquin and Sacramento Rivers through the Delta-Mendota Canal to O`Neill Forebay. The water is then be pumped into San Luis Reservoir and diverted through 1.8 miles of Pacheco Tunnel Reach 1 to the Pacheco Pumping Plant. At the pumping plant, the water is lifted to the 5.3-mile-long high-level section of Pacheco Tunnel Reach 2. The water flows through the tunnel and, without additional pumping, through the Pacheco Conduit to the bifurcation of the Santa Clara and Hollister Conduits (USBR). This project would require the construction of approximately 23 miles of conveyance pipeline, and associated appurtenances, connecting the Santa Clara Conduit to the existing Coastal Distribution System (CDS). The water supplied to the Pajaro Basin via the CVP is expected to be delivered to the CDS with the existing pressure in the Santa Clara Conduit. The import pipeline would be sized from 42 to 60-inches in diameter depending on required yield and planned operation. The PVWMA has a CVP entitlement of 19,900 AFY reserved for it by USBR. This alternative assumes up to 60% of this entitlement would be available.

Yield:

42-inch: 6,900 AFY / 54-inch: 11,900 AFY / 60-inch: 10,300 AFY

Capital Cost:

42-inch: $115.2 Million (cost includes ASR injection and extraction)
54-inch: $146.2 Million (cost includes ASR injection and extraction)
60-inch: $168.8 Million (cost includes Inland Distribution System)

Operations & Maintenance:

42-inch: $730,000/Year + $3.5 Million annual water cost
54-inch: $820,000/Year + $6.0 Million annual water cost
60-inch: $900,000/Year + $5.0 Million annual water cost

Annualized Capital and O&M Cost:

42-inch: $12.7 Million / 54-inch: $17.6 Million / 60-inch: $18.6 Million
(30-year capital recovery at 6% interest)

Water Quality Considerations:

CVP water meets the identified agriculture water quality objectives with the possible exception of phytophthora. Water quality fluctuates according to hydrologic conditions in northern California.

Implementation Issues:

Significant permitting and environmental evaluation.

Implementation Timeline:

Long-Term*

***Timelines:**
Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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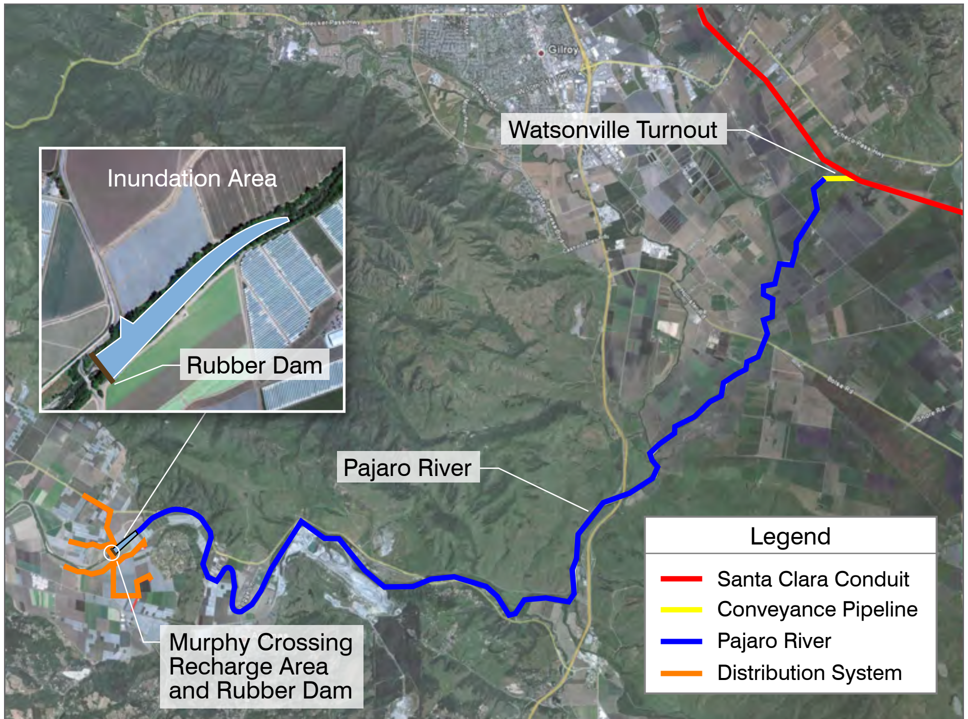
Cost:

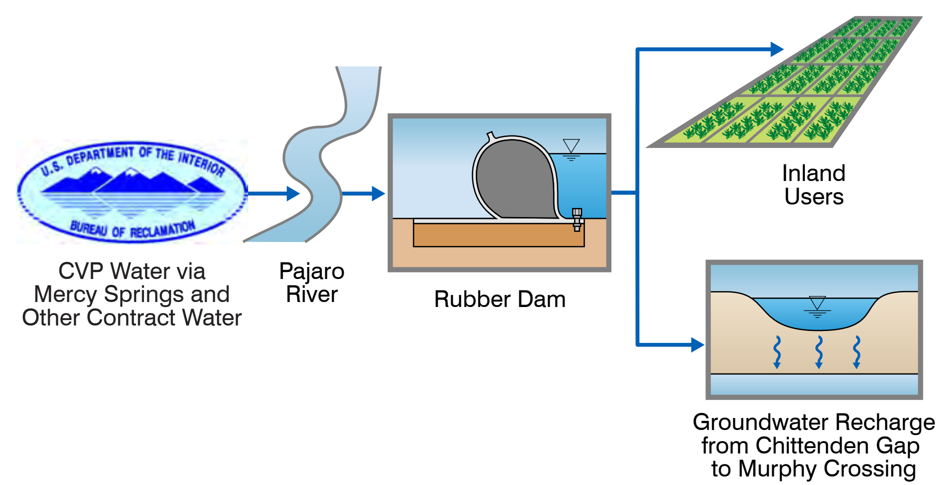
S-6: Imported CVP Water 2012 Basin Management Plan Update Pajaro Valley Water Management Agency			
Project Element		**Cost Estimate**	
	42-inch	**54-inch**	**60-inch**
Watsonville Turnout Structure[1]	$200,000	$200,000	$200,000
Import Pipeline[1]	$32,300,000	$41,500,000	$45,400,000
Crossings[1]	$8,200,000	$10,300,000	$1,200,000
Appurtenances[1]	$4,100,000	$5,200,000	$5,900,000
Inland Distribution System[1]	-	-	$15,900,000
Supplemental Wells[1]	-	-	$9,500,000
ASR-Injection/Extraction Wells[1]	$7,300,000	$7,300,000	-
Monitoring Wells[1]	$400,000	$400,000	-
Pump Stations Required for CDS[1]	$700,000	$700,000	-
Total Direct Cost	**$53,200,000**	**$65,600,000**	**$78,100,000**
Construction Contingency (30%)	$16,000,000	$19,700,000	$23,500,000
General Conditions (20%)	$10,700,000	$13,200,000	$15,700,000
Contractor Overhead and Profit (10%)	$5,400,000	$6,600,000	$7,900,000
Sales Tax (8.25% of 50% of Direct Cost)	$2,200,000	$2,800,000	$3,300,000
Total Construction Cost	**$87,500,000**	**$107,900,000**	**$128,500,000**
Engineering, Legal, Admin, Permits (20%)	$17,500,000	$21,600,000	$25,700,000
CVP Water Entitlements ($1,300/AF x 60% of Contract Amount) [2]	$9,000,000	$15,500,000	$13,400,000
Land Purchase	$500,000	$500,000	$500,000
Right of Way Easements	$700,000	$700,000	$700,000
Total Estimated Project Implementation Cost	**$115,200,000**	**$146,200,000**	**$168,800,000**
Annualized Construction Cost[3]	$8,400,000	$10,700,000	$12,300,000
O & M Pipeline (1%)	$400,000	$500,000	$500,000
O & M Pump (2.5%)	$200,000	$200,000	$300,000
Annual Water Cost	$3,500,000	$6,000,000	$5,200,000
Power Costs	$200,000	$200,000	$200,000
Total Annualized Cost	**$12,700,000**	**$17,600,000**	**$18,500,000**
Annual Yield AF	**6,900**	**11,900**	**10,300**
Unit Cost ($/AF)	**$1,800**	**$1,500**	**$1,800**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Fee based on yield; yield is based on a 60% reliability of the contract amount (e.g. Contract Amount 17,200AFY * 60% = 10,300 AFY
(3) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-7: River Conveyance of Mercy Springs CVP Water and Rubber Dam at Murphy Crossing



PROJECT PLAN



PROJECT SCHEMATIC

Background:

In November 1998, the PVWMA entered into an agreement for the assignment of 6,260 AFY of contracted Central Valley Project (CVP) water from the Mercy Springs Water District. Over the last 10 years, actual yields of CVP water for south of Delta agricultural use have varied between 10% and 100% of nominal contract, with a five-year average of 45%. This project would convey the contract water via the Pajaro River to the area of Murphy Crossing for groundwater recharge and distribution to inland customers. An inflatable rubber dam constructed across the Pajaro River would be used during irrigation months to retain water, facilitating groundwater recharge and pumping to inland users. The dam would be lowered during the winter months. The facilities required for this project would include approximately 2,200 LF of pipeline from the Santa Clara Conduit to the Pajaro River, an inflatable rubber dam, pump station, filtration and disinfection system at Murphy Crossing, and distribution pipelines.

Yield:

4,000 AFY (approximately 2,000 AFY of groundwater recharge and 2,000 AFY of water impounded behind the rubber dam and pumped to inland users)

Capital Cost:

$50.2 Million (cost includes estimated CVP water infrastructure cost recovery charge of $25 million)

Operations & Maintenance:

$2.4 Million

$500/AF is assumed to cover all costs of the CVP water to the point of delivery on the Santa Clara conduit.

Annualized Capital and O&M Cost:

$6.1 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

CVP water quality fluctuates according to hydraulic conditions in northern California. Existing groundwater in the Murphy Crossing area is high in salts.

Implementation Issues:

Rubber dam permitting and environmental concerns. Cost sharing for existing CVP water infrastructure cost recovery charge would need to be negotiated with other agencies. Water delivery yields would vary based on hydraulic conditions in northern California. If the PVWMA does not develop facilities to acquire Mercy Springs water by 2019, SCVWD and Westlands Water District would be the sole recipients of all water entitlements assigned under the agreement. The Agency would likely need to obtain other CVP water in addition to the Mercy Springs contract in some years due to reduced allocations.

Implementation Timeline:

Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years | Mid-Term = 10 - 20 years | Long-Term = 20 - 30 years

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Cost:

S-7: River Conveyance of Mercy Springs CVP Water with Rubber Dam at Murphy Crossing and Inland Distribution 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Pipeline to Pajaro River (2,200 LF)	$700,000
Rubber Dam Spillway (6ft high)	$1,000,000
Installation, Test, and Commission	$200,000
Civil Site Improvements (concrete base, power to site)	$300,000
Pump Station (3-150 HP Vertical Turbine Pumps)	$800,000
Filtration (6000 gpm system)	$2,500,000
Disinfection	$100,000
Distribution System (24,300 LF)	$6,600,000
Crossing - Pajaro River	$600,000
Total Direct Cost	**$12,800,000**
Construction Contingency (30%)	$3,800,000
General Conditions (20%)	$2,600,000
Contractor Overhead and Profit (10%)	$1,300,000
Sales Tax (8.25% of 50% of Direct Cost)	$500,000
Total Construction Cost	**$21,000,000**
CVP Water Entitlements	$25,000,000
Engineering, Legal, Admin, Permits (20%)	$4,200,000
Total Estimated Project Implementation Cost	**$50,200,000**
Annualized Construction Cost(2)	$3,700,000
O&M Pipeline (1%)	$73,000
O & M Rubber Dam	$100,000
O&M System Flow Control	$50,000
Pump Power (5000 gpm for 2100AFY, for 2300 hours at $0.15/kW-h)	$200,000
Annual Water Cost ($500/AF)(3)	$2,000,000
Total Annualized Cost	**$6,100,000**
Annual Yield AF(4)(5)	**4,000**
Unit Cost ($/AF)	**$1,500**

Notes:

(1) Fee based on yield; yield is based on a 60% reliability of the contract amount (e.g. Contract Amount 17,200 AFY * 60% = 10,300 AFY yield)

(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

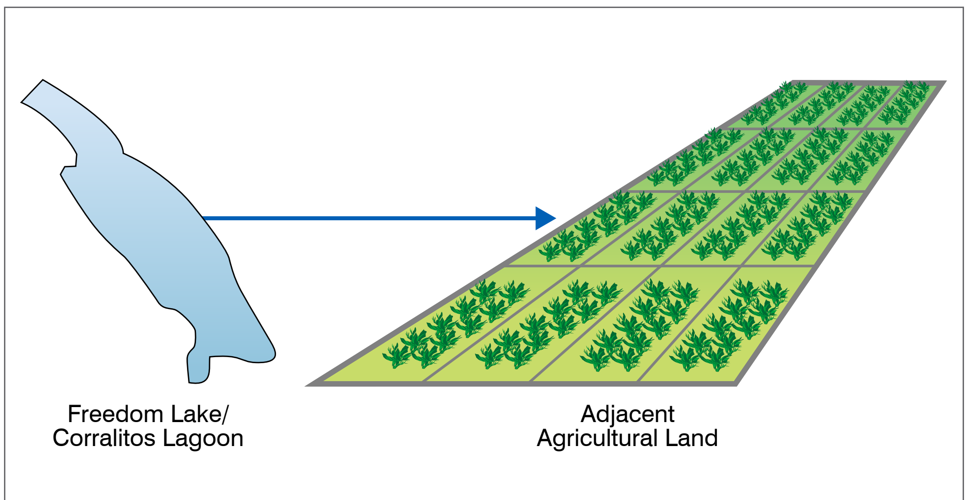
(3) Annual cost of water includes fees for O&M of upstream CVP infurstructure

(4) Infiltration and evaporation water loss along the Pajaro River is estimated to be .25 cfs - which is approximately 56 AF over a seven month period (conversaiton with Derrik Williams).

(5) Acctual Yield is based on historical CVP allotments, between 5%-50% of nominal concract. The yeild here reflects an average delivery of 30% minus any losses (See Warren Koenig paper BMP Options dated 2/28/2002). Iniltration rates of 0.3 m^3/s (10.6 cfs) from C. Ruehl, A. T. Fisher et. al, *"Differential Guaging and Tracer Tests Resolve seepage Fluxes in a Strongly-losing stream"*, Journal of Hydrology.

S-8: Freedom Lake/Corralitos Lagoon

PROJECT PLAN



PROJECT SCHEMATIC

Background:

Freedom Lake/Corralitos Lagoon is located approximately 4.5 miles northwest of Watsonville and adjacent to Scott Park. The lake is formed by a dam at its southern end and collects local runoff. The surface area of the lake is approximately 22 acres; the average depth of the lake is unknown. Five feet average depth was assumed for the purposes of estimating water yield. This alternative uses water from Freedom Lake/Corralitos Lagoon for irrigation of nearby farmland during the summer months (April-Oct). It is assumed the water will recharge during the winter months (Nov-Mar) and therefore provide an annual supply of approximately 100 AF. This alternative would include the construction of a pump station, filtration and disinfection system, and a conveyance pipeline to adjacent farmland.

Yield:

100 AFY (assumed depth of five feet)

Capital Cost:

$2.5 Million

Cost does not include water rights.

Operations & Maintenance:

$40,000/Year

Annualized Capital and O&M Cost:

$200,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

Suspended solids and phytophthora are potential water quality concerns for water diverted from Freedom Lake/Corralitos Lagoon.

Implementation Issues:

Significant environmental and permitting issues related to wetland habitat. Water rights.

Implementation Timeline:

Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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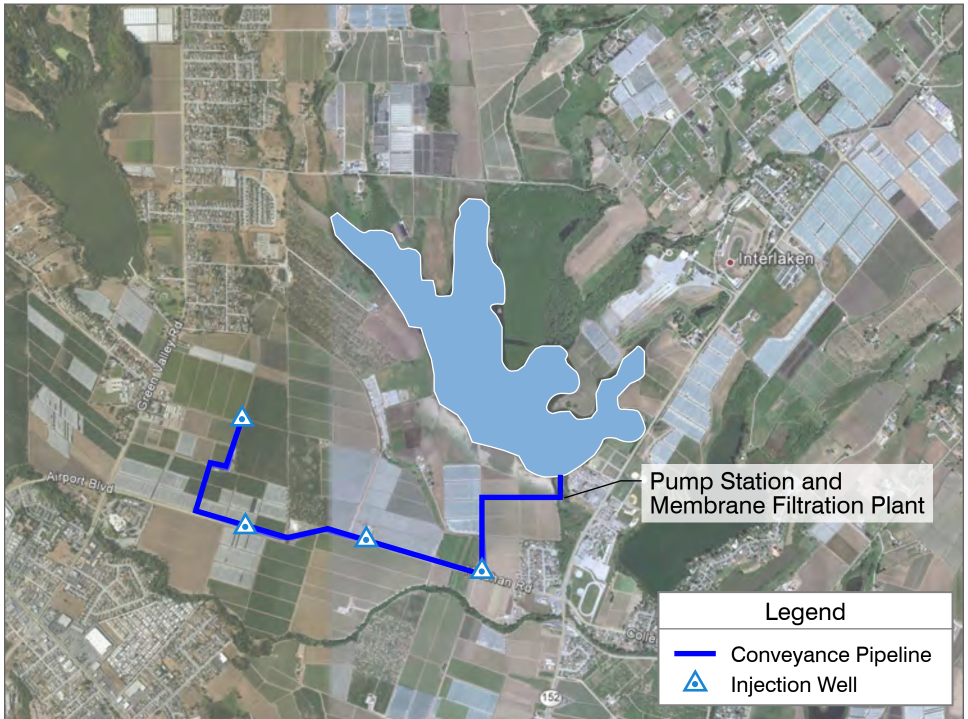
Cost:

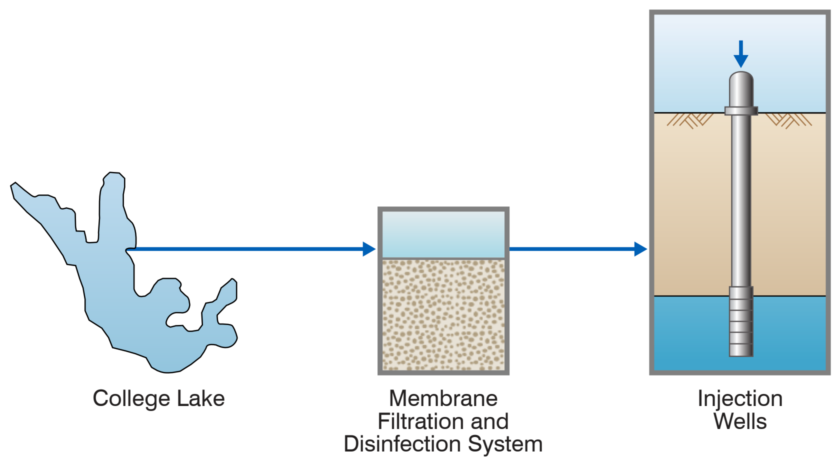
S-8: Freedom Lake / Corralitos Lagoon **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
New Conveyance Pipeline	$500,000
Pump Station	$300,000
Environmental Habitat and Mitigation	$200,000
Filtration	$200,000
Disinfection	$50,000
Total Direct Cost	**$1,300,000**
Construction Contingency (30%)	$390,000
General Conditions (20%)	$300,000
Contractor Overhead and Profit (10%)	$100,000
Sales Tax (8.25% of 50% of Direct Cost)	$50,000
Total Construction Cost	**$2,100,000**
Engineering, Legal, Admin, Permits	$420,000
Total Estimated Project Implementation Cost	**$2,500,000**
Annualized Construction Cost[(1)]	$180,000
O & M Pipeline (1%)	$10,000
O & M Pump and Filters (2.5%)	$20,000
Disinfection	$10,000
Total Annualized Cost	**$200,000**
Annual Yield AF	**100**
Unit Cost ($/AF)	**$2,000**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-9: College Lake Groundwater Injection in Winter



PROJECT PLAN



PROJECT SCHEMATIC

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Background:

College Lake is a seasonal water body in a fault-controlled depression located to the north of Holohan Road west of Highway 152, near St. Francis Cemetery. The lake captures runoff from an 11,000-acre watershed during the winter. This project would filter and disinfect diverted water from College Lake during the winter through a new pipeline to groundwater injection wells. The facilities for this project would include injection wells, approximately one and a half miles of new 12-inch water main, a new pump station, a membrane filtration plant with disinfection, and monitoring wells.

Yield:

1,000 AFY

Capital Cost:

$23.3 Million

Operations & Maintenance:

$280,000/Year

Annualized Capital and O&M Cost:

$2.0 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

It is assumed membrane filtration is needed to treat College Lake water for groundwater injection. Nitrate levels must meet the Surface Water Treatment Rule. UV disinfection may be required to meet Surface Water Treatment Rule Trihalomethane (THM) limits.

Implementation Issues:

Permitting issues.

Implementation Timeline:

Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

Cost:

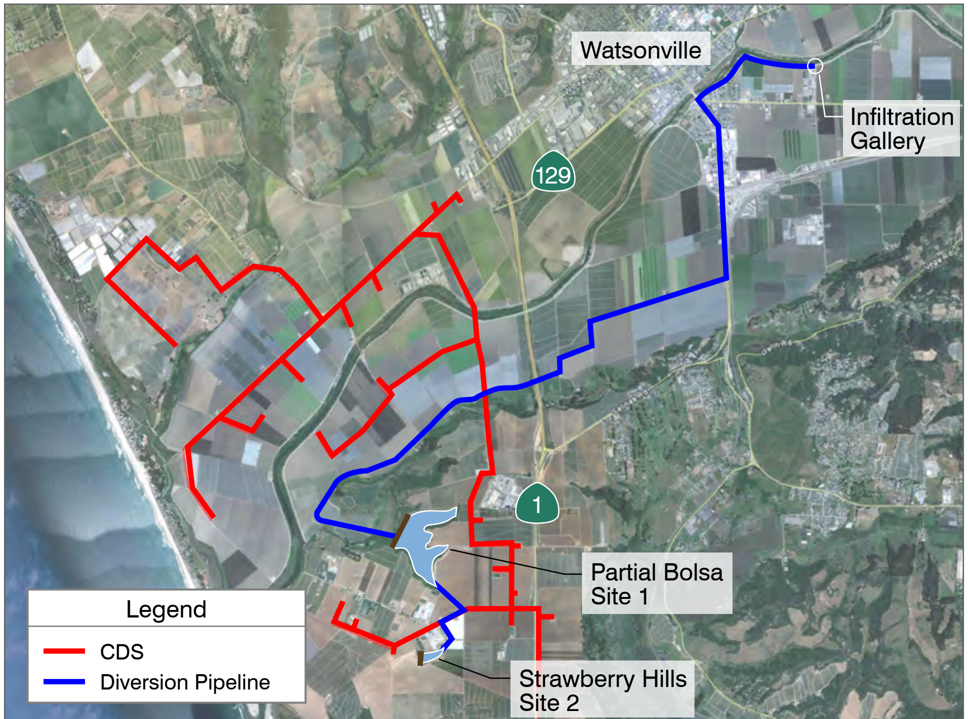
S-9 College Lake Groundwater Injection in Winter **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
New Conveyance Pipeline	$1,600,000
Pump Station (150 HP)	$400,000
Injection Wells (4 Wells @ 500 gpm)	$3,800,000
Monitoring Wells	$400,000
Membrane filtration or full conventional treatment (1)	$5,400,000
Disinfection	$200,000
Total Direct Cost	**$11,800,000**
Construction Contingency (30%)	$3,500,000
General Conditions	$2,400,000
Contractor Overhead and Profit (10%)	$1,200,000
Sales Tax (8.25% of 50% of Direct Cost)	$500,000
Total Construction Cost	**$19,400,000**
Engineering, Legal, Admin, Permits	$3,900,000
Total Estimated Project Implementation Cost	**$23,300,000**
Annualized Construction Cost(2)	$1,700,000
O & M Pipeline (1%)	$20,000
O & M Pump and Treatment (2.5%)	$150,000
Disinfection	$10,000
Power Cost	$50,000
Monitoring	$50,000
Total Annualized Cost	**$2,000,000**
Annual Yield AF	**1,000**
Unit Cost ($/AF)	**$2,000**

Notes:

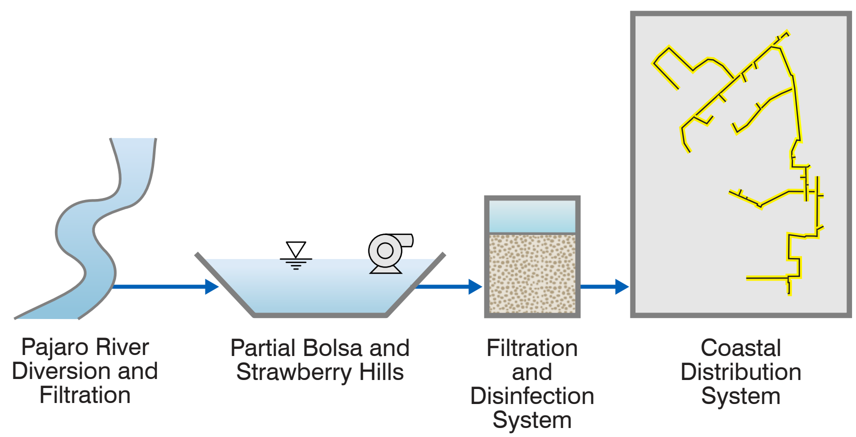
(1) Ceramic Membrane filters are utilized to address concerns of phytophthora and algae that foul injection wells.

