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Chapter 9. Projects and Management Actions

180/400-Foot Aquifer Subbasin
Groundwater Sustainability Plan

Prepared for:

SVBGSA

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Contents

Figures

Tables

9 PROJECTS AND MANAGEMENT ACTIONS

9.1 Introduction

This chapter describes the projects and management actions that will allow the Subbasin to attain sustainability in accordance with §354.42 and §354.44 of the SGMA regulations. This chapter includes a description of a water charges framework, proposed groundwater management actions, and proposed projects. In this GSP, the term groundwater management actions generally refers to activities that support groundwater sustainability without infrastructure; projects are activities supporting groundwater sustainability that require infrastructure.

The water charges framework, management actions, and projects adopted in this GSP will achieve a number of outcomes including:

- Achieving groundwater sustainability by meeting Subbasin-specific sustainable management criteria by 2040
- Providing equity between who benefits from projects and who pays for projects
- Providing a source of funding for project implementation
- Providing incentives to constrain groundwater pumping within limits

This GSP is developed as part of an in integrated sustainability plan that is being developed by the SVBGSA to achieve groundwater sustainability in all six subbasins of the Salinas Valley that lie in Monterey County. Therefore, the projects and actions included in this GSP are part of a larger set of integrated projects and actions for the entire Valley. All of the integrated projects and management actions for the Salinas Valley are included in this GSP, although the benefit may be limited in this Subbasin.

The management actions and projects included in this chapter outline a framework for achieving sustainability, however many details must be negotiated before any of the projects and management actions can be implemented. These negotiations and discussions will occur while the GSPs for the five remaining subbasins in the Salinas Valley are drafted. Furthermore, the discussions will likely continue during the early years of GSP implementation. Members of the GSA and stakeholders in the Subbasin should view these projects and management actions as a starting point for more detailed discussions. Where appropriate, details that must be agreed upon are identified for each management action or project.

Furthermore, project costs and associated costs per acre-foot should not be interpreted as the cost of irrigation. The cost per acre-foot provided is a means to compare the various projects. Because most growers will be allowed to pump some groundwater and irrigate with that groundwater,

water supplied by the projects in this chapter represent only a portion of each grower's irrigation water. Therefore, actual costs seen by growers are proportional to individual needs project water.

The approach for implementing management actions and projects will provide individual landowners and public entities flexibility in how they manage water and how the Subbasin achieves groundwater sustainability. All groundwater pumpers will be allowed to make individual decisions on how much groundwater they pump based on their perceived best interests.

9.2 Water Charges Framework

The water charges framework is the fundamental structure for managing groundwater pumping and funding projects. This framework is designed to achieve two important outcomes:

1. Promote voluntary pumping reductions; and
2. Fund new water supply projects by charging fees for various levels of pumping.

A similarly structured water charges framework will be implemented in all Salinas Valley subbasins in Monterey County. However, details such as pumping allowance quantities, pumping fees, and tier structures will be different for each subbasin. These differences will reflect the fact that each subbasin's water charges framework is based on the specific hydrogeology and conditions of that subbasin.

Details of the water charges framework will be developed during the first three years of GSP implementation, and will be included in an agreement approved by the SVBGSA. The water charges framework includes the following components, described further below.

- **Exempt Groundwater Pumpers** may include *de-minimis* pumpers or other classes of pumpers that are not managed by this GSP.
- **Sustainable Pumping Allowances** are a base amount of groundwater pumping assigned to each non-exempt groundwater pumper. The sum of all sustainable pumping allowances is the sustainable yield of the subbasin. The sustainable yield will be regularly reassessed based on improved data and tools.
- **Transitional Pumping Allowances** are the difference between current assumed pumping and the sustainable pumping allowance. These transitional pumping allowances may be reduced over time to move from current pumping practices to sustainable pumping.
- **Supplementary Pumping** is all groundwater pumping above the sustainable and transitional pumping allowance.

- Sustainable and transitional pumping allowances are quantified for every non-exempt groundwater pumper. These allowances are not water rights. Instead, they are pumping amounts that form the basis of a financial fee structure to both implement the regulatory functions of the SVBGSA and fund new water supply projects.
- Pumping is recorded annually for all non-exempt pumpers.
- All pumpers are charged either a regulatory fee or a groundwater replenishment fee based on a tiered rate structure. Groundwater pumped within the sustainable pumping allowance is charged a base rate as a regulatory fee. Groundwater pumped in excess of the sustainable pumping allowance is charged the base rate plus a surcharge. Any groundwater pumped above the transitional pumping allowance is subject to the base rate plus a supplementary pumping fee.
- Base rate funds are used to implement the regulatory functions of implementing SGMA. This may include developing and implementing an improved water metering program, regular data collection and monitoring, negotiating program details, acquiring water rights or contracts, conducting feasibility studies for the priority or alternative projects, permitting and developing one or more of the management actions or projects described in this chapter.
- The surcharge and supplementary fee funds are used to build projects and pay annual costs of purchasing and treating water that have a defined benefit to individuals or groups.
- Transitional pumping allowances are phased out over 10 to 15 years to encourage pumping within the sustainable yield.

The fee structure in the water charges framework is designed to promote conservation and voluntary pumping reductions. Individual groundwater pumpers may choose to switch to less water-intensive crops, implement water use efficiencies, fallow a portion of their land, or transition to non-groundwater sources. Alternatively, if reducing pumping is not the best economic option, a pumper may instead opt to pay the overproduction surcharges and supplementary fees.

The fee structure and allowances will not be uniform across the Salinas Valley subbasins in the final water charges framework agreement. Different subbasins in the Salinas Valley will be subject to different fee and pumping allowance structures based on the particular conditions of each subbasin. The fee structures in each subbasin will be developed in accordance with all existing laws, judgements, and established water rights.

The following components of the water charges framework constitute the agreed to structure that the final water charges framework will reflect.

9.2.1 Well Registration

All groundwater production wells, including wells used by *de-minimis* pumpers, must be registered with the GSA. If the well has a meter, the meter must be calibrated on a regular schedule in accordance with manufacturer standards and any programs developed by the GSA. Although d*e-minimis* must register their wells, they are exempt from the flowmeter installation and flowmeter calibration requirements. The details of the well registration program, and how it integrates with existing ordinances and requirements, will be developed during the first two years of GSP implementation.

9.2.2 Pumping Allowances

Pumping allowances are established to enable development of the tiered pumping rate system and calculation of over-pumping surcharges and supplemental fees. Pumping allowances are not a water right. The proposed process for establishing initial pumping allowances is as follows:

- **Sustainable Pumping Allowances**: All land parcels located outside of the service area of a municipal water provider, and land parcels located within the service area of a municipal water provider that are actively farmed as of 2017, will receive a sustainable yield pumping allowance based on a pro-rata share of their subbasin's sustainable yield. The methodology for determining pro-rata shares will be developed during the first two years of GSP implementation. The pro-rata shares may be based on some combination of land acreage, historical crop types grown on the parcel, standardized crop duties for the particular subbasin, historical groundwater use, or other factors. Because the sustainable pumping allowances are designed to limit pumping to the subbasin's sustainable yield, it is likely that the pro-rata sustainable allowances will be less than the current groundwater use in most (but not necessarily all) Salinas Valley subbasins.

  Sustainable allowances for municipal and industrial groundwater pumpers will be addressed when sustainable pumping allowances are being developed for agricultural pumpers. Because these allowances are not water rights, municipal and industrial water users will be able to pump groundwater even without a quantified sustainable allowance. However, if municipal and industrial groundwater pumpers are not provided a sustainable allowance, any groundwater pumping by these entities will be subject to the pumping surcharge or supplemental fees.

- **Transitional Pumping Allowances**: In addition to any sustainable pumping allowance that may be awarded, agricultural, municipal, industrial, and other groundwater pumpers will receive a transitional pumping allowance. The transitional pumping allowance will be quantified based on the difference between a groundwater user's actual historical pumping amounts (estimated or measured) and their sustainable allowance. The purpose of this transitional allowance is to ensure that no pumper is required to immediately reduce their pumping, but rather pumpers have an opportunity to reduce their pumping over a set period of time. Maximum annual (calendar year) pumping between 2012 and 2017 will be used to determine transitional pumping allowances. These years are chosen for general consistency with the future water budget calculations.

- ***De minimis* Pumpers**: Notwithstanding the foregoing, *de minimis* pumpers are exempt from the fees under the water charges framework.

9.2.3 Transitional Pumping Allowance Phase-out

Transitional pumping allowances will be phased out until total pumping allowances in each Subbasin is less than or equal to the calculated sustainable yield. The phase-out may occur over a time span of 10 to 15 years. The extent and timing of the phase-outs will vary by subbasin to achieve sustainability. The specific phase-out amounts and timing will be determined during the first two years of GSP implementation, and may be periodically modified by the SVBGSA. These adjustments will be initiated as additional data and analyses refine the sustainable yield estimate.

An example of how the sustainable allowance, transitional allowance, and supplemental fees work together is shown in Figure 9-1. In this example, a parcel is assigned a sustainable allowance of 100 acre-feet per year, which is shown in blue. Any pumping within that allowance will be charged the base fee. The parcel currently uses 128 acre-feet per year. Therefore, the initial transitional pumping allowance is 28 acre-feet per year, which is shown in yellow. This transitional allowance is phased out over 10 years. Any pumping within the transitional allowance is charged the pumping surcharge. Any pumping above the transitional allowance is charged the supplemental fee. This is shown by the dark orange bars. Beginning in year 10, any pumping above the sustainable allowance is charged the supplemental fee because there is no transitional allowance beginning in that year.

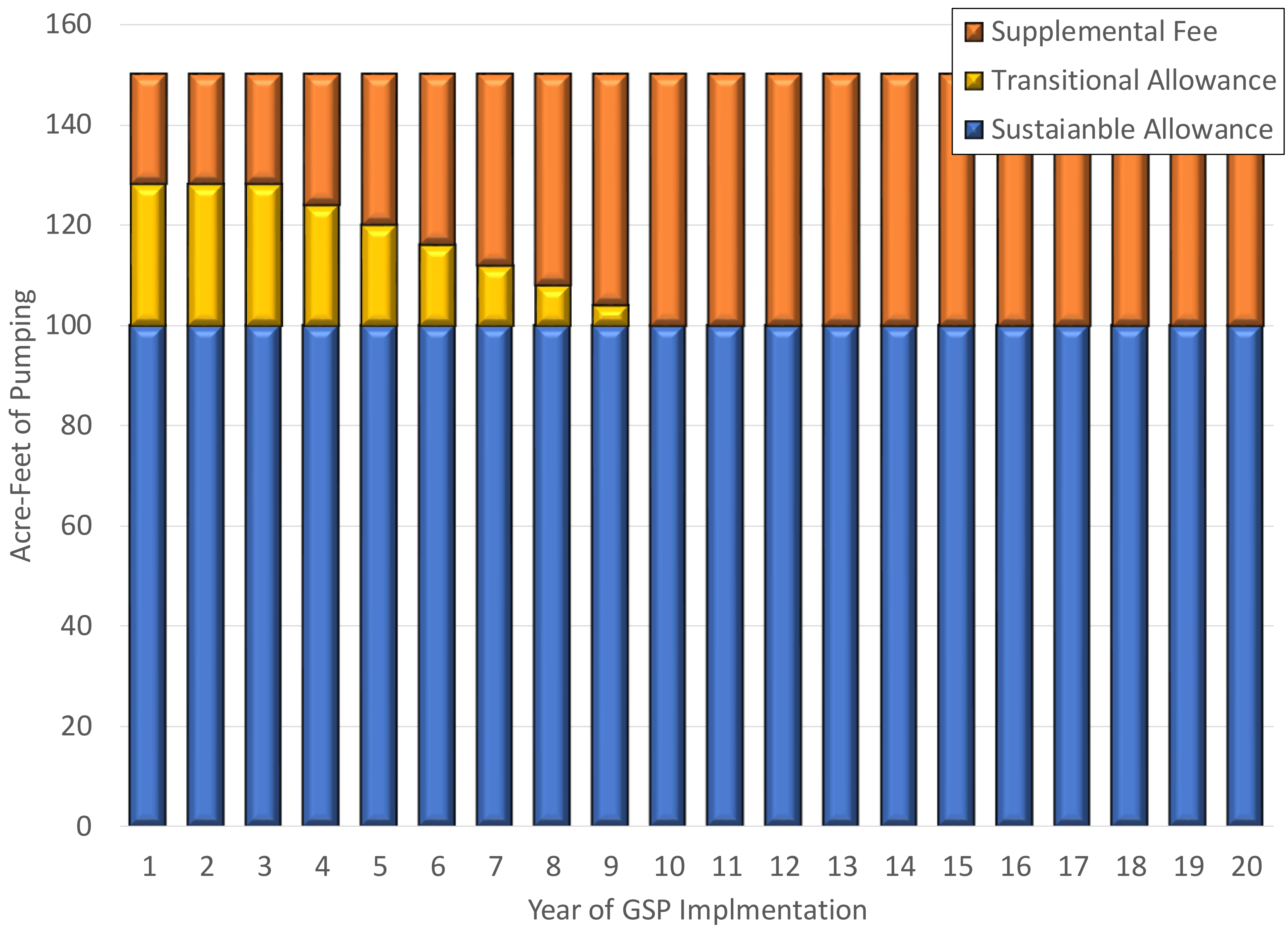


Figure 9-1. Example Pumping Allowances

9.2.4 Carryover and Recharge

To provide pumpers the flexibility to pump more during dry years and less during wet years, the unused portion of a pumping allowance for a given year may be carried over for use in subsequent years. The amount a pumper can carryover is limited to an amount equal to that pumper's current single year pumping allowance. The SVBGSA may elect to impose an annual loss factor that reduces a pumper's carryover credits due to natural hydrogeologic losses from the Subbasin. The exact loss percentage will be agreed to in the final water charges framework.

The carryover element of pumping allowances allows groundwater pumpers to pump more water only if they have previously banked pumping credits, and offers significant flexibility to pumpers while keeping long-term pumping within the sustainable yield. This directly addresses the requirements of the SGMA regulations §354.44(b)(9) which requires that, "chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods".

Water recharged by an individual or entity will be recognized by award of recharge credit to the recharging individual or entity on a one acre-foot for one acre-foot basis, subject to losses that the SVBGSA may elect to impose. Recharge credit balances will be reduced or debited when the recharged water is recovered. The SVBGSA will develop a system of confirming and accounting for recharge credits and debits as discussed in Section 9.2.7.

9.2.5 Relocation and Transfer of Pumping Allowances

Pumping allowances may be moved between properties temporarily or permanently. Such re-location of pumping allowances is subject to review by the SVBGSA to ensure that such relocation or transfer does not prevent sustainability goals from being met. The SVBGSA will model the effects of the relocation to assess any significant and unreasonable impacts from the proposed relocation. Relocating pumping allowances provides pumpers with flexibility to manage their land, water resources, and finances as they desire. Pumping allowances could also be permanently or temporarily transferred between different owners, and could be used for another pumping purpose.

9.2.6 Non-Irrigated Land

Although much of the land in the 180/400-Foot Aquifer Subbasin is either currently under irrigation or is supplied by municipalities, there is some land that may be currently fallow. The GSP recognizes that owners of such land may wish to begin pumping in the future consistent with their overlying rights. Such pumping is not limited by this GSP. The SVBGSA may wish to provide sustainable allowances to all land owners, effectively slightly diminishing the allowance of current irrigators to provide some allowance for fallow land. Optionally, non-exempt pumpers who did not receive an initial pumping allowance may:

1. Acquire pumping allowance from willing sellers subject to GSA approval, and/or
2. Pay the surcharges associated with pumping above their pumping allowance.

The final approach to addressing allowances for fallow land will be developed in the first two years of GSP implementation.

9.2.7 Administration, Accounting, and Management

The SVBGSA will administer the water charges program. Administrative duties would include developing initial pumping allowances; tracking pumping allowance ownership; accounting for water use; accounting for carryover credits and recharge credits; calculating, assessing, and collecting fees; and reviewing proposed re-location and transfer of pumping allowances. The SVBGSA would use Water Charges revenues to fund projects that develop new water supplies for the benefit of the Subbasin.

The total amount of groundwater pumped by each land owner or entity will be measured in a number of ways:

- Municipal groundwater users and small water systems report their measured groundwater usage to the SWRCB Division of Drinking Water. These data are available on the State's Drinking Water Information Clearinghouse website ("Drinking Water Information Clearinghouse"). These data will be used to quantify municipal and small water system pumping.
- Agricultural pumping will be metered, and that pumping will be reported directly to either MCWRA or the SVBGSA.
- Pumping by *de-minimis* users will be estimated using a flat pumping quantity per year, such as 0.39 acre-feet per *de-minimis* pumper per year.

9.2.8 Details to be Developed

As mentioned at the beginning of Section 9.2, a number of details must be agreed to before the water charges framework can be initiated. An initial list of details that must be negotiated are presented below to provide SVBGSA members and stakeholders an understanding of the range of specifics that are open for negotiation.

- Are *de-minimis* pumpers that pump less than two acre-feet per year for domestic purposes exempt from the water charge framework and other management actions?

- Are any class of pumpers other than *de-minimis* pumpers exempt from the water charge framework and other management actions?
- How are sustainable pumping allowances set?
- How are transitional allowances phased out in the Subbasin? Over what time frame are pumping allowances ramped down?
- What is the base pumping rate?
- What is the pumping surcharge fee?
- What is an equitable balance between base pumping rate collected in the 180/400-Foot Aquifer Subbasin and base pumping rate collected in other subbasins?
- What is an equitable balance between surcharge pumping rate collected in the 180/400-Foot Aquifer Subbasin and surcharge pumping rate collected in other subbasins?
- How is currently non-irrigated land addressed?
- How are municipalities addressed?
- What are the limits and parameters of the carryover and recharge options?
- What in involved in approving relocation or transfer of pumping credits?

9.3 Management Actions

Management actions are new or revised non-structural programs or policies that are intended to reduce or optimize local groundwater use. Management actions will be implemented only if they are deemed cost effective or necessary to achieve sustainability.

9.3.1 All Management Actions Considered for Integrated Management of the Salinas Valley

This GSP is part of an integrated plan for managing groundwater in all six subbasins of the Salinas Valley that lie within Monterey County. The projects and management actions described in this GSP constitute an integrated management program for the entire Valley. The program's projects and management actions were selected from a lager set of potential actions. Appendix 9-A includes the full list of potential management actions that were considered for the Valley-wide integrated management program.

The potential management actions listed on Appendix 9-A were assessed for effectiveness in achieving sustainability throughout the Salinas Valley. Five management actions were selected as the most reliable, implementable, cost-effective, and acceptable to stakeholders. The first three management actions benefit the entire Salinas Valley; the last two management actions are specific to the 180/400-Foot Aquifer Subbasin.

9.3.2 Priority Management Action 1: Agricultural Land and Pumping Allowance Retirement

Water charges revenues may be used by the SVBGSA to acquire and retire irrigated land and/or pumping allowances (potentially including carryover credits and recharge credits) to reduce pumping. All acquisitions will be completed on a voluntary basis from willing sellers at negotiated market prices. The SVBGSA would cease irrigation on acquired land to reduce pumping. The SVBGSA would coordinate with other local agencies and stakeholders to determine beneficial uses of the acquired land (e.g. establishment of native vegetation).

Landowners selling pumping allowances to the SVBGSA separate from land will be permitted to convert their land to be in compliance with the County of Monterey's General Plan. The number of de-minimis wells authorized on converted land will be based on the amount of pumping allowance sold to the SVBGSA. The final ratio of sold pumping allowance to the number of de-minimis wells allowed will be agreed to in the final water charges framework. For illustrative purposes, one de-minimis well could be authorized for every 20 to 40 acre-feet of pumping allowance sold to the SVBGSA. The details of how much pumping must be retired for every de-minimis pumper allocation will be developed during the first three years of GSP implementation.

9.3.2.1 Relevant Measurable Objectives

The measurable objectives benefiting from land retirement include:

- Groundwater elevation measurable objectives throughout the Salinas Valley (depending on the location of the land retirement). Less pumping will result in higher groundwater levels.

- The groundwater storage measurable objective. This measurable objective is based on total pumping in the Subbasin, therefore land retirement with reduced pumping contributes to meeting this objective and will help achieve the goal of reducing total extractions to the long-term sustainable yield.

- Land subsidence measurable objectives throughout the Subbasin (depending on the location of the land retirement). Land retirement will reduce the pumping stress on the local aquifer(s) and thereby reduce the potential for subsidence.

- The seawater intrusion measurable objective (depending on the location of the land retirement). Land retirement near the coast will reduce the pumping stress that causes water levels to drop below sea level and cause seawater intrusion.

9.3.2.2 Expected Benefits and Evaluation of Benefits

The primary benefit from land retirement is reduced Subbasin pumping. A second benefit is either halting the decline or raising groundwater elevations. Depending on the location of the land retirement, ancillary benefits of shallower groundwater elevations may include avoiding subsidence and reducing seawater intrusion rates. Because it is unknown how many landowners will willingly enter the land retirement program, it is difficult to quantify the expected benefits at this time.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. A direct correlation between agricultural land retirement and changes in groundwater levels is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

9.3.2.3 Circumstances for Implementation

Agricultural land retirement relies on willing sellers. No other triggers are necessary or required. The circumstance for implementation is for willing sellers to contact the SVBGSA.

9.3.2.4 Public Noticing

Any agricultural land retirement achieved through a land sale will be recorded with the County of Monterey Office of the Tax Assessor. All agricultural land retirement, whether through sale of land or pumping allowance, will be recorded in the publicly accessible portion of the water charges framework database.

9.3.2.5 Permitting and Regulatory Process

No permitting or regulatory processes are necessary for buying land or pumping allowances.

9.3.2.6 Implementation Schedule

The option for land retirement will begin immediately after the water charges framework is finalized and adopted. Although the land retirement program is ongoing, it is reliant on willing sellers and will likely be implemented intermittently.

9.3.2.7 Legal Authority

California Water Code §10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges.

9.3.2.8 Estimated Cost

Market values for agricultural land eligible for sustainable yield and transitional pumping allowances are reported to range from $26,000 per acre to $70,000 per acre (American Society of Farm Managers and Rural Appraisers, 2019). While some vineyards have sold for higher prices, it is unlikely that the SVBGSA will seek to acquire and retire the Subbasin's highest-quality vineyard land due to cost considerations.