(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-10: Dams at Bolsa and Strawberry Hills with Pajaro Diversion



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This alternative involves the construction of earth fill dams across two natural depression areas south of the Pajaro River for the storage of water diverted from the river during winter months. Site 1 would use a portion of the Bolsa de Cayetano Canyon's natural depression and would have a capacity of approximately 680 AF. This southeastern portion the Bosa Canyon would require the construction of a 75 feet high earth dam with a crest length of 1,200 feet, a spillway, and outlet works.

Site 2 uses a smaller natural depression located on the Strawberry Hills Forever, LLC property south of Jensen Road and has the capacity of approximately 130 AF. The Strawberry Hills site would require a 25 feet high earth dam with a crest length of 500 feet, spillway and outlet works. Each location would require a pump station, filtration and disinfection system, and pipelines to connect to the Coastal Distribution System. The diversion facilities would consist of filtration facilities, and pumping station located approximately 0.5 miles upstream of the confluence of Salsipuedes Creek and the Pajaro River.

Yield:

810 AFY

Capital Cost:

$100.2 Million

Operations & Maintenance:

$400,000 /Year

Annualized Capital and O&M Cost:

$7.7 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

TDS and phytophthora are the major water quality concerns for water diverted from the Pajaro River.

Implementation Issues:

Significant permitting issues related to steelhead habitat and water rights. Actual quantity of water diverted may be much less in some years. Reservoir lining and monitoring. Potential seismic issues.

Implementation Timeline:

Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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Cost:

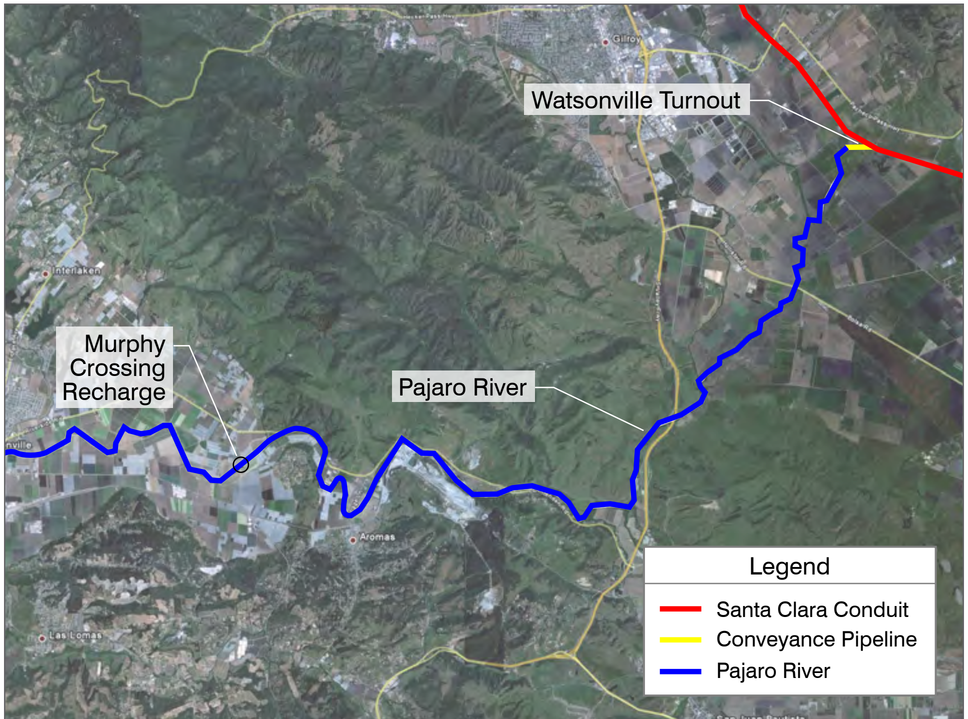
S-10: Dams at Bolsa and Strawberry Hills with Pajaro River Diversion 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Earth fill Dams, Spillway and Outlet Works	$28,500,000
Reservoir Lining (73 acres) Double layer of 60 mil HDPE	$6,400,000
Diversion Pump Station	$800,000
Transmission Pipeline	$12,500,000
Filtration and Disinfection (for injection to CDS) 2000 gpm	$900,000
Site 1: Pump Stations (one Vertical Turbine Pump 250HP)	$500,000
Site 2: Pump Stations (one Vertical Turbine Pump 50HP)	$300,000
Site 1: Pipeline (Connection to CDS 12" PVC)	$300,000
Site 2: Pipeline (Connection to CDS - 6" PVC)	$75,000
Total Direct Cost	**$50,300,000**
Construction Contingency (30%)	$15,100,000
General Conditions (20%)	$10,100,000
Contractor Overhead and Profit (10%)	$5,000,000
Sales Tax (8.25% of 50% of Direct Cost)	$2,100,000
Total Construction Cost	**$82,600,000**
Engineering, Legal, Admin, Permits (20%)	$16,500,000
Land Acquisition (75 Acres)[1]	$1,100,000
Total Estimated Project Implementation Cost	**$100,200,000**
Annualized Construction Cost[2]	$7,300,000
O & M Dam and Liner	$100,000
O&M Pipeline (1%)	$100,000
O & M Pump and Treatment (2.5%)	$40,000
Pump Power (2000 gpm for 680AFY, for 1846 hours at $0.15/kW-h)	$50,000
Pump Power (300 gpm for 130AFY, for 2353 hours at $0.15/kW-h)	$10,000
Pump Power (2400 gpm for 810AFY, for 1833 hours at $0.15/kW-h)	$100,000
Total Annualized Cost	**$7,700,000**
Annual Yield AF	**810**
Unit Cost ($/AF)	**$9,500**

Notes:

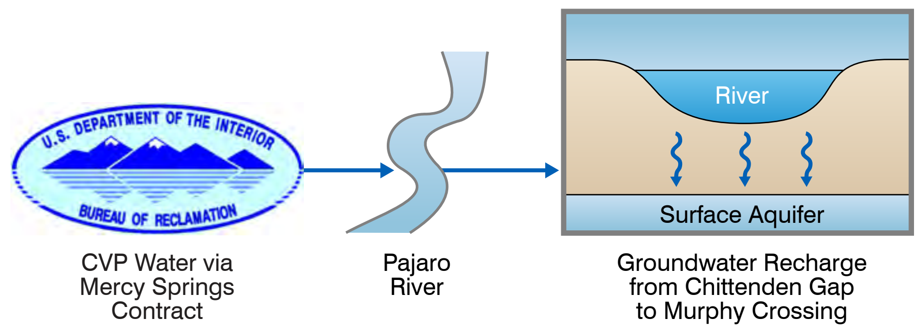
(1) Property Values are per correspondence with Chuck Allen, July 18, 2011 (coastal flat non-agriculture = $15,000/acre).

(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-11: River Conveyance of Mercy Springs CVP Water for Recharge at Murphy Crossing



PROJECT PLAN



PROJECT SCHEMATIC

Background:

In November 1998, the PVWMA entered into an agreement for the assignment of 6,260 AFY of contracted CVP water from the Mercy Springs Water District. Over the last 10 years, actual yields of CVP water for south of Delta agricultural use have varied between 10% and 100% of nominal contract, with a five-year average of 45%.This project would convey Mercy Springs contract water via the Pajaro River for groundwater recharge from the eastern edge of the groundwater basin to Murphy Crossing. Approximately 2,200 LF of pipeline would need to be constructed to bring water from the Santa Clara Conduit to the Pajaro River. CVP water would be released to the Pajaro River at a rate of approximately 6 cfs (2700 gpm) during months of relatively low flow, commonly from June through December.

Note: The BMP Committee modified this project during the screening process to include water from an unidentified source due to the uncertainty of Mercy Springs CVP water as a source.

Yield:

2,000 AFY (assumes an average of 11 AF per day for 6 months)

Capital Cost:

$26.2 Million

(cost includes estimated CVP water infrastructure cost recovery charge of $25 million)

Operations & Maintenance:

$1.1 Million

$500/AF is assumed to cover all costs of the CVP water to the point of delivery on the Santa Clara conduit.

Annualized Capital and O&M Cost:

$3.2 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

CVP water quality fluctuates according to hydrologic conditions in northern California. Existing groundwater in the Murphy Crossing area is high in salts.

Implementation Issues:

Cost sharing for existing CVP water infrastructure cost recovery charge would need to be negotiated with other agencies. Water delivery amounts would vary based on hydraulic conditions in northern California. If the PVWMA does not develop facilities to acquire Mercy Springs water by 2019, SCVWD and Westlands Water District would be the sole recipients of all water entitlements assigned under the agreement.

Implementation Timeline:

Near-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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Cost:

S-11: River Conveyance of Mercy Springs CVP Water for Recharge at Murphy Crossing **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
Pipeline to Pajaro River	$600,000
Total Direct Cost	**$600,000**
Construction Contingency (30%)	$200,000
General Conditions (20%)	$120,000
Contractor Overhead and Profit (10%)	$60,000
Sales Tax (8.25% of 50% of Direct Cost)	$20,000
Total Construction Cost	**$1,000,000**
CVP Water Entitlements	$25,000,000
Engineering, Legal, Admin, Permits	$200,000
Total Estimated Project Implementation Cost	**$26,200,000**
Annualized Construction Cost(2)	$2,000,000
O&M Pipeline (1%)	$100,000
O&M System Flow Control	$50,000
Annual Water Cost ($500/AF)(3)	$1,000,000
Total Annualized Cost	**$3,200,000**
Annual Yield AF(4)(5)	**2,000**
Unit Cost ($/AF)	**$1,600**

Notes:

(1) Fee based on yield; yield is based on a 60% reliability of the contract amount (e.g. Contract Amount 17,200 AFY * 60% = 10,300 AFY yield)

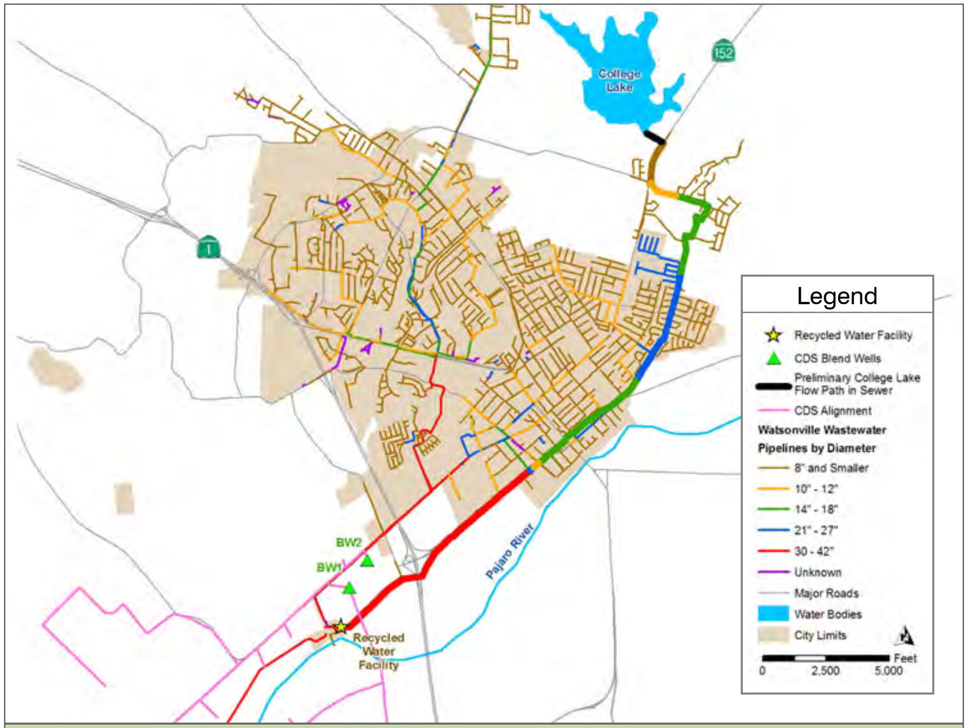
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

(3) Annual cost of water includes fees for O&M of upstream CVP infurstructure

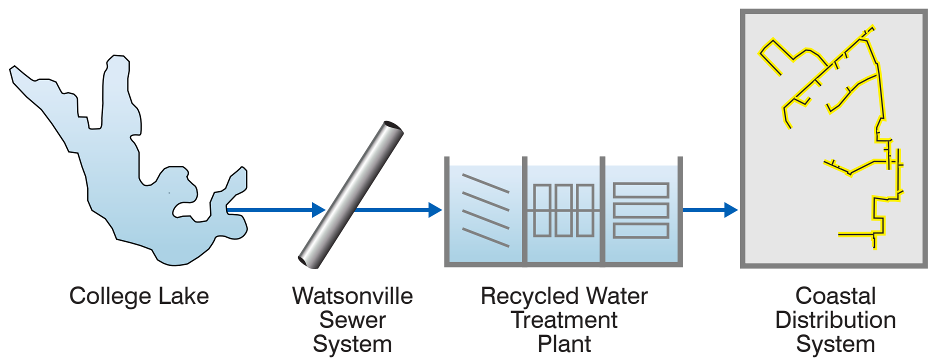
(4) River transfer of water loss is estimated to be .25 cfs - which is approximately 56 AF over a seven month period (conversaiton with Derrik Williams).

(5) Acctual Yield is based on historical CVP allotments, between 5%-50% of nominal concract. The yeild here reflects an average delivery of 30% minus any losses (See Warren Koenig paper BMP Options dated 2/28/2002). Iniltration rates of 0.3 m^3/s (10.6 cfs) from C. Ruehl, A. T. Fisher et. al, *"Differential Guaging and Tracer Tests Resolve seepage Fluxes in a Strongly-losing stream",* Journal of Hydrology.

S-12: College Lake to Recycled Water Treatment Plant in Summer



PROJECT PLAN



PROJECT SCHEMATIC

Background:

College Lake is a seasonal water body in a fault-controlled depression located to the north of Holohan Road west of Highway 152, near St. Francis Cemetery. The lake captures runoff from an 11,000-acre watershed during the winter. This project would divert water from College Lake and Pinto Lake to the Watsonville sanitary sewer collection system during the summer for conveyance to the Watsonville wastewater treatment plant, where it would be treated and pumped to the CDS. Approximately 4.3 miles of new pipe, dedicated to transmit College Lake water to the existing sewer would need to be constructed. The recycled water treatment plant would need to be expanded to meet increased flow volumes.

Yield:

2,000 AFY

Capital Cost:

$34.4 Million

Cost would include approximately 4.3 miles of new conveyance pipeline, pump station and filtration, sewer system upgrade, treatment plant upgrades, 1.0 MG storage tank, and land acquisition (150 acres at $5,000 per acre).

Operations & Maintenance:

$650,000/Year

Annualized Capital and O&M Cost:

$3.2 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Water from College Lake would reduce the TDS of delivered water.

Implementation Issues:

Permitting issues related to steelhead habitat and water rights.

Implementation Timeline:

Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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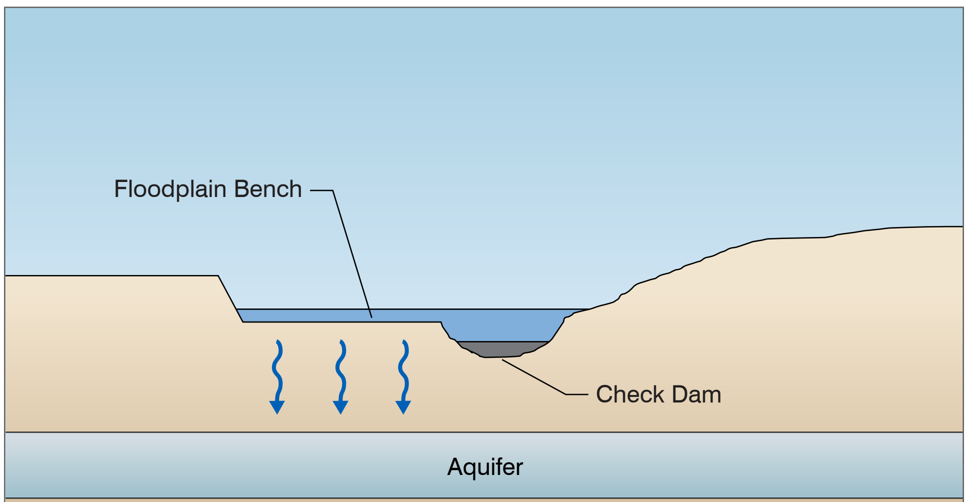
Cost:

S-12: College Lake to Recycled Water Treatment Plant in Summer **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
New Conveyance Pipeline	$6,800,000
College Lake Headgate, Diversion Pumps, & Pinto Lake Diversion	$1,300,000
Pump Station (3-200HP Vertical Turbine Pumps)	$900,000
Environmental Habitat and Mitigation	$1,000,000
Treatment Plant Expansion	
1.0 MG Storage Tank	$1,800,000
Additional Pumps (2- 350hp Vertical Turbine)	$200,000
DensaDeg equipment	$800,000
Filter equipment	$800,000
UV equipment	$700,000
Installation @ 25%	$600,000
Civil & Mechanical	$2,200,000
E&IC	$1,200,000
Total Direct Cost	**$17,100,000**
Construction Contingency (30%)	$5,100,000
General Conditions (20%)	$3,400,000
Contractor Overhead and Profit (10%)	$1,700,000
Sales Tax (8.25% of 50% of Direct Cost)	$700,000
Total Construction Cost	**$28,000,000**
Engineering, Legal, Admin, Permits (20%)	$5,600,000
Land Acquisition (150 acres @ $5,000/acre) (1)	$800,000
Total Estimated Project Implementation Cost	**$34,400,000**
Annualized Construction Cost (2)	$2,500,000
O & M Reservoir	$3,000
O&M Pipeline (1%)	$80,000
O & M Pump and Treatment (2.5%)	$450,000
Pump Power (2200 gpm for 667AFY, for 1650 hours at $0.15/kW-h)	$120,000
Total Annualized Cost	**$3,200,000**
Annual Yield AF	**2,000**
Unit Cost ($/AF)	**$1,600**

Notes:
(1) Property Values are per correspondence with Chuck Allen's (College Lake farmland = $5,000/acre)
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-13: Groundwater Recharge Upstream of Murphy Crossing with Water from Soap Lake and San Benito Floodplains

PROJECT PLAN



PROJECT SCHEMATIC

Background:

This alternative involves construction of a floodplain bench along the San Benito River, and construction of a series of check dams to raise the channel bed. The combined action could increase the amount of infiltration from the San Benito River during high flows, recharging groundwater. Potentially 500 AFY of San Benito surface flow that currently passes down into the Pajaro River could be diverted to the Gilroy-Hollister groundwater basin. The bench would be cut into the south bank of the San Benito River between Holister and Highway 101. Low boulder or gabion check dams would raise the bed of the river.

Yield:

500 AFY

Note that the San Andreas Fault and the Chittenden Gap inhibit or prevent movement between the Gilroy-Hollister groundwater basin and the Pajaro basin. As a result, most recharge is likely to be within the Gilroy-Hollister groundwater basin.

Capital Cost:

$49 Million

Operations & Maintenance:

$30,000/Year

Annualized Capital and O&M Cost:

$3.6 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Salinity, nitrate, boron, hardness, and trace elements that occasionally exceed drinking water standards are the major water quality concerns for groundwater from the Gilroy-Holister groundwater basin.

Implementation Issues:

The project would require acquisition or flood easements on 240 acres of farmland along the San Benito River, as well as mass grading in the floodplain and channel. There would be significant permitting issues. Further analysis would be needed to assess whether the creation of floodplain benches would increase recharge to the extent suggested. Actual quantity of water diverted may be much less in some years.

Implementation Timeline:

Mid to Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

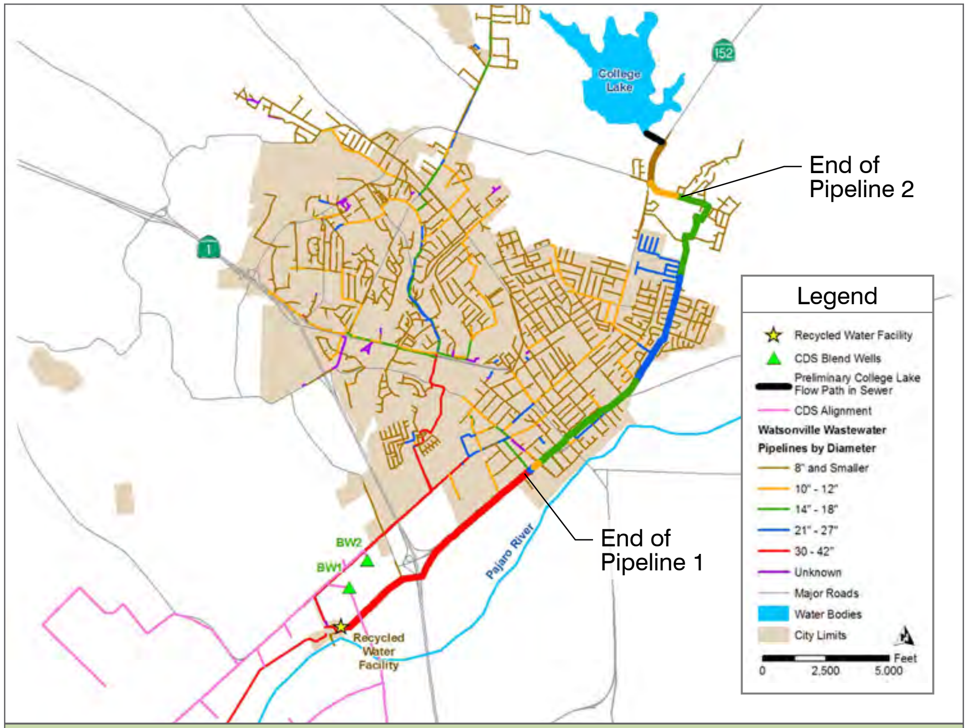
Cost:

S-13: Groundwater Recharge Upstream of Murphy Crossing with Water from Soap Lake and San Benito Floodplains
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

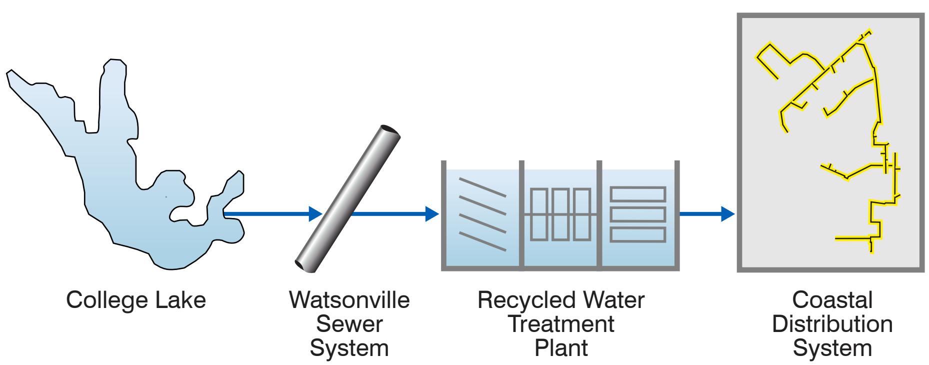
Project Element	**Cost Estimate**
Floodplain Bench Construction and Revegetation	$19,000,000
Check Dam Construction	$1,000,000
Total Direct Cost	**$20,000,000**
Construction Contingency (30%)	$6,000,000
General Conditions (20%)	$4,000,000
Contractor Overhead and Profit (10%)	$2,000,000
Sales Tax (8.25% of 50% of Direct Cost)	$800,000
Total Construction Cost	**$32,800,000**
Engineering, Legal, Admin, Permits	$6,600,000
Land Acquisition(1)	$9,600,000
Total Estimated Project Implementation Cost	**$49,000,000**
Annualized Construction Cost(2)	$3,600,000
O & M Check Dams	$2,000
Annual Bench Maintenance (sediment removal)	$30,000
Total Annualized Cost	**$3,600,000**
Annual Yield AF	**500**
Unit Cost ($/AF)	**$7,200**

Notes:
(1) Property Values are per correspondence with Chuck Allen, July 18 2011 (inland flat = $40,000/acre)
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-14: Partial College Lake to Recycled Water Treatment Plant in Summer



PROJECT PLAN



PROJECT SCHEMATIC

Background:

College Lake is a seasonal water body in a fault-controlled depression located to the north of Holohan Road west of Highway 152, near St. Francis Cemetery. The lake captures runoff from an 11,000-acre watershed during the winter. This project would divert water from College Lake to the Watsonville sanitary sewer collection system during the summer for conveyance to the Watsonville wastewater treatment plant, where it would be treated and pumped to the CDS.

This alternative is sized to use the existing capacity of the recycled water treatment plant and not require treatment expansion. Option 1 involves adding sufficient sewer capacity (4.3 miles of new sewer) to enable the unused nighttime treatment plant capacity to be fully utilized. Option 2 involves adding a relatively short length of new sewer (1.2 miles) to minimize construction costs and use a portion of the unused nighttime treatment plant capacity.

Yield:

Option 1: 460 AFY

Option 2: 170 AFY

Capital Cost:

Option 1: $16.4 Million

Option 2: $7.7 Million

Cost includes the new conveyance pipeline, pump station, sewer system upgrade, and land acquisition (150 acres at $5,000 per acre). Costs do not include the College Lake headgate, diversion pumps, nor the Pinto Lake diversion.

Operations & Maintenance:

Option 1: $90,000/Year

Option 2: $50,000/Year

Annualized Capital and O&M Cost:

Option 1: $1.3 Million

Option 2: $600,000

(30-year capital recovery at 6% interest)

Water Quality Considerations:

Water from College Lake would reduce the TDS of delivered water.

Implementation Issues:

Permitting issues related to steelhead habitat and water rights.

Implementation Timeline:

Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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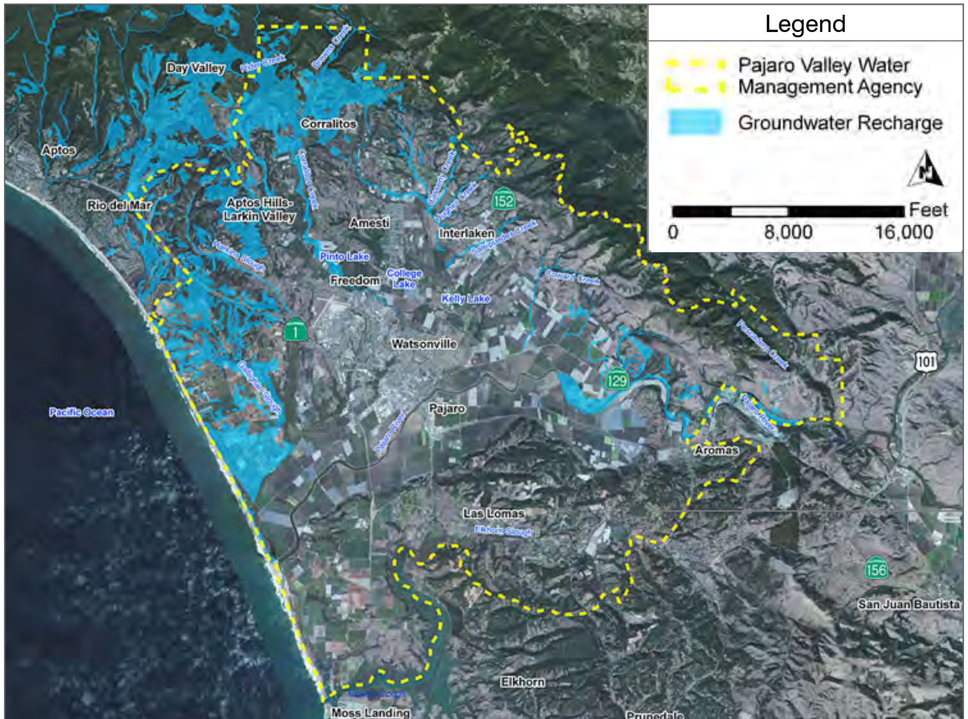
Cost:

S-14: Partial College Lake to Recycled Water Treatment Plant in Summer
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

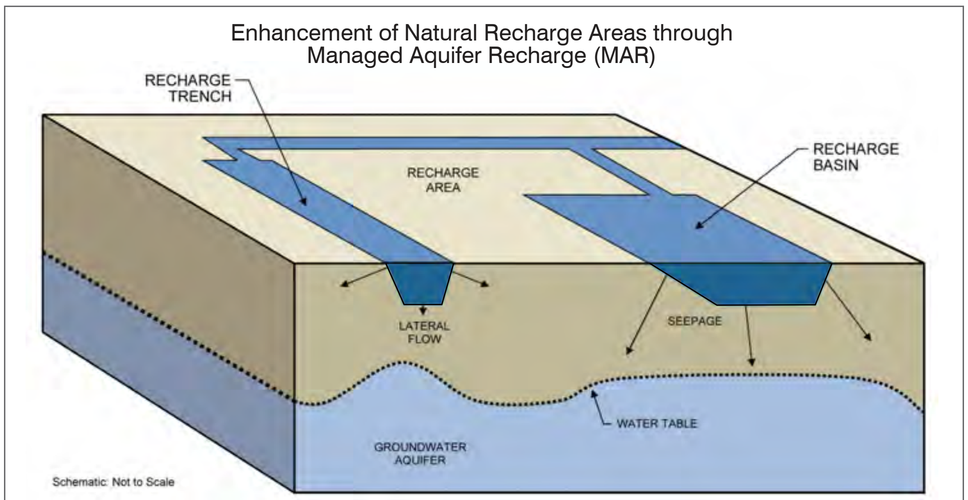
Project Element	**Option 1**	**Option 2**
New Conveyance Pipeline	$5,400,000	$1,500,000
Pump Station	$1,500,000	$1,000,000
Environmental Habitat and Mitigation	$1,000,000	$1,000,000
Total Direct Cost	**$7,900,000**	**$3,500,000**
Construction Contingency (30%)	$2,400,000	$1,100,000
General Conditions (20%)	$1,600,000	$700,000
Contractor Overhead and Profit (10%)	$800,000	$400,000
Sales Tax (8.25% of 50% of Direct Cost)	$300,000	$200,000
Total Construction Cost	**$13,000,000**	**$5,900,000**
Engineering, Legal, Admin, Permits (20%)	$2,600,000	$1,200,000
Land Acquisition (150 acres @ $5,000/acre) [1]	$800,000	$800,000
Total Estimated Project Implementation Cost	**$16,400,000**	**$7,900,000**
Annualized Construction Cost [2]	$1,200,000	$600,000
O&M Pipeline (1%)	$50,000	$20,000
O & M Pump and Treatment (2.5%)	$40,000	$30,000
Total Annualized Cost	**$1,300,000**	**$600,000**
Annual Yield AF	**460**	**170**
Unit Cost ($/AF)	**$2,800**	**$3,500**

Notes:
(1) Property Values are per correspondence with Chuck Allen, July 18, 2011 (College Lake farmland = $5,000/acre)
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-15: Protection of Natural Recharge Areas and Small Scale Managed Aquifer Recharge



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The PVWMA Service Area contains natural freshwater recharge areas that contribute to the replenishment of the regional groundwater system. Freshwater recharge occurs under certain conditions in various locales and throughout Pajaro Valley including areas underlain by permeable soils or alluvium and near natural hydrologic features (creeks, lakes, and sloughs). This alternative would identify high value, natural freshwater recharge areas based on various criteria including underlying geology, groundwater recharge capability, and location relative to urban and agricultural land uses and then would develop objectives and guidelines for future protection of these areas. Small Scale Managed Aquifer Recharge (MAR) involves deliberate infiltration of surface water using basins, trenches, and stream banks and provides the mechanism to enhance the surface water recharge capacity. Once natural freshwater recharge areas are identified and their value assessed, this alternative would then evaluate the potential for using MAR to augment groundwater recharge at suitable sites and, where viable, involve the design and construction of MAR facilities. The sources of water for MAR projects could include captured stormwater runoff or water conveyed from other sources. In certain areas, it may be possible to develop MAR sites in conjunction with proposed Aquifer Storage and Recovery (ASR) projects to increase available supply and offset groundwater extraction.

Yield:

Cannot be determined until suitable areas are identified and MAR projects are designed.

Capital Cost:

It is difficult to determine at this time. Would include costs to evaluate natural recharge areas, test for MAR suitability, and design and construct filtration facilities and conveyance systems.

Operations & Maintenance:

Depending on number of MAR projects considered, assume comparable to O&M of an infiltration basin.

Annualized Capital and O&M Cost:

Unknown

Water Quality Considerations:

MAR projects could have water quality implications depending on the source of water.

Implementation Issues:

Permitting may be required depending on water source and land use issues at particular locations.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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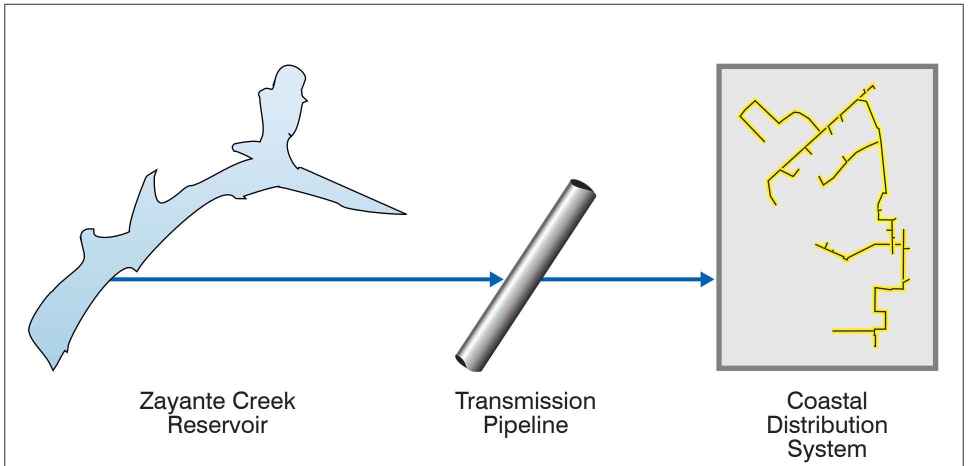
S-16: Zayante Creek Reservoir and Pipeline

PROJECT PLAN



PROJECT SCHEMATIC

Background:

Zayante Creek is located 27 miles northwest of Watsonville and approximately 3.5 miles north of Felton. Zayante Creek and its tributaries drain a total of 39 square miles (27% of the San Lorenzo drainage basin) through predominately mountainous terrain before flowing into the San Lorenzo River along the eastern edge of the San Lorenzo valley.

This alternative involves construction of an earth fill dam at the southern end of the Zayante Creek valley and use of the natural erosive geologic formation, comprised of Santa Margarita Sandstone, as a reservoir. The dam would be similar to the Loch Lomond Reservoir but with a much larger inundated area. The reservoir water would then be pumped to the Coastal Distribution System (CDS) in the Pajaro Valley. The facilities required include a 190' tall earth fill dam with a crest length of 1200', pump station, filtration and disinfection, intermediate pump stations, a 25-mile pipeline connecting the new reservoir with the CDS, and associated appurtenances.

Yield:

10,000 AFY

Capital Cost:

$221.7 Million

Cost does not include water rights or environmental mitigation.

Operations & Maintenance:

$1.7 Million/Year

Annualized Capital and O&M Cost:

$17.9 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Sedimentation/siltation is a major water quality concern for this watershed area. EPA has identified Zayante Creek and Mountain Charlie Gulch (a tributary) as an impaired waterway for sedimentation/siltation.

Implementation Issues:

Significant environmental and permitting issues related to habitat and water rights. Potential seismic issues. Relocation of residential properties along valley floor. Easements for transmission pipeline.

Implementation Timeline:

Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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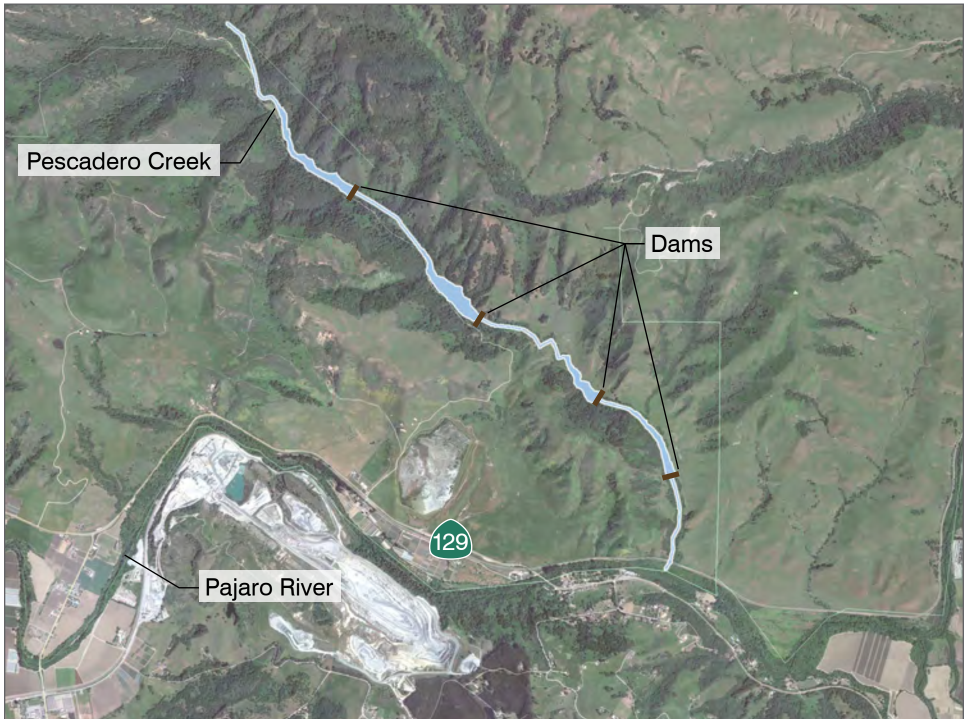
Cost:

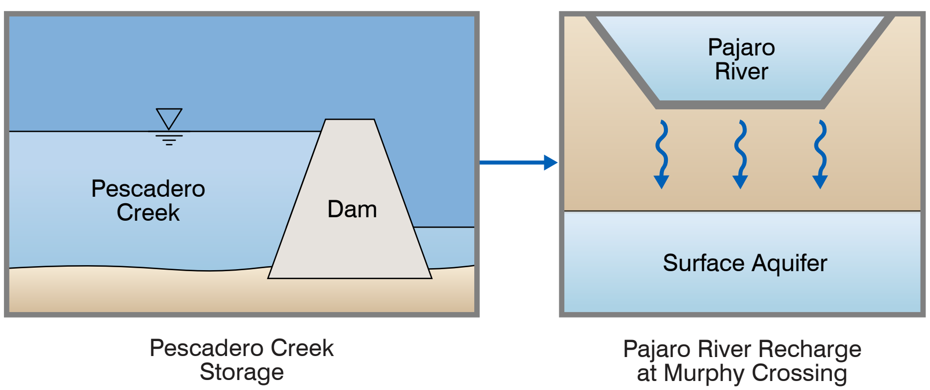
S-16: Zayante Creek Reservoir and Pipeline **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
Transmission Pipeline	$41,500,000
Crossings	$10,200,000
Appurtenances	$5,200,000
Zayante Creek Dam*	$35,000,000
Pump Station at Dam	$4,000,000
Additional Pump Stations	$1,700,000
Filtration and Disinfection	$4,500,000
Total Direct Cost	**$102,100,000**
Construction Contingency (30%)	$30,600,000
General Conditions (20%)	$20,400,000
Contractor Overhead and Profit (10%)	$10,200,000
Sales Tax (8.25% of 50% of Direct Cost)	$4,200,000
Total Construction Cost	**$167,500,000**
Engineering, Legal, Admin, Permits (20%)	$33,500,000
Land Purchase (Residential Area)(2)	$20,000,000
Right of Way and Easements	$700,000
Total Estimated Project Implementation Cost	**$221,700,000**
Annualized Construction Cost(1)	$16,100,000
O & M Pipeline (1%)	$400,000
O & M Pump and Filters (2.5%)	$300,000
Power Costs (rough estimate)	$1,000,000
O & M Dam	$50,000
Total Annualized Cost	**$17,900,000**
Annual Yield AF	**10,000**
Unit Cost ($/AF)	**$1,800**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.
(2) Land Puchase costs reflect limited site-specific information

S-17: Series of Dams on Pescadero Creek



PROJECT PLAN



PROJECT SCHEMATIC

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Background:

Pescadero Creek is located approximately 3.5 miles east of the City of Aromas in the southeastern portion of Santa Cruz County. This alternative would use winter creek flows to fill a series of small storage reservoirs created by dams placed along the creek alignment. The dams would be approximately 20-30 feet high and have a crest length of approximately 150-200 feet. The water stored in these dams would be released in the summer to the Pajaro River and used to recharge the ground water near Murphy Crossing.

The stored water would flow from the Pescadero Creek dam site to Pajaro River by gravity so no pumping would be required. For this alternative four dam locations were evaluated. Each site would have an estimated capacity of 50 AF.

Yield:

200 AFY (50 AF per dam site)

Capital Cost:

$7.2 Million

Cost does not include water rights, environmental mitigation, or land and easement acquisition.

Operations & Maintenance:

$20,000/Year

Annualized Capital and O&M Cost:

$550,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

This alternative assumes stored water can be used for groundwater recharge at Murphy Crossing without treatment.

Implementation Issues:

Significant environmental and permitting issues related to habitat and water rights. Potential seismic issues.

Implementation Timeline:

Mid to Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

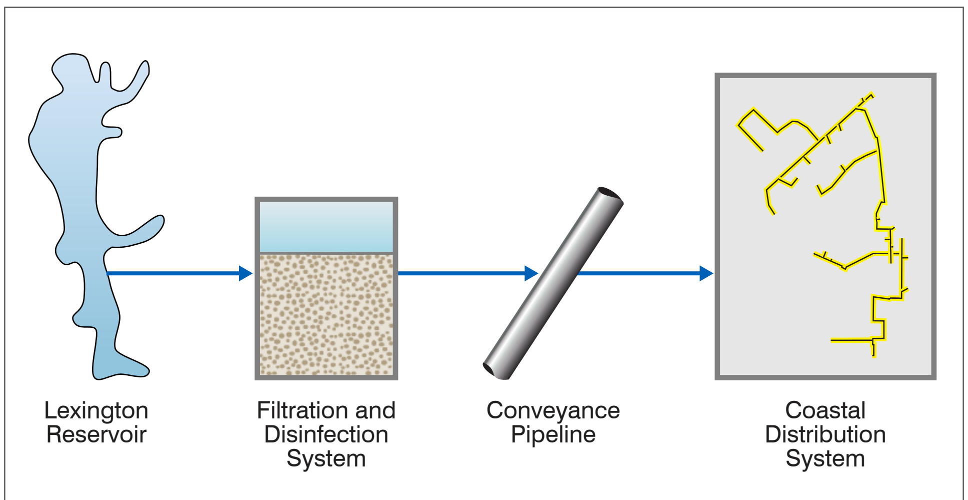
Cost:

S-17: Series of Dams along Pescadero Creek **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
Earth fill Dams, Spillway and Outlet Works (4 dams)	$3,000,000
Dam = 20,000 cuyds.(Engineered Fill)	
Roadway Improvements	$570,000
(2 mi. new road and 4 mi. of improvments)	
Total Direct Cost	**$3,570,000**
Construction Contingency (30%)	$1,100,000
General Conditions (20%)	$710,000
Contractor Overhead and Profit (10%)	$360,000
Sales Tax (8.25% of 50% of Direct Cost)	$150,000
Total Construction Cost	**$5,890,000**
Engineering, Legal, Admin, Permits (20%)	$1,200,000
Land Acquisition or Easements(1)	$100,000
Total Estimated Project Implementation Cost	**$7,200,000**
Annualized Construction Cost(2)	$530,000
O & M Dam (Sediment Removal)	$20,000
Total Annualized Cost	**$550,000**
Annual Yield AF	**200**
Unit Cost ($/AF)	**$2,800**

Notes:
(1) The cost assumes $2,000 per acre to purchase an easement for 50 acres
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-18: Pipeline from Lexington Reservoir

PROJECT PLAN



PROJECT SCHEMATIC

Background:

Lexington Reservoir is located adjacent to Highway 17 in Santa Clara County. The reservoir is part of the Santa Clara Valley Water District and currently provides water for the Silicon Valley. This alternative would pump water from Lexington Reservoir through a pipeline to agricultural users in Santa Cruz County and the Coastal Distribution System (CDS). The alternative would include filtration and chlorination, two new pump stations, two 1-million gallon equalization tanks, a new pipeline, and three pressure-reducing stations. The costs do not include an intake facility and the costs of water rights.

Yield:

2,100 AFY

Capital Cost:

$147 Million

Operations & Maintenance:

$1.8 Million

Annualized Capital and O&M Cost:

$12.5 Million

Water Quality Considerations:

It is assumed filtration and disinfection is required before the water can be pumped to the CDS.

Implementation Issues:

Significant environmental, permitting, and water rights issues.

Implementation Timeline:

Mid- to Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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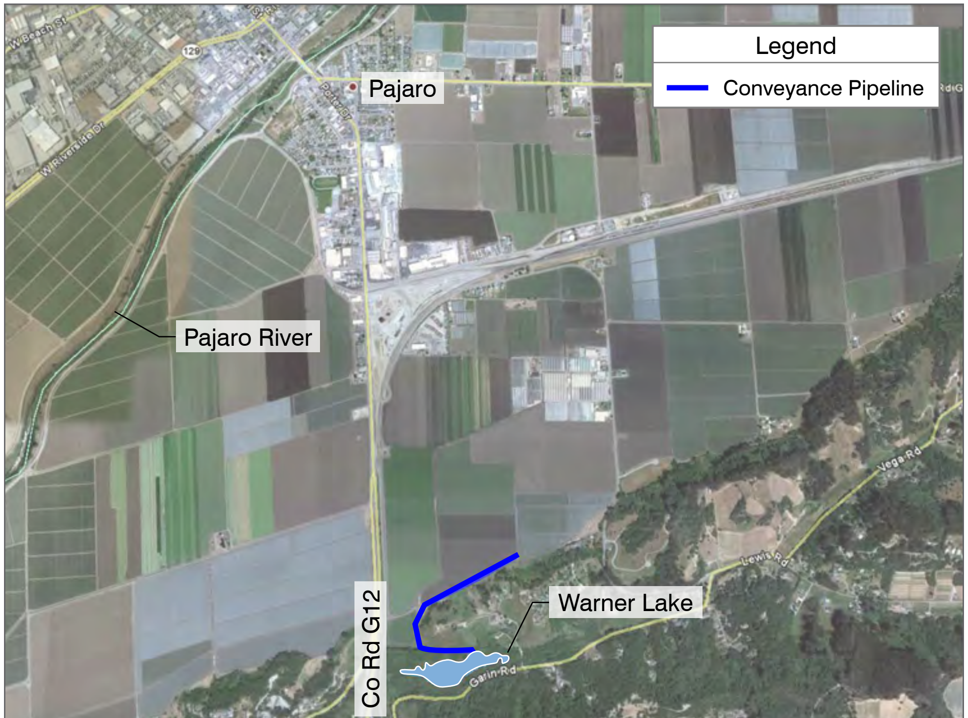
Cost:

S-18: Pipeline from Lexington Reservoir
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

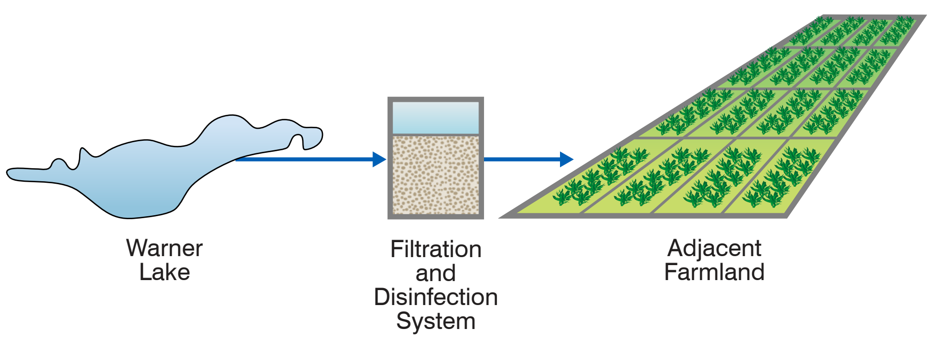
Project Element	**Cost Estimate**
Transmission Pipeline	$64,800,000
Primary Pump Station	$3,000,000
Additional Pump Stations	$3,000,000
Pressure Reducing Stations (Three Locations)	$600,000
1 MG Storage Tank (Welded Steel)	$1,000,000
Filtration and Disinfection	$2,200,000
Total Direct Cost	**$74,600,000**
Construction Contingency (30%)	$22,400,000
General Conditions (20%)	$14,900,000
Contractor Overhead and Profit (10%)	$7,500,000
Sales Tax (8.25% of 50% of Direct Cost)	$3,100,000
Total Construction Cost	**$122,500,000**
Engineering, Legal, Admin, Permits (20%)	$24,500,000
Total Estimated Project Implementation Cost	**$147,000,000**
Annualized Construction Cost[(1)]	$10,700,000
O & M Pipeline (1%)	$700,000
O & M Pump and Filters (2.5%)	$100,000
Power Costs (rough estimate)	$1,000,000
O & M Dam	$2,000
Total Annualized Cost	**$12,500,000**
Annual Yield AF	**2,100**
Unit Cost ($/AF)	**$6,000**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-19: Warner Lake



PROJECT PLAN



PROJECT SCHEMATIC

Background:

Warner Lake is located approximately 1.5 miles south of the City of Pajaro and adjacent to County Road G12. The lake is formed by a natural depression at the extension of the foothills. The surface area of the lake is approximately 6.5 acres; the average depth of the lake is unknown. Five feet average depth was assumed for the purposes of estimating water yield. This alternative uses water from Warner Lake for irrigation of nearby farmland during the summer months (April-Oct). It is assumed the water will recharge during the winter months (Nov-Mar) and therefore provide an annual supply of approximately 30 AF. This alternative would include the construction of a pump station, filtration and disinfection system, and a conveyance pipeline to adjacent farmland

Yield:

30 AFY

Capital Cost:

$1.6 Million

Operations & Maintenance:

$35,000/Year

Annualized Capital and O&M Cost:

$150,000

Water Quality Considerations:

Suspended solids and phytophthora are potential water quality concerns for water diverted from Warner Lake.