Assuming that retiring one acre of eligible land would reduce pumping by 3 acre-feet and that the SVBGSA can acquire and retire land for $26,000 per acre to $70,000 per acre, the cost per acre-foot of pumping reduction will range from approximately $8,700 per acre-foot to $23,300 per acre-foot. If amortized over 25 years at a 6% interest rate, these one-time capital expenditures are equivalent to annualized costs of approximately $680 per acre-foot to $1,820 per acre-foot.

9.3.3 Priority Management Action 2: Outreach and Education for Agricultural BMPs

Priority Management Action 2 advances outreach and education programs that support innovative irrigation and agricultural practices across the Salinas Valley. These programs will educate farmers, promote water conservation, crop sustainability, and crop advancements. These programs will help minimize the impacts of potentially reduced groundwater supplies to the agricultural community.

Outreach and education for agricultural BMPs provides funding to farmers for outreach and education on new technologies, potential pilot programs, and other innovative ideas that support the overall advancement of the farming community and ultimately provide an overall benefit to the sustainability of the groundwater basin.

9.3.3.1 Relevant Measurable Objectives

The measurable objectives benefiting from outreach and education include:

- Groundwater elevation measurable objectives throughout the Salinas Valley. Less pumping will result in higher groundwater levels.
- The groundwater storage measurable objective. This measurable objective is based on total pumping in the Subbasin; therefore, the education and outreach will focus on

identifying best management practices that will reduce pumping and will help achieve the goal of reducing total extractions to the long-term sustainable yield.

- Land subsidence measurable objectives throughout the Subbasin. Outreach and education will focus on reducing pumping and water conservation methods, therefore will reduce the pumping stress on the local aquifer(s) and thereby reduce the potential for subsidence.

- The seawater intrusion measurable objective (depending on the location). Decreased water use near the coast will reduce the pumping stress that causes water levels to drop below sea level and cause seawater intrusion.

9.3.3.2 Expected Benefits and Evaluation of Benefits

The primary benefit of implementing an outreach and education program focused on the entire Salinas Valley is to provide the latest technologies and opportunities to modify agricultural practices that would allow farmers to reduce pumping needs but realize the same crop yields. This program could also be a mechanism for grant opportunities, funded through the SVBGSA to identify pilot programs and other innovative technological advancements that could provide an overall groundwater basin benefit.

9.3.3.3 Circumstances for Implementation

The circumstance for implementation is for willing farmers to participate in an education and outreach program and to work with the SVBGSA to identify opportunities. No other triggers are necessary or required.

9.3.3.4 Public Noticing

There will be public noticing of education and outreach programs.

9.3.3.5 Permitting and Regulatory Process

No permitting or regulatory processes are necessary for an education and outreach program.

9.3.3.6 Implementation Schedule

The option for an outreach and education program will begin immediately after the water charges framework is finalized and adopted. This program will be on going.

9.3.3.7 Legal Authority

No authority is needed to promote outreach and education.

9.3.3.8 Estimated Cost

The Outreach and Education Program would be an annual program that would be implemented. The SVBGSA would set aside approximately $100,000 each year to promote opportunities for education seminars, grant writing tasks, etc. focused on best management practices in the agricultural industry.

9.3.4 Priority Management Action 3: Reservoir Reoperation

Reservoir reoperation entails working closely with MCWRA, National Marine Fisheries, and other stakeholders on developing a revised management scheme for the Nacimiento and San Antonio Reservoirs, which control the Salinas River flows. The purpose of this management action is to operate the reservoirs to achieve two goals:

1. Allow surface flow releases to recharge groundwater in the various Salinas Valley subbasins almost every winter
2. Allow summer flows to better reach the SRDF diversion

The reservoir reoperations would more tightly integrate environmental flows with sustainable groundwater management activities in the Valley to improve water availability for agricultural users and other groundwater users. The major beneficiaries of this management action would be the Upper Valley and Forebay Subbasins, as they receive most of the river percolation. There is limited benefit for the 180/400-Foot Aquifer Subbasin, primarily to allow enough water to flow to the SRDF for CSIP operations.

Reservoir operations are controlled by MCWRA, and therefore the SVBGSA cannot directly modify reservoir operations. Over the next few years, MCWRA will develop a Habitat Conservation Plan (HCP) that establishes the reservoir operating rules for the Salinas Valley. The HCP offers an opportunity for reservoirs to be explicitly operated for improved groundwater management as well as environmental flows and flood control. The SVBGSA will participate in developing the HCP to implement the reservoir operations in a way that promotes this management action.

9.3.4.1 Relevant Measurable Objectives

The measurable objectives benefiting from reservoir reoperation include:

- Groundwater elevation measurable objectives throughout the Salinas Valley. Re-operating the Salinas River reservoirs will allow for more surface water percolating to groundwater, primarily in the Upper Valley and the Forebay Subbasins, and would recharge groundwater subbasins and raise groundwater levels.

- The groundwater storage measurable objective. Increased groundwater recharge near the Salinas River will help improve groundwater storage.
- Land subsidence measurable objectives. Increased groundwater recharge near the Salinas River will help reduce or prevent subsidence.
- The seawater intrusion measurable objective. By allowing additional surface flows to reach the SRDF, more surface water will be used in the CSIP area with reduced pumping which would result in lower seawater intrusion potential.
- The interconnected surface water measurable objective. By allowing more flows to stay in the Salinas River year-round, the areas that are interconnected would stay connected to groundwater and benefit all beneficial users on the river.

9.3.4.2 Expected benefits and evaluation of benefits

The primary benefit from reservoir reoperation is increased flows in the Salinas River in the winter, to allow for additional groundwater recharge in the subbasins and more flexible use of the groundwater in storage. A second benefit is the availability of water at the SRDF diversion to allow for greater surface water use in the CSIP area and potentially allow for CSIP area expansion.

Because of the current pending HCP on the Salinas River, the exact details of the operations of the reservoir in the future are unknown. The SVBGSA will work collaboratively with MCWRA to make sure the reservoirs are operated in a manner to benefit groundwater recharge and help with the sustainable management of the Salinas Valley groundwater basin.

9.3.4.3 Circumstances for implementation

The San Antonio and Nacimiento Reservoirs are currently operated by MCWRA to satisfy multiple beneficial uses. This management action will be implemented when MCWRA develops the HCP. The pending HCP will prescribe additional criteria for reservoir operations. As part of these new rules, the SVBGSA will work with MCWRA to work winter flow releases into the operations.

9.3.4.4 Public noticing

This management action is part of the MCWRA HCP process, and the public noticing will occur as part of the HCP development.

9.3.4.5 Permitting and Regulatory Process

This management action will follow the ongoing permitting and regulatory process used by MCWRA for reservoir operations.

9.3.4.6 Legal Authority

The SVBGSA does not have any authority over surface water management or reservoir operations. Thus, the SVBGSA will work collaboratively with MCWRA on developing appropriate reservoir operation rules that benefit groundwater recharge.

9.3.4.7 Implementation Schedule

The reservoir reoperation management action schedule will be contingent upon the development and finalization of the HCP and other reservoir operations criteria. The implementation schedule will start as soon as new reservoir operations criteria are developed in collaboration with MCWRA. The HCP is scheduled to be completed within the next three to five years.

9.3.4.8 Estimated Cost

The estimated costs are related to SVBGSA participation in the HCP process. This will include attending meetings and providing comments to the HCP. MCWRA will fund the completion of the HCP, therefore, the costs for development of the HCP are not included in the cost estimated. For costing purposes, we have assumed the HCP is a three-year process. SVBGSA participation will cost approximately $50,000 per year, for a total cost of $150,000.

9.3.5 Priority Management Action 4: Restrict Pumping in CSIP Area

A number of the priority projects included in Section 9.4 are designed to ensure a reliable, year-round supply of water to growers in the CSIP area. These projects will remove any need for groundwater pumping in the CSIP area. To promote use of CSIP water, the SVBGSA will pass an ordinance preventing any pumping for irrigating agricultural lands served by CSIP.

9.3.5.1 Relevant Measurable Objectives

- Groundwater elevation measurable objectives. Restricting pumping will limit groundwater drawdown that may lead to significant and unreasonable groundwater elevations.

- Groundwater storage measurable objective. Reducing pumping will directly help the SBGSA reach the pumping goals in the groundwater storage measurable objective.

- Land subsidence measurable objectives. Reduced groundwater pumping yields higher groundwater levels, helping reduce or prevent subsidence.
- Seawater intrusion measurable objective. Reducing pumping may reduce landward gradients that induce seawater intrusion. This will lower seawater intrusion potential.

9.3.5.2 Expected benefits and evaluation of benefits

The primary benefit from the CSIP pumping restrictions is controlling Subbasin pumping. A second benefit is either halting the decline or raising groundwater elevations from the reduced pumping. An ancillary benefit from shallower groundwater elevations may include avoiding subsidence and reducing seawater intrusion.

Reductions in groundwater pumping will be measured directly through the improved metering program and recorded in the data management system. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using DWR’s InSAR maps as detailed in Chapter 7. Seawater intrusion will be measured using MCWRA’s existing mapping approach as detailed in Chapter 7. A direct correlation between the CSIP pumping restrictions and changes in groundwater levels is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

9.3.5.3 Circumstances for implementation

CSIP pumping restrictions will only be implemented after the CSIP optimization projects are implemented, providing a reliable supply of water to growers in the CSIP area.

9.3.5.4 Public Noticing

Public meetings will be held to inform groundwater pumpers and other stakeholders that the CSIP pumping reduction program is being developed. The CSIP pumping reduction program will be developed in an open and transparent process. Groundwater pumpers and other stakeholders will have the opportunity at these meetings to provide input and comments on the process and the program elements.

9.3.5.5 Permitting and Regulatory Process

The CSIP pumping reduction program is subject to CEQA. The CSIP pumping reduction program would be developed in accordance with all applicable groundwater laws and respect all groundwater rights.

9.3.5.6 Legal Authority

California Water Code §10726.4 (a)(2) provides GSAs the authorities to control groundwater extractions by regulating, limiting, or suspending extractions from individual groundwater wells or extractions from groundwater wells in the aggregate.

9.3.5.7 Implementation Schedule

CSIP pumping restrictions will be implemented within one year of substantially completing the CSIP projects (Preferred Projects 2, 3, 4, and 5).

9.3.5.8 Estimated cost

The SVBGSA will support the development of a mandatory pumping reduction program. The implementation of the program will be through MCWRA and is estimated to take two years to develop. The support of the implementation program will be $50,000 for two years or a total of $100,000. This does not include the cost of the CEQA permitting or any ongoing program oversight.

9.3.6 Priority Management Action 5: Support and Strengthen MCWRA Restrictions on Additional Wells in the Deep Aquifer

MCWRA Ordinance 5302 temporarily restricts drilling new wells in the Deep Aquifer in an Area of Impact that is generally northwest of Davis Road. Exceptions are made for replacement wells, domestic wells, and municipal supply wells. This is a temporary urgency ordinance pending development of permanent regulations.

SVBGSA will work with the MCWRA to extend this ordinance or develop a new ordinance to prevent any new wells from being drilled into the deep aquifer until more information is known about the Deep Aquifer's sustainable yield. This study is anticipated to be completed by MCWRA over the next three years. SVBGSA will comment on the MCWRA study of the deep aquifer to ensure that the study and the resulting permanent regulations will promote groundwater sustainability as defined in this GSP.

9.3.6.1 Relevant Measurable Objectives

- Groundwater elevation measurable objectives. Restricting pumping will limit groundwater drawdown that may lead to significant and unreasonable groundwater elevations.

- Groundwater storage measurable objective. Reducing pumping will directly help the SBGSA reach the pumping goals in the groundwater storage measurable objective.

- Land subsidence measurable objectives. Reduced groundwater pumping yields higher groundwater levels, helping reduce or prevent subsidence.

- Seawater intrusion measurable objective. Reducing pumping may reduce landward gradients that induce seawater intrusion. This will lower seawater intrusion potential.

9.3.6.2 Expected benefits and evaluation of benefits

The primary benefit from the Deep Aquifer pumping restrictions is reduced Subbasin pumping. A second benefit is either halting the decline or raising groundwater elevations from the reduced pumping. An ancillary benefit from shallower groundwater elevations may include avoiding subsidence and reducing seawater intrusion.

Reductions in groundwater pumping will be measured directly through the improved metering program and recorded in the data management system. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using DWR's InSAR maps as detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing mapping approach as detailed in Chapter 7. A direct correlation between the Deep Aquifer pumping restrictions and changes in groundwater levels is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

9.3.6.3 Circumstances for implementation

SVBGSA will support extension Ordinance 5302 immediately. Deep Aquifer pumping will only be allowed after MCWRA completes its study of the Deep Aquifer and its sustainable yield.

9.3.6.4 Public Noticing

Public meetings will be held to inform groundwater pumpers and other stakeholders that Deep Aquifer study is being developed, and that additional pumping restrictions may result from this study. The Deep Aquifer pumping reduction program will be developed in an open and transparent process. Groundwater pumpers and other stakeholders will have the opportunity at these meetings to provide input and comments on the process and the program elements.

9.3.6.5 Permitting and Regulatory Process

The Deep Aquifer pumping reduction program is subject to CEQA. The pumping reduction program would be developed in accordance with all applicable groundwater laws and respect all groundwater rights.

9.3.6.6 Legal Authority

California Water Code §10726.4 (a)(2) provides GSAs the authorities to control groundwater extractions by regulating, limiting, or suspending extractions from individual groundwater wells or extractions from groundwater wells in the aggregate.

9.3.6.7 Implementation Schedule

SVBGSA will support extension Ordinance 5302 immediately.

9.3.6.8 Estimated cost

The Deep Aquifer study and subsequent regulations will be developed by MCWRA. SVBGSA will supply oversight and support. The estimated cost for this oversight and support is be $40,000 per year for four years for a total of $160,000.

9.4 Projects

Projects involve new or improved infrastructure to meet SMCs in the Subbasin. Several potential projects are included in this GSP that are currently being pursued by other agencies. These projects are considered sufficiently established, and will be constructed independently of this GSP.

Projects fall into two categories:

- **Priority Projects**: The priority projects are the more cost-effective projects that could be implemented under the GSP. However, not all Priority Projects may be required depending on final benefit of each project. In addition, some of these projects are currently already in the planning stages or in design by other agencies and the GSP is identifying the projects to be supported as a benefit to the groundwater basin.

- **Alternative Projects:** The alternative projects are the generally less cost-effective projects. Depending on the efficacy of the priority projects, one or more of the alternative projects may be implemented to meet the SMCs.

Overview and general provisions of the projects are described in Sections 9.4.1 through 9.4.3. Priority Projects and Alternative Projects are described in Sections 9.4.4 and 9.4.5.

9.4.1 Overview of Project Types

There are four major types of projects that can be developed to supplement the Subbasin’s groundwater supplies or limit seawater intrusion:

1. In-lieu recharge through direct delivery of water to replace groundwater pumping
2. Direct recharge through recharge basins or wells
3. Indirect recharge through decreased evapotranspiration or increased infiltration
4. Hydraulic barrier to control seawater intrusion

9.4.1.1 In-Lieu Recharge through Direct Delivery

Direct delivery projects use available water supplies for irrigation in lieu of groundwater. This option offsets the use of groundwater, allowing the groundwater basin to recharge naturally. Direct delivery projects rely on the construction of a pipeline to deliver the water to agricultural or municipal users, as well as a pump station and storage facility to handle supply and demand variations. Direct delivery is a highly efficient method to reduce groundwater pumping because it directly offsets and decreases the amount of water pumped from the aquifer, allowing the aquifer levels to rebound through natural recharge. One of the drawbacks of direct delivery is that the delivered water must be available during the dry season, a time period when water supplies are less likely to be available, especially during a dry year.

9.4.1.2 Direct Recharge through Recharge Basins and wells

Recharge basins are large artificial ponds that are filled with water that seeps from the basin into the groundwater system. Recharge efficiencies can range greatly and the recharge efficiency of a recharge basin is contingent on the properties of the underlying soil, losses to evaporation, and potential seepage into streambed alluvium and flow out of the basin before it can recharge the deeper aquifers. Recharge efficiencies are difficult to measure without sophisticated subsurface monitoring.

Recharge through recharge basins can occur all year round; although efficiency might be lower during the rainy seasons if underlying soils are already saturated. Recharge basins have the advantage of generally being less expensive to build and operate than in-lieu distribution systems or injection systems.

Injection wells are used to inject available water supplies directly into the groundwater basin. Injection can occur all year round, including during the rainy season. Injection wells are typically more efficient at raising groundwater levels than recharge basins because they target specific aquifers; although a well’s recharge ability is affected by the surrounding aquifer properties. The injected water typically flows through the aquifer from the injection location to locations with lower water levels. The rate of travel depends on the hydraulic conductivity and soil properties. Although they have a very high efficiency, injection wells are generally more expensive to operate than recharge basins. Additionally, injection wells require higher quality water than recharge basins.

9.4.1.3 Indirect Recharge through Decreased Evapotranspiration or Increased Percolation

Within the Subbasin there are areas that represent opportunities for increased groundwater supply through either a decrease in evapotranspiration or an increase in percolation. Example projects include removal of invasive species from riparian corridors (decreased evapotranspiration) and stormwater capture (increased percolation).

Stormwater capture projects are typically relatively low yield per acre compared to direct recharge basins (Section 9.4.1.2), however they can cover relatively large areas without negative impacts to land use. Removal of invasive species in riparian corridors may provide multiple benefits such as flood control benefits; and storm water capture may provide water quality benefits. Implementation costs for these projects are typically capital intensive with only minor long-term maintenance costs. Thus, the water supply benefit/cost ratio can increase significantly over the long term.

9.4.1.4 Hydraulic Barrier to Control Seawater Intrusion

A proposed hydraulic barrier would consist of a network of wells drilled a short distance inland from the coast and aligned approximately parallel to the coastline, across the width of the Subbasin. A hydraulic barrier can be operated as a recharge barrier, wherein water is injected into the wells and the resulting water level mound creates the hydraulic barrier. Or the barrier can be operated as an extraction barrier, wherein the wells are pumped and the resulting water level trough creates the hydraulic barrier. Recharge barriers require a source of water for recharge; extraction barriers require an end-use for the pumped water. Either configuration would require conveyance piping and may require water treatment.

9.4.2 General Project Provisions

Many of the priority and alternative projects listed below are subject to similar requirements. The general provisions that are applicable to many or all projects include certain permitting and regulatory requirements, the methodology for public notice, and the legal authority to initiate and complete the projects.

9.4.2.1 Summary of permitting and regulatory processes

Projects of a magnitude capable of having a demonstrable impact on the GSP will require a CEQA environmental review process. Projects will require either an Environmental Impact Report, Negative Declaration, or a Mitigated Negative Declaration. Additionally, any project that coordinates with federal facilities or agencies may require NEPA documentation.

There will be a number of local, county and state permits, right of ways, and easements required depending on pipeline alignments, stream crossings, and project type.

Projects with wells will require a well construction permit.

9.4.2.2 Public Noticing

Before any project initiates construction as part of GSP implementation, it will go through a public notice process to ensure that all groundwater users and other stakeholders have ample opportunity to comment on projects before they are built. The general steps in the public notice process will include the following:

- GSA staff will bring an assessment of the need for the project to the SVBGSA Board in a publicly noticed meeting. This assessment will include:
    - A description of the undesirable result(s) that may occur if action is not taken
    - A description of the proposed project
    - An estimated cost and schedule for the proposed project
    - Any alternatives to the proposed project
- The SVBGSA Board will notice stakeholders in the area of the proposed project and allow at least 30 days for public response.
- After the 30-day public response period, the SVBGSA Board will vote whether or not to approve design and construction of the project.

In addition to the public noticing detailed above, all projects will follow the public noticing requirements per CEQA.

9.4.2.3 Legal Authority Required for Projects

California Water Code §10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges.

9.4.3 All Projects Considered for Integrated Management of the Salinas Valley

This GSP is part of an integrated plan for managing groundwater in all six subbasins of the Salinas Valley that lie in Monterey County. The projects listed in this GSP constitute an integrated management program for the entire Valley. The program's projects were selected from a lager set of potential projects. Appendix 9-B lists the potential projects that were considered for the Valley-wide integrated management program.

The potential projects listed in Appendix 9-B were assessed for cost effectiveness in achieving sustainability throughout the Salinas Valley. Thirteen projects were selected for further consideration based on them being the most reliable, implementable, cost-effective, and acceptable to stakeholders. These 13 projects were separated into priority projects and alternative projects. The priority projects are the most cost effective, and some subset of the priority projects will be implemented in the Salinas Valley as part of the six Salinas Valley GSPs. A limited number of alternative projects may be implemented in the Salinas Valley based on further analysis of the effectiveness of the priority projects, water availability, and refined cost estimates.

9.4.4 Selected Priority Projects for Integrated Management of the Salinas Valley

Nine projects are included in this GSP as priority projects. Some subset of these priority projects will be implemented as part of the six Salinas Valley GSPs. The priority projects may need to be supplemented by additional alternative projects for each subbasin to achieve sustainability. The alternative projects are described in Section 9.4.5 of this GSP. The nine priority projects are summarized in Table 9-1.

Table 9-1. Priority Projects

Priority Project #	Project Name	Water Supply	Project Type
1	Invasive Species Eradication	Groundwater	Indirect Recharge
2	Optimize CSIP Operations	Recycled Water	In Lieu Recharge
3	Modify M1W Recycled Water Plant	Recycled Water	In Lieu Recharge
4	Expand Area Served by CSIP	Recycled Water	In Lieu Recharge
5	Maximize Existing SRDF Diversion	Salinas River	In Lieu Recharge
6	Seawater Intrusion Pumping Barrier	N/A	SWI Barrier
7	11043 Diversion Facilities Phase I: Chualar	Salinas River	Direct Recharge
8	11043 Diversion Facilities Phase II: Soledad	Salinas River	Direct Recharge
9	SRDF Winter Flow Injection	Salinas	Direct Recharge

Short descriptions of each priority project are included below. Generalized costs are also included for planning purposes. Components of these projects including facility locations, pipeline routes, recharge mechanisms, and other details may change in future analyses. Therefore, each of the projects listed below should be treated as a generalized project representative of a range of potential project configurations.

9.4.4.1 Assumptions used in developing projects

Assumptions that were used to develop projects and cost estimates are provided in Appendix 9-C. Assumptions and issues for each project need to be carefully reviewed and revised during the pre-design phase of each project. Project designs, and therefore costs, could change considerably as more information is gathered.

The cost estimates included below are order of magnitude estimates. These estimates were made with little to no detailed engineering data. The expected accuracy range for such an estimate is within +50 percent or –30 percent. The cost estimates are based on our perception of current conditions at the project location. They reflect our professional opinion of costs at this time and are subject to change as project designs mature.

Capital costs include major infrastructure including pipelines, pump stations, customer connections, turnouts, injection wells, recharge basins, and storage tanks. Capital costs also include 30% contingency for plumbing appurtenances, 15% increase for general conditions, 15% for contractor overhead and profit, and 8.75% for sales tax. Engineering, legal, administrative, and project contingencies was assumed as 30% of the total construction cost and included within the capital cost. Land acquisition at $45,000/acre was also included within capital costs.

Annual operations and maintenance (O&M) fees include the costs to operate and maintain new project infrastructure. O&M costs also include any pumping costs associated with new infrastructure. O&M costs do not include O&M or pumping costs associated with existing infrastructure, such as existing Salinas Valley Reclamation Plant (SVRP) costs because these are assumed to be part of water purchase costs. Water purchase costs were assumed to include repayment of loans for existing infrastructure; however, these purchase costs will need to be negotiated. The terms of such a negotiation could vary widely.

Capital costs were annualized over 25 years and added with annual O&M costs and water purchase costs to determine an annualized dollar per acre-foot ($/AF) cost for each project.

9.4.4.2 Preferred project 1: Invasive Species Eradication

The SVBGSA will support and enhance existing programs eradicating *arundo donax* and other invasive species along the Salinas River. This project supports the existing efforts currently being completed by MCWRA/Resource Conservation District’s Salinas River Stream Maintenance Program. This project will reduce evapotranspiration from these invasive plants, leaving more water in the Salinas River and increasing aquifer recharge or reducing the amount of water required to be released from Nacimiento and San Antonio Reservoirs.

The Salinas River watershed fosters *arundo donax* and other non-native invasive plant species such as tamarisk. The Salinas River watershed has the second-largest infestation of non-native *arundo donax* in California: approximately 1,500 to 1,800 acres. Its removal has been incorporated into the MCWRA's on-going Salinas River Stream Maintenance Program. MCWRA is working with the Monterey County Resource Conservation District (MCRCD) as lead in the *arundo donax* mitigation efforts. Landowners abutting the Salinas River and its side channels have also participated as part of a mitigation program managing other channel maintenance activities.

Demonstration efforts beginning in 2014 included removal of *arundo donax* from approximately 75 acres in the Chualar and Gonzales areas. Additional phases, which have or are being funded through grants by the Wildlife Conservation Board and USDA and with support from other agencies and voluntary landowners, are removing *arundo donax* from an additional 425 acres between Gonzales and Soledad and to re-treat other areas as necessary to prevent re-growth. An estimated 1,000 to 1,300 acres of invasive species still remains in the river channel and removal is currently unfunded.

This preferred project proposes continuing the efforts of clearing all invasive species throughout the entire Salinas River channel. Although the aerial imagery and ground surveys show the largest infestations between King City and Chualar, there are patches upstream of King City and downstream of Chualar. The proposed project would include three distinct phases: initial treatment, re-treatment, and on-going monitoring and maintenance treatments.

The initial treatment phase includes mechanical and/or chemical treatment of the remaining 1,000 to 1,300 acres of invasive species removal in all areas of the river that have yet to be treated. The re-treatment phase includes re-treatment of the initial 500 acres that have already had an initial treatment and re-treatment of all 1,500 to 1,800 acres over a three-year period. The final phase is the on-going monitoring and maintenance treatment phase. This phase requires annual monitoring for re-growth of the invasive species or new invasive species and chemical treatment every three to five years.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include:

- Groundwater elevation measurable objective
- Groundwater storage measurable objective

Expected Benefits and Evaluation of Benefits

This project is included here as part of the complete Valley-wide groundwater management program. The primary benefit from this project is increased groundwater recharge due to reduced evapotranspiration in the southern Salinas Valley subbasins. The expected benefit of this project is between 4 and 20 acre-feet/acre, which results in 6,000 AF to 36,000 AF of water that would remain in the river or would not be required to be released from Nacimiento and/or San Antonio Reservoirs. Figure 9-2 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from this project. Figure 9-3 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from this project. The benefit is greatest at the south end of the 180/400-Foto Aquifer Subbasin, where there is no extensive aquitard separating the aquifers from the Salinas River. Model results suggest that this project reduces seawater intrusion by approximately 890 AF/yr. on average.

Invasive species removal has other benefits in addition to water savings. Thick stands of invasive species can, over time, lead to a narrower river channel, increasing flow velocities, eroding channel banks, and blocking bridge structures when large portions of vegetation break loose. Often, invasive species do not provide overhanging native riparian canopy resulting in higher water temperatures and lower oxygen content in the river.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between invasive species eradication and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

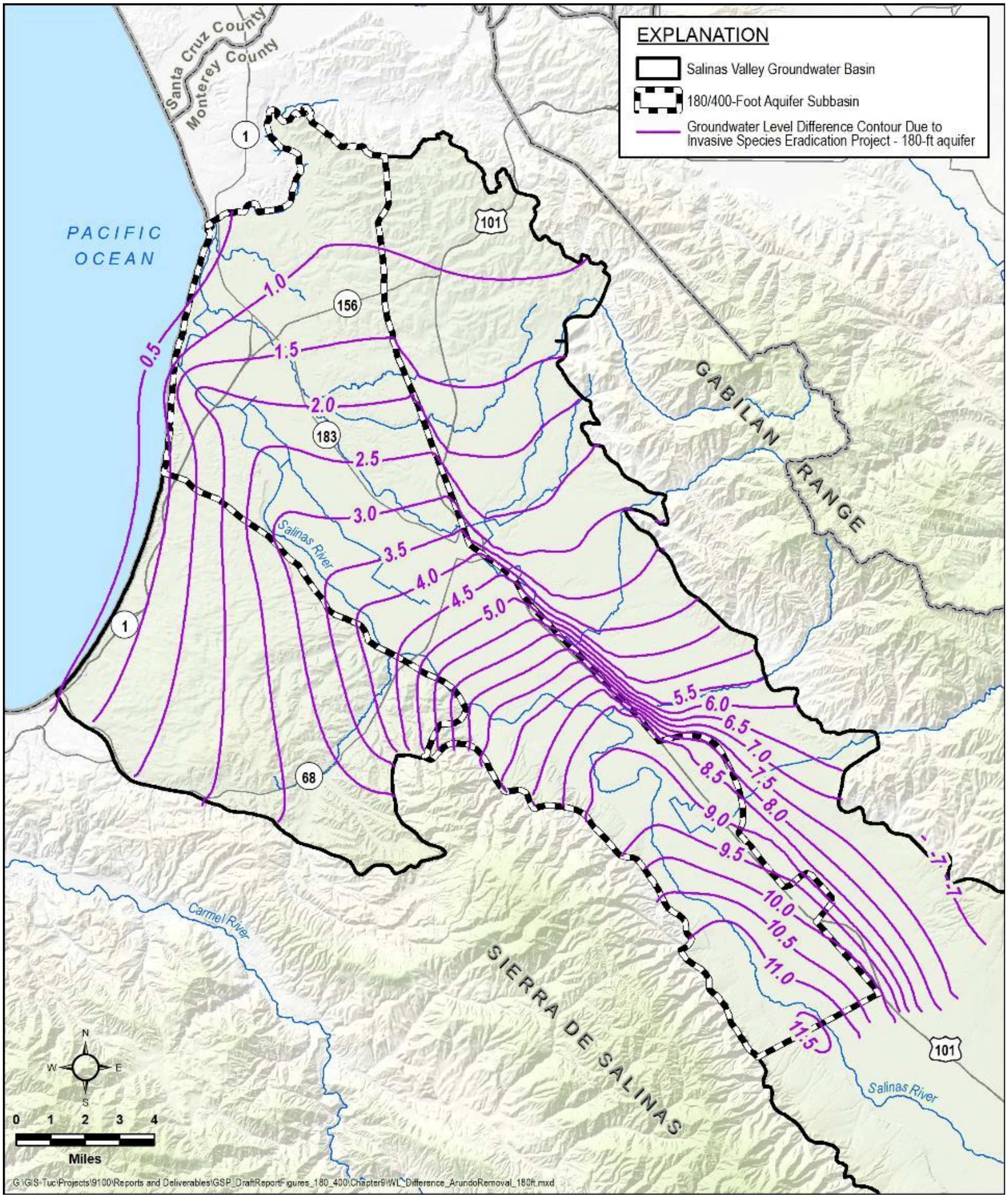


Figure 9-2: Esitmated Groundwater Level Benefit in the 180-Foot Aquifer from Arundo Removal

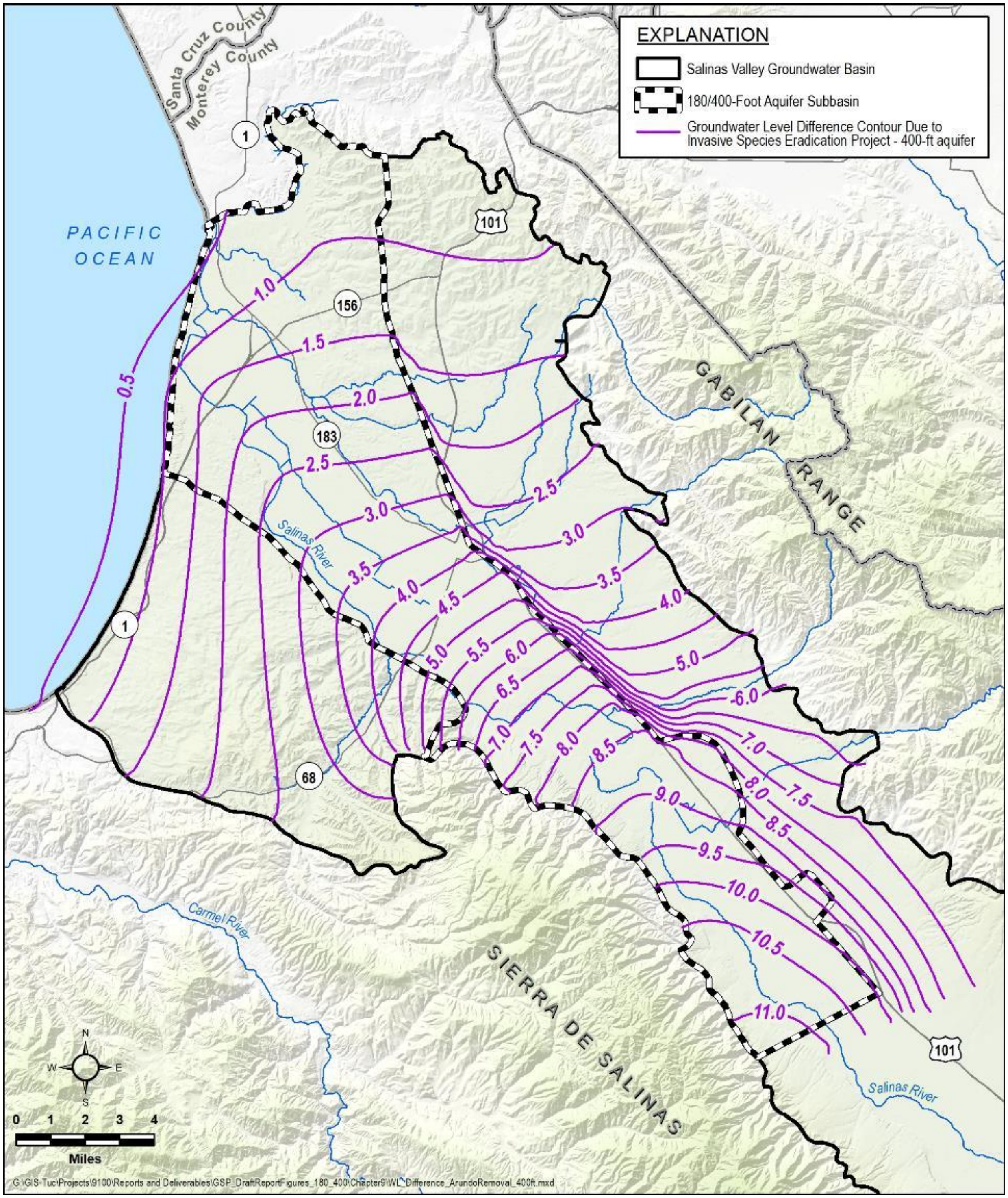


Figure 9-3: Esitmated Groundwater Level Benefit in the 400-Foot Aquifer from Arundo Removal

Circumstances for Implementation

Invasive species eradication is a preferred project that is already ongoing in the Salinas Valley. Supporting these ongoing efforts will be initiated as soon as funds become available. No additional circumstances for implementation are necessary.

Public Noticing

The public noticing practices and requirements of the existing invasive species eradication programs will be continued as part of this project.

Permitting and Regulatory Process

The permitting process of the existing invasive species eradication programs will be continued as part of this project.

Implementation Schedule

The implementation schedule is presented in Figure 9-4. It is anticipated that Phase I will take two years. Phase II will overlap with Phase I and take an additional two to three years. Phase III, which is on-going maintenance will continue past Year 3.

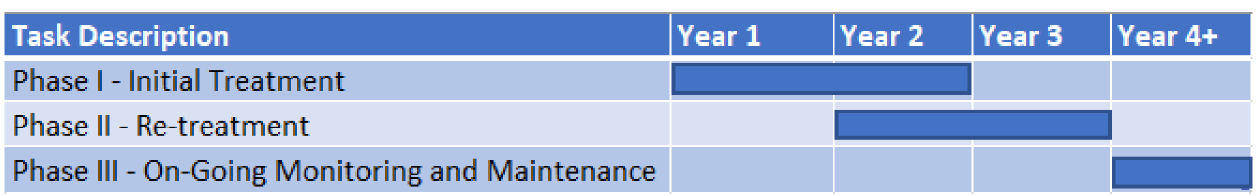


Figure 9-4. Implementation Schedule for Invasive Species Eradication

Legal Authority

The SVBGSA will use the legal authority for invasive species eradication contained in the existing eradication program.

Estimated Cost

Estimated capital cost for the invasive species eradication project is estimated at $35,230,000. Annual O&M costs are anticipated to be approximately $325,000. The indirect projected yield for the invasive species eradication project is estimated at 20,000 AF per year. The cost of water for this project is estimated at $160/AF/yr.

CSIP PROJECTS

Preferred projects 2, 3, 4, and 5 all work together to improve and expand the performance of the CSIP system. The goal of these four projects, taken together, is to provide a reliable, year-round supply of water to all growers in the current CSIP system, and to expand the system as possible. The four projects are presented here as individual projects, even though they are all part of an integrated CSIP strategy.

9.4.4.3 Preferred Project 2: Optimize CSIP Operations

The CSIP system is operated and maintained by MCWRA. MCWRA has started evaluating opportunities to optimize the CSIP distribution system. This preferred project provides support for various elements of the MCWRA optimization project that is directly beneficial to the sustainability of the groundwater basin. The costs for a portion of this project will be funded directly through MCWRA. Additional funding will be provided by SVBGSA.

The CSIP distribution system has known flow and pressure constraints. The CSIP system will be optimized to better accommodate diurnal and seasonal fluctuation in irrigation demand, maximizing use of water supplied from the SVRP and the SRDF, thereby reducing the need for groundwater pumping. Furthermore, this project aligns CSIP irrigation with availability of water rather than on demand to ensure the available supply water can be used to a greater extent.

There are constraints in the delivery of water to the CSIP distribution system, specifically with the existing water main which passes under the Salinas River and the associated flow meter. In addition, there is also not enough water storage within the system to take advantage of all the available supplies. These bottlenecks in the system and lack of storage lead farmers to turn on their on-site wells to supplement their irrigation needs when either the flow is not available, or the pressure is not sufficient. Solutions to alleviate these constraints and any others would be explored.

The approach for CSIP system optimization includes the following general activities:

1. <u>Hydraulic Modeling</u>. This activity will develop and calibrate a hydraulic model of the CSIP water distribution system and will identify the hydraulic deficiencies in the system and recommend upgrades to enhance the delivery system. This activity is currently being completed by MCWRA, therefore the costs for this component of the project are not included in the costs identified below.
2. <u>Irrigation/ Scheduling System Development</u>. This activity will develop a program that will allow growers to order and schedule their water deliveries; reducing peak demands in the system. Part of the irrigation scheduling program will introduce incentives for farmers to modify irrigation practices (e.g., tiered rate pricing) which will promote use of

water during off-peak times. In addition, real-time SCADA monitoring capabilities of the distribution system would be added.

3. Add Water Storage. This activity will add storage capacity for recycled water and SRDF water deliveries throughout the water distribution system. The hydraulic modeling will identify the ideal locations for storage that would provide the most benefit to the system. Additional storage reservoirs will allow the CSIP system to store water diverted by SRDF during low demand periods for later delivery when demand is high. Reservoirs would also assist in maintaining adequate pressure in the existing system and provide more flexibility in the timing of SRDF deliveries.
4. Piping Upgrades: The hydraulic model will identify deficiencies in the water distribution system that will require piping upgrades. The exact piping upgrades are unknown. This component of the project is a placeholder for anticipated upgrades required to the system to assist in the regulation of flow and pressure.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include:

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

The primary benefit from CSIP optimization includes reduction or avoidance of groundwater pumping from wells in the CSIP area throughout the year. Two sets of wells pump groundwater in the CSIP area: Non-CSIP supplemental wells and CSIP supplementary wells. Non-CSIP supplemental wells are privately owned wells used to provide groundwater for irrigation either in lieu of, or in addition to, irrigation water provided by the CSIP system. CSIP Supplementary wells are MCWRA owned wells that provide water to the CSIP system when the combination of SVRP and SRDF water is insufficient to meet demands. This project will benefit other subbasins, such as the Monterey and Eastside subbasins by reducing pumping that impacts the neighboring subbasins.

Figure 9-5 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from projects 2, 3, and 5, combined. Figure 9-9 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from projects 2, 3, and 5, combined. These projects were combined into a single simulation because of how closely they are intertied. Model results suggest that this project reduces seawater intrusion by approximately 2,200 AF/yr. on average.

Figure 9-7 presents the non-CSIP supplemental well pumping data since 1993. Historical pumping data provided by MCWRA indicates that since 2010, the average pumping of non-CSIP supplemental wells located within the CSIP distribution area is around 2,000 AF/yr.

Figure 9-8 presents the historical pumping for CSIP supplementary wells. A sharp decline in pumping occurred in 2010 when the SRDF came online. Omitting years 2014 through 2016 when the SRDF was offline, the average CSIP supplemental well yield since 2010 is approximately 3,350 AF/yr. Combining the average non-CSIP supplemental well pumping and the CSIP supplementary well pumping yields an average of approximately 5,500 AF/yr. of reported well pumping within the CSIP area.

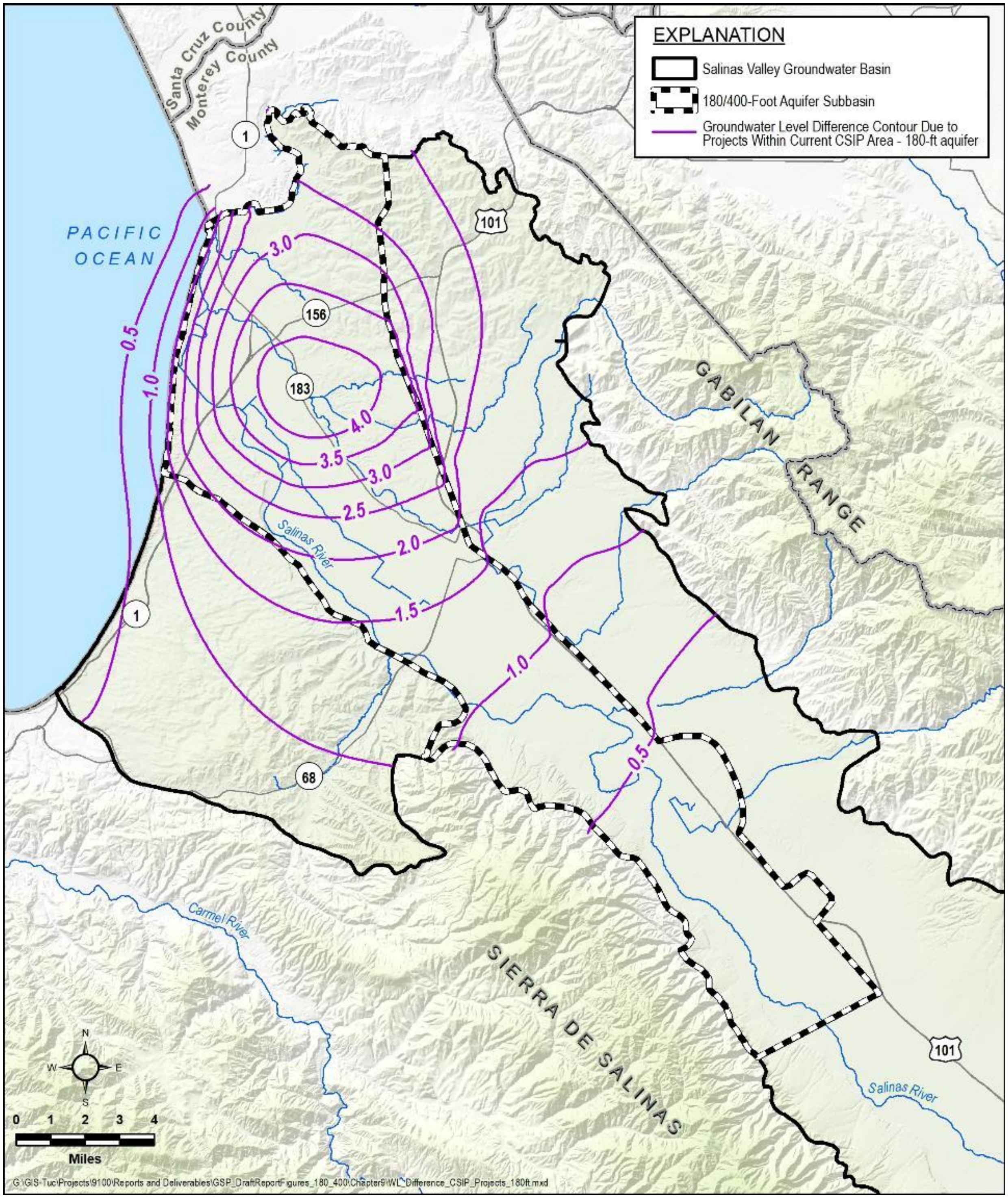


Figure 9-5: Esitmated Groundwater Level Benefit in the 180-Foot Aquifer from All CSIP Projects