Implementation Issues:

Environmental and permitting issues related to wetland habitat. Water rights.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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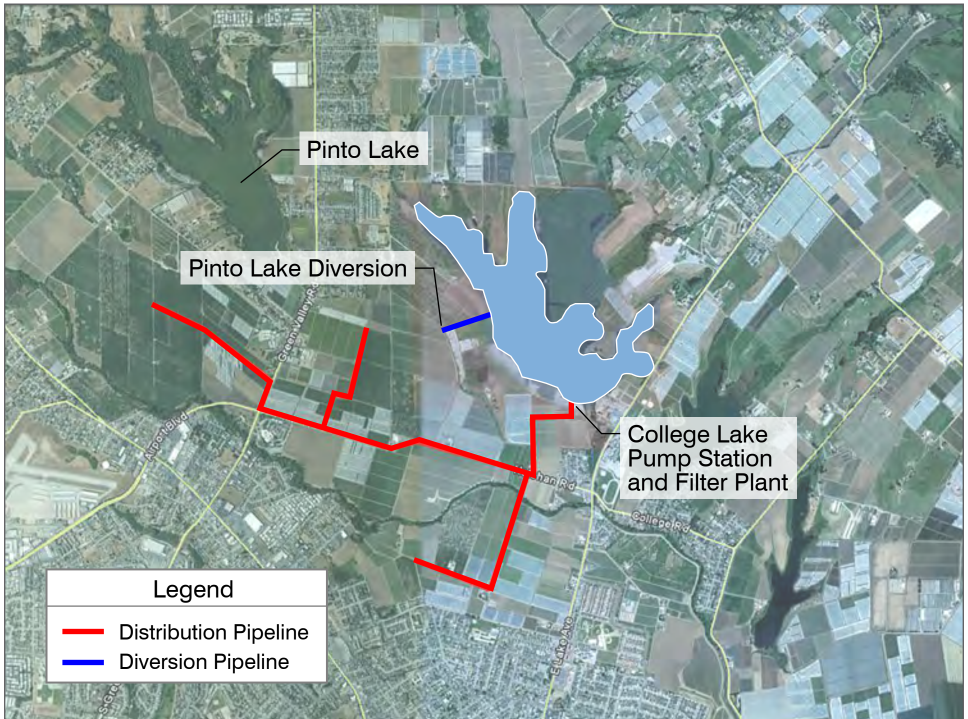
Cost:

S-19: Warner Lake
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

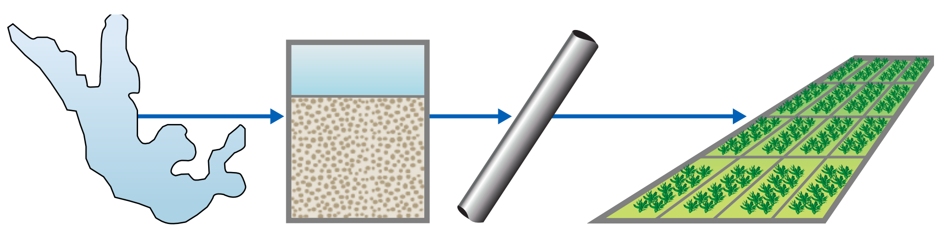
Project Element	Cost Estimate
New Conveyance Pipeline	$270,000
Pump Station	$200,000
Environmental Habitat and Mitigation	$100,000
Filtration	$200,000
Disinfection	$30,000
Total Direct Cost	**$800,000**
Construction Contingency (30%)	$240,000
General Conditions (20%)	$160,000
Contractor Overhead and Profit (10%)	$80,000
Sales Tax (8.25% of 50% of Direct Cost)	$40,000
Total Construction Cost	**$1,320,000**
Engineering, Legal, Admin, Permits (20%)	$270,000
Total Estimated Project Implementation Cost	**$1,600,000**
Annualized Construction Cost[(1)]	$120,000
O & M Pipeline (1%)	$10,000
O & M Pump and Filters (2.5%)	$20,000
Power Costs (25 hp @ 1700 hours)	$5,000
Total Annualized Cost	**$150,000**
Annual Yield AF	**30**
Unit Cost ($/AF)	**$5,000**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-20: College Lake with Pipeline to Adjacent Farmland



PROJECT PLAN



PROJECT SCHEMATIC

Background:

College Lake is a seasonal water body in a fault-controlled depression located to the north of Holohan Road west of Highway 152, near St. Francis Cemetery. The lake captures runoff from an 11,000-acre watershed during the winter. This project would divert water from College Lake and Pinto Lake during the summer through a new pipeline to inland growers. The water pumped out of College Lake would go through filtration and disinfection at College Lake prior to entering the pipeline. Construction would include approximately four miles of new 18-inch water main, a new pump station, and a filtration plant with disinfection.

Yield:

2,400 AFY

Capital Cost:

$23.9 Million

Operations & Maintenance:

$340,000/Year

Annualized Capital and O&M Cost:

$2.1 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Phytophthora, algae, and pesticides.

Implementation Issues:

Water rights and permitting issues related to steelhead habitat.

Implementation Timeline:

Near-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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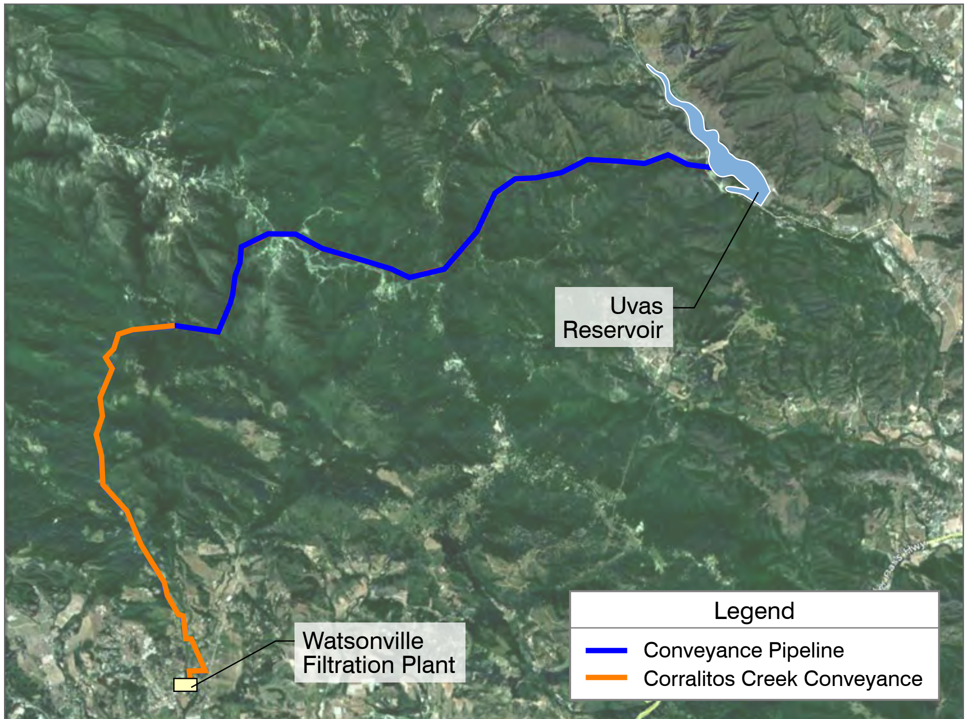
Cost:

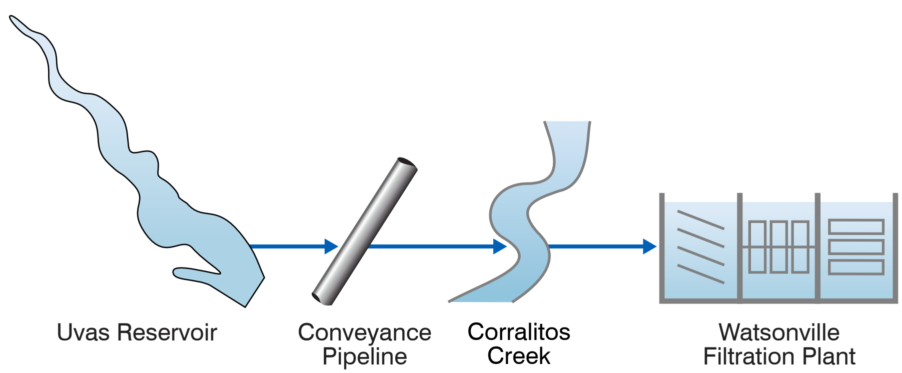
S-20: College lake with Pipeline to Adjacent Farmland 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
New Conveyance Pipeline	$5,800,000
College Lake Headgate, Diversion Pumps, & Pinto Lake Diversion (1)	$1,300,000
Pump Station (3-200HP Pumps)	$900,000
Environmental Habitat and Mitigation	$1,000,000
Filtration (6000 gpm system)	$2,500,000
Disinfection	$500,000
Total Direct Cost	**$12,000,000**
Construction Contingency (30%)	$3,600,000
General Conditions (20%)	$2,400,000
Contractor Overhead and Profit (10%)	$1,200,000
Sales Tax (8.25% of 50% of Direct Cost)	$500,000
Total Construction Cost	**$19,700,000**
Engineering, Legal, Admin, Permits (20%)	$4,000,000
Land Acquisition (40 acres @ $5,000/acre) (2)	$200,000
Total Estimated Project Implementation Cost	**$23,900,000**
Annualized Construction Cost (3)	$1,800,000
O & M Pipeline (1%)	$60,000
O & M Pump and Filters (2.5%)	$130,000
Disinfection	$10,000
Pump Power (2000 gpm for 833AFY, for 1800 hours at $0.15/kW-h) x 3	$140,000
Total Annualized Cost	**$2,100,000**
Annual Yield AF	**2,400**
Unit Cost ($/AF)	**$900**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Property Values are per correspondence with Chuck Allen, July 18, 2011 [college lake larmland = $5,000/acre]
(3) Annualized costs are based on a 30-year capital recovery period at 6% interest.

S-21: Imported Water Supply from Uvas Reservoir



PROJECT PLAN



PROJECT SCHEMATIC

Background:
This alternative involves running a pipeline from the Uvas Reservoir about 6 miles to the summit and discharging the water into Brown's Creek/Corrilitos Creek watershed. The water would help maintain the flows in the creeks during the dry summer months and could be used by the City of Watsonville through their existing water intake on Brown's Creek.

Yield:
2,000 AFY

Capital Cost:
Unknown

Operations & Maintenance:
Unknown

Annualized Capital and O&M Cost:
Unknown

Water Quality Considerations:
Could improve quality of water in the creeks.

Implementation Issues:
Santa Clara Valley Water District does not currently have excess water in Uvas Reservoir in the summer.

Implementation Timeline:
Mid- to Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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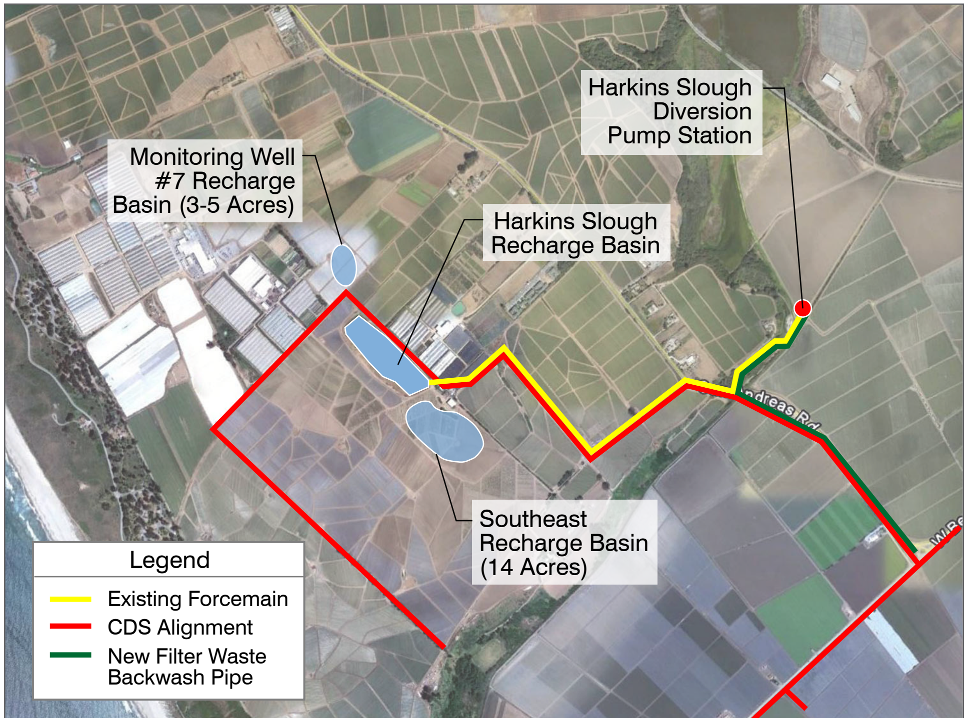
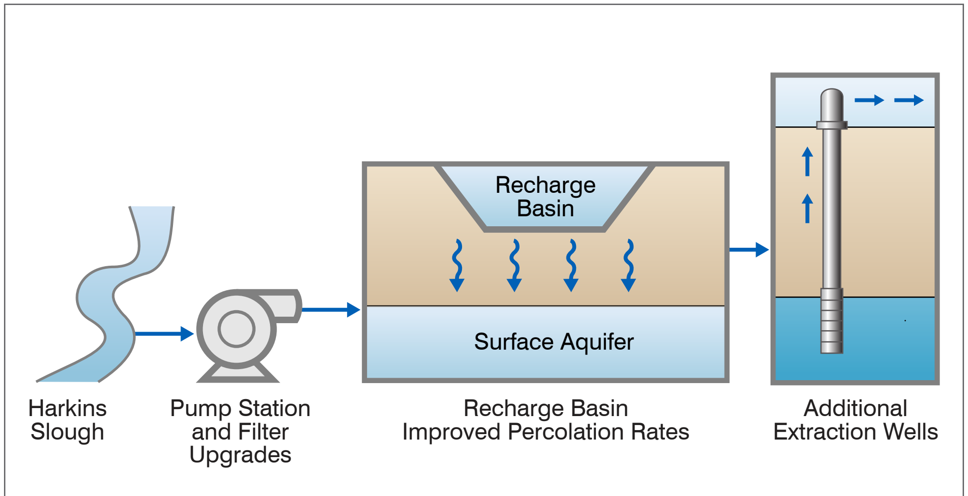
S-22: Harkins Slough Recharge Facilities Upgrades



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Harkins Slough Recharge Project was constructed in 2002 and was included in the 2002 BMP. The project is permitted to divert water between November and May. The water is filtered and pumped to the Harkins Slough Recharge Basin for storage in the shallow groundwater aquifer. Extraction wells located around the recharge basin extract water and supply the CDS during the irrigation season. The water rights permit from the SWRCB limits the maximum diversion from Harkins Slough and Watsonville Slough to 2,000 AFY. The average annual yield of the project was estimated to be 1,100 AFY from the extraction wells in the 2002 BMP. Since 2002, the Harkins Slough recovery wells have only produced 180 AFY on average and just over 2,100 AF since 2002. This project will provide improved infrastructure to help maximize the project yield. The proposed project includes new shallow extraction wells at the recharge basin, pump station upgrades at the slough diversion, additional filters to reduce the loading rate per filter, coagulant addition facilities to improve filtration, approximately 4,000 feet of filter waste backwash discharge pipeline from the filters to Beach Road, and a sump and sumps pumps at the filters to pump waste backwash to the existing sewer on Beach Road. The USDA Natural Resources Conservation Service (NRCS) is planning to construct a wetlands on land between Harkins Slough and Watsonville Slough and divert water from the sloughs into it, which would improve the water quality diverted to the recharge basin. The Agency is coordinating this project with the NRCS project.

Yield:

1,000 AFY

Capital Cost:

$5.8 Million

Operations & Maintenance:

$90,000

Annualized Capital and O&M Cost:

$510,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

Total suspended solids and turbidity

Implementation Issues:

The Agency has gained a better understanding of recharge basin hydrogeology through various studies, which should allow improved recovery well design and yields. However, increased recovery well yields cannot be confirmed until the new wells are proven.

Implementation Timeline:

Near-Term*

***Timelines:**

Near-Term = 0 - 10 years Mid-Term = 10 - 20 years Long-Term = 20 - 30 years

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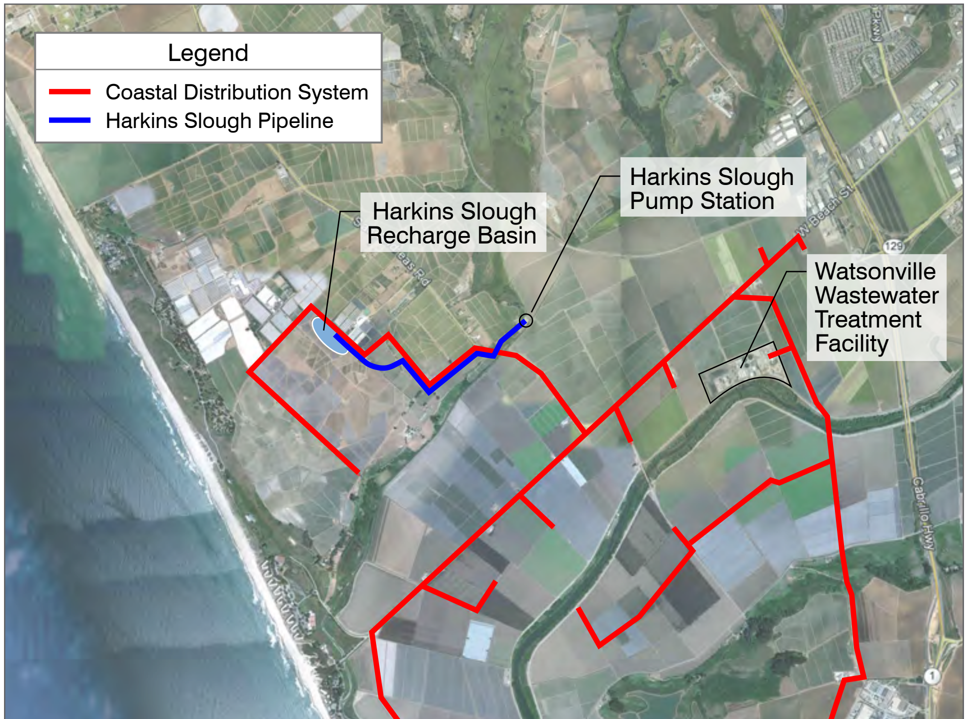
Cost:

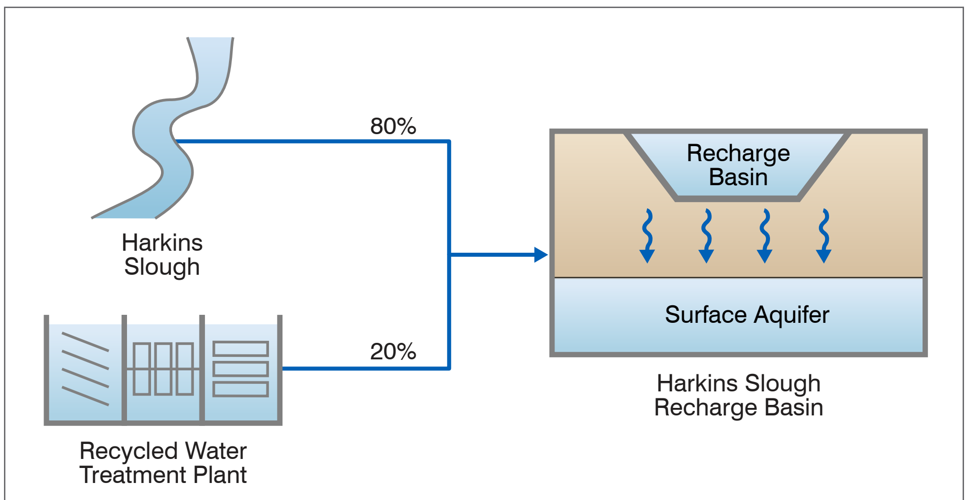
S-22: Harkins Slough Recharge Basin Facilities Upgrades 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Additional shallow extraction wells	$1,000,000
Pump station upgrades	$500,000
Coagulant addition facilities & additional filters	$800,000
Filter waste backwash discharge line and pump station	$600,000
Total Direct Cost	**$2,900,000**
Construction Contingency (30%)	$870,000
General Conditions (20%)	$580,000
Contractor Overhead and Profit (10%)	$290,000
Sales Tax (8.25% of 50% of Direct Cost)	$120,000
Total Construction Cost	**$4,800,000**
Engineering, Legal, Admin, Permits (20%)	$1,000,000
Total Estimated Project Implementation Cost	**$5,800,000**
Annualized Construction Cost[(1)]	$420,000
O & M Pump and Treatment (3%)	$90,000
Total Annualized Cost	**$510,000**
Annual Yield AF	**1,000**
Unit Cost ($/AF)	**$500**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-1: Recycled Water to Harkins Slough Recharge Basin



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This alternative uses the existing Harkin Slough Recharge Facilities for surface spreading of recycled water for groundwater recharge. The existing recycled water treatment facility at the Watsonville Wastewater Treatment Plant (WWTP) produces recycled water meeting Title 22 disinfected tertiary recycled water standards. The surface spreading of recycled water treated to the disinfected tertiary standard is limited to an initial blend of 80% diluent water and 20% recycled water. 2,000 AF of diluent water would be provided from the existing Harkin Slough diversion and 500 AF of recycled water would be provided during the winter from the WWTP. Existing infrastructure would bring the diluent water and recycled water to the basin site. The use of recycled water would require the construction of monitoring wells between the basin and potable wells. In addition, potable wells located downgradient of the recharge area which would not allow for at least a three-month recycled water travel time to a well would need to be abandoned.

Yield:

500 AFY

Capital Cost:

$2.2 Million

Operations & Maintenance:

$350,000/Year

Annualized Capital and O&M Costs:

$510,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

Diluent water from Harkins Slough must meet nitrite and nitrate MCLs. Recycled water must meet total organic carbon (TOC) limits. Significant groundwater monitoring required to evaluate travel time and diluent water and groundwater quality.