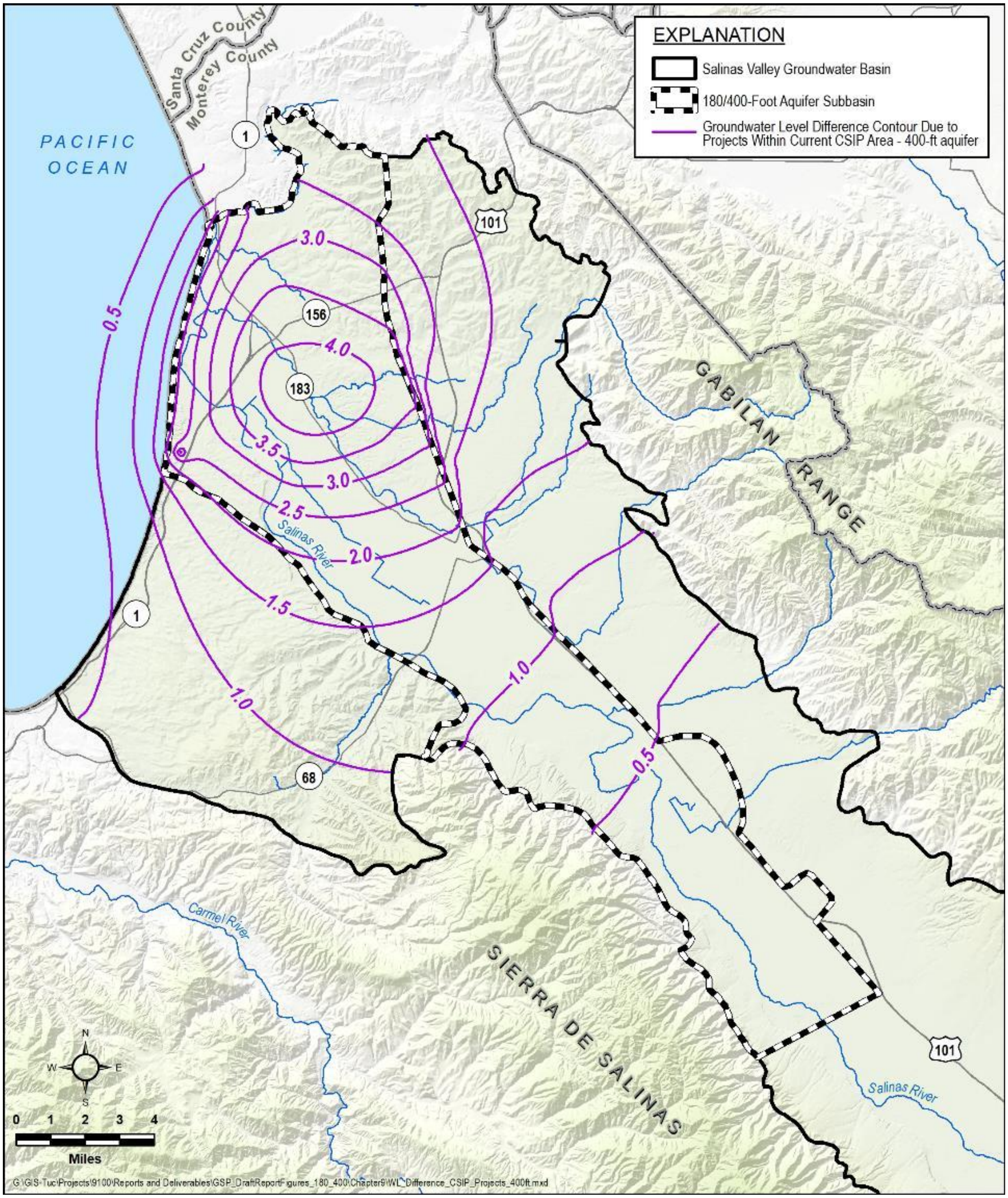


Figure 9-6: Esitmated Groundwater Level Benefit in the 400-Foot Aquifer from All CSIP Projects

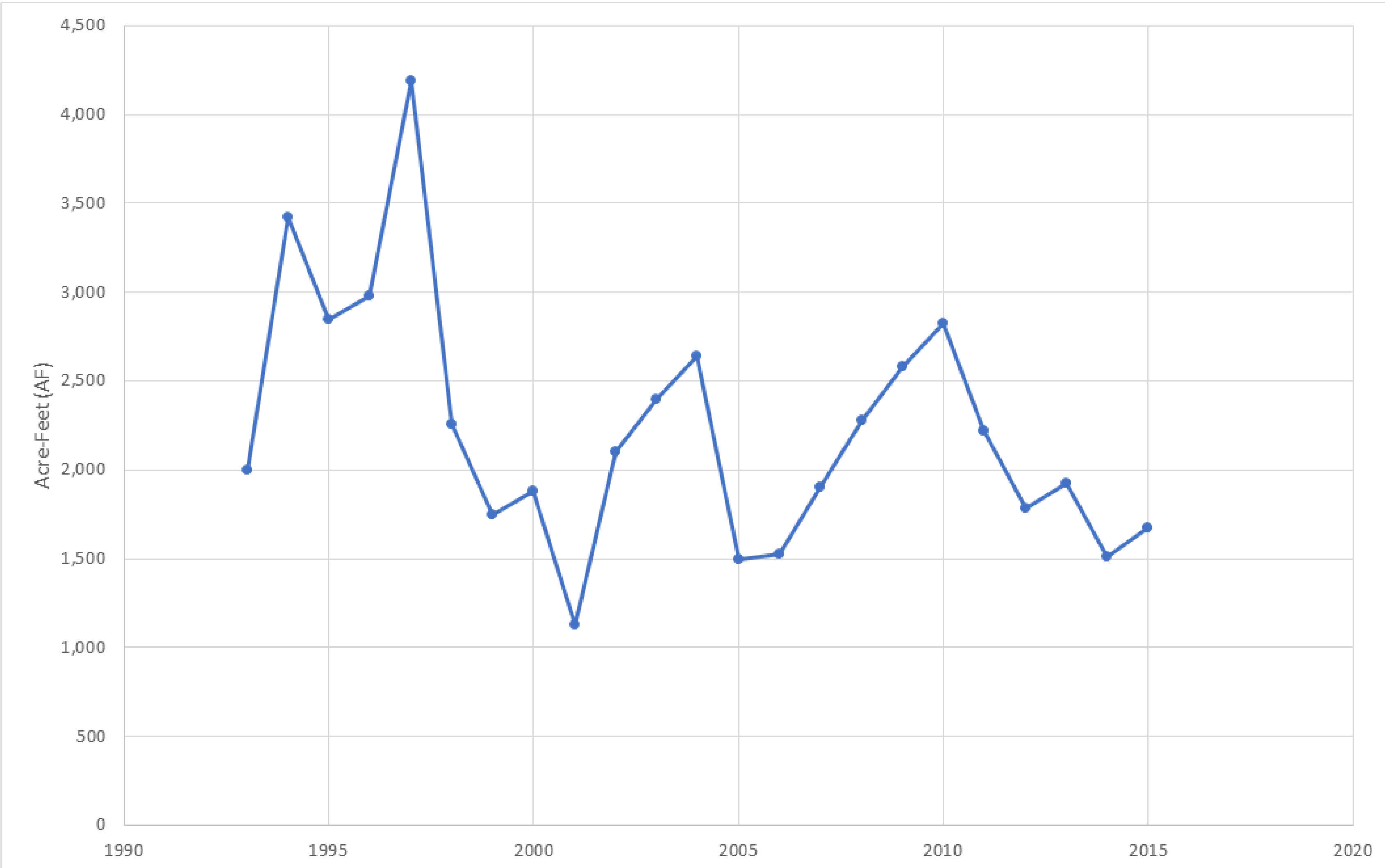


Figure 9-7. Non CSIP-Supplemental Well within the CSIP Program Area - Standby Active (CSIP-SBA) Well Production 1993 to 2015

Figure 9-8. CSIP Supplemental Well Production 1999 to 2018

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between CSIP optimization and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

The CSIP optimization project is a preferred project that builds on plans currently being initiated by MCWRA. Supporting and expanding these ongoing efforts will be initiated as soon as funds become available. No additional circumstances for implementation are necessary.

Legal Authority

MCWRA, who owns and operates the CSIP system, is a member of the SVBGSA. Therefore, optimizing the CSIP system is a benefit to one of the SVBGSA members. The SVBGSA will work in cooperation with MCWRA to modify and optimize the CSIP system.

Implementation Schedule

The implementation schedule is presented in Figure 9-9. It is anticipated to take three to six years to implement.

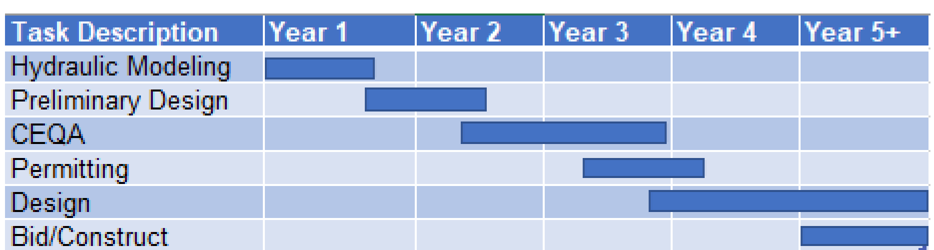


Figure 9-9. Implementation Schedule for CSIP Optimization

Estimated Cost

Estimated capital cost for the CSIP optimization project is estimated at $16,400,000. Annual O&M costs are anticipated to be approximately $200,000. The projected yield for the CSIP optimization project is estimated at 5,500 AF/year. The cost of water for this project is estimated at $270/AF/yr.

9.4.4.4 Preferred Project 3: Modify Monterey One Water Recycled Water Plant – Winter Modifications

Monterey One Water (M1W) is currently designing and permitting this project. SVBGSA will work closely with M1W to support and implement this project. Monterey One Water's Regional Wastewater Treatment Plant (RTP) has a maximum capacity of 29.6 mgd. Currently, the facility is only treating 16 to 18 mgd of influent wastewater. During the wet weather months, 100% of all secondary treated wastewater is discharged to the ocean, forgoing the opportunity for beneficial reuse. During the wet weather months, there is some demand for recycled water in the CSIP system; however, M1W cannot efficiently produce the reduced demand for tertiary treated water to supply the growers. As a result, growers turn to the groundwater basin for their irrigation needs during these months. Modifications are required at the M1W RTP in order to efficiently treat and store recycled water during the wet weather months.

Under the M1W Recycled Water Plant Modifications Project, the SVRP will be improved to allow delivery of tertiary treated wastewater to the CSIP system when recycled water demand is less than 5 mgd.

Table 9-2 provides the groundwater well pumping for the past seven years during the winter months when the SVRP plant is not on-line. This results in an average wet weather pumping rate of 1,100 AF/yr.; with a minimum of 300 AF/yr. in wet years, and a maximum of 1,790 AF/yr. in dry years. The SVRP improvements would largely eliminate the need for this wintertime pumping. The demand for water during the winter from the SVRP will also increase with the expanded CSIP zone; increasing the potential Project Yield from 1,100 AF/year to an estimated 1,300 AF/year.

Table 9-2. Groundwater Winter Well Pumping FY 2011-2012 to FY 2017-2018

	Dec 2011-Jan 2012	Dec 2012-Jan 2013	Dec 2013 -Jan 2014	Nov 2014-Jan 2015	Nov 2015-Feb 2016	Nov 2016-Mar 2017	Nov 2017-Mar 2018
November				303	213	325	28
December	723	52	730	38	199	223	38
January	1,067	253	509	516	96	62	183
February					520	102	907
March						580	90
Total	**1,790**	**305**	**1,239**	**857**	**1,028**	**1,292**	**1,246**

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Groundwater elevation measurable objective
- Groundwater storage measurable objective

- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

The primary benefits from M1W SVRP Modifications is additional water supply to the CSIP system during low-demand wet weather months, reducing groundwater pumping. The M1W SVRP Modifications project has the potential to yield up to 1,100 AF/yr. via in-lieu recharge providing an alternate to groundwater sources in the existing CSIP area and an additional 200 AF/yr. in the expanded CSIP area. This project will benefit other subbasins, such as the Monterey subbasins by reducing pumping that impacts the neighboring subbasins.

Figure 9-5 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from projects 2, 3, and 5, combined. Figure 9-9 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from projects 2, 3, and 5, combined. These projects were combined into a single simulation because of how closely they are intertied. Model results suggest that this project reduces seawater intrusion by approximately 2,200 AF/yr. on average.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between M1W improvements and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

The SVRP modifications project is currently being planned and implemented by M1W as part of the Pure Water Monterey Groundwater Replenishment Project. No other circumstances for implementation are necessary.

Legal Authority

The SVRP modification project is currently being planned and implemented by M1W. No legal authority is necessary.

Implementation Schedule

The implementation schedule is presented in Figure 9-10. It is anticipated to take approximately two years to implement.

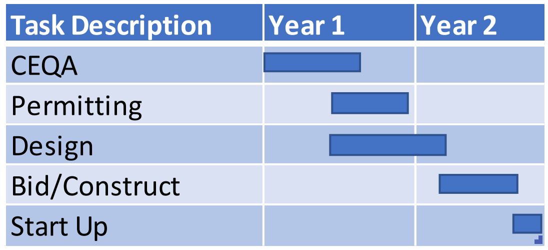


Figure 9-10. Implementation Schedule for M1W SVRP Modifications

Estimated Cost

The project cost will be covered through delivery charges to existing CSIP customers. Because a funding mechanism for this project has already been identified, these costs will not be incorporated into the Water Charges Framework.

The following estimates are provided by MCWRA New Source Water Supply Study, Final Report. Estimated capital cost for the M1W Winter Modification project was estimated at $1,493,000 (Raftelis, 2018). The cost of water for this project is estimated at $90/AF.

9.4.4.5 Preferred Project 4: Expand Area Served by CSIP

The CSIP expansion project involves enlarging the system's service area, thereby increasing the demand for water in the spring and fall and lessening dependence on existing groundwater wells. The existing CSIP supplies may not be sufficient to meet the summertime demand of the expanded CSIP area without an increase in water supply from the SRDF or another source. If additional water supply sources are available in the summer, the expanded service area will be supplied water. The CSIP Optimization Project (PP#2) will be required to be implemented before water has the potential to be supplied to the expanded CSIP area during the summer.

In previous studies, approximately, 8,500 acres have been identified on the north, east and south sides of the existing CSIP service area that could be included in the expanded service area. These areas were identified in the Cal-Am Coastal Water Project Draft Environmental Impact Report (ESA, 2009), and are shown on Figure 9-11. Other studies have suggested smaller expansions. In 2011, MCRWA considered approximately 3,500 acres for annexation into the CSIP service area as displayed in Figure 9-12. More recently, the May 2018 *Progress Report on Pure Water Monterey Expansion*, stated the current plan for expansion considers an additional 3,500 acres, a 29% increase in its service area (Monterey One Water, 2018).

Based on the report *Recommendations to Address the Expansion of Seawater Intrusion in the Salinas Valley Groundwater Basin*, a working group was established and recommended beginning an annexation plan for the expansion of the CSIP service area concurrently with optimization of the existing CSIP system in the immediate term by 2020 (MCWRA, 2018). The working group recommended expanding into areas nearest the advancing seawater intrusion front. The annexation plan would be implemented in the mid- to long-term assumed after 2020.

Assuming 3,500 acres of new farmland are annexed into the system, and with an assumed unit agricultural water demand of 2.8 AF/acre (MCWRA, 2017), the expanded area may present an additional demand of 9,900 AF/yr. Initial estimates reported in the 2009 Cal-Am Coastal Project Draft EIR (ESA, 2009) suggested the 8,500 acre expansion proposal might require an additional 14,000 AF/yr. of water. Assuming the lesser of these two estimates, the 9,900 AF/yr. would offset an equal amount of pumping from the Subbasin. The final size and location of CSIP expansion will be determined through additional hydraulic modeling and engineering that identifies the most cost-effective areas for expansion.

The CSIP expansion would include construction of a new distribution network. The distribution network will be developed only after the final location of CSIP expansion is agreed upon. Extrapolating from the existing CSIP system, the expanded area may include on the order of 13 miles of new pipeline. Because the existing distribution system is at its hydraulic capacity, the new network would likely be separate from the existing pipelines. A new 48” transmission main would extend from the existing SVRP storage pond to the expanded service area; with the exception of a smaller diameter pipeline serving an area southwest of the M1W SVRP. A crossing of the Salinas River would be required. Pipeline diameters would decrease further downstream in the distribution network. Turnouts would be installed for each new agricultural use customer.

Locations to be served in the expanded area would prioritize areas where risk of seawater intrusion is highest and hydraulics are favorable for gravity flow from the SVRP treated water storage pond. Some areas to the east of Castroville along Highway 156 above 80 feet mean sea level would likely need booster pumping to overcome elevation increases in that area. According to the 2009 DEIR, this area represents approximately 3,000 AF/yr. of the projected 14,000 AF/yr. increase.

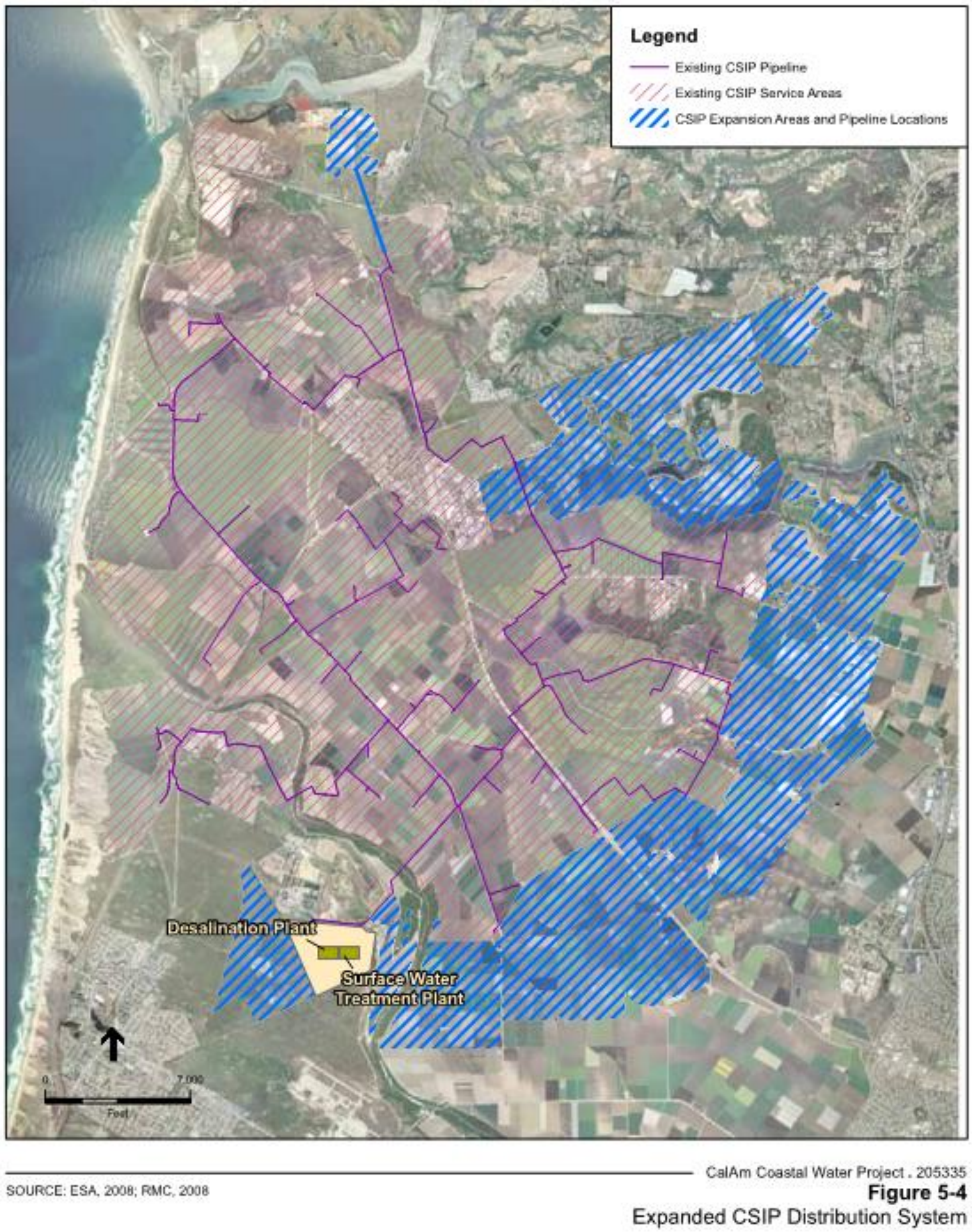


Figure 9-11. Potential CSIP Distribution System Expansion Areas (Image from Cal-Am Coastal Water Project Draft EIR, 2005)

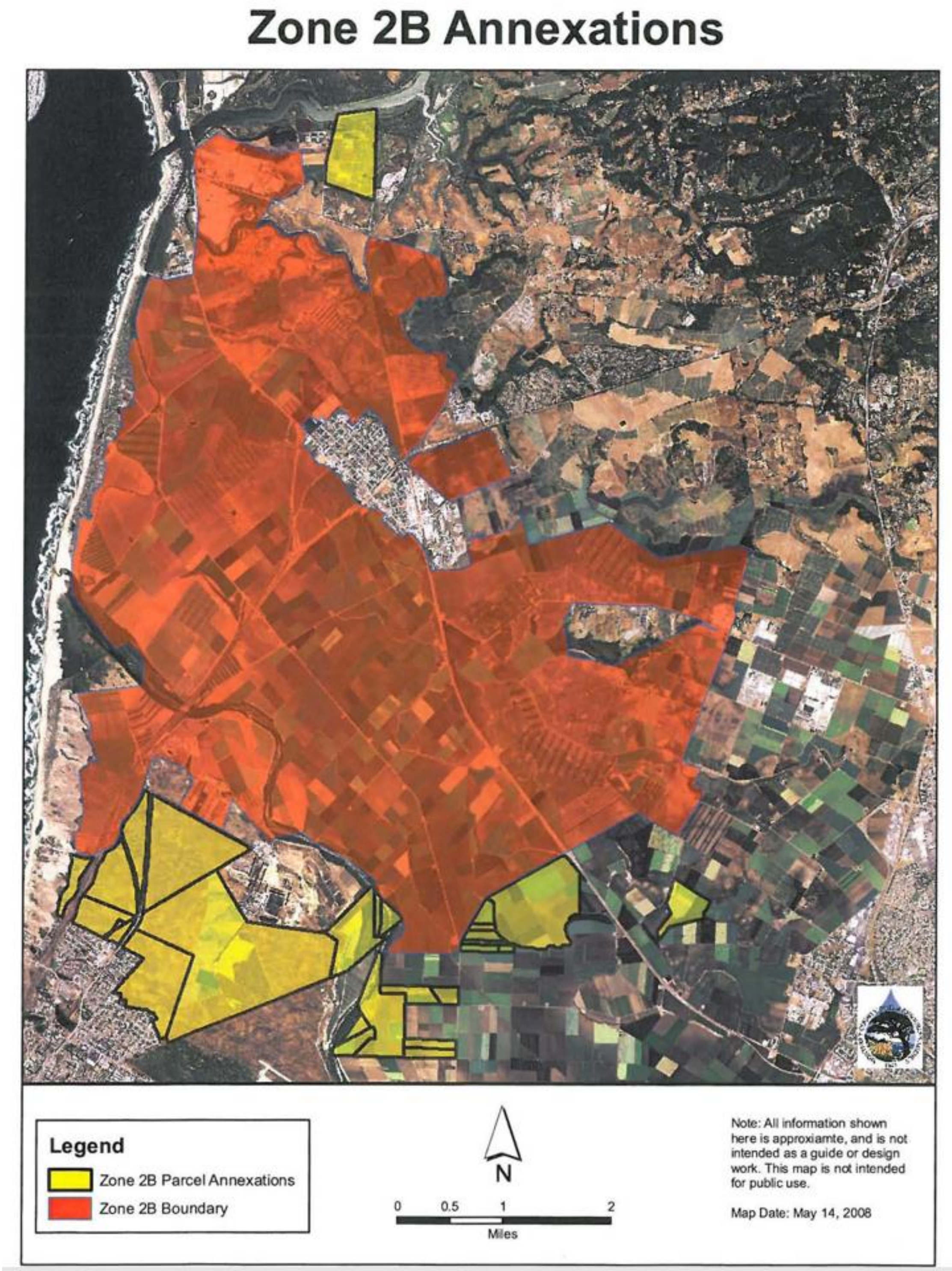


Figure 9-12. Zone 2B Requests for Annexation from 2011 (Courtesy of MCWRA)

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

The primary benefits from CSIP expansion include the increase in demand for recycled water and river diversion water supplies thus reducing groundwater pumping in the Subbasin. This increased demand could be supplied to the new service areas during the winter, spring and fall when excess supply is available to the CSIP system. If additional water supplies are available in the summer, the new service could also be supplied in the summer. The expanded service area would lessen groundwater pumping by an amount equal to the quantity delivered: approximately 9,900 AF/yr. This project will benefit other subbasins, such as the Monterey and Eastside subbasins by reducing pumping that impacts the neighboring subbasins.