Implementation Issues:

Numerous studies must be conducted and approved by CDPH before project can be implemented. Recycled water volume limited to an initial blend of 20% recycled water and 80% diluent water. Source water evaluation of Harkins Slough must be conducted. Harkins Slough water may not be accepted by CDPH for diluent water. Recycled water may require further treatment to meet TOC requirements. Harkins Slough Recharge Facilities recovery wells can no longer be used.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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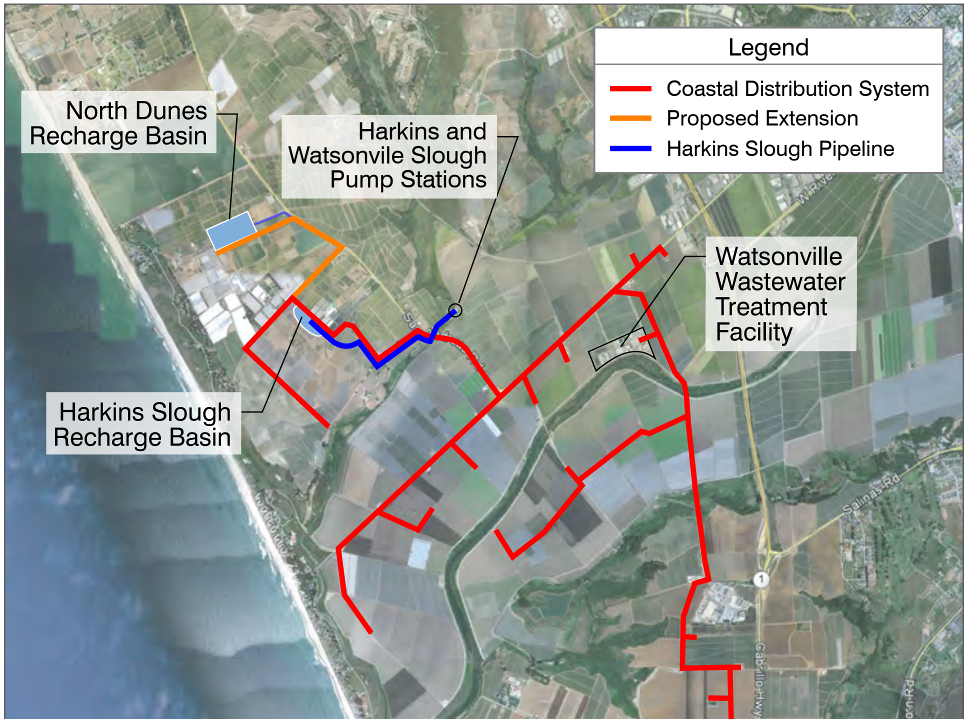
Cost:

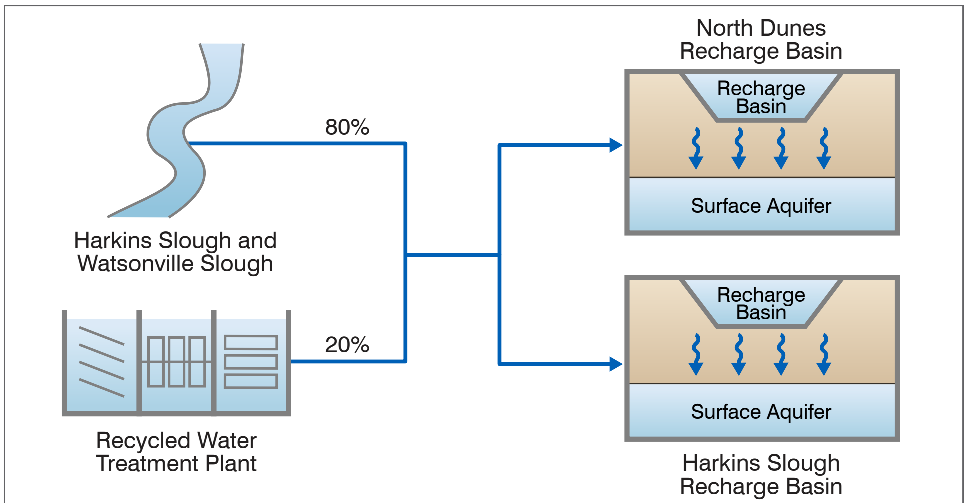
R-1: Recycled Water to Harkins Slough Recharge Basin 2012 Basin Management Plan Update Pajaro Valley Water Management Agency		
Project Element		**Cost Estimate**
Monitoring Wells (6 wells)		$600,000
	Total Direct Cost	**$600,000**
Construction Contingency (30%)		$180,000
General Conditions		$120,000
Contractor Overhead and Profit (10%)		$60,000
Sales Tax (8.25% of 50% of Direct Cost)		$20,000
	Total Construction Cost	**$1,000,000**
Engineering, Legal, Admin, Permits		$200,000
Regulatory Studies		$1,000,000
	Total Estimated Project Implementation Cost	**$2,200,000**
Annualized Construction Cost[(1)]		$160,000
O & M Pump and Well (existing)		$20,000
Power Costs Pump		$80,000
Monitoring		$250,000
	Total Annualized Cost	**$510,000**
Annual Yield AF		**500**
	Unit Cost ($/AF)	**$1,000**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-2: Recycled Water to Harkins Slough and North Dunes Recharge Basins



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This alternative uses the existing Harkin Slough Recharge Facilities for surface spreading of recycled water for groundwater recharge. In addition, a new 25-acre North Dunes recharge basin would be constructed 0.6 miles northwest of Harking Slough Project. The existing recycled water treatment facility at the Watsonville Wastewater Treatment Plant (WWTP) produces recycled water meeting Title 22 disinfected tertiary recycled water standards. The surface spreading of recycled water treated to the disinfected tertiary standard is limited to an initial blend of 80% diluent water and 20% recycled water. 2,000 AF of diluent water would be provided from the existing Harkin Slough and 1,200 AF from Watsonville Slough. 800 AF of recycled water would be provided during the winter from the WWTP, 500 AF to the Harkins Slough Recharge Basin and 300 AF to North Dunes Basin. Existing infrastructure would bring the diluent water and recycled water to the Harkin Slough Basin. Approximately 1.3 miles of new conveyance pipeline would be required to being water to the new North Dunes Basin. The use of recycled water would require the construction of monitoring wells between the basins and potable wells. In addition, potable wells located downgradient of the recharge area which would not allow for at least a six-month recycled water travel time to a well would need to be abandoned. Expansion of the filtration system would also be required to treat water from Watsonville Slough.

Yield: **800 AFY**

Capital Cost: **$17.5 Million**

Operations & Maintenance: **$370,000/Year**

Annualized Capital and O&M Costs:

$1.7 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Diluent water from Harkins Slough must meet nitrite and nitrate MCLs. Recycled water must meet total organic carbon (TOC) limits. Significant groundwater monitoring required to evaluate travel time and diluent water and groundwater quality.

Implementation Issues:

Numerous studies must be conducted and approved by CDPH before project can be implemented. Recycled water volume limited to an initial blend of 20% recycled water and 80% diluent water. Source water evaluation of Harkins Slough must be conducted. Harkins Slough water may not be accepted by CDPH for diluent water. Recycled water may require further treatment to meet TOC requirements. Harkins Slough Project recovery wells can no longer be used.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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Cost:

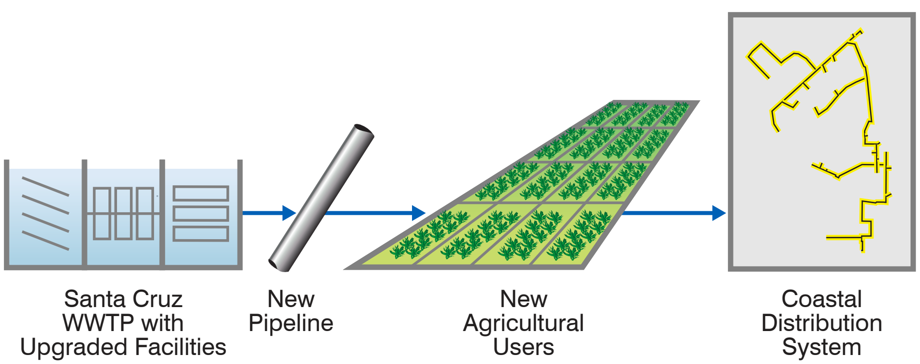
R-2: Recycled Water to Harkins Slough and North Dunes Recharge Basins
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

Project Element	**Cost Estimate**
North Dunes Recharge Basin[1]	$3,600,000
Conveyance Pipeline (CDS Extension)	$1,200,000
Filtration Expansion (3000 gpm Pressure filter)	$1,300,000
Watsonville Slough Pumps Station (2-100HP)	$500,000
Monitoring Wells (18 wells)[2]	$1,100,000
Abandon Potable Wells?	
Total Direct Cost	**$7,700,000**
Construction Contingency (30%)	$2,300,000
General Conditions (20%)	$1,500,000
Contractor Overhead and Profit (10%)	$800,000
Sales Tax (8.25% of 50% of Direct Cost)	$300,000
Total Construction Cost	**$12,600,000**
Engineering, Legal, Admin, Permits (20%)	$2,500,000
Land Acquisition[3] (30 acres)	$1,400,000
Regulatory Studies	$1,000,000
Total Estimated Project Implementation Cost	**$17,500,000**
Annualized Construction Cost[4]	$1,300,000
O & M Pipeline and basin (1%)	$50,000
O & M Pump (2.5%)	$10,000
Power Costs	$60,000
Monitoring	$250,000
Total Annualized Cost	**$1,700,000**
Annual Yield AF	**800**
Unit Cost ($/AF)	**$2,100**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) It is assumed some monitoring well are currently in place for the Harkin Slough Project, addition wells need to determine six month retention time areas
(3) Property Values are per correspondence with Chuck Allen's [Coastal Farmland = $45,000/acre]
(4) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-3: Pipeline from Santa Cruz Wastewater Treatment Plant

PROJECT PLAN



PROJECT SCHEMATIC

Background:

The City of Santa Cruz discharges treated water from its wastewater treatment plant to an ocean outfall. The existing facility produces water that is suitable for some agricultural applications (indirect irrigation of nontable crops), but the plant would need to be upgraded to include further treatment in order for the water to be used in the PVWMA service area. The alternative involves upgrading the City of Santa Cruz's WWTP to include a facility to provide added treatment to up to 6.6 mgd, a new pump station, a new 24-inch 20 -mile long pipeline from Santa Cruz WWTP to PVWMA's service area, and a 3 MG storage facility for flow equalization. Recycled water would be pumped from Santa Cruz through the new pipeline to the existing Coastal Distribution System, allowing expansion of the service areas to new users north of the existing CDS.

Yield:

4,300 AFY

Capital Cost:

$131 Million

Operations & Maintenance:

$1.5 Million

Annualized Capital and O&M Costs:

$11.0 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Santa Cruz's WWTP currently does not have the level of treatment for current agriculture needs and would need to be upgraded.

Implementation Issues:

Environmental permitting and water rights.

Implementation Timeline:

Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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Cost:

R-3: Pipeline from Santa Cruz Wastewater Treatment Plant
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

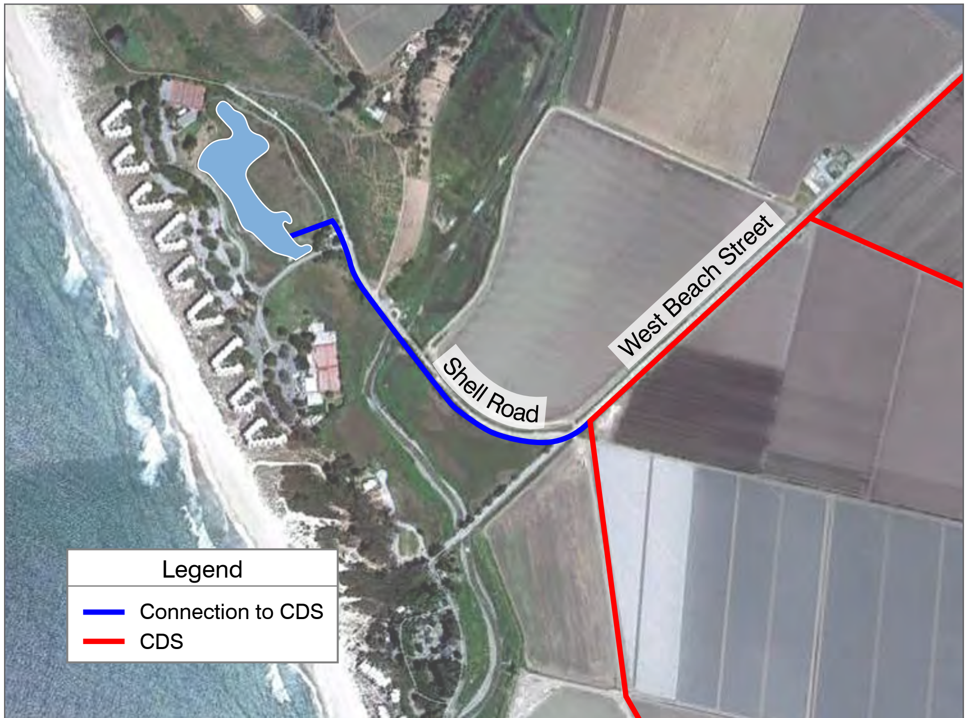
Project Element	**Cost Estimate**
Tertiary Treatment Expansion [(1)]	$26,000,000
Pump Station (three Vertical Turbine Pumps 450HP ea.)	$1,500,000
Transmission Pipeline (Connection to CDS 20 mi, 24")	$39,000,000
Total Direct Cost	**$66,500,000**
Construction Contingency (30%)	$20,000,000
General Conditions (20%)	$13,300,000
Contractor Overhead and Profit (10%)	$6,700,000
Sales Tax (8.25% of 50% of Direct Cost)	$2,700,000
Total Construction Cost	**$109,200,000**
Engineering, Legal, Admin, Permits	$21,800,000
Total Estimated Project Implementation Cost	**$131,000,000**
Annualized Construction Cost[(2)]	$9,500,000
O&M Pipeline (1%)	$390,000
O & M Pump and Treatment (2.5%)	$700,000
Pump Power (9200 gpm for 4300 AFY, for 2600 hours at $0.15/kW-h)	$360,000
Total Annualized Cost	**$11,000,000**
Annual Yield AF	**4,300**
Unit Cost ($/AF)	**$2,600**

Notes:

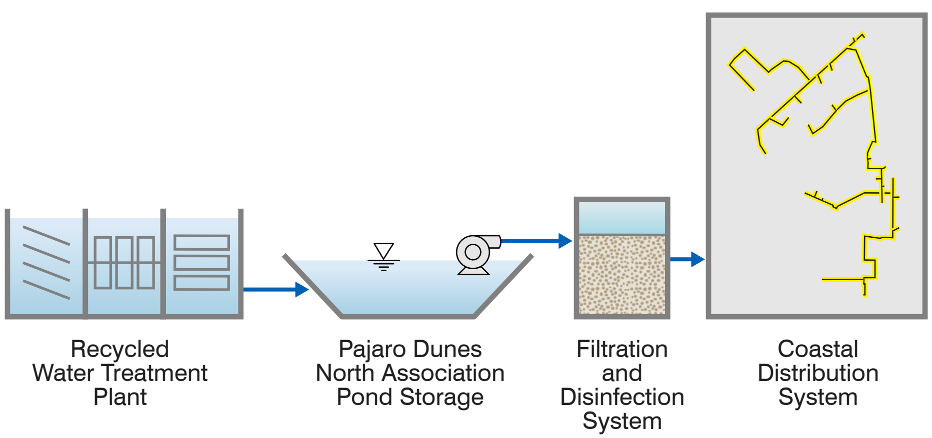
(1) Costs based on; City of Santa Cruz/ Soquel Creek Water District Alternative Water Supply Study Evaluation of Regional Water Supply Alternatives, March 2002, 4171D.00.

(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-4: Pajaro Dunes North Diurnal Recycled Water Storage



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Pajaro Dunes North Association consists of 308 homeowners at Pajaro Dunes North, covering approximately 25 acres at the western end of Beach Road. This site includes a man-made lagoon with up to 7 acres of surface area. Current lagoon area is approximately 3.5 acres, and has a capacity of approximately 15 to 17 AF. This project would include the excavation and expansion of the lagoon, installation of a liner, construction of a pump station, filtration and disinfection facilities, conveyance pipeline to the Coastal Distribution System, and a diversion channel to prevent flooding from the north.

Yield:

750 AFY

Capital Cost:

$6.4 Million

Operations & Maintenance:

$120,000/Year

Annualized Capital and O&M Costs:

$460,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

It is assumed that sand filtration and disinfection of water stored in the lagoon would be sufficient for delivery to the CDS. This assumption would need to be confirmed during pre-design.

Implementation Issues:

Significant environmental and permitting issues. Potential geotechnical and sediment issues. Lease agreement.

Implementation Timeline:

Near-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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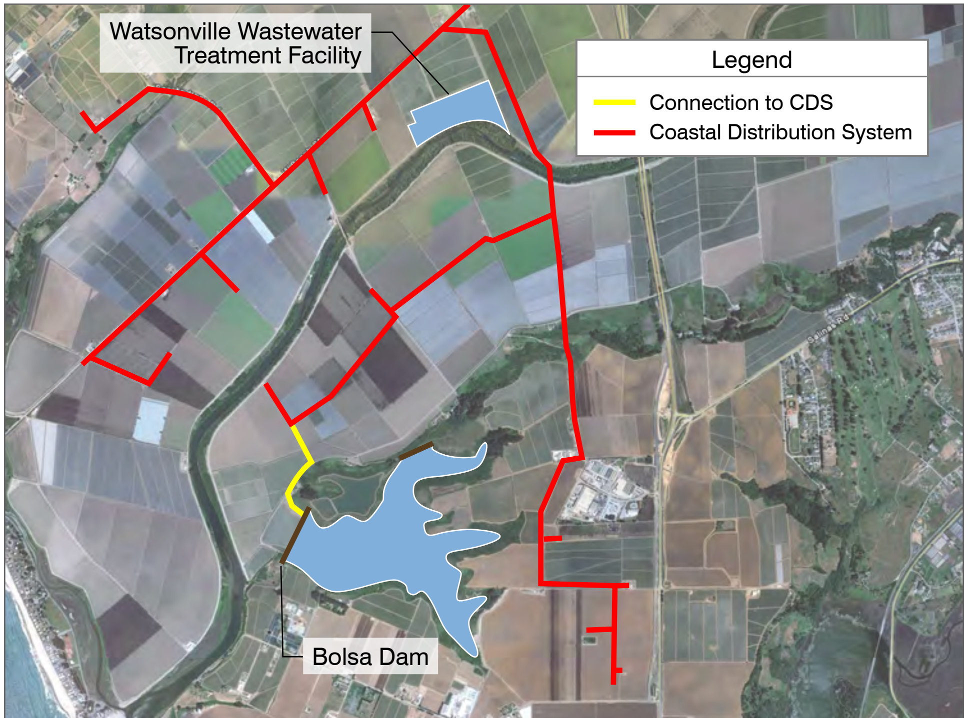
Cost:

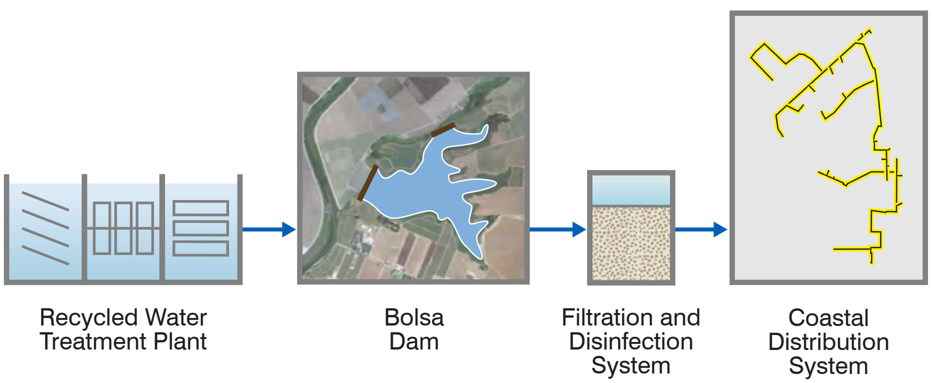
R-4: Pajaro Dunes North Diurnal Recycled Water Storage 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Lagoon Dredging (5 Acres @ 4 feet deep)	$770,000
Path/Perimeter Berm Reconstruction	$50,000
Reservoir Lining (double layer)	$910,000
Pump Station (1-100 HP Vertical Turbine Pump)	$320,000
Filtration (pressure filters)	$540,000
Disinfection	$50,000
Connection to CDS Pipeline	$400,000
Pit Dewatering	$50,000
Monitoring Wells	unknown
Environmental Mitigations	$100,000
North Levee and Diversion Channel (Flooding Protection)	$30,000
Total Direct Cost	**$3,200,000**
Construction Contingency (30%)	$960,000
General Conditions (20%)	$640,000
Contractor Overhead and Profit (10%)	$320,000
Sales Tax (8.25% of 50% of Direct Cost)	$132,000
Total Construction Cost	**$5,300,000**
Engineering, Legal, Admin, Permits (20%)	$1,100,000
Total Estimated Project Implementation Cost	**$6,400,000**
Annualized Construction Cost[(2)]	$460,000
O & M Pipeline (1%)	$4,000
O & M Pump and Treatment (2.5%)	$20,000
Annual Lease Agreement	$75,000
Power Costs (1500 gpm for 750 AFY, for 1090 hours at $0.15/kW-h)	$21,000
Total Annualized Cost	**$600,000**
Annual Yield AF	**750**
Unit Cost ($/AF)	**$800**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-5: Bolsa Dam for Winter Recycled Water Storage



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The recycled water treatment facilities have the capacity to produce approximately 2,500 AF of recycled water during the winter months when there is little or no irrigation demand. This alternative involves construction of the Bolsa de San Cayetano dam and reservoir for seasonal recycled water storage to allow the 2,500 AF of recycled water to be pumped to the reservoir in the winter and used to meet irrigation demand in the summer. The dam and reservoir would be located in Monterey County on the south side of the Pajaro River and adjacent to Trafton Road. The reservoir site is surrounded by 100 to 150 feet high terrace upland that has been eroded from a canyon. The earth fill dam would be located across the mouth of the canyon to form the reservoir. A small saddle dam would also be constructed on the north ridge. It is assumed that the reservoir would need to be lined to meet regulatory requirements, and the water would need to be filtered and disinfected after storage to meet user requirements.

Yield:

2,500 AFY

Capital Cost:

$128.6 Million

Cost would include main dam, saddle dam, spillway outlet works, pump station, filtration, and conveyance pipeline from and to the Coastal Distribution System.

Operations & Maintenance:

$400,000/Year

Annualized Capital and O&M Cost:

$9.7 Million (30 year capital recovery at 6% interest)

Water Quality Considerations:

It is assumed that sand filtration and disinfection of water stored in the lagoon would be sufficient for delivery to the CDS. This assumption would need to be confirmed during pre-design.

Implementation Issues:

Significant permitting issues. Reservoir lining and monitoring. Potential seismic issues.

Implementation Timeline:

Long-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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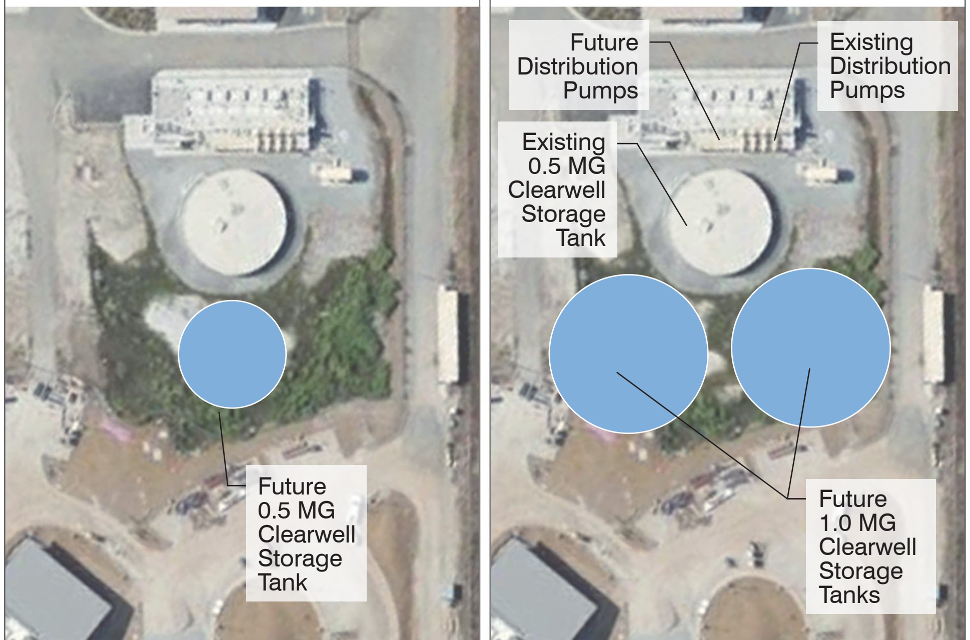
Cost:

R-5: Bolsa Dam for Winter Recycled Water Storage
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

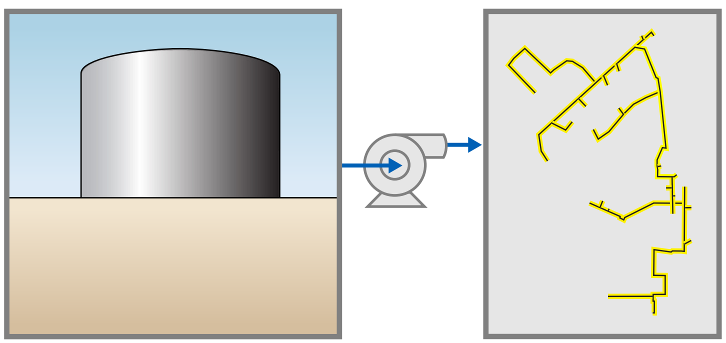
Project Element	**Cost Estimate**
Bolsa Main Dam, Saddle Dam Spillway, Outlet Works [1]	$31,800,000
Road Relocation[1]	$600,000
Reservoir Lining	$18,500,000
Lining Clean Soil Fill/Cover	$6,000,000
Pump Station and Filtration (back into CDS)	$5,000,000
Connection to CDS Pipeline	$800,000
Total Direct Cost	**$62,700,000**
Construction Contingency (30%)	$18,800,000
General Conditions (20%)	$12,500,000
Contractor Overhead and Profit (10%)	$6,300,000
Sales Tax (8.25% of 50% of Direct Cost)	$2,600,000
Total Construction Cost	**$102,900,000**
Engineering, Legal, Admin, Permits (20%)	$20,580,000
Land Acquisition (170 Acres half of this is farm land) [2]	$5,100,000
Total Estimated Project Implementation Cost	**$128,600,000**
Annualized Construction Cost[3]	$9,300,000
O & M Pipeline (1%)	$8,000
O & M Pump and Treatment (2.5%)	$125,000
O & M Dam 0.15%)	$50,000
Power Costs (3000 gpm for 3000AFY, for 4500 hours at $0.15/kW-h)	$200,000
Total Annualized Cost	**$9,700,000**
Annual Yield AF	**2,500**
Unit Cost ($/AF)	**$3,900**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Property values are per correspondence with Chuck Allen July 18, 2011 (Coastal Flat = $40,000/acre). Cost of land is
(3) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-6: Increased Recycled Water Storage at Treatment Plant



PROJECT PLAN



Additional Storage Tank and Pumps at Treatment Plant

Increased Ability to Match CDS Supply and Demand

PROJECT SCHEMATIC

Background:

The recycled water treatment facilities currently include approximately one million gallons (MG) of recycled water storage. Future addition of another 0.5 MG storage was identified as part of the facilities design. Space is available south of the existing storage tank to add approximately two million gallons of storage. Additional storage would allow more recycled water to be sent to the CDS during the peak demand months (May through September) to match the hours of peak demand.