Figure 9-13 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from the CSIP expansion project. Figure 9-14 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from the CSIP expansion project. Model results suggest that this project reduces seawater intrusion by approximately 2,800 AF/yr. on average.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between CSIP expansion and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

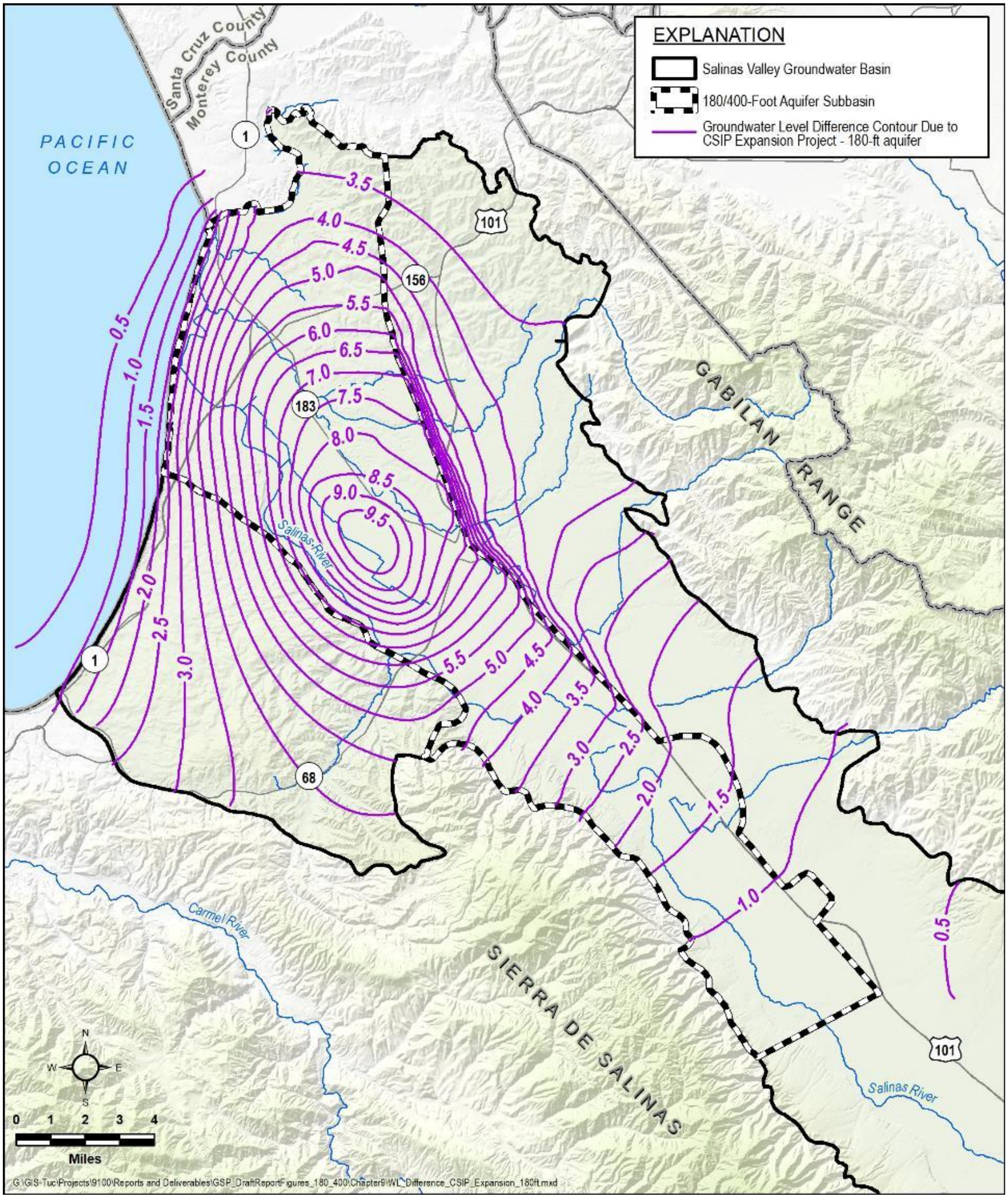


Figure 9-13: Esitmated Groundwater Level Benefit in the 180-Foot Aquifer from the CSIP Expansion Project

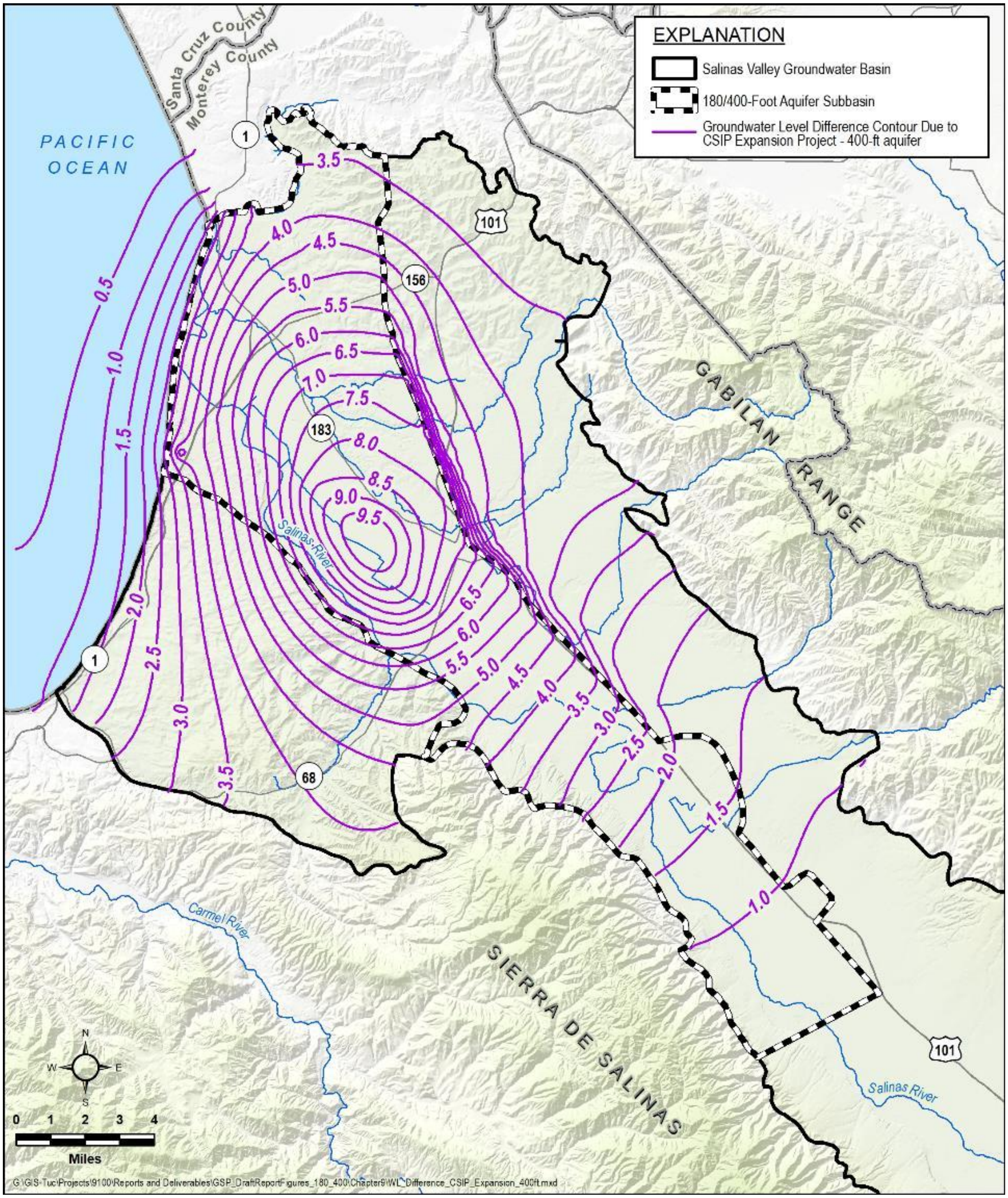


Figure 9-14: Esitmated Groundwater Level Benefit in the 400-Foot Aquifer from the CSIP Expansion Project

Circumstances for Implementation

The CSIP expansion project will be implemented after completion of the CSIP optimization project.

Legal Authority

MCWRA, who owns and operates the CSIP system, is a member of the SVBGSA. Therefore, expanding the CSIP system is a benefit to one of the SVBGSA members. The SVBGSA will work in cooperation with MCWRA to design and construct the CSIP expansion.

Implementation Schedule

The implementation schedule is presented in Figure 9-15. It is anticipated to take five years to implement. Year 1 for this project would not start until the CSIP Optimization Project has been implemented.

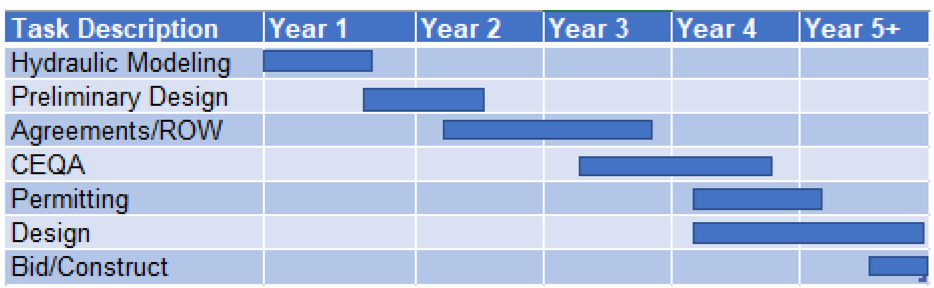


Figure 9-15. Implementation Schedule for CSIP Distribution System Expansion

Estimated Cost

Estimated capital cost for the CSIP expansion project is estimated at $73,366,000. Annual O&M costs are approximately $480,000. The estimated projected yield for the project is 9,900 AF/year. The cost of water for this project is estimated at $630/AF.

9.4.4.6 Preferred Project 5: Maximize Existing SRDF Diversion

MCWRA owns and operates the Salinas River Diversion Facility (SRDF). The SRDF operates normally at 36 cfs and has a maximum capacity of 48 cfs if necessary. The facility operates between April 1st and October 31st and can deliver annually up to approximately 15,000 AFY to the CSIP system. The original Engineer's Report for the SRDF proposed a facility that could instantaneously deliver 85 cfs with a total annual diversion between 9,700 and 12,800 AFY. The instantaneous delivery was scaled back during design to reduce costs for the project.

The existing SRDF can theoretically divert up to 15,000 AF/yr. to the CSIP system, although since its startup in 2010 it has provided an average of 3,400 AF/yr. between the months of April and October with a maximum delivery in FY 18-19 of 6,500 AF/yr. This deficit between the facility's capacity and its actual deliveries is largely attributable to a misalignment between the timing of supply and demand for the water. Currently, the CSIP's agricultural demand is primarily during the day. Recycled water is used as the first priority in supplying the CSIP, so the need for SRDF water during the day is limited. This results in the farmers and MCWRA turning on their wells to supplement the water supplies on average of 5,500 AF/yr. (see PP#2).

Since FY 2001-2002, the average demand in the CSIP system has been 20,400 AF/yr., and the average supply from the SVRP has been 13,100 AF/yr.; therefore, the average supply needed from the SRDF is 7,300 AF/yr. At minimum, there has been at least 8,500 AF/yr. available from the SRDF and more typically, on average 11,600 AF/yr. is available.

Therefore, with no added capital expenditures, it is recommended to increase the production from the SRDF to meet the total demands of the CSIP existing system (approximately 7,300 AF/yr.). In addition, there would be additional capacity available to offset a portion of the demand from the expanded CSIP area, up to an additional 4,300AF/yr. CSIP Optimization (PP#2) must be completed to be able to maximize the SRDF deliveries.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected benefits and Evaluation of Benefits

The primary benefits from maximizing the existing SRDF facilities includes provision of additional water supply to the CSIP system allowing for its expansion into new service areas as well as providing a potential source of water for aquifer recharge through injection wells (See Priority Project #10 Winter Flow Injection). Maximizing the existing SRDF has the potential to yield up to 11,600 AF/yr. when operated April through October.

Figure 9-5 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from projects 2, 3, and 5, combined. Figure 9-9 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from projects 2, 3, and 5, combined. These projects were combined into a single simulation because of how closely they are intertied. Model results suggest that this project reduces seawater intrusion by approximately 2,200 AF/yr. on average.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between SRDF improvements and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

Maximizing the existing SRDF improvement project will be implemented following the completion of Priority Project #2, CSIP Optimization and Priority Project #3, Expand Area Served by CSIP Area.

Legal Authority

No additional legal authority is needed to maximize the use of the existing SRDF.

Implementation Schedule

This project is to be implemented following the completion of Priority Project #2 and #3.

Estimated Cost

There is no capital cost required for this project because the facilities are already sized to deliver 15,000 AF/yr. The project requires additional annual O&M including higher energy and treatment costs to supply the water. The estimated projected yield for the project is 11,600 AF/year. The yield for this project is the same yield that is identified in Priority Project #2 and a portion of the yield identified in Priority Project #3. The cost of water for this project is estimated at $220/AF.

9.4.4.7 Preferred Project 6: Seawater Intrusion Pumping Barrier

Seawater intrusion will be halted using a pumping barrier along the coast. The barrier will be approximately 8.5 miles in length between Castroville and Marina. The intrusion barrier comprises 18 extraction wells; although this number may change as the project is refined. Nine wells will be located in the 180-Foot Aquifer and 9 wells will be located in the 400-Foot Aquifer. Supplemental water to replace the extracted water would come from one or a number of other sources. For costing purposes, the initial barrier alignment is assumed to largely parallel Highway 1 diverging to the northeast on the northern side of Castroville. This alignment will be refined as land access agreements are developed and cost estimates are refined. Wells will be installed spaced approximately every 2,000 feet. The wells would be installed to the depth of the base of the 400-foot aquifer, approximately 750 feet bgs.

The 9 wells in the 180-Foot Aquifer are assumed to produce 700 gpm for a total extraction rate of 6,300 gpm or 14 cfs. The 9 wells in the 400-Foot Aquifer are assumed to produce 1,400 gpm for a total extraction of 12,600 gpm or 28 cf. The 18 wells would withdraw up to 30,000 AF/yr. This number is conservatively high and will be refined as the project design is refined. Extracted groundwater would be conveyed in a new pipeline for ultimate discharge back into the Pacific Ocean. Alternatively, the extracted water or a portion thereof could be conveyed to a new or existing desalination facility where it can be treated for potable and/or agricultural use. The water extracted from these wells will be brackish due to historical seawater intrusion, therefore, the extraction will serve to remove the brackish water and allow replacement for fresh water from other sources, most likely a combination of desalinated water, excess surface water from the Salinas River, and/or purified recycled water.

An optional barrier using injection instead of extraction was also considered. This option would use the same 9 wells in the 180-Foot Aquifer and 9 wells in the 400-Foot Aquifer, but would use these wells to develop an injection mound rather than a drawdown barrier. The mound developed by injection would need to be high enough compensate for the density of seawater at the coast. Assuming the 180-Foot Aquifer has an average depth of 270 feet, and using the Ghyben-Herzberg relationship for saltwater intrusion, the injection mound in the 180-Foot Aquifer at the coastline would need to be 6.75 feet above mean sea level to fully stop seawater intrusion. Assuming the 4000-Foot Aquifer has an average depth of 550 feet, and using the same relationships, the injection mound in the 400-Foot Aquifer at the coastline would need to be 13.75 feet above mean sea level to fully stop seawater intrusion.

Mounding calculations presented in Appendix 9C suggest that approximately 46,000 AF/yr. of water would need to be injected to create the required mounding. Of this 46,500 AF/yr., 3,4500 AF/yr. would be injected into the 180/400-Foot Aquifer Subbasin. Water that could be injected in accordance with existing regulations and ordinances includes treated Salinas River water, desalinated ocean water, and advanced purified recycled water. Treated Salinas River water and desalinated ocean water would be preferentially delivered to growers and municipalities rather than injected. The only likely source of water for injection is therefore advanced purified recycled water. Because it is unlikely that a reliable year-round supply of advanced purified recycled water will be available for a reasonable cost, the injection option was temporarily tabled.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Seawater intrusion measurable objectives

Expected Benefits and Evaluation of Benefits

The project will stop and reverse seawater intrusion, helping to remediate and restore the 180/400-foot aquifer subbasin.

Circumstances for Implementation

The seawater intrusion barrier project is a preferred project and will be implemented as soon are financially and legally possible. A number of land and access agreements will be needed before the project can be implemented.

Legal Authority

Section 10726.2(a) of the California Water Code gives the SVBGSA the right to acquire the land necessary for the required infrastructure.

Implementation Schedule

The implementation schedule is presented in Figure 9-16. It is anticipated to take five years to implement.

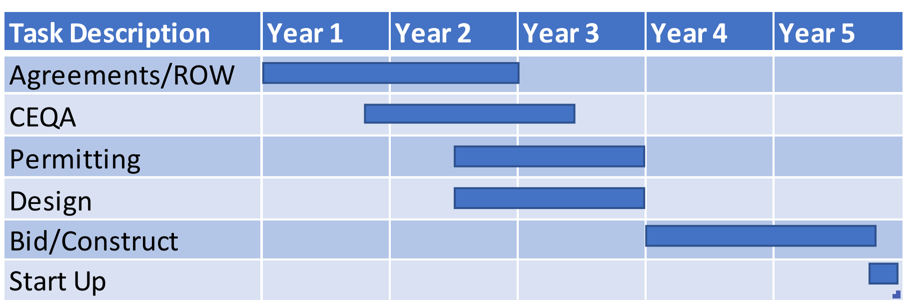


Figure 9-16. Implementation Schedule for Seawater Intrusion Extraction Barrier

Estimated Cost

Estimated capital cost for the Seawater Intrusion Pumping Barrier project is estimated at $102,389,000. This includes 44,000 LF of 8-inch to 36-inch pipe and rehabilitation of the existing M1W outfall. Annual O&M costs are anticipated to be approximately $9,800,000. The projected yield for the Seawater Intrusion Pumping Barrier is -30,000 AF per year. The cost of water for this project is estimated at $590/AF. This project assumes the water will be discharged through the existing M1W outfall. If Alternative Project #1 is pursued, the upgrade to the outfall will not be required.

9.4.4.8 Preferred Project 7: 11043 Diversion Facilities Phase I: Chualar

MCWRA holds Permit 11043 (Permit), which is a wet weather diversion right on the Salinas River. The diversion can only occur in two identified locations: Near Soledad and Chualar. The Permit has an annual maximum diversion limit of 135,000 AF. Permit Condition 13 only allows water to be diverted when there are natural flows in the river. In addition, under Condition 13, the maximum allowed diversion is 400 cfs. Based on the conditions of the permit, a conservative estimate is that approximately 63,000 AF of water can be diverted during average years from either diversion point between the months of December through March. Figure 9-17illustrates the volume of water that can be diverted, based on historical flows and the size of the diversion structure.