Yield:

0.5 MG Storage: 250 AFY
1.0 MG Storage: 500 AFY
2.0 MG Storage: 750 AFY

Capital Cost:

0.5 MG Storage: $2.8 Million
1.0 MG Storage: $3.6 Million
2.0 MG Storage: $6.4 Million

Cost for each option includes, site work, new 350 hp vertical turbine pump, electrical, instrumentation, and controls.

Operations & Maintenance:

0.5 MG Storage: $28,000/Year
1.0 MG Storage: $45,000/Year
2.0 MG Storage: $64,000/Year

Annualized Capital and O&M Costs:

0.5 MG Storage: $230,000
1.0 MG Storage: $310,000
2.0 MG Storage: $520,000
(30-year capital recovery at 6% interest)

Water Quality Considerations:

Water stored in the enclosed onsite reservoirs would not require additional treatment before being pumped to the CDS.

Implementation Issues:

Space and clearance limitations for two 1.0 million gallon tanks.

Implementation Timeline:

Near-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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Cost:

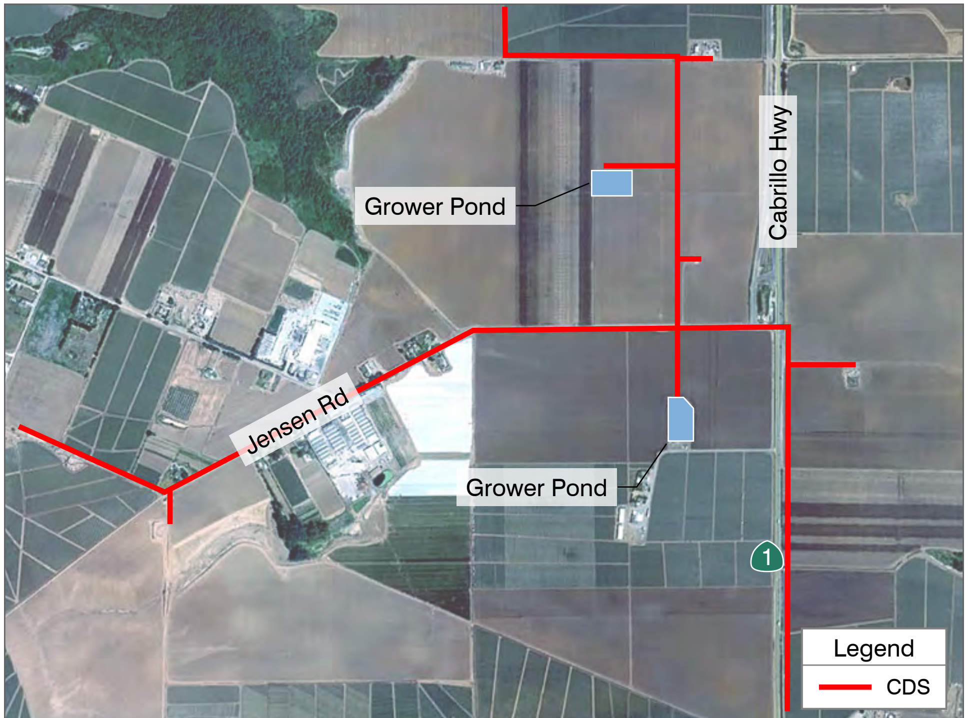
R-6: Increased Recycled Water Storage at Treatment Plant 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	0.5 MG Reservoir	1.0 MG Reservoir	2- 1.0 MG Reservoirs
Project Element	**Cost**	**Cost**	**Cost**
Site Work	$250,000	$300,000	$500,000
Reservoir	$825,000	$1,200,000	$2,300,000
Tank Appurtenances	$30,000	$30,000	$60,000
Additional Pump (Vertical Turbine Pump 350HP)[(1)]	$60,000	$60,000	$120,000
Electrical and I&C	$260,000	$260,000	$260,000
Total Direct Cost	**$1,400,000**	**$1,900,000**	**$3,200,000**
Construction Contingency (30%)	$420,000	$570,000	$960,000
General Conditions (20%)	$280,000	$380,000	$640,000
Contractor Overhead and Profit (10%)	$140,000	$190,000	$320,000
Sales Tax (8.25% of 25% of Direct Cost)	$30,000	$40,000	$70,000
Total Construction Cost	**$2,300,000**	**$3,000,000**	**$5,200,000**
Engineering, Legal, Admin, Permits (20%)	$460,000	$600,000	$1,040,000
Total Estimated Project Implementation Cost	**$2,800,000**	**$3,600,000**	**$6,200,000**
Annualized Construction Costs [(2)]	$200,000	$260,000	$450,000
Reservoir O & M (0.15%)	$2,000	$2,000	$4,000
O&M Pumps (2.5%)	$8,000	$8,000	$10,000
Power Costs (3000gpm for 250AFY, for 450 hours at $0.15/kW-h)	$18,000	$35,000	$50,000
Total Annualized Cost	**$230,000**	**$310,000**	**$510,000**
Annual Yield	250	500	750
Unit Cost ($/AF)	**$900**	**$600**	**$700**

Notes:

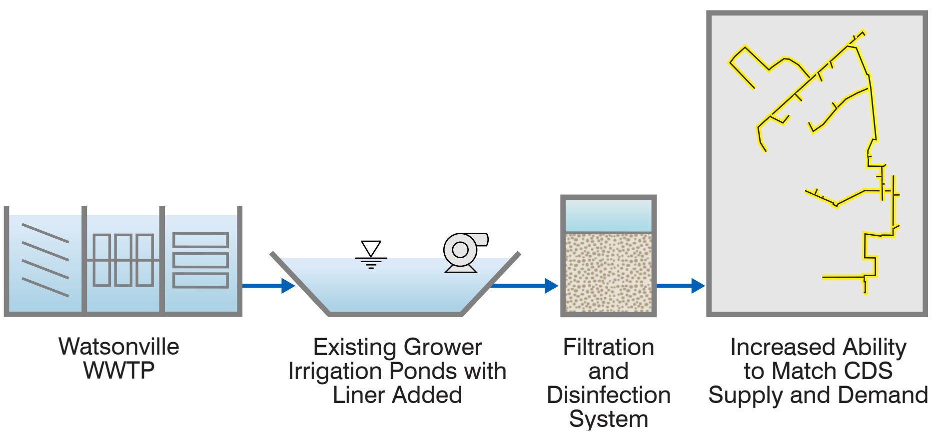
(1) The extended cost for the 2 MG option reflects two additional pumps.

(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-7: Increased Recycled Water Storage via Grower Ponds



PROJECT PLAN



PROJECT SCHEMATIC

Background:

Several open storage ponds are located along the Coastal Distribution System (CDS) and used by growers to hold groundwater pumped from low flow wells. These existing grower ponds could be used to store recycled water from the Watsonville WWTP generated during times of low demand. The recycled water would then be pumped from the ponds back into the CDS during peak demand. The alternative evaluates the modifications to a single pond with dimensions of 150 feet by 300 feet and a depth of 8 feet. This size of grower pond would have the capacity to store approximately 7 AF or 2.2 MG. The alternative would include the construction of a pump station, filtration and disinfection system as well as the expansion and lining of an existing grower pond located adjacent to the CDS pipeline.

Yield:

750 AFY

Capital Cost:

$3.0 Million

Operations & Maintenance:

$100,000/Year

Annualized Capital and O&M Costs:

$320,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

Water stored in open ponds would require additional treatment before being pumped to the CDS.

Implementation Issues:

Environmental permitting

Implementation Timeline:

Near-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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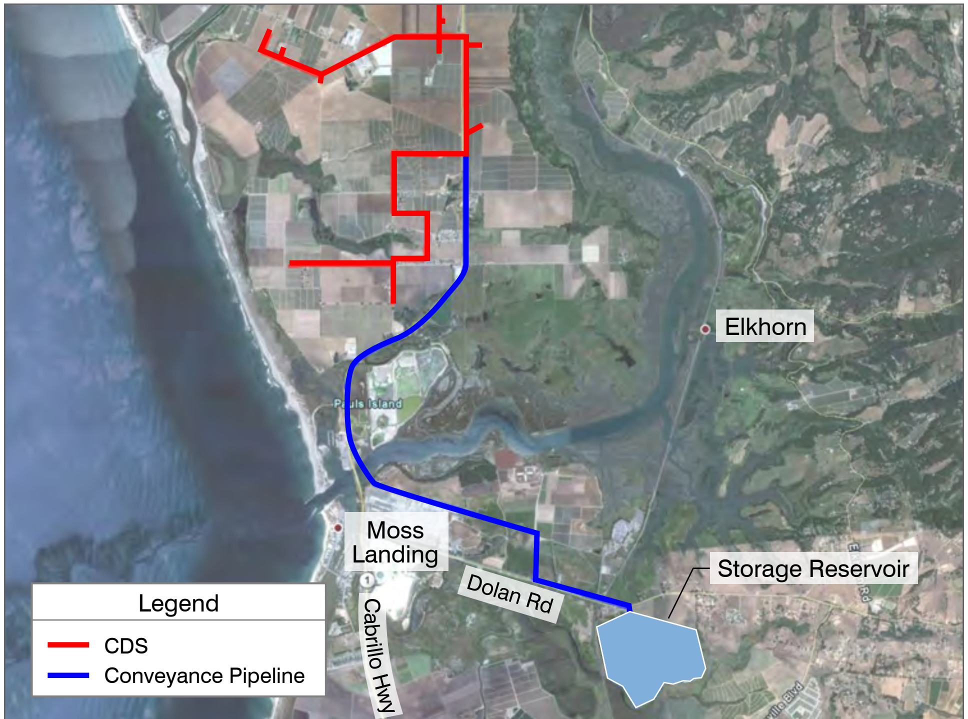
Cost:

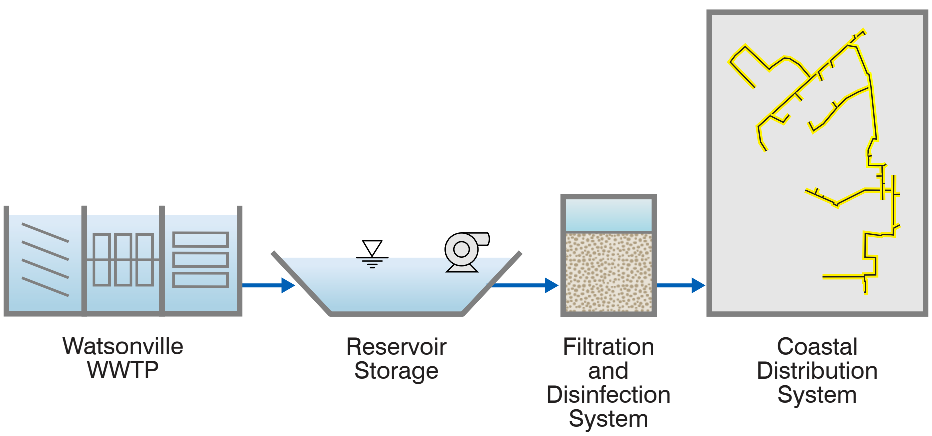
R-7: Increased Recycled Water Via Grower Ponds **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
Pond Lining (Pond Size 150' x 300')[1] Double layer of 40 mil HDPE	$120,000
Site Work[2] ($12/cuyd)	$90,000
Filtration	$720,000
Disinfection (for injection to CDS)	$50,000
Pump Station (two Vertical Turbine Pumps 100HP)	$460,000
Pipeline (Connection to CDS)	$100,000
Total Direct Cost	**$1,500,000**
Construction Contingency (30%)	$450,000
General Conditions (20%)	$300,000
Contractor Overhead and Profit (10%)	$150,000
Sales Tax (8.25% of 50% of Direct Cost)	$60,000
Total Construction Cost	**$2,500,000**
Engineering, Legal, Admin, Permits (20%)	$500,000
Land Acquisition (1 Acre)[3]	$20,000
Total Estimated Project Implementation Cost	**$3,000,000**
Annualized Construction Cost[4]	$220,000
O&M Pipeline, Liner and Embankment (1.5%)	$3,000
O & M Pump and Treatment (2.5%)	$30,000
Pump Power (3000gpm for 750AFY, for 2900 hours at $0.15/kW-h)	$70,000
Total Annualized Cost	**$320,000**
Annual Yield AF	**750**
Unit Cost ($/AF)	**$400**

Notes:
(1) This is an average size pond site at 8 feet deep and would hold approximately 7 AF or 2.2 MG.
(2) Excavation in existing depression (Assume 65% of excavation required). Pond is 8 feet is depth.
(3) Property values are per correspondence with Chuck Allen, July 18 2011. (Coastal Flat = $40,000/acre) current sites are not used for agriculture
(4) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-8: Seasonal Recycled Water Storage South of PVWMA



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Watsonville recycled water treatment facilities have the capacity to produce approximately 2,500 AF of recycled water during the winter months (Nov-Mar) when there is little or no irrigation demand. This alternative involves the construction of a large open storage reservoir south of PVWMA in Monterey County. The reservoir would be approximately 3 miles south of the southern end of the Coastal Distribution System (CDS) and sized to receive the 2,500 AF during the winter months. The stored water would be pumped back to the CDS for use during the growing season (Apr-Oct). The new conveyance pipeline could be used to expand the southern CDS service area . The facilities would include a lined 200-acre reservoir, pump station, conveyance pipeline, and filtration and disinfection systems.

Yield:

2,500 AFY

Capital Cost:

$109.3 Million

Operations & Maintenance:

$410,000/Year

Annualized Capital and O&M Costs:

$8.3 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Water stored in open reservoir would require additional treatment before being pumped to the CDS.

Implementation Issues:

Significant environmental and permitting issues.

Implementation Timeline:

Mid- to Long-Term*

***Timelines:**

Near-Term = 0 - 10 years

Mid-Term = 10 - 20 years

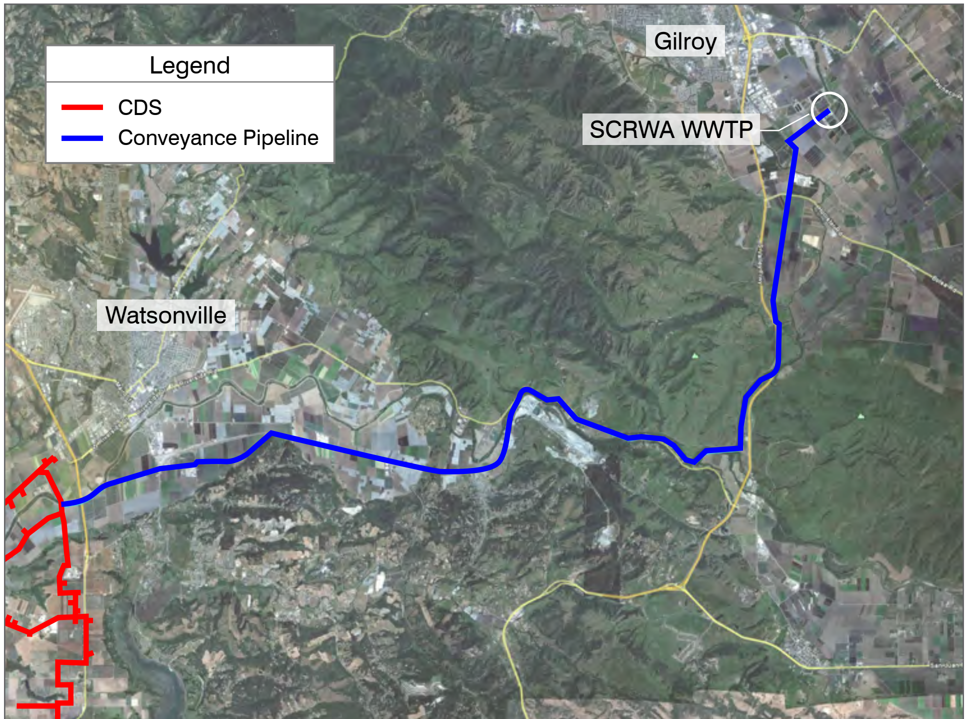
Long-Term = 20 - 30 years

Cost:

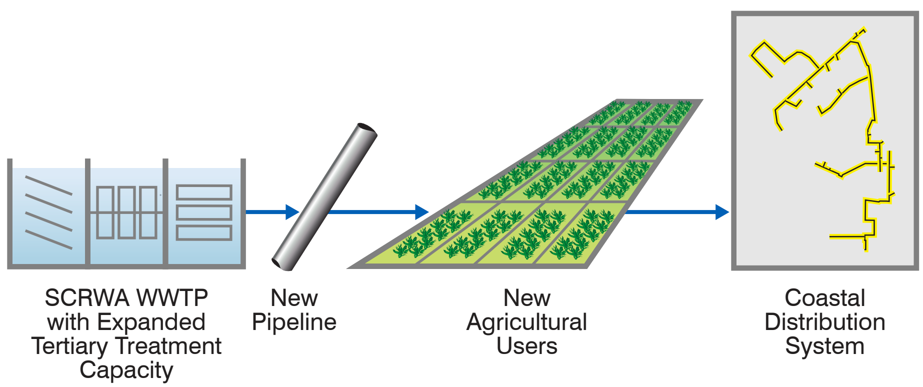
R-8: Seasonal Recycled Water Storage South of PVWMA 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Pond Lining (7.26 million sq.ft.)[1] Double layer of 60 mil HDPE	$14,500,000
Site Work ($12/cuyd) 2.1 million cu.yds.	$25,000,000
Filtration and Disinfection (for injection to CDS)	$2,600,000
Pump Station (4 -200HP Vertical Turbine Pumps)	$1,200,000
Pipeline (Connection to CDS 3.7 mi)	$7,000,000
Elkhorn Crossing (1200' at $1,500/ft)	$1,800,000
Total Direct Cost	**$52,100,000**
Construction Contingency (30%)	$15,600,000
General Conditions (20%)	$10,400,000
Contractor Overhead and Profit (10%)	$5,200,000
Sales Tax (8.25% of 50% of Direct Cost)	$2,100,000
Total Construction Cost	**$85,400,000**
Engineering, Legal, Admin, Permits (20%)	$17,100,000
Land Acquisition (170 Acre)[2]	$6,800,000
Total Estimated Project Implementation Cost	**$109,300,000**
Annualized Construction Cost[3]	$7,900,000
O&M Liner and Embankment (0.15%)	$60,000
O&M Pipeline (1%)	$70,000
O & M Pump and Treatment (2.5%)	$100,000
Pump Power (2000 gpm for 833AFY, for 2300 hours at $0.15/kW-h) x3	$180,000
Total Annualized Cost	**$8,300,000**
Annual Yield AF	**2,500**
Unit Cost ($/AF)	**$3,300**

Notes:
(1) This storage area is designed to hold 2500 AF (170 acre site at 15' deep)
(2) Property values are per correspondence with Chuck Allen, July 18, 2011 [Coastal Flat = $40,000/acre]
(3) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-9: Winter Recycled Water from SCRWA



PROJECT PLAN



PROJECT SCHEMATIC

Background:

South County Regional Wastewater Authority (SCRWA) treats wastewater from Gilroy and Morgan Hill. SCRWA owns and operates the existing WWTP, located along Southside Drive approximately 2 miles southeast of Gilroy. The WWTP can treat an average dry weather flow (ADWF) of up to 9 million gallons per day (mgd) to secondary treatment standards. The treatment process consists of influent screening, aerated grit removal, nitrification, denitrification, oxidation ditches, and secondary clarification. The current ADWF is approximately 8.5 mgd. The WWTP can divert up to 9 mgd of secondary effluent to a tertiary treatment process that meets the recycled water criteria of California's Title 22 tertiary recycled water classification.

This alternative would pump recycled water from SCRWA WWTP through a new pipeline to the existing Coastal Distribution System during the growing season. The facilities required would include a new pump station and construction of 22-miles of 16-inch pipeline.

Yield:

1,300 AFY (2.0 mgd for 7 months)

Capital Cost:

$56 Million

Operations & Maintenance:

$430,000/Year

Annualized Capital and O&M Costs:

$4.5 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

SCRWA WWTP produces recycled water that meets the criteria of California's Title 22 tertiary recycled water classification.

Implementation Issues:

Plans for distribution of SCRWA recycled water are proceeding in accordance with a Recycled Water Master Plan which does not include capacity for exporting water to the Pajaro Valley. Contract fee with SCRWA and annual water cost are not included.

Implementation Timeline:

Mid-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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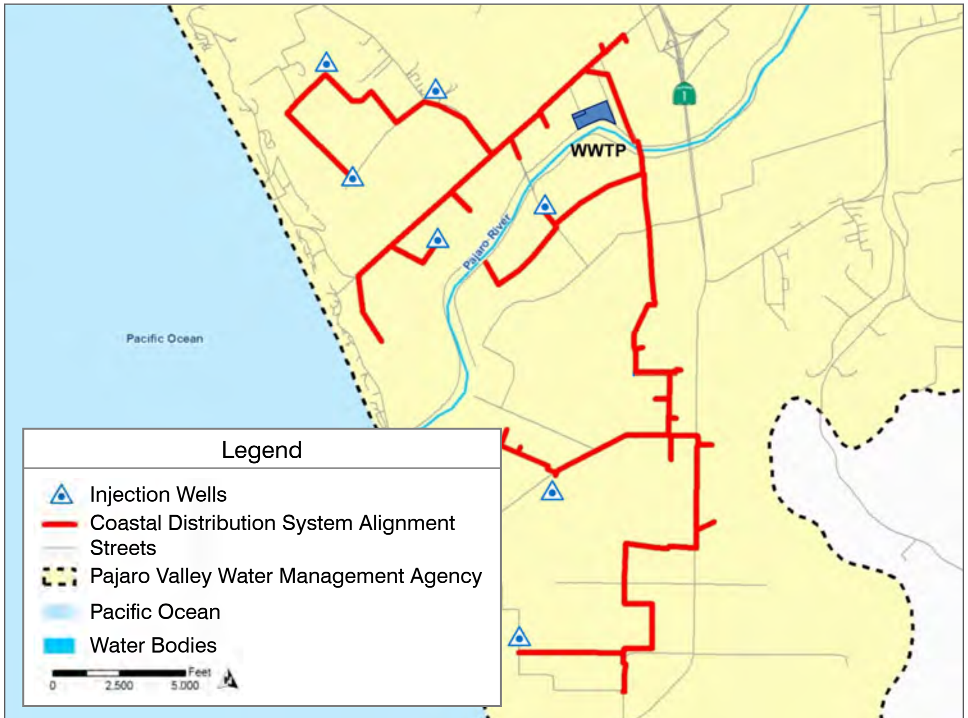
Cost:

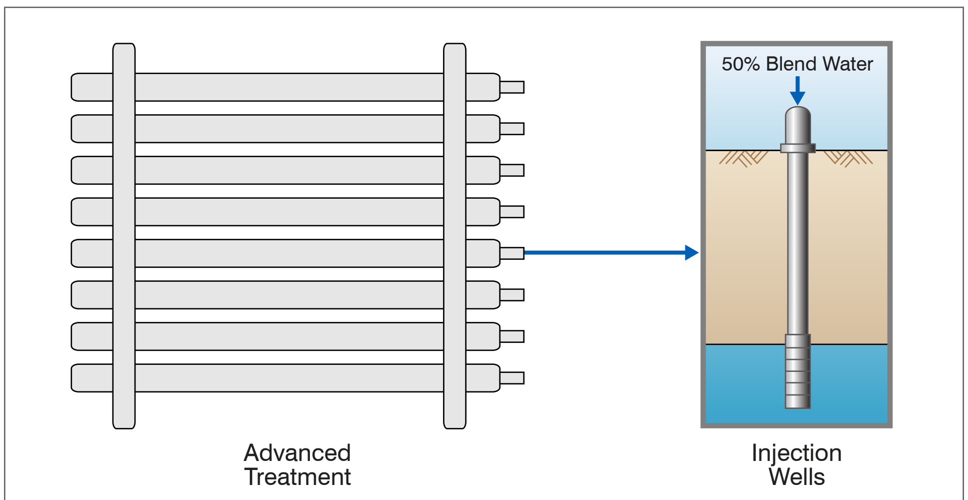
R-9: Recycled Water from South County Regional Wastewater Authority 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Buy in Fee	unknown
Pump Station (3-150HP Verticle Turbine Pumps)	$700,000
Transmission Pipeline (Connection to CDS 22 mi, 16")	$27,900,000
Total Direct Cost	**$28,600,000**
Construction Contingency (30%)	$8,600,000
General Conditions (20%)	$5,700,000
Contractor Overhead and Profit (10%)	$2,900,000
Sales Tax (8.25% of 50% of Direct Cost)	$1,200,000
Total Construction Cost	**$47,000,000**
Engineering, Legal, Admin, Permits (20%)	$9,400,000
Total Estimated Project Implementation Cost	**$56,000,000**
Annualized Construction Cost[(1)]	$4,100,000
O&M Pipeline (1%)	$300,000
O & M Pump and Treatment (2.5%)	$20,000
Pump Power (2700 gpm for 1300 AFY, for 2715 hours at $0.15/kW-h)	$110,000
Total Annualized Cost	**$4,500,000**
Annual Yield AF	**1,300**
Unit Cost ($/AF)	**$3,500**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-10: Winter Recycled Water Advanced Treatment and Injection



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The recycled water treatment facilities have the capacity to produce approximately 2,500 AF of recycled water during the winter months when there is little or no irrigation demand. This alternative involves construction of advanced treatment facilities to allow groundwater injection of the recycled water, on the western side of the Coastal Distribution System. The advanced treatment would include microfiltration, reverse osmosis and advanced oxidation. Monitoring wells would also be constructed. During initial operation diluent water is required to be injected at a 1:1 ratio to recycled water. Over a five-year period, the recycled water contribution could potentially be incrementally increased to 100% based on monitoring results over the same period.

Yield:

2,500 AFY

Capital Cost:

$105 Million

Operations & Maintenance:

$1.5 Million/Year

Annualized Capital and O&M Cost:

$5.0 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Injection wells would have to be placed appropriate distance from potable sources to meet minimum travel time requirements.

Implementation Issues:

Considerable regulatory and permitting issues.

Requires 2,500 AFY of diluent water to be injected at least during first years of operation.

Implementation Timeline:

Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years

Mid-Term = 10 - 20 years

Long-Term = 20 - 30 years

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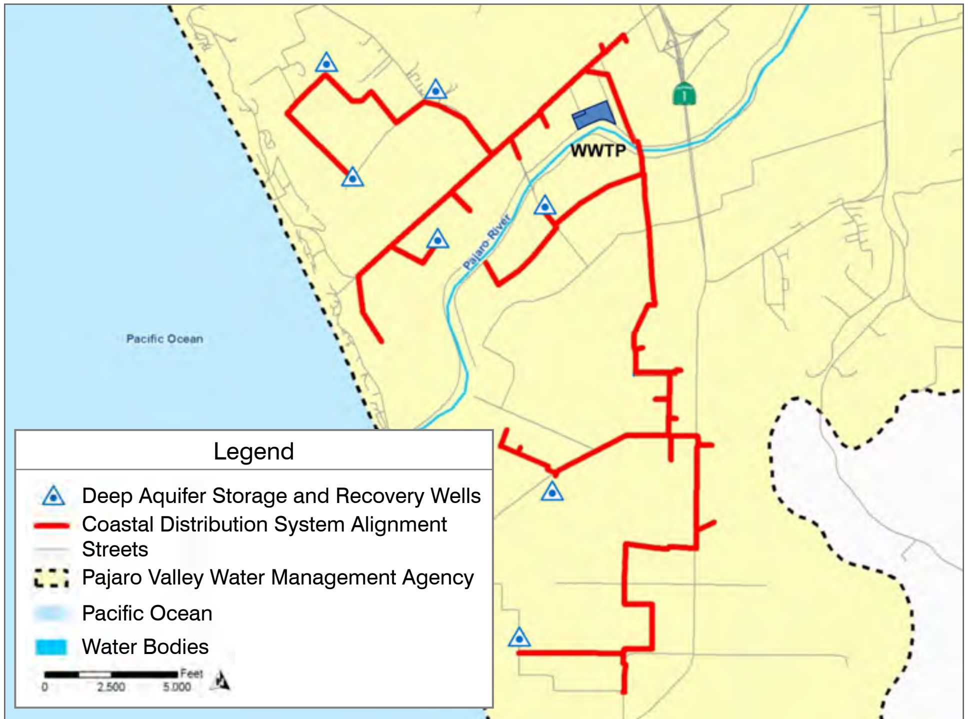
Cost:

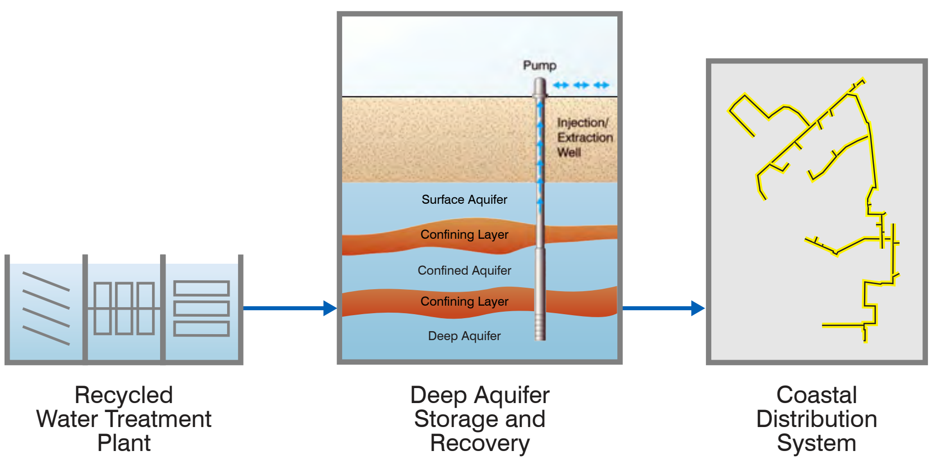
R-10: Winter Recycled Water Advanced Treatment and Injection 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Injection Wells (7 wells @ 600 gpm)	$16,600,000
Treatment (Micro Filtration, RO, and Oxidation)[(1)]	$50,400,000
Total Direct Cost	**$67,000,000**
Construction Contingency (30%)	$20,100,000
General Conditions (20%) *(included above)*	-
Contractor Overhead and Profit (10%) *(included above)*	-
Sales Tax (8.25% of 50% of Direct Cost, *inculded above*)	-
Total Construction Cost	**$87,100,000**
Engineering, Legal, Admin, Permits	$17,400,000
Total Estimated Project Implementation Cost	**$104,500,000**
Annualized Construction Cost [(2)]	$7,600,000
O & M Pump and well (2.5%)	$210,000
O & M Treatment (MF, RO)	$1,300,000
Total Annualized Cost	**$9,200,000**
Annual Yield AF	**2,500**
Unit Cost ($/AF)	**$3,700**

Notes:
(1) Pipeline connection included in well cost.
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-11: Winter Recycled Water Deep Aquifer ASR



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The Watsonville Recycled Water Treatment facilities have the capacity to produce approximately 3,200 AF of recycled water during the winter months when there is little or no irrigation demand. During the winter, this tertiary treated water would be injected into deep aquifers confined by overlying and underlying geologic formations that do not produce water. The water would then be recovered from the same wells later during times of peak demand. This alternative involves the construction of approximately eight 2000 - 2500' deep injection wells located on the western side of the Coastal Distribution System. Number of wells and recovery yield may vary depending on individual well site conditions.

Yield:

3,200 AFY (assumes 100% recovery)

Capital Cost:

$47.3 Million

Operations & Maintenance:

$1.6 Million/Year

Annualized Capital and O&M Cost:

$5.1 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Requires storage zone to be developed around well before initial recovery. Costs associated with monitoring and engineering studies showing groundwater quality is protected are not included.

Implementation Issues:

Significant regulatory and permitting issues.

Implementation Timeline:

Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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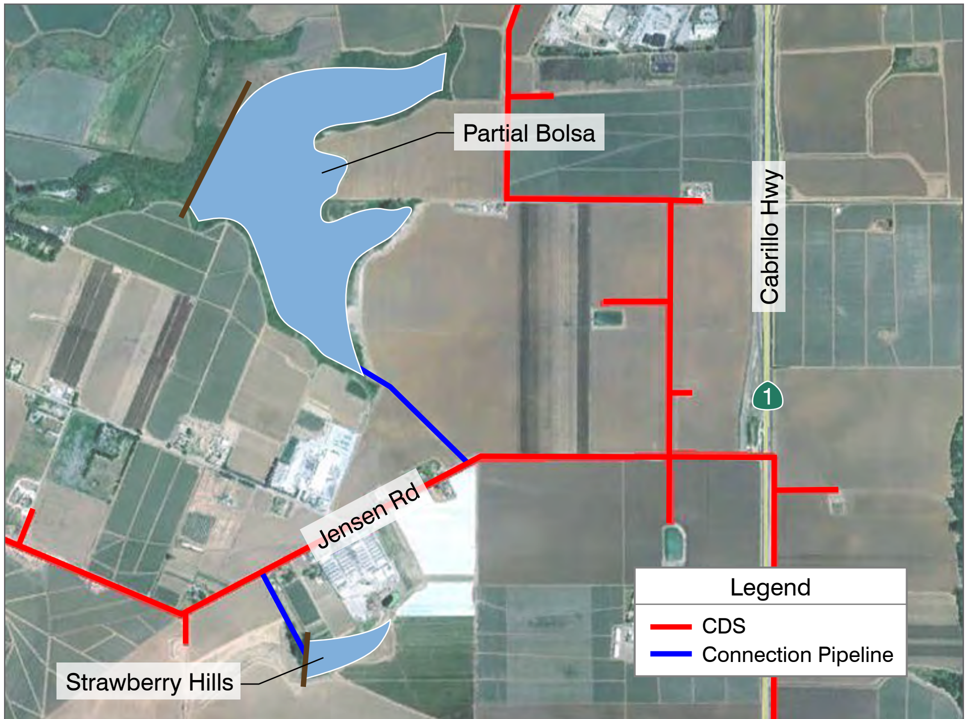
Cost:

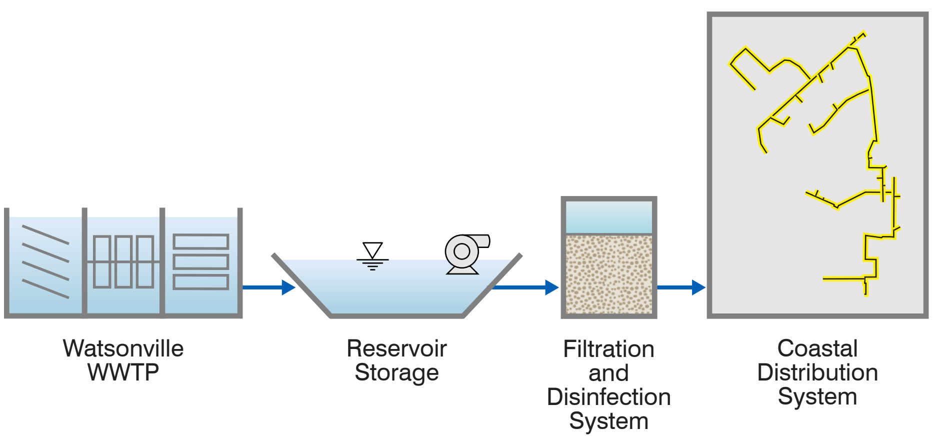
R-11: Winter Recycled Water Deep Aquifer ASR **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
Injection and Recovery Wells [(1)]	$30,300,000
Total Direct Cost	**$30,300,000**
Construction Contingency (30%)	$9,100,000
General Conditions (20%) *(incuded in well cost)*	-
Contractor Overhead and Profit (10%) *(included in well cost)*	-
Sales Tax (8.25% of 50% of Direct Cost)	$0
Total Construction Cost	**$39,400,000**
Engineering, Legal, Admin, Permits (20%)	$7,900,000
Total Estimated Project Implementation Cost	**$47,300,000**
Annualized Construction Cost [(2)]	$3,400,000
O & M Pump and Well	$400,000
Injection Power Cost (50 HP Pumps @ 600gpm - $0.15/kW-h)	$40,000
Recovery Power Cost (450 HP Pumps @ 600gpm - $0.15/kW-h)	$1,200,000
Total Annualized Cost	**$5,000,000**
Annual Yield AF	**3,200**
Unit Cost ($/AF)	**$1,600**

Notes:
(1) Limited transmissivity data for soils at 2000+ feet, Injection and Recovery rates my vary.
(2) 9 wells @ 600 gpm injection and 600 gpm recovery. Pipeline connection to CDS included in well cost.
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

R-12: Dams at Bolsa and Strawberry Hills for Recycled Water Storage



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This alternative involves the construction of earth fill dams across two natural depression areas south of the Pajaro River for recycled water storage. Site 1 would use a portion of the Bolsa de Cayetano Canyon's natural depression and would have a capacity of approximately 680 AF. This southeastern portion the Bosa Canyon would require the construction of a 75 feet high earth dam with a crest length of 1,200 feet, a spillway, and outlet works.

Site 2 uses a smaller natural depression located on the Strawberry Hills Forever LLC property south of Jensen Road and has the capacity of approximately 130 AF. The Strawberry Hills site would require a 25 feet high earth dam with a crest length of 500 feet. Each location will require a lining system, pump station, filtration and disinfection system, and pipelines to connect to the Coastal Distribution System.

Yield:

810 AFY

Capital Cost:

$74.6 Million

Operations & Maintenance:

$170,000 /Year

Annualized Capital and O&M Cost:

$5.6 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

It is assumed that sand filtration and disinfection of water stored in the lagoon would be sufficient for delivery to the CDS. This assumption would need to be confirmed during pre-design.

Implementation Issues:

Significant permitting issues. Reservoir lining and monitoring. Potential seismic issues.

Implementation Timeline:

Long-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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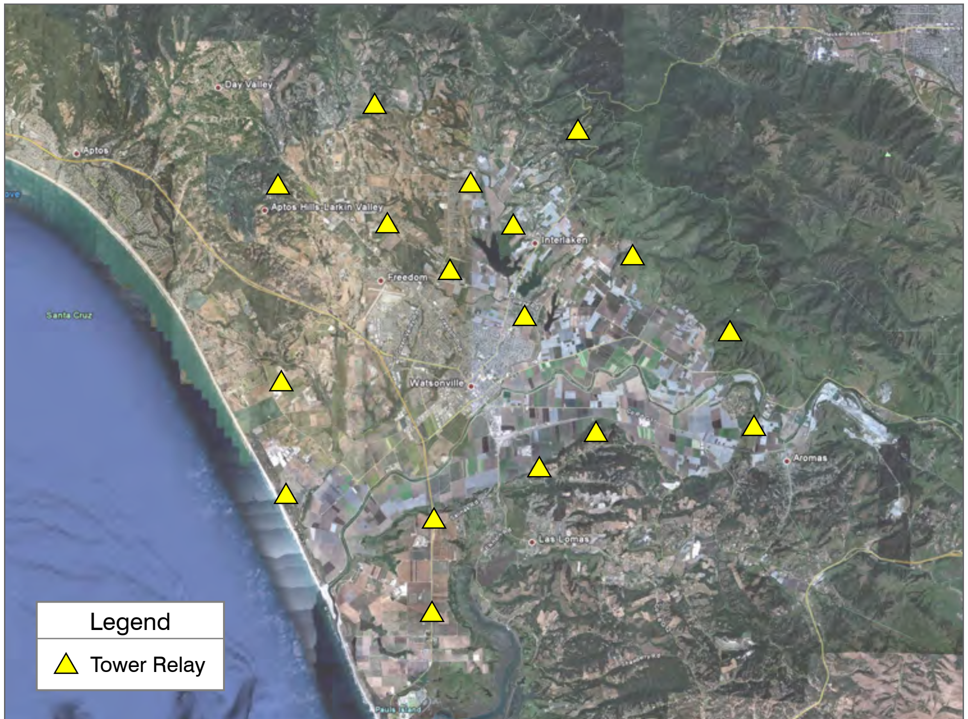
Cost:

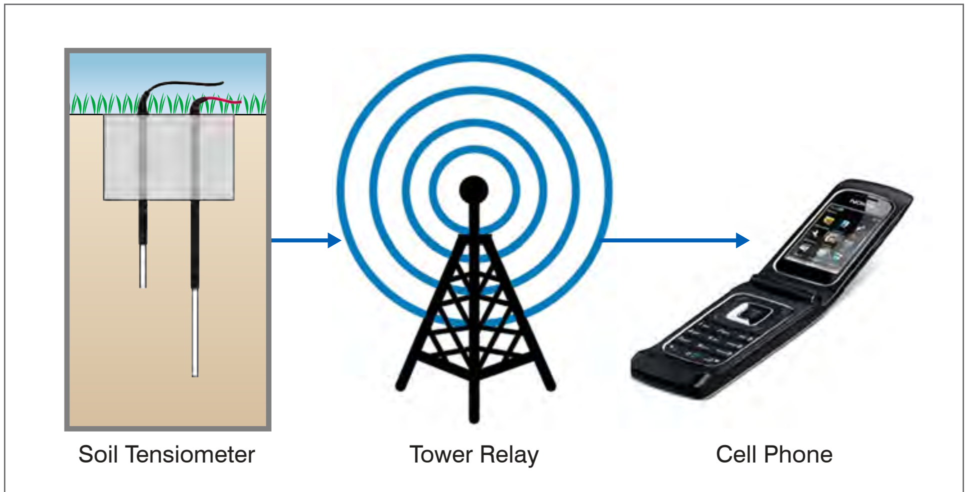
R-12: Dams at Bolsa and Strawberry Hills for Recycled Water Storage 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Earth fill Dams, Spillway and Outlet Works	$28,500,000
Reservoir Lining (73 acres double layer of 60 mil HDPE)	$6,400,000
Filtration and Disinfection	$1,100,000
Pump Stations	$700,000
Pipelines	$325,000
Total Direct Cost	**$37,100,000**
Construction Contingency (30%)	$11,200,000
General Conditions (20%)	$7,500,000
Contractor Overhead and Profit (10%)	$3,800,000
Sales Tax (8.25% of 50% of Direct Cost)	$1,600,000
Total Construction Cost	**$61,200,000**
Engineering, Legal, Admin, Permits (20%)	$12,300,000
Land Acquisition (75 Acres)(1)	$1,100,000
Total Estimated Project Implementation Cost	**$74,600,000**
Annualized Construction Cost(2)	$5,400,000
O & M Dam and Liner (0.15%)	$50,000
O&M Pipeline (1%)	$10,000
O & M Pump and Treatment (2.5%)	$50,000
Pump Power (2000 gpm for 680AFY, for 1846 hours at $0.15/kW-h)	$50,000
Pump Power (300 gpm for 130AFY, for 2353 hours at $0.15/kW-h)	$10,000
Total Annualized Cost	**$5,600,000**
Annual Yield AF	**810**
Unit Cost ($/AF)	**$6,900**

Notes:
(1) Property Values are per correspondence with Chuck Allen July 18, 2011 (Coastal Flat = $40,000/acre) current sites are not used for agriculture so using lower values
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

D-1: Increased Irrigation Efficiency with Soil Tensiometers



PROJECT PLAN



PROJECT SCHEMATIC

Background:

Soil tensiometers can provide real time data on in situ soil characteristics and irrigation effectiveness. This alternative involves installation of soil tensiometers and a network of communication towers to provide data that would allow growers to manage irrigation needs with increased accuracy and reduce water use.

Yield:

1,000 to 2,000 AFY

Estimated yield assumes 10 to 20% reduction of water use, that 50,000 AFY of water is used for agriculture, and that 20% of agriculture demand will use this new system.

Capital Cost:

$84,000

Cost assumes that soil tensiometer sets will be purchased or rented by the land owner, and are not included in the capital costs. Costs are based on $7,100/base station and $3,000/repeater tower. Some infrastructure currently exists. This cost is to finish the complete project of 5 base stations and 15 repeater towers.

Operations & Maintenance:

$5,000/Year

Annualized Capital and O&M Costs:

$15,000 (30-year capital recovery at 6% interest)

Water Quality Considerations:

None.

Implementation Issues:

Estimation of reduction in water use is based on very preliminary assumptions.

Implementation Timeline:

Near-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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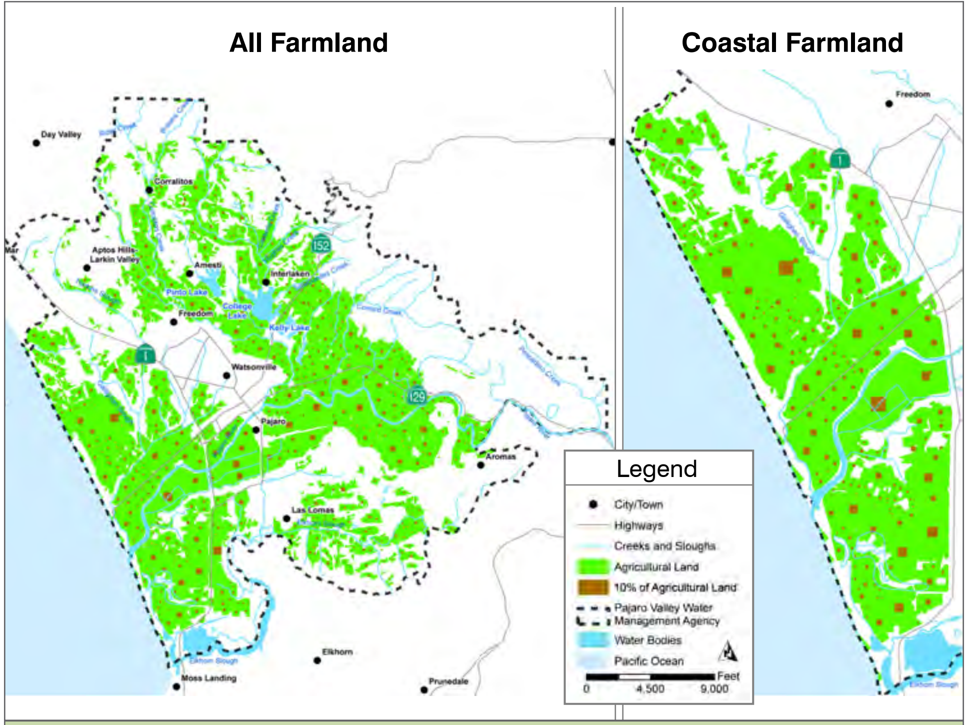
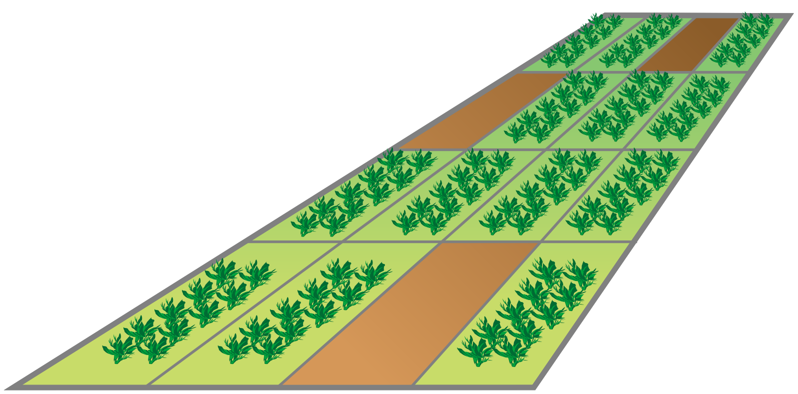
Cost:

D-1: Increased Irrigation Efficiency with Soil Tensiometers 2012 Basin Management Plan Update Pajaro Valley Water Management Agency	
Project Element	**Cost Estimate**
Tower Relay Purchasing	$50,000
Total Direct Cost	**$50,000**
Construction Contingency (30%)	$15,000
General Conditions	-
Contractor Overhead and Profit (10%)	-
Sales Tax (8.25% of 50% of Direct Cost)	-
Total Construction Cost	**$70,000**
Engineering, Legal, Admin, Permits	$14,000
Total Estimated Project Implementation Cost	**$84,000**
Annualized Cost (1)	$10,000
O&M (10%)	$5,000
Total Annualized Cost	**$15,000**
Annual Yield (AF)	**1,500**
Unit Cost ($/AF)	**$10**
Notes: (1) Annualized costs are based on a 30-year capital recovery period at 6% interest.	

D-2: Fallow 10% of Farmland



PROJECT PLAN



10% Fallowing of Farmland

PROJECT SCHEMATIC

Background:

This alternative involves the fallowing of either (1) 10% of all farmland in the Pajaro basin or (2) 10% of coastal farmland. This corresponds to fallowing of approximately 3,500 acres in the entire basin, or approximately 800 acres near the coast. The landowner or tenant would be responsible for determining which 10% of their land would be fallow at a given time. The mechanism for ensuring that fallowing is occurring has not yet been determined.

Yield:

All farmland: 5,000 AFY

Coastal farmland: 1,500 AFY

(assumes 10% fallowing = 10% reduction in water use)

Capital Cost:

Unknown

Operations & Maintenance:

All farmland: $50,000/Year (assumed for confirming fallowing)

Coastal farmland: $20,000/Year (assumed for confirming fallowing)

Annualized Capital and O&M Costs:

Unknown

Water Quality Considerations:

Not applicable

Implementation Issues:

A mechanism is needed to ensure fallowing is carried out equitably. Yield could be less than 10% of water use.