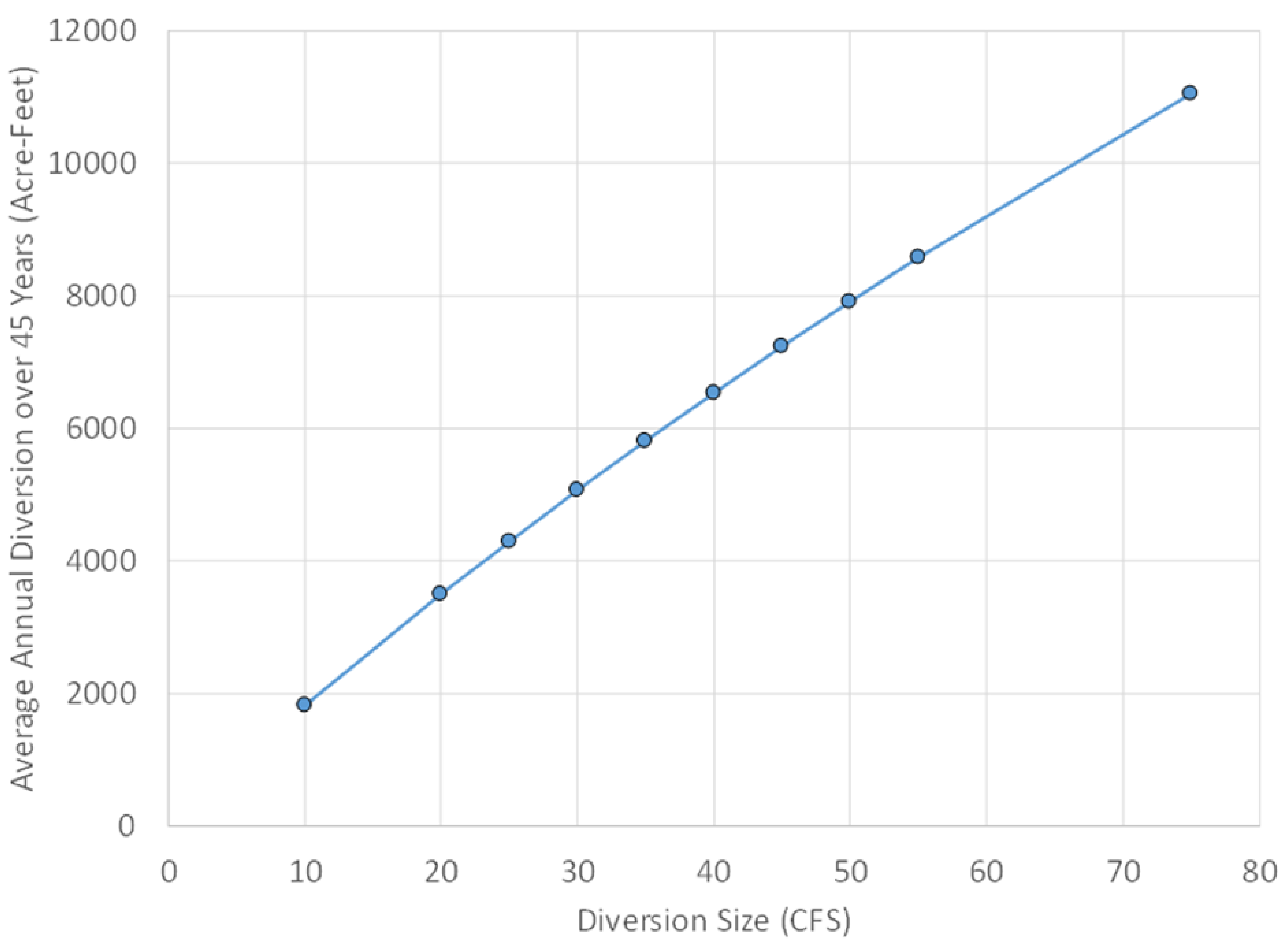


Figure 9-17: Water Right 11043 Averaage Annual Historical Diversions Volume for Various Sized Diversion Structures

Preferred Project 7 proposes to construct extraction facilities at the Chualar location and pump the water to the Eastside Subbasin where the water can then be infiltrated or injected into the groundwater basin at known pumping depressions. The first phase includes a diversion facility at the Chualar diversion site that would be sized to provide approximately 6,000 to 10,000 AF/yr. of water to the southeast edge of the City of Salinas. To obtain this volume of water, a diversion structure that can pump between 30 and 65 cfs is required. The diversion structure could be sized to extract more than 10,000 AFY, however, it may not be economical to construct a larger facility. This issue can be further evaluated during the preliminary design stages of the project. The project would require the following facilities:

- A radial collector diversion facility with pump house capable of pumping between 30 and 65 cfs (13,500 and 29,000 gpm).
- A 30 to 48" diameter, 23,750 linear foot (4.5 miles) transmission pipe to convey water to an infiltration basin or injection wells.
- An infiltration basin that could be farmed in the summer and fallowed during the winter. It is estimated between 100 and 200 acres (estimating 0.25 in/hr. infiltration rate) would be required for the infiltration basin.
- An alternative to the infiltration basin is to construct a filtration and chlorination treatment facility and injection wells near the pumping depression. This alternative is more expensive but potentially more effective than the infiltration basins.

A radial collector well consists of a vertical, large diameter caisson which is sunk to a level below the water table; caisson diameters typically range between 8 to 20 feet. Extending from the central caisson is one or more lateral perforated screens which are typically 125 to 250 feet in length. The horizontal laterals collect water from the subsurface and convey it to the central caisson which also serves as a pump station. From the caisson, the water is pumped to its destination. Water collected in this manner offers the advantage of having undergone riverbank filtration, generally offering improved and more consistent water quality than that of water collected directly from a surface water. The radial collector wells also have a lower ground surface footprint than the equivalent number of vertical wells that would be needed to extract the same amount of water. Radial collector wells such as they Ranney Well™, have capacities ranging from 0.1 to 50 mgd. The radial collector for the 11043 Chualar Diversion would be sized for a capacity of 19 to 42 mgd.

For conceptual project evaluation purposes, the system is assumed to include:

- One 16' diameter caisson to 100' depth
- Six 12" diameter laterals, 150' in length

- Elevated pump house and control room for four 3,000-HP, 7,500 gpm pumps
- A 30 to 48" diameter, 23,750 linear foot transmission pipe to convey water from the diversion facility to the injection well sites.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

There is no direct benefit from this project on the 180/400-Foot Aquifer Subbasin. This project is included here as part of the complete Valley-wide groundwater management program. The primary expected benefit of Preferred Project 8 is to provide an alternative water supply source to recharge the Eastside groundwater basin near the cone of depression, thereby either raising groundwater levels or lowering the rate of groundwater level decline.

Figure 9-18 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from this project. Figure 9-19 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from this project. Model results suggest that this project reduces seawater intrusion by approximately 660 AF/yr. on average.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between the 11043 diversion and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

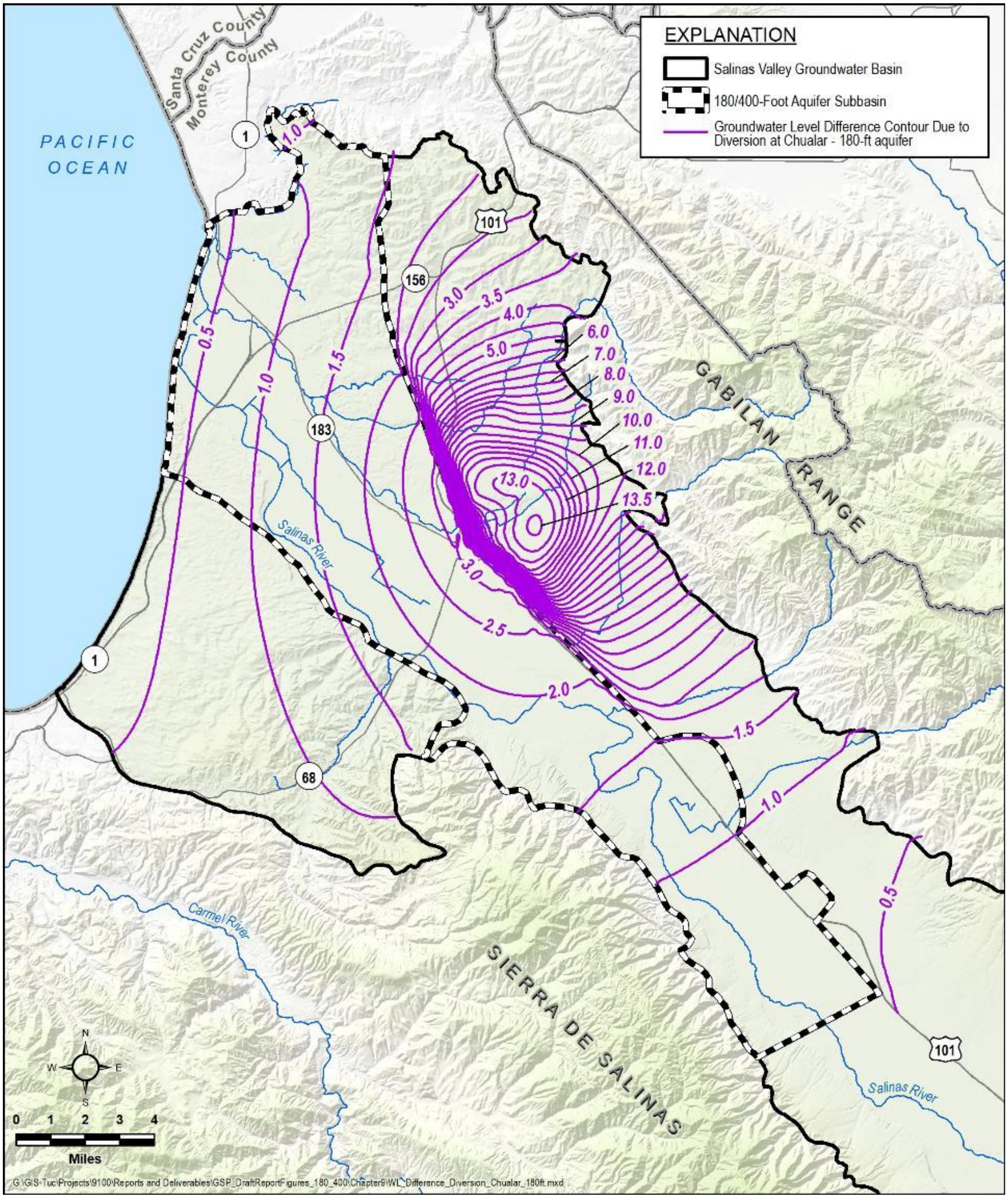


Figure 9-18: Esitmated Groundwater Level Benefit in the 180-Foot Aquifer from the 11043 Diversion at Chualar

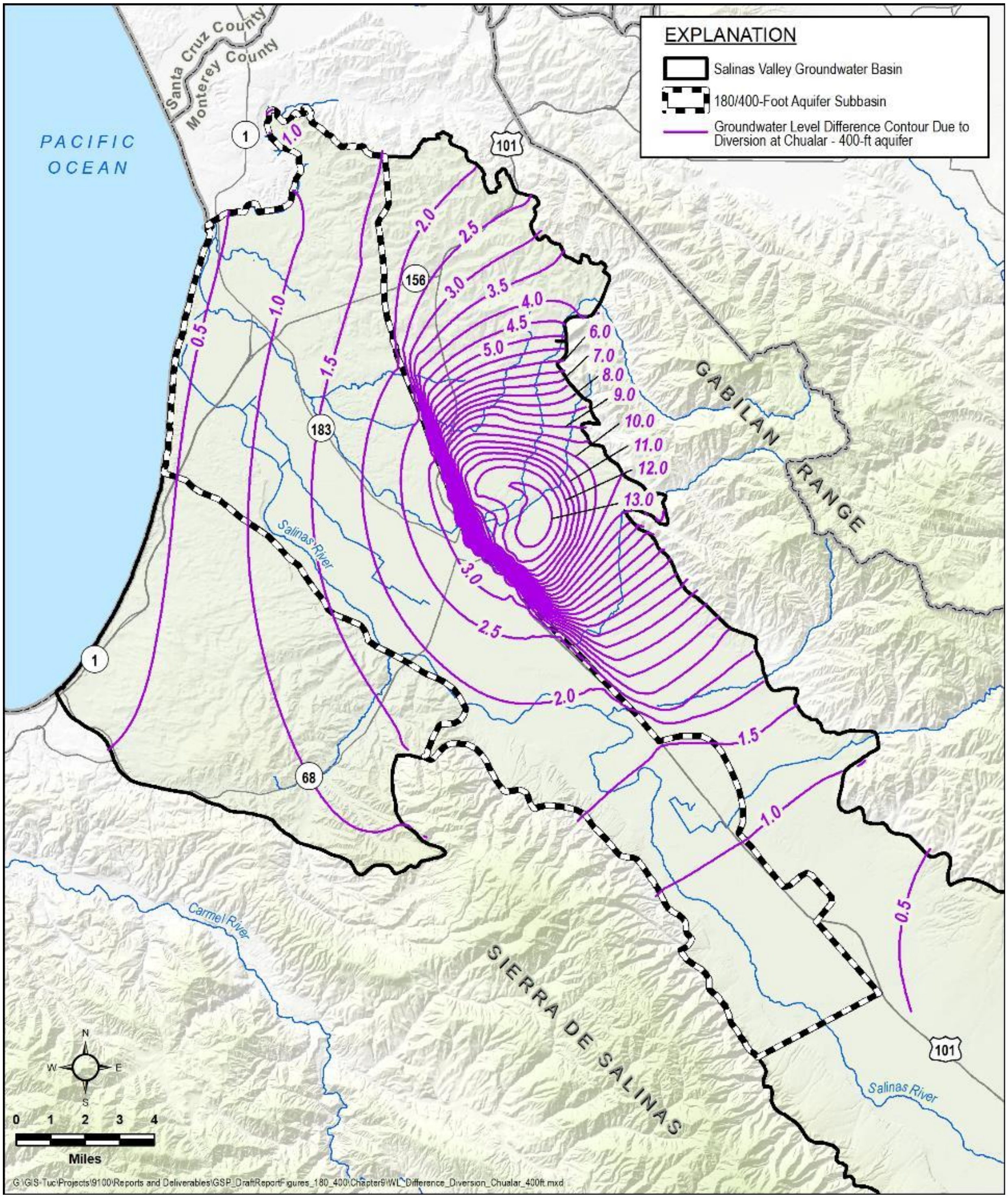


Figure 9-19: Esitmated Groundwater Level Benefit in the 400-Foot Aquifer from the 11043 Diversion at Chualar

Circumstances for Implementation

The 11043 Diversion Project; Phase I Chualar is a preferred project, and will be implemented as soon are financially and legally possible. A number of land and access agreements will be needed before the project can be implemented.

Legal Authority

MCWRA, who holds the 11043 permit, is a member of the SVBGSA. Either MCWRA will use the permit as a member of the SVBGSA, or MCWRA will transfer the permit to SVBGSA.

The SVBGSA has the right to divert and store water once it has access to the 11043 Permit. Section 10726.2 (b) of the California Water Code provides GSAs the authority to, “Appropriate and acquire surface water or groundwater and surface water or groundwater rights, import surface water or groundwater into the agency, and conserve and store within or outside the agency”.

Implementation Schedule

The implementation schedule is presented in Figure 9-20. It is anticipated to take nine years to implement.

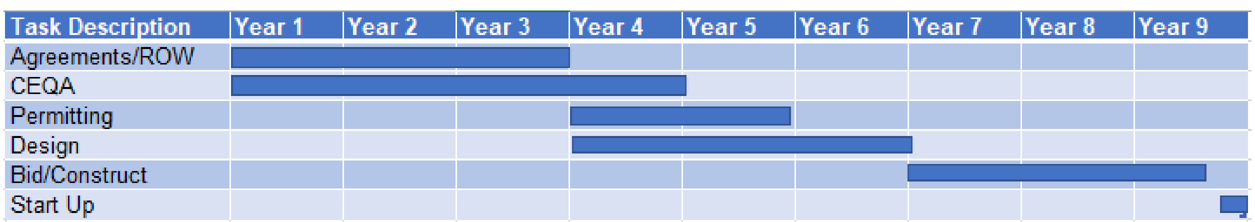


Figure 9-20. Implementation Schedule for 11043 Permit Project

Estimated Cost

Estimated capital cost for the 11043 Diversion Facilities: Phase I, Chualar is estimated at $47,654,000. Annual O&M costs for the 8,000 AF are anticipated to be approximately $2,296,000. The cost of water for this project is estimated at $750/AF.

9.4.4.9 Preferred Project 8: 11043 Diversion Facilities Phase II: Soledad

As noted in Preferred Project 7, MCWRA holds Permit 11043 (Permit), which is a diversion right on the Salinas River. The diversion can only occur in two identified locations: Near Soledad and Chualar. The Permit has an annual maximum diversion limit of 135,000 AF. Permit

Condition 13 only allows water to be diverted when there are natural flows in the river. In addition, under Condition 13, the maximum allowed diversion is 400 cfs. Based on the conditions of the permit, a conservative estimate is that approximately 63,000 AF of water can be diverted during average years from either diversion point between the months of December through March.

Preferred Project 8 proposes to construct extraction facilities similar to Preferred Project 7, at the Soledad location and pump the water to the eastside where the water can then be infiltrated into the groundwater basin at known pumping depressions or areas of poor water quality. The second phase includes a diversion facility at the Soledad diversion site that would be sized to provide approximately 6,000 to 10,000 AF of water to the farmland between Soledad and Gonzales along the foothills of the Gabilan Range. The diversion structure may be sized to extract more than 10,000 AFY, however, it may not be economical to construct a larger facility. This issue can be further evaluated during the preliminary design stages of the project. The project would require the following facilities:

- A radial collector diversion facility with pump house capable of pumping between 30 and 65 cfs (13,500 and 29,000 gpm).
- A 30 to 48” diameter, 23,750 linear foot (4.5 miles) transmission pipe to convey water to an infiltration basin or injection wells.
- An infiltration basin that could be farmed in the summer and fallowed during the winter. It is estimated between 100 and 200 acres (estimating 0.25 in/hr. infiltration rate) would be required for the infiltration basin.
- An alternative to the infiltration basin is to construct a filtration and chlorination treatment facility and injection wells near the pumping depression.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

There is no direct benefit from this project on the 180/400-Foot Aquifer Subbasin. This project is included here as part of the complete Valley-wide groundwater management program. The primary expected benefit of Preferred Project 6 is to provide an alternative water supply source to recharge the Eastside groundwater basin, thereby either raising groundwater levels or lowering the rate of groundwater level decline.

Figure 9-21 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from this project. Figure 9-22 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from this project. Model results suggest that this project reduces seawater intrusion by approximately 100 AF/yr. on average.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between the 11043 diversion and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

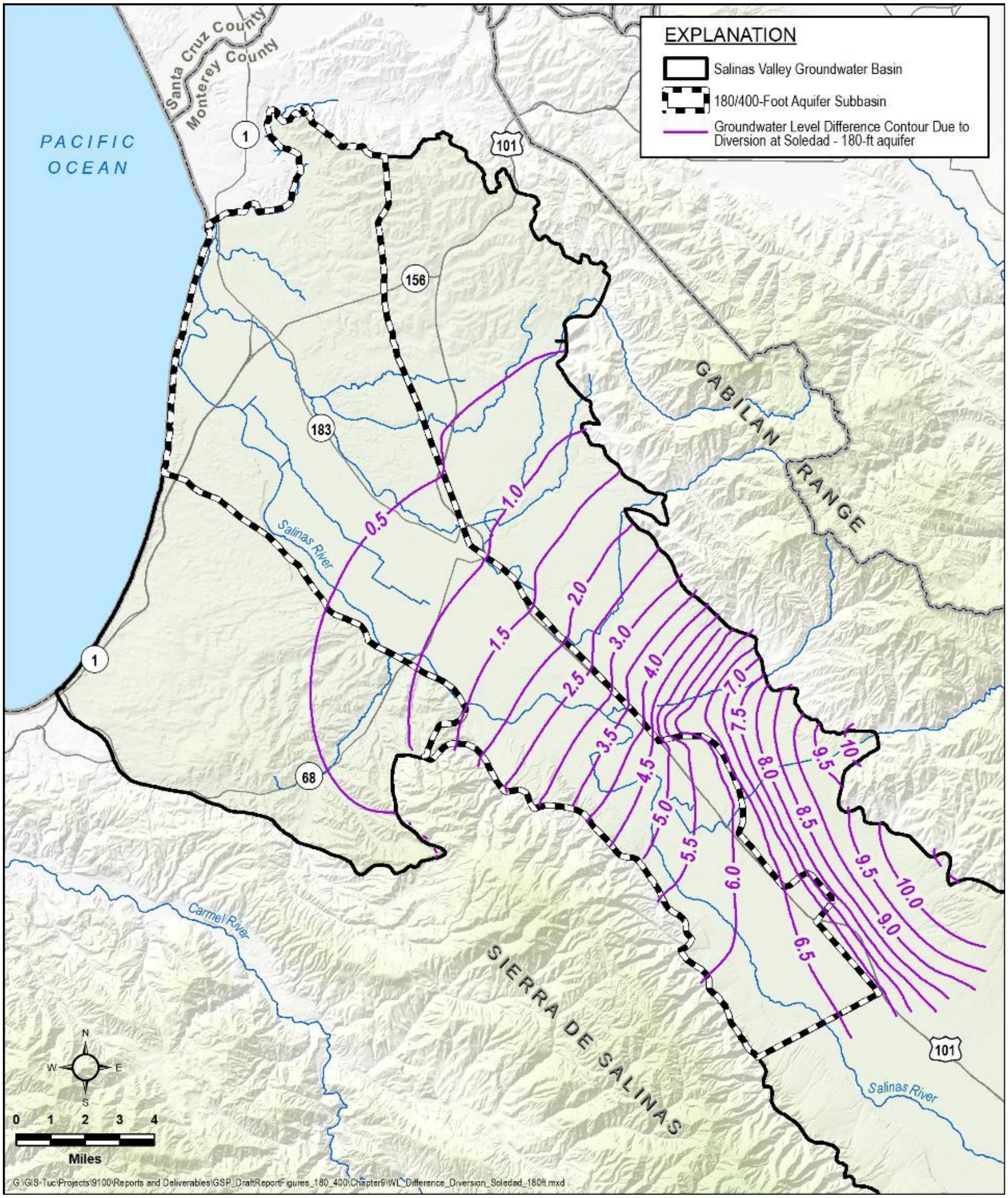


Figure 9-21: Esitmated Groundwater Level Benefit in the 180-Foot Aquifer from the 11043 Diversion at Soledad

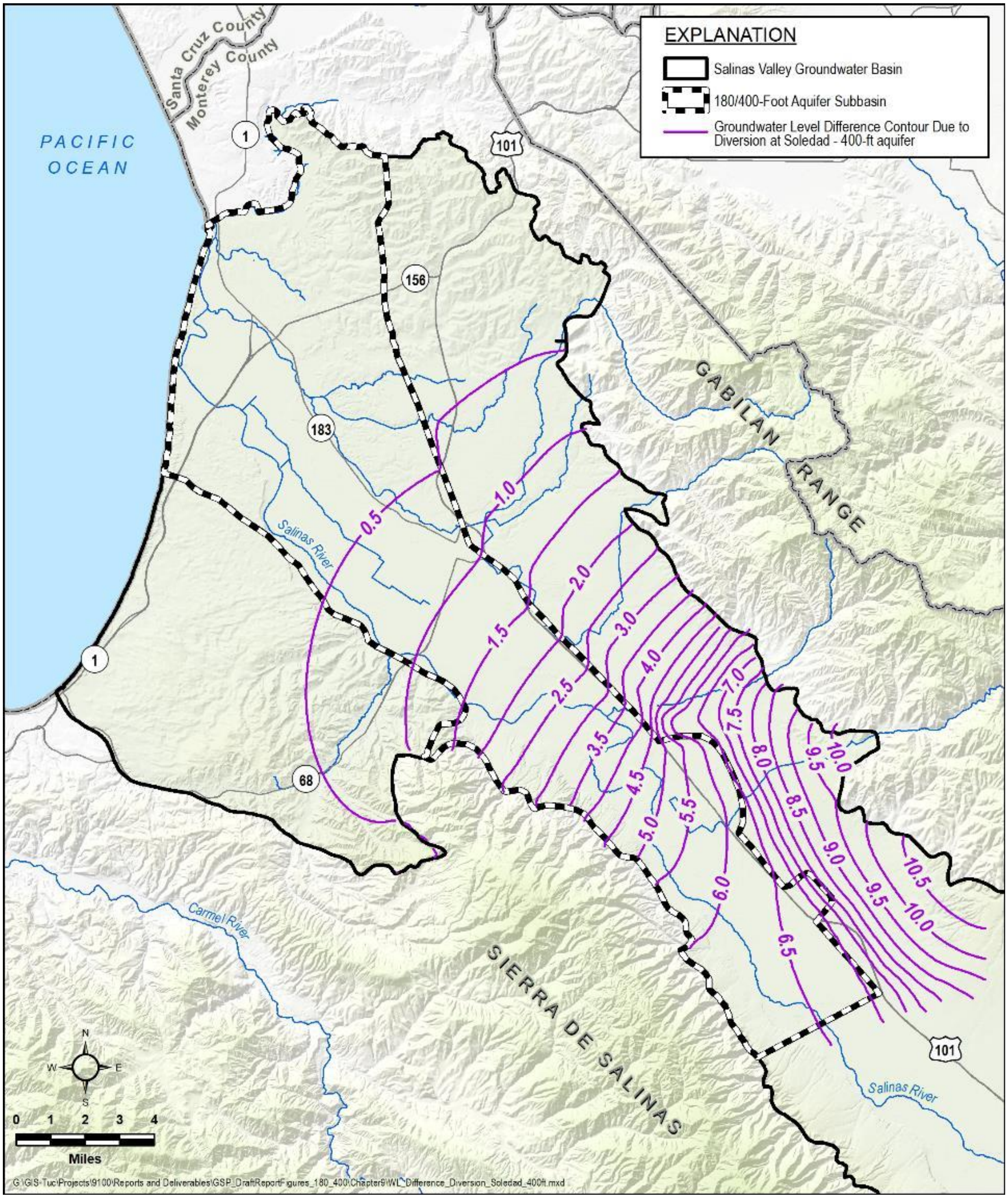


Figure 9-22: Esitmated Groundwater Level Benefit in the 400-Foot Aquifer from the 11043 Diversion at Soledad

Circumstances for Implementation

The 11043 diversion project is a preferred project, and will be implemented as soon are financially and legally possible. A number of land and access agreements will be needed before the project can be implemented.

Legal Authority

MCWRA, who holds the 11043 permit, is a member of the SVBGSA. Either MCWRA will use the permit as a member of the SVBGSA, or MCWRA will transfer the permit to SVBGSA.

The SVBGSA has the right to divert and store water once it has access to the 11043 Permit. Section 10726.2 (b) of the California Water Code provides GSAs the authority to, "Appropriate and acquire surface water or groundwater and surface water or groundwater rights, import surface water or groundwater into the agency, and conserve and store within or outside the agency".

Implementation Schedule

The implementation schedule is presented in Figure 9-23. It is anticipated to take nine years to implement.

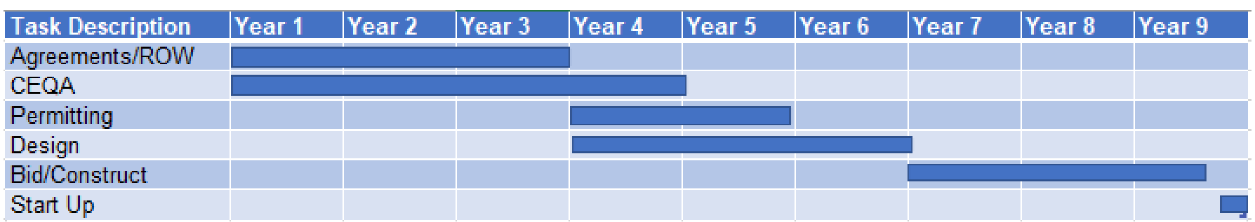


Figure 9-23. Implementation Schedule for 11043 Permit Project

Estimated Cost

Estimated capital cost for the 11043 Diversion Facilities is estimated at $60,578,000. Annual O&M costs for the 8,000 AF are anticipated to be approximately $5,050,000. The cost of water for this project is estimated at $880/AF.

9.4.4.10 Preferred Project 9: SRDF Winter Flow Injection

Preferred Project 9 would divert winter flows from the Salinas River using the existing SRDF facilities, and inject the water into the 180/400-Foot Aquifer Subbasin to maintain groundwater levels, improve water quality, and prevent further seawater intrusion. This project could benefit other subbasins, such as the Monterey and Eastside subbasins by providing potable water to these subbasins for direct recharge and/or municipal potable use.

One constraint on this project is securing and clarifying water rights. The operation of the SRDF was subject to the environmental flow prescriptions outlined in the Biological Opinion issued by NOAA's National Marine Fisheries Service (NMFS) in 2007 and incorporated into MCWRA's water diversion permit 21089; MCWRA's water diversion permit limits diversions to 27,900 AF/yr. Therefore, depending on the size of the planned facilities, additional water rights may need to be secured. Preferred Project #5 states that, the proposed summer diversion is 15,000 AF, leaving an additional 12,900 AF available during the winter if the permit for diversion from the SRDF is modified to allow diversions between November and March.

For diversions to occur, there must be adequate flow in the Salinas River and flows for fish migration must be satisfied. At the SRDF fish ladder bypass, flows are maintained at 45 cfs for migration when the lagoon sandbar is open to the ocean, and 15 cfs for migration when the lagoon sandbar is closed and flow is routed to the Old Salinas River channel. A minimum flow of 2 cfs is maintained to the lagoon when SRDF irrigation diversions are occurring or aquifer conservation releases from Nacimiento and/or San Antonio reservoirs are being made to the Salinas River.

Under this alternative project, water would be diverted from the Salinas River at a flow rate of 36 cfs. Water would then be pumped to an expanded surface water treatment plant where it would be chlorinated, filtered, and conveyed to new injection wells in the 180/400-foot Aquifer Subbasin. Likely increased levels of sediment in the river water during the winter will possibly require additional filtration or higher levels of maintenance on the existing filtration system. If river levels are low (less than 5 feet), the river dam would be used for the diversion. If river levels are higher than 5 feet, the river dam would not be required.

Winter extractions are assumed to yield flows of 36 cfs, or 16,000 gpm. New injection wells will include wells set in both the 180- and 400- Foot aquifers, back-flush facilities including back wash pumps and percolation basin for water disposal into the vadose zone, electrical and power distribution and motor control facilities.

Based on an injection rate of 1,000 gpm per injection well, 16 new injection wells would be installed. The wells would be located to the east toward the City of Salinas where they would inject water into the 180/400-Foot Aquifer Subbasin.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include:

- Groundwater elevation measurable objective
- Groundwater storage measurable objective

- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

Under MCWRA's existing permit, 27,900 acre-feet can be extracted from the river annually. Assuming that a maximum of 15,000 acre-feet are provided to CSIP, 12,900 acre-feet of water is available for winter recharge. Additional water could be available for recharge if CSIP does not use all 15,000 acre-feet, or if additional water rights are identified.

Figure 9-24 shows the expected groundwater elevation benefit in the 180-Foot Aquifer from this project. Figure 9-25 shows the expected groundwater elevation benefit in the 400-Foot Aquifer from this project. Model results suggest that this project reduces seawater intrusion by approximately 1,600 AF/yr. on average.

Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between injecting winter streamflow in the Subbasin and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

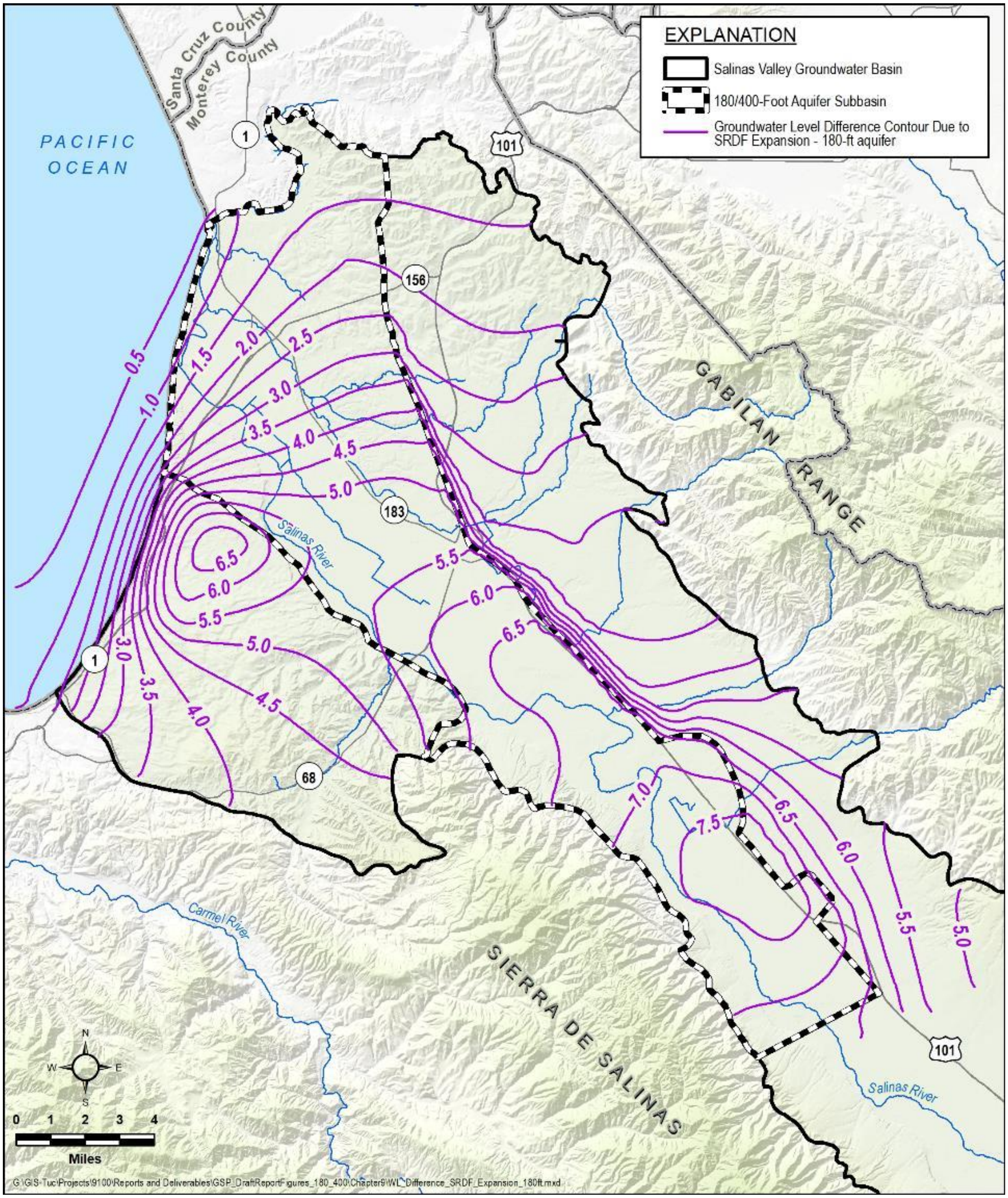


Figure 9-24: Esitmated Groundwater Level Benefit in the 180-Foot Aquifer from the 11043 Diversion at Soledad

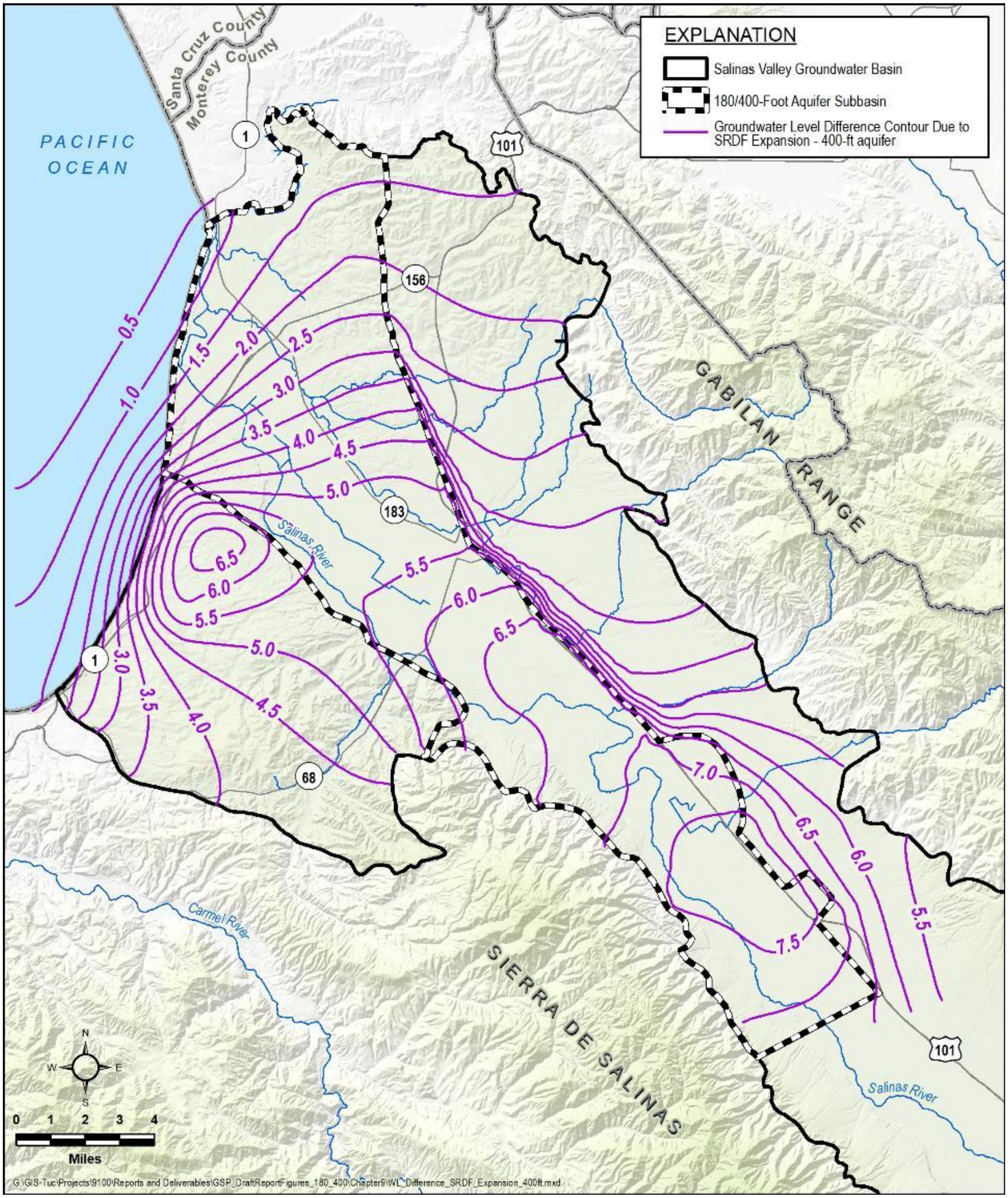


Figure 9-25: Esitmated Groundwater Level Benefit in the 400-Foot Aquifer from the 11043 Diversion at Soledad

Circumstances for Implementation

Winter recharge will be implemented only if the existing water right permit is modified to allow for diversions between November and March. At this time, we are not proposing to modify the volume of water being proposed to be diverted.

This project will likely be subject to new flow restrictions and reservoir operations resulting from the planned HCP. This project will not proceed until the water rights and flow prescriptions from the HCP have been determined.

Legal Authority

The SVBGSA can acquire water for recharge under California Water Code section 10726.2 (b) which give the SVBGSA authority to "Appropriate and acquire surface water or groundwater …" as well as "the spreading, storing, retaining, or percolating into the soil of the waters for subsequent use"

Implementation Schedule

The implementation schedule is presented in Figure 9-26. It is anticipated to take four years to implement which excludes any improvements performed under Preferred Project 5.

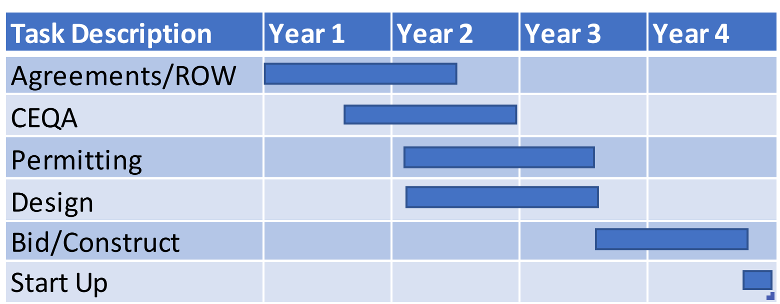


Figure 9-26. Implementation Schedule for Radial Collector Water Injection

Estimated Cost

Estimated costs for the injection of winter flows from the expanded SRDF were estimated based upon using the existing SRDF facilities. The majority of the costs are for the construction of the injection wells. Capital costs are assumed to be $51,191,000 for construction of an injection well field consisting of 16 wells as well as construction of a 4-mile conveyance pipeline between the SRDF site and the injection well system. The cost of an expanded surface water treatment system for the SRDF expansion is not included in this estimate.

Annual O&M costs are estimated at $3,624,000 for the operation of the injection well field. Total annualized cost is $7,629,000. Based on a project yield of 12,900 AF/yr., the unit cost of water is $590/AF/yr.

9.4.5 Alternative Projects

The priority projects listed above, coupled with the management actions described in Section 9.3, might not lead to full sustainability in the 180/400-Foot Aquifer Subbasin. Four alternative projects are included in this GSP. These alternative projects supply additional water to the 180/400-Foot Aquifer Subbasin. Not all projects will necessarily be implemented by the SVBGSA. Projects will be implemented only if they are deemed cost effective or necessary to achieve sustainability.

One or more of these projects may be implemented based on future need and cost. The alternative projects are summarized in Table 9-3 and described below.

Table 9-3. Alternative Projects

Alternative Project #	Project Name	Water Supply	Project Type
1	Desalinate Water from the Seawater Barrier Extraction Wells	Brackish Groundwater	In Lieu Recharge
2	Recharge Local Runoff from Eastside Range	Stormwater	Direct Recharge
3	Winter Potable Reuse Water Injection	Recycled Water	In Lieu Recharge
4	Seasonal Water Storage in 180/400 Aquifer	Salinas River	In Lieu Recharge

9.4.5.1 Alternative Project 1: Desalinate Water from the Seawater Barrier Extraction Wells

This project would treat water extracted from the seawater intrusion barrier and allow for its reinjection in the 180-Foot Aquifer and 400-Foot Aquifer. The project relies upon the desalination of brackish water extracted from the 180/400-foot aquifer subbasin to feed a treatment facility and discharge the treated water in injection wells east of the intrusion barrier.

The desalination treatment could be provided as a standalone plant, or supply one of three proposed desalination plants in the region. The final decision on whether to implement this alternative project, and whether to desalinate the source water with a standalone plan or one of the three planned plants will depend on which of these alternatives is the most cost effective. The following plants are in various planning and design stages in the Monterey Bay Area:

- Monterey Peninsula Water Supply Project desalination plant, 6.4 mgd (7,100 AF/yr.)
- Deep Water Desalination Plant, 22 mgd (25,000 AF/yr.)
- People's Water Supply Project desalination plant, 12 mgd (13,400 AF/yr.)

Two of the desalination plants are being considered at Moss Landing: DeepWater Desal Project and the People's Desalination Project. These two plants are currently envisioned to be able to receive influent source water flows of 49 mgd (55,000 AF/yr.) in the case of DeepWater Desal and 30 mgd (33,600 AF/yr.) for the People's Desalination Project. Construction of the Cal-Am MPWSP desalination plant adjacent to M1W's RTP is anticipated to commence in late 2019.

Depending on the desalination plant selected, the source water pipeline would consist of approximately 11 miles of source water pipeline to convey up to 22,000 gpm (32 mgd or 35,500 AF/yr.) of flow to the plant. The pipeline would range from 18" to 36" in diameter.

Assuming a 42% recovery efficiency, 12,700 gpm of brine would need to be sent to an ocean outfall. The 9,200 gpm of treated water would be sent for injection east of the seawater intrusion barrier. An additional 9 miles of 24" pipeline would be needed to convey this desalinated water to an injection well field or recharge basin. Relevant Measurable Objectives

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include:

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

The desalination plants may provide up to approximately 15,000 acre-feet of water for both in-lieu and direct recharge to the Subbasin. This project could benefit other subbasins, such as the Monterey and Eastside subbasins by providing potable water to these subbasins for both in-lieu and direct recharge.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between providing desalinated water to the Subbasin and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

The desalination alternative project is one of five alternative projects that may provide additional water to the Subbasin. The project will only be implemented after all five alternative projects have been refined. The most cost-effective project of the five will be selected to supply additional water to the Subbasin.

Using an existing or planned plant for desalination requires the plant be permitted and fully designed. The desalination alternatives using existing plants will not proceed until one or more of the plants have been fully permitted for construction.

Legal Authority

Water used for desalination would be pumped from the seawater intrusion barrier wells, and can be used by SVBGSA as long as the water is not exported out of the basin.

Implementation Schedule

The implementation schedule is presented in Figure 9-27. It is anticipated to take eight years to implement. The schedule is highly contingent upon whether a completely new desalination plant is conceived or if an existing plant already in the planning stages is elected.