Implementation Timeline:

Near-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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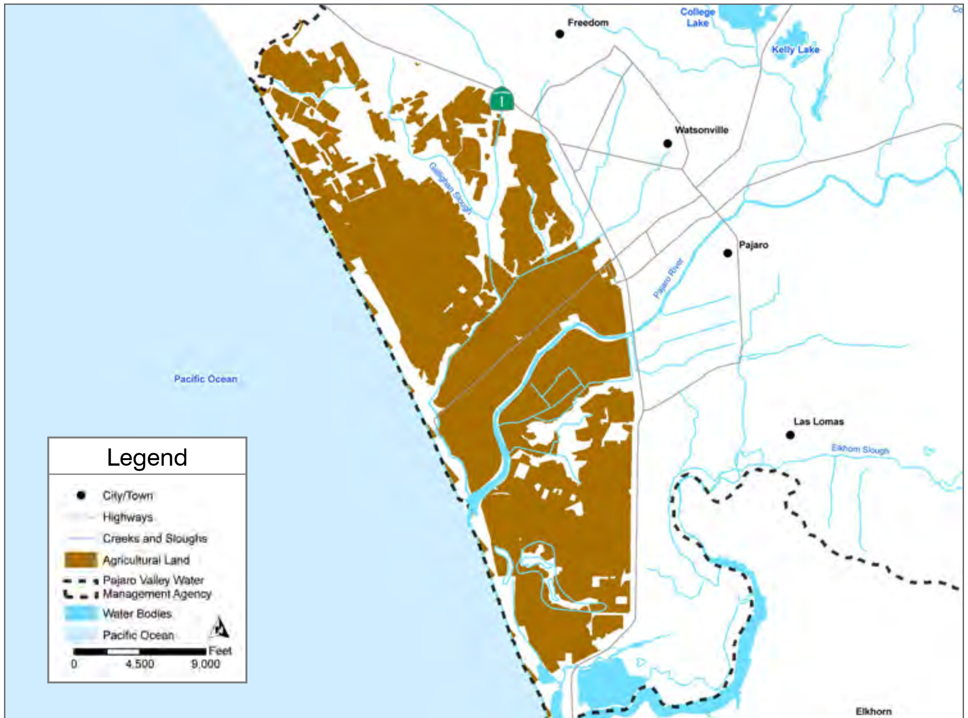
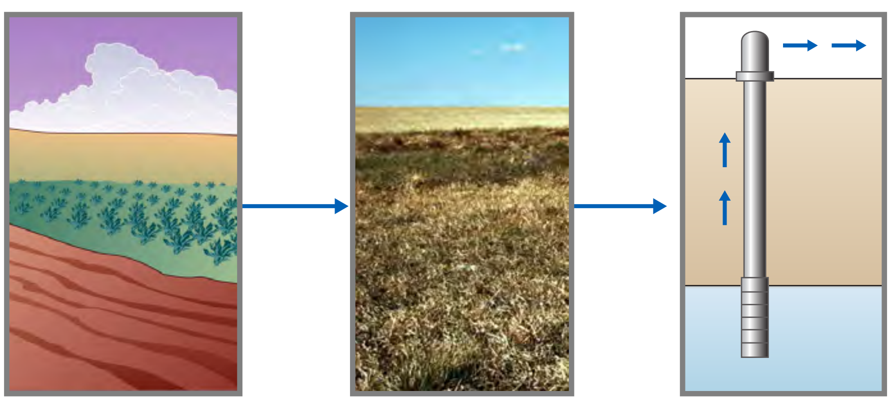
COST ESTIMATE SHEET NOT ASSOCIATED WITH THIS PROJECT

D-3: Fallow 8,000 Acres of Coastal Land



PROJECT PLAN



Coastal Agricultural Land

Coastal Fallowed Land

No Groundwater Pumping on Coast

PROJECT SCHEMATIC

Background:

This alternative involves the purchase and fallowing of approximately 8,000 acres of coastal agricultural land. Fallowing land would eliminate coastal pumping in the Pajaro groundwater basin which has been identified as the main cause of seawater intrusion, and potentially increase the sustainable yield of the basin.

Yield:

16,000 AFY (assumes 2 AFY/acre fallowed)

Capital Cost:

Land Acquisition: $320 Million

Land acquisition cost is based on 8,000 acres of coastal farmland at $40,000/acre.

Operations & Maintenance:

Costs to cover administration and land maintenance are not included in this estimate.

Annualized Capital and O&M Costs:

$24 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Cessation of coastal pumping would remove the main driver of seawater intrusion and help maintain water quality at inland wells.

Implementation Issues:

Fallowing 8,000 acres of agricultural land will have a significant impact on the local economy in the form of lost jobs and reduced tax revenue. Additionally, purchasing such large quantities of land will likely drive land values up, making acquisition more difficult and costly. These costs are not included in the annualized cost presented above.

Implementation Timeline:

Long-Term*

***Timelines:**

Near-Term = 0 - 10 years

Mid-Term = 10 - 20 years

Long-Term = 20 - 30 years

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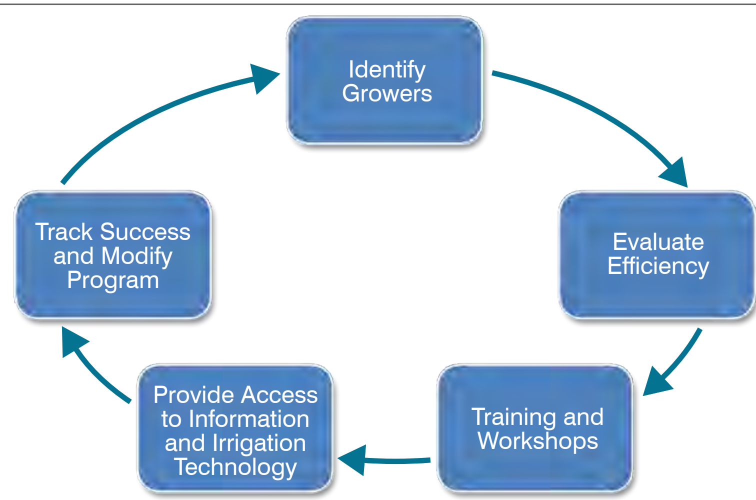
D-3: Fallow 8,000 Acres of Coastal Land
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

Project Element	**Cost Estimate**
Land Purchase (8,000 acres @ $40,000/acre)	$320,000,000
Total Direct Cost	**$320,000,000**
Engineering, Legal, Admin, Permits (3%)	$10,000,000
Total Estimated Project Implementation Cost	**$330,000,000**
Annualized Cost [1]	$24,000,000
O&M	Unknown
Total Annualized Cost	**$24,000,000**
Annual Yield AF (2AF/acre)	**16,000**
Unit Cost ($/AF)	**$1,500**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

D-4: Irrigation Efficiency Training

PROJECT PLAN



PROJECT SCHEMATIC

Background:

Irrigation efficiencies are realized by delivering the optimal amount of water to a particular crop type. An efficient irrigation system has high uniformity of distribution, applies water at a rate consistent with the soil conditions, minimizes evaporation and runoff, reduces pre-irrigation applications, and uses accurate scheduling to apply the right amount of water at the right time. Program elements would include: identify growers who could most benefit from efficiency improvements; identify growers of high-water use crops, particularly those who have not been engaged in previous outreach efforts; conduct workshops and on-farm "tailgate" meetings to share information; train field managers and irrigation staff; conduct efficiency audits and make recommendations for existing operations; create a forum for confidential information exchange with growers; and expand the stakeholder group and use it to provide suggestions and input into the program progress to improve outcomes for all program elements.

Yield:

Unknown

Capital Cost:

Unknown

Operations & Maintenance:

Unknown

Annualized Capital and O&M Costs:

Unknown

Water Quality Considerations:

Water conservation may result in water quality improvements, due to reduced agricultural return flow, and the reduction in the need for new water sources.

Implementation Issues:

Need grower buy-in;

Implementation Timeline:

Near-Term*

***Timelines:**
Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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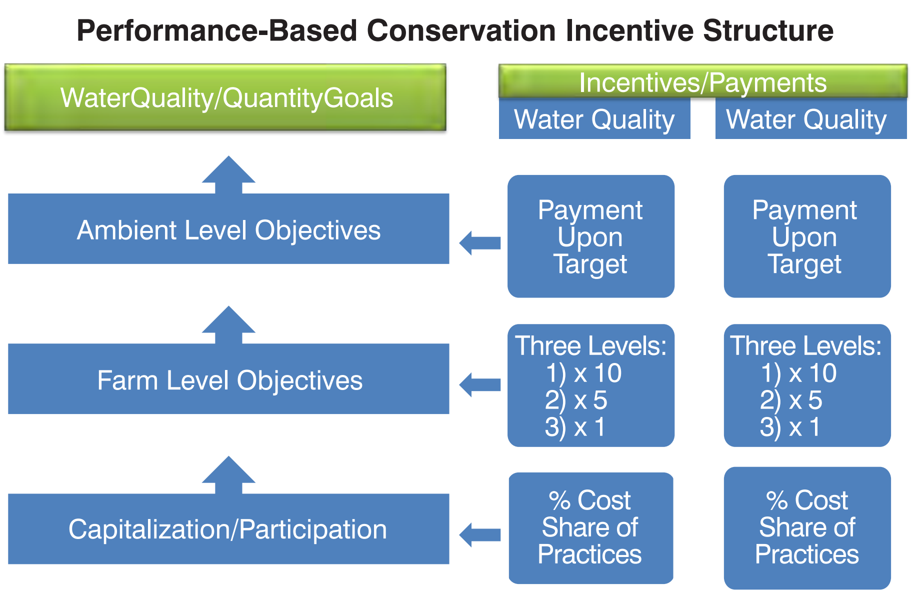
D-5: Performance-Based Water Conservation Incentives



PROJECT SCHEMATIC

Background:

A performance-based conservation incentive program could lower agricultural water consumption by establishing use targets for growers based on percent reduction and overall water use. The incentive for the growers to meet these target levels of water reduction would be in the form of lower water rates or direct reimbursement. Currently a pilot program is underway to develop this program in more detail.

Pilot Program:

The performance-based conservation incentive pilot is a new program developed in partnership between the Resource Conservation District of Santa Cruz County and Driscoll's Strawberry Associates Inc, made possible by a grant from the USDA's Conservation Innovation Program. The pilot's goals are to: 1) Improve conservation outcomes for water quality and quantity in the Pajaro Valley; while stimulating innovation through standardized metrics and conservation incentive structure; 2) Create new economic opportunities for farmers, while allowing them flexibility of new approaches in meeting nutrient and aquifer impacts targets; and 3) Create a replicable model to be used in other geographic settings, crops, and to be adapted by agricultural policy makers and the private sector. The partnership intends to achieve this by:

- Developing appropriate performance-based indicators and metrics for setting nutrient reduction and water conservation targets; and
- Developing a standardized incentive structure for nutrients and water conservation and means of verification for conservation incentive payments.

Yield:

10% - 20% potential savings

Capital Cost:

5-10% savings could be realized from reduced infrastructure needs

Operations & Maintenance:

Not applicable

Annualized Capital and O&M Cost:

Not applicable

Water Quality Considerations:

Could increase water quality in basin and runoff if targets are met.

Implementation Issues:

Sustained funding source. Pilot program results.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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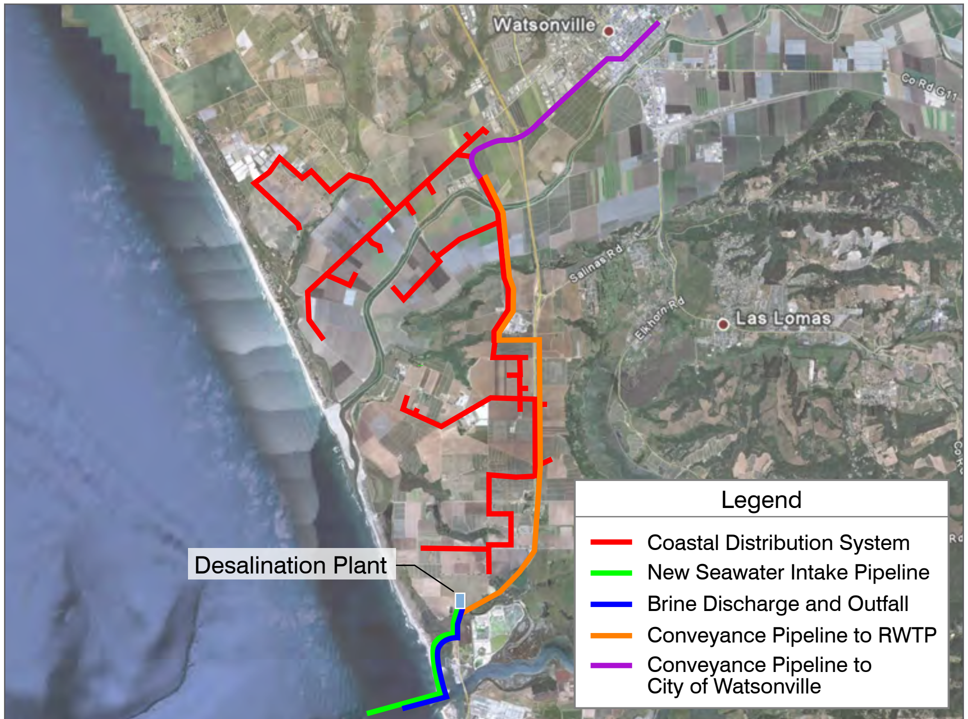
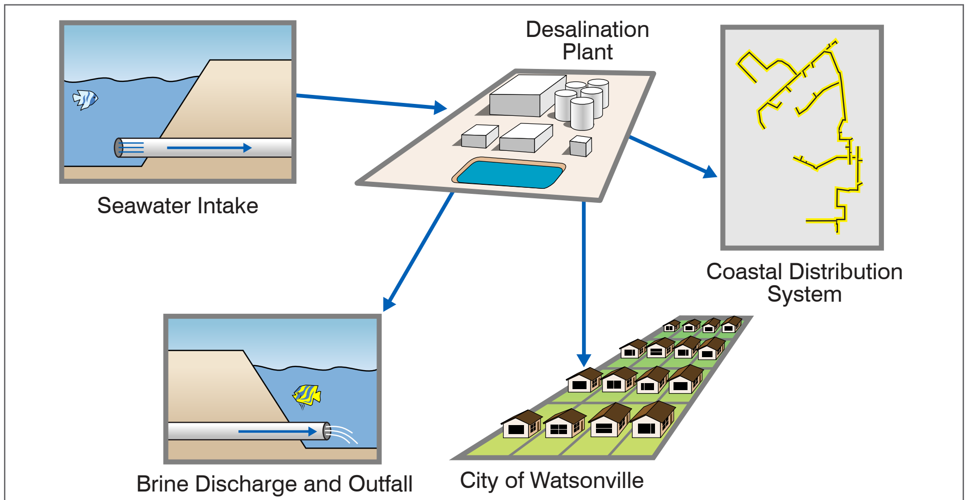
COST ESTIMATE SHEET NOT ASSOCIATED WITH THIS PROJECT

SEA-1: Seawater Desalination



PROJECT PLAN



PROJECT SCHEMATIC

Background:

This project includes construction and operation of a seawater desalination facility that would produce potable water from seawater. The project consists of a seawater intake and pipeline, desalination plant, brine discharge and outfall facilities, product water conveyance pipelines to the recycled water treatment plant clearwell and three City of Watsonville potable wells (8-miles of 24-inch pipe), and storage facilities. The treated water would be used for agricultural irrigation during the irrigation season via an expanded CDS, and as potable water for the CIty of Wastsonville during the winter months.

Yield:

7,500 AFY

Yield is based on coastal agriculture using all project water during a 6-month growing season and 50% of the water for the month before and after the 6-month peak season totaling 6,500 AFY and the City of Watsonville using 1,000 AFY during the rest of the year by connecting to the potable water distribution at 3 wells. Additional yield could be added with more infrastructure to additional City wells.

Capital Cost:

$228 Million

Additional costs for water conveyance will need to be added if additional yield is desired. This project would also require the addition of the northern CDS to deliver all 6,500 AFY to coastal growers.

Operations & Maintenance:

$8.9 Million/Year

Annualized Capital and O&M Costs:

$25.5 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Desalinated water quality will need to be defined during preliminary design phases.

Implementation Issues:

Extensive environmental permitting. Site of intake and outfall has not been defined. Yield during winter months will not be fully utilized.

Implementation Timeline:

Mid- to Long-Term*

***Timelines:**

Near-Term = 0 - 10 years   Mid-Term = 10 - 20 years   Long-Term = 20 - 30 years

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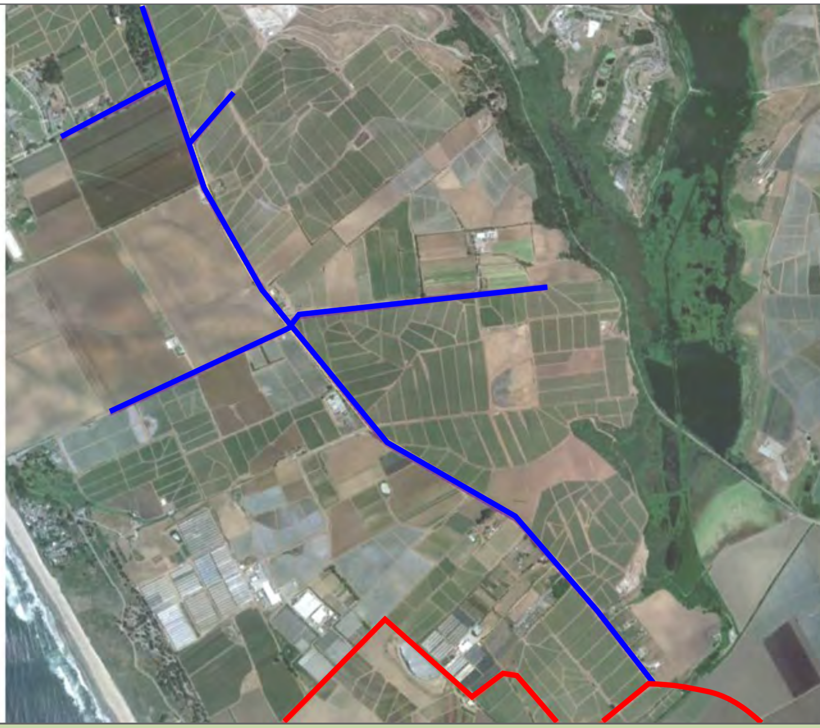
SEA-1: Desalination
2012 Basin Management Plan Update
Pajaro Valley Water Management Agency

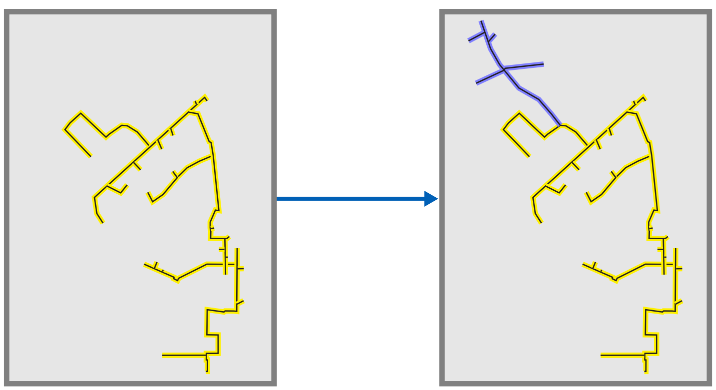
Project Element	**Cost Estimate**
New 24" Conveyance Pipeline to WWTP	$10,548,000
New 24" Conveyance Pipeline to City of Watsonville	$5,220,000
18" Brine Disposal Pipeline	$972,000
Intake/Intake Pump Station	$27,270,000
Prechlorination System	$112,400
Dechlorination System	$153,800
Ferric Chloride System	$352,300
Prefiltration	$8,502,400
Dewatering Equipment	$5,710,000
Filtered Water Lift Station	$2,510,000
RO Membranes	$2,083,333
RO Skids	$4,761,905
RO HP Pumps	$1,090,100
PX Booster Pumps	$587,000
Energy Recovery	$1,418,651
Building	$8,608,800
Electrical	$11,389,783
Instrumentation/Control	$9,111,827
Transfer Pump Station	$350,000
Permeate Flush System	$174,700
Process Piping	$1,544,300
Yard Piping	$1,639,600
Cartridge Filters	$780,000
Clean-in-Place System	$180,000
Lime System	$183,000
Carbon Dioxide System	$425,000
Chlorination System	$493,200
Ground Storage Tank	$3,000,000
High Service Pumping Station	$910,000
Site Work	$3,091,400
Total Direct Cost	**$113,200,000**
Construction Contingency (30%)	$33,960,000
General Conditions (20%)	$22,640,000
Contractor Overhead and Profit (10%)	$11,320,000
Sales Tax (8.25% of 50% of Direct Cost)	$4,670,000
Total Construction Cost	**$185,800,000**
Engineering, Legal, Admin, Permits (20%)	$37,160,000
Permitting	$5,000,000
Total Estimated Project Implementation Cost	**$228,000,000**
Annualized Construction Cost(1)	$16,570,000
O & M Pipeline	$500,000
Desal Plant O&M	$8,400,000
Total Annualized Cost	**$25,500,000**
Annual Yield AF	**7,500**
Unit Cost ($/AF)	**$3,400**

Notes:
(1) Annualized costs are based on a 30-year capital recovery period at 6% interest.

I-1: CDS Expansion



PROJECT PLAN



PROJECT SCHEMATIC

Background:

The existing Coastal Distribution System (CDS) was installed to provide delivered water to coastal growers. Depending on the success of conservation, expansion of the CDS may be needed to stop seawater intrusion and balance the basin. This alternative does not have a project yield but rather contains the infrastructure required to deliver the water from other projects to coastal growers outside of the existing delivered water zone. The proposed alignment would extend north from the existing CDS to serve agricultural land south of Zils Road. The expanded area has an average water demand of approximately 2,000 AFY. The pipeline routing could be modified if the Watsonville Slough and North Dunes Recharge Basin Project were built.

Yield:

None. This alternative provides the infrastructure necessary to deliver water to the coast but does not provide the water source.

Capital Cost:

$13 Million

Operations & Maintenance:

$70,000

Annualized Capital and O&M Cost:

$1 Million (30-year capital recovery at 6% interest)

Water Quality Considerations:

Project water blending.

Implementation Issues:

Since seawater intrusion has had little impact on wells north of the existing CDS, growers in this area may have little motivation to use delivered water.

Implementation Timeline:

Near- to Mid-Term*

***Timelines:**

Near-Term = 0 - 10 years
Mid-Term = 10 - 20 years
Long-Term = 20 - 30 years

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Cost:

I-1: CDS Expansion **2012 Basin Management Plan Update** **Pajaro Valley Water Management Agency**	
Project Element	**Cost Estimate**
New 24-inch Conveyance Pipeline	$4,400,000
New 18-inch Conveyance Pipeline	$1,700,000
New 12-inch Conveyance Pipeline	$500,000
Total Direct Cost	**$6,600,000**
Construction Contingency (30%)	$2,000,000
General Conditions (20%)	$1,300,000
Contractor Overhead and Profit (10%)	$660,000
Sales Tax (8.25% of 50% of Direct Cost)	$270,000
Total Construction Cost	**$10,800,000**
Engineering, Legal, Admin, Permits (20%)	$2,200,000
Total Estimated Project Implementation Cost	**$13,000,000**
Annualized Construction Cost(2)	$950,000
O & M Pipeline (1%)	$70,000
Total Annualized Cost	**$1,000,000**
Annual Yield AF	**0**
Unit Cost ($/AF)	**NA**

Notes:
(1) Cost based on 2002 BMP and adjusted to 2011 dollars (ENR-CCI 1.2961)
(2) Annualized costs are based on a 30-year capital recovery period at 6% interest.

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Appendix D: Conservation Literature Review

Appendix D: Conservation Literature Review

Several previous studies and plans, including the previous BMP, have examined the opportunities for water conservation in the Basin. These documents include "Water Conservation 2000" prepared for PVWMA by CH2MHill (2000); "Approaches to Water Conservation: Pajaro Valley by Catherine Carlton and Tiffani Jarnigan (2011); the 2002 BMP; and the 2010 City of Watsonville Urban Water Management Plan (UWMP).

"Water Conservation 2000" was a comprehensive study prepared in conjunction with the 2000 BMP (which was adopted as the revised 2002 BMP). This study discussed existing water supply issues, (then) current conservation activities, potential conservation strategies for both the agricultural and urban sectors, a proposed implementation program for agricultural and urban water conservation, the feasibility issues surrounding these programs, and the outreach program that should accompany the programs. The agricultural conservation program focused on irrigation efficiency, and identified 4,500 AFY as an achievable goal. The urban conservation program identified 600 - 1000 AFY as an achievable target (based on the 1993 BMP). The cost of agricultural conservation was estimated at $300,000 annually. The urban program which relied heavily on ordinances, pricing structures, water audits, and fixture/appliance rebate programs, did not include a specific price.

Chapter 3, "Management Measures," of the 2002 BMP discusses conservation as well as a range of other management tools including price strategies, land fallowing, pump management, and recharge area protection. The 2002 BMP identifies 5000 AFY as the conservation goal. This is based on the 4,500 AFY of agricultural conservation, and 500 AFY of urban conservation, analyzed in the "Water Conservation 2000" study.

The 2011 study by Carlton and Jarnigan, "Approaches to Water Conservation: Pajaro Valley," focuses on agricultural conservation, building on the 2000 conservation report and the 2002 BMP, but widening the scope of potential conservation efforts. In addition to irrigation efficiency, the study looks at land fallowing, rainwater harvesting, and conservation pricing as means to reduce water usage in the Basin.

The 2010 UWMP addresses urban conservation. The City receives some surface water (approximately 900 AFY), but is largely dependent on groundwater (6,728 AFY in 2010) for its water supply. The UWMP states the 500 AFY conservation goal in the 2002 BMP is likely too low, and uses a higher goal of 1000 AFY. The conservation tools are essentially those described in the BMP: ordinances, rebates, audits and repairs, metering and pricing strategies, and public outreach/education.