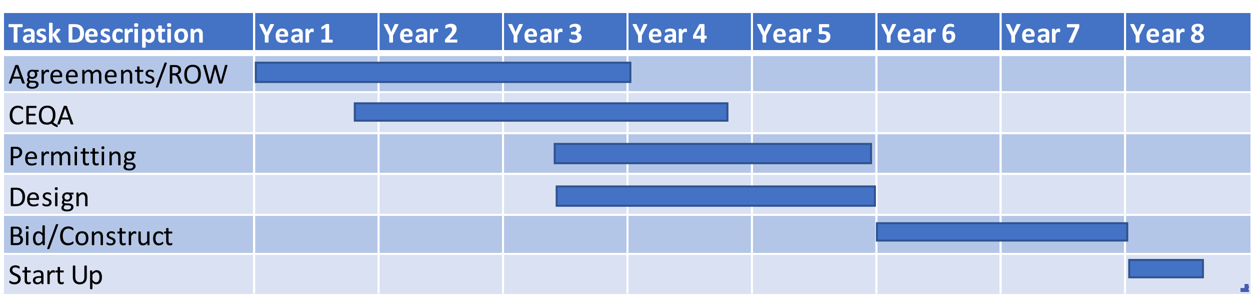


Figure 9-27. Implementation Schedule for Desalination of Extraction Barrier Seawater

Estimated Cost

Estimated costs for desalination depend on the facility used to desalinate the extracted water. For comparison purposes, a high-level estimate was developed for a 13 mgd facility. Capital costs are assumed to be $182,000,000 based on a construction unit cost of $14 million/mgd for desalination plants and associated intake/outfall facilities, a unit cost consistent with other desalination plant projects evaluated by WaterReuse (Kennedy/Jenks, 2014). As a point of comparison, the 6.4-mgd Cal-Am MPWSP project has an estimated capital construction cost of $226,900 equivalent to approximately $35 million/mgd. The total capital costs with the markups and the addition of the source water pipelines from the extraction barrier well field and desalinated water pump station and pipelines to a groundwater recharge site to the east, would be $341,472,000.

Annual O&M costs are estimated at $9,890,000 for the desalination plant and distribution of desalinated water. Based on a project yield of 15,000 AF/yr of desalinated water, the unit cost of water is $2,440/AF/yr. This is a very rough estimate and will be refined in the first three years on GSP implementation.

9.4.5.2 Alternate Project 2: Recharge Local Runoff from Eastside Range

This project recharges local runoff from the Gabilan Range and diverts it to groundwater recharge basin(s) before it reaches the Salinas River.   This project will require additional legal and engineering analysis to evaluate water rights and actual available water supply from each of the watersheds. The project assumes that the stormwater is not being diverted upstream, however, many of the mountain ranges have diversion operations already occurring upstream in the watershed. Rain gauges and studies will be required to determine the true estimate of water available from each watershed.

This project can be implemented in two forms: on-farm recharge and stream diversion recharge. On farm recharge would be similar to the program initiated in Pajaro Valley that compensates landowners for retaining and recharging stormwater before it reaches any identified waterway. This program likely leads to less benefit, but is also less expensive to develop.

The diversion recharge alternative diverts water from the major tributaries in the Eastside Subbasin to groundwater recharge basins. Figure 9-28shows the watersheds in the Gabilan Range adjacent to the Eastside Subbasin. Figure 9-28 also provides an approximate volume of water, in acre-feet, available during a 2-, 5-, 10-, and 25-year storm event for each of the watersheds. A series of recharge basins and piping network will be required. The system will operate by gravity. For costing purposes, it is estimated that approximately 10,000 feet of pipeline would be required in addition to what is constructed in Preferred Project #9. In addition, 6 to 8 recharge basins at approximately 50 to 100 acres each will be required to infiltrate stormwater.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include

- Groundwater elevation measurable objective

- Groundwater storage measurable objective
- Land subsidence measurable objectives
- Groundwater quality measurable objective

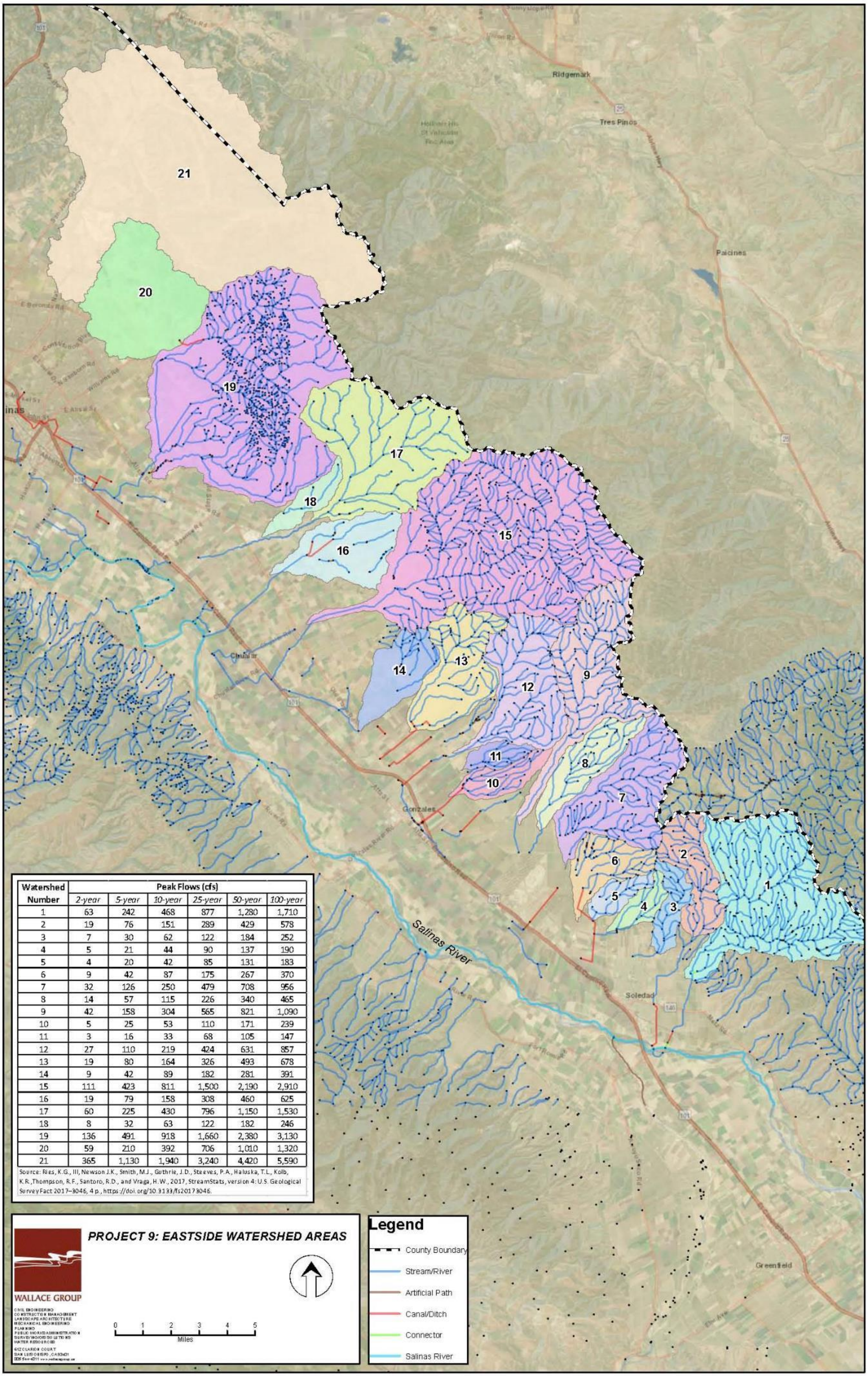
Expected Benefits and Evaluation of Benefits

There is no direct benefit from this project on the 180/400-Foot Aquifer Subbasin. This project is included here as part of the complete Valley-wide groundwater management program. The primary expected benefit of Alternative Project #2 is to provide an alternative water supply source to recharge the Eastside groundwater basin and improve water quality in Eastside groundwater basin.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between the 11043 diversion and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

The local recharge project is an alternative project, and will be implemented only if additional water is required to reach sustainability. A number of agreements and rights must be secured before the project is implemented. Primarily, a more formal cost/benefit analysis must be completed to determine if the on-farm recharge or stream diversion recharge options are preferable. If on-farm recharge is preferable, an incentive program must be developed that works with the proposed water charges framework. If the stream diversion option is preferable, water diversion rights must be secured, which may take a significant number of years.



Watershed Number	Peak Flows (cfs)					
	2-year	*5-year*	*10-year*	*25-year*	*50-year*	*100-year*
1	63	242	468	877	1,280	1,710
2	19	76	151	289	429	578
3	7	30	62	122	184	252
4	5	21	44	90	137	190
5	4	20	42	85	131	183
6	9	42	87	175	267	370
7	32	126	250	479	708	956
8	14	57	115	226	340	465
9	42	158	304	565	821	1,090
10	5	25	53	110	171	239
11	3	16	33	68	105	147
12	27	110	219	424	631	857
13	19	80	164	326	493	678
14	9	42	89	182	281	391
15	111	423	811	1,500	2,190	2,910
16	19	79	158	308	460	625
17	60	225	430	796	1,150	1,530
18	8	32	63	122	182	246
19	136	491	918	1,660	2,380	3,130
20	59	210	392	706	1,010	1,320
21	365	1,130	1,940	3,240	4,420	5,590

Source: Ries, K.G., III, Newson J.K., Smith, M.J., Guthrie, J.D., Steeves, P.A., Haluska, T.L., Kolb, K.R., Thompson, R.F., Santoro, R.D., and Vraga, H.W., 2017, StreamStats, version 4: U.S. Geological Survey Fact 2017–3046, 4 p., https://doi.org/10.3133/fs20173046.

Figure 9-28. Eastside Watersheds

Table 9-4. Estimated Eastside Watershed Runoff

Storm	Runoff (AF)	Storm	Runoff (AF)	Storm	Runoff (AF)
Watershed 1, 9600 Acres		Watershed 8, 2368 Acres		Watershed 15, 17536 Acres	
2-Year Storm	136	2-Year Storm	33.5	2-Year Storm	449.9
5-Year Storm	294.3	5-Year Storm	72.6	5-Year Storm	1,026.60
10-Year Storm	463.9	10-Year Storm	114.4	10-Year Storm	1,591.80
25-Year Storm	752.7	25-Year Storm	185.7	25-Year Storm	2,445.90
Watershed 2, 2816 Acres		Watershed 9, 5376 Acres		Watershed 16, 3264 Acres	
2-Year Storm	39.9	2-Year Storm	76.2	2-Year Storm	83.7
5-Year Storm	86.3	5-Year Storm	164.8	5-Year Storm	191.3
10-Year Storm	136.1	10-Year Storm	259.8	10-Year Storm	296.3
25-Year Storm	220.8	25-Year Storm	421.5	25-Year Storm	455.3
Watershed 3, 1152 Acres		Watershed 10, 1280 Acres		Watershed 17, 8000 Acres	
2-Year Storm	16.3	2-Year Storm	17.9	2-Year Storm	204.1
5-Year Storm	35.3	5-Year Storm	39.2	5-Year Storm	468.8
10-Year Storm	55.7	10-Year Storm	61.9	10-Year Storm	726.2
25-Year Storm	90.3	25-Year Storm	100.4	25-Year Storm	1,115.80
Watershed 4, 896 Acres		Watershed 11, 704 Acres		Watershed 18, 1024 Acres	
2-Year Storm	12.7	2-Year Storm	9.9	2-Year Storm	26.1
5-Year Storm	27.5	5-Year Storm	21.6	5-Year Storm	60
10-Year Storm	43.3	10-Year Storm	34	10-Year Storm	93
25-Year Storm	70.3	25-Year Storm	55.2	25-Year Storm	142.8
Watershed 5, 896 Acres		Watershed 12, 4672 Acres		Watershed 19, 17344 Acres	
2-Year Storm	12.7	2-Year Storm	66.2	2-Year Storm	443.2
5-Year Storm	27.5	5-Year Storm	143.2	5-Year Storm	1,016.40
10-Year Storm	43.3	10-Year Storm	225.8	10-Year Storm	1,574.40
25-Year Storm	70.3	25-Year Storm	366.3	25-Year Storm	2,419.10
Watershed 6, 1984 Acres		Watershed 13, 3904 Acres		Watershed 20, 6016 Acres	
2-Year Storm	12.7	2-Year Storm	55.1	2-Year Storm	199.1
5-Year Storm	60.8	5-Year Storm	119.7	5-Year Storm	386.3
10-Year Storm	95.9	10-Year Storm	188.7	10-Year Storm	565.2
25-Year Storm	155.6	25-Year Storm	306.1	25-Year Storm	828.5
Watershed 7, 5120 Acres		Watershed 14, 2240 Acres		Watershed 21, 25664 Acres	
2-Year Storm	72.5	2-Year Storm	31.3	2-Year Storm	854
5-Year Storm	156.9	5-Year Storm	68.7	5-Year Storm	1,647.80
10-Year Storm	247.4	10-Year Storm	108.2	10-Year Storm	2,411.00
25-Year Storm	401.4	25-Year Storm	175.6	25-Year Storm	3,534.20

Legal Authority

The SVBGSA has the right to divert and store water once it has access to the appropriate water rights. Water rights are not needed to infiltrate on-farm runoff. Section 10726.2 (b) of the California Water Code provides GSAs the authority to, "Appropriate and acquire surface water or groundwater and surface water or groundwater rights, import surface water or groundwater into the agency, and conserve and store within or outside the agency"

Implementation Schedule

The implementation schedule for the stream diversion option is presented in Figure 9-29. It is anticipated to take 11 years to implement. The on-farm recharge project may take less time to implement.

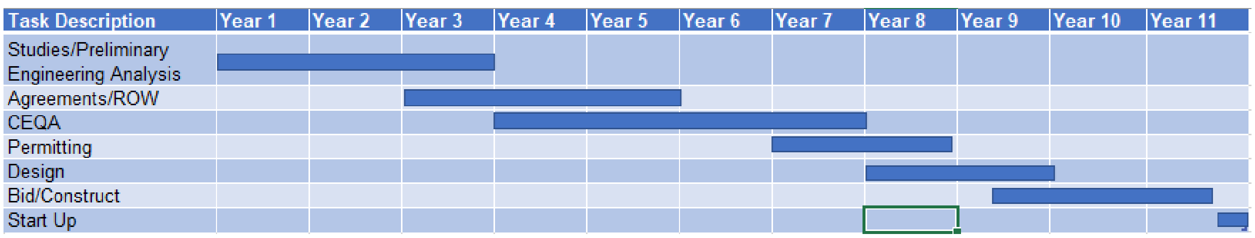


Figure 9-29. Implementation Schedule for Local Runoff with Stream Diversion Project

Estimated Cost

Estimated capital cost for the Stream Diversion option of the Recharge Local Runoff from Eastside project is estimated at $60,340,800. Annual O&M costs are anticipated to be approximately $1,261,000. The cost of water for this project is estimated at $1,709/AF. The estimated cost for the on-farm recharge option is likely less per AF, but must still be developed.

9.4.5.3 Alternative Project 3: Winter Potable Reuse Water Injection

This project would treat additional secondary wastewater effluent through an expanded Advanced Water Purification Facility (AWPF) at M1W's RTP, and injecting it into the 180/400-foot aquifer subbasin for maintenance of groundwater levels, improvement of water quality, and prevention of further seawater intrusion. This alternative project assumes the extra AWPF capacity planned under the Expanded Pure Water Monterey (PWM) project is installed, but that Cal-Am does not require the additional purified recycled water. Instead, the water could be provided to MCWRA for groundwater recharge in the Salinas Valley Groundwater Basin.

Pure Water Monterey Groundwater Replenishment Project is under construction and a Supplemental EIR for an expanded PWM Project is being considered is being developed. This supplemental EIR covers an expansion which would raise the maximum production rate at the

AWPF to 7.6 mgd. Under this expansion, the project would provide up to 5,750 AF/yr. for groundwater recharge in the Seaside Basin, 200 AF/yr. for drought reserve, and 600 AF/yr. for MCWD irrigation, for a total production of 6,550 AF/yr.

The proposed Expanded PWM project also includes associated conveyance, injection and extraction facilities. Because the project depends on M1W's use of secondary wastewater effluent as a source of feed water to the AWPF, there will be a reduction in discharge of secondary effluent to Monterey Bay

If Cal-Am does not take the AWPF water, it could be available for injection into the 180/400-Foot Aquifer Subbasin, or other subbasins in the Salinas Valley. In particular, MCWD is currently conducting a feasibility study on injecting purified recycled water into the Monterey Subbasin. The project proposes using purified recycled water available to MCWD from the AWPF, some of which is available year-round per the district's agreement with M1W, for indirect potable reuse and prevention of further seawater intrusion. This project is consistent with, and can readily be implemented in conjunction with, the winter potable reuse project.

This project would involve the treatment of an additional 2.6 mgd at the SVRP AWPF. The project assumes that M1W installs the additional facilities needed at the AWPF (e.g., additional treatment and pumping equipment, chemical storage, pipelines, and appurtenances within the existing 3.5-acre existing building area) needed to achieve a peak production rate of 7.6 mgd.

Assuming production of the purified recycled water during winter months only (November through March), the 2,250 AF/yr. would be delivered to the 180/400-Foot Aquifer Sub-Basin via a 16" diameter, 6-mile long pipeline. Water would be injected through four new injection wells west of Salinas; two back-up injection wells would also be installed. Associated injection well facilities would include backwash well pumps, backwash percolation basins, electrical power supply, and motor controls.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include:

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

The AWPF may provide up to approximately 2,200 acre-feet of water for direct recharge to the Subbasin. This project could benefit other subbasins, such as the Monterey and Eastside subbasins by potentially providing water to these subbasins for direct recharge.

Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between providing winter advanced treated water to the Subbasin and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

The recharge of winter AWPF water project is one of four alternative projects that may provide additional water to the Subbasin. The project will only be implemented after all four alternative projects have been refined. If needed, the most cost-effective project of the four will be selected to supply additional water to the Subbasin.

This project can only be implemented after the AWPF is expanded, and only if Cal-Am is not injecting the water into the Seaside Basin. This project will not proceed until all of these circumstances have been met.

Legal Authority

The SVBGSA can acquire water for recharge under California Water Code section 10726.2 (b) which give the SVBGSA authority to "Appropriate and acquire surface water or groundwater …" as well as "the spreading, storing, retaining, or percolating into the soil of the waters for subsequent use." All AWPF recharge will be done in accordance with the Division of Drinking Water's recycled water regulations.

Implementation Schedule

The implementation schedule is presented in Figure 9-30. It is anticipated to take between three and four years to implement.

Figure 9-30. Implementation Schedule for Winter Potable Reuse Water Injection

Estimated Cost

Estimated costs for the injection of winter flows from the expanded AWPF were estimated based upon a 2,250 AF/yr. available for injection during the wet weather season (November through March). Capital costs are assumed to be $35,300,000 for construction of an injection well field consisting of six wells as well as construction of a 6-mile conveyance pipeline between the AWPF site and the injection well field.

Annual O&M costs are estimated at $500,000 for the operation of the injection well field. Based on a project yield of 2,250 AF/yr., the unit cost of water is $1,450/AF. Note that the cost of water treatment through the AWPF is not included in this estimate.

9.4.5.4 Alternative Project 4: Use the Upper Portion of the 180/400-Foot Aquifer Subbasin for Seasonal Storage

Under Alternative Project 4, conventional groundwater extraction well facilities would be constructed in the upper (i.e., southern) portion of the 180/400-Foot Aquifer Subbasin to provide improved off-peak irrigation season groundwater storage and peak irrigation season supplemental water for supply and environmental needs. Due to the laterally-extensive presence of the Salinas Valley Aquitard within much of the 180/400-Foot Aquifer Subbasin, the ability to for the Salinas River to effectively recharge the most productive aquifer zones for cyclic storage and extraction is limited. However, the Salinas Valley Aquitard is less prominent farther south, eventually pinching out near Chualar. This project concept relies on the ability to place extraction wells in an area of the upper 180/400-Foot Aquifer Subbasin where the Salinas Valley Aquitard is thin to missing, thereby allowing the Salinas River to recharge at least some of the more productive aquifer zones in the winter, and extracting that water for delivery in the summer.

This project could be most beneficial for supplementing flows to the existing Salinas River Diversion Facility (SRDF) at times when instream flows are insufficient to meet SRDF diversion and/or environmental flow requirements. This project could also be combined with various conveyance schemes to deliver the produced water to groundwater deficit areas in other parts of the 180/400-foot aquifer and/or Eastside subbasins to offset coastal pumping and seawater intrusion.

The project would entail construction of traditional vertical production wells to deliver water for either direct discharge to the Salinas River downstream of the site via a short pipeline and constructed energy dissipation system for discharge to the river channel, or to a centrally-located sump, from which the water would be discharged to a coastal distribution network.

The extraction wells will only screen the 180-Foot Aquifer; accordingly, total well depths would likely not exceed 350 feet below ground surface (bgs). Three extraction wells would be installed, two as primary wells and one as a back-up well. Ideally, the wellfield would be located in close proximity to the Salinas River in order to minimize costs associated with water conveyance back to the river channel during peak irrigation periods.

For costing purposes, the extraction wells are capable of production rates up to 2,000 gpm. With two primary wells extracting water during a typical six-month irrigation season, approximately 3,000 AF would be available as supplemental water. This water, once extracted, would create a similar volume of available storage space within the aquifer system. Well spacing could be such that the seasonal drawdown would be spread over about one mile along the river.

On average, this aquifer storage volume would be recharged by percolating Salinas River flows during a typical winter high flow season. Assuming a five-month recharge period, this would equate to an average aquifer recharge rate of about 10 cubic feet per second (cfs) over the one-mile seasonal drawdown zone.

Relevant Measurable Objectives

Relevant measurable objectives benefiting from this project include:

- Groundwater elevation measurable objective
- Groundwater storage measurable objective
- Seawater intrusion measurable objectives
- Land subsidence measurable objectives

Expected Benefits and Evaluation of Benefits

The primary anticipated benefit is up to 3,000 AF of water available to the Subbasin for direct delivery and in-lieu recharge. This water could both offset coastal pumping and reduce seawater intrusion.

Reductions in groundwater pumping will be measured directly and recorded in the water charges framework database. Changes in groundwater elevation will be measured with the groundwater level monitoring program detailed in Chapter 7. Subsidence will be measured using the DWR provided subsidence maps detailed in Chapter 7. Seawater intrusion will be measured using MCWRA's existing seawater intrusion mapping approach. A direct correlation between seasonal storage of water in the upper reaches of the Subbasin and changes in groundwater levels, subsidence, or seawater intrusion is likely not possible because this is only one among many management actions and projects that will be implemented in the Subbasin.

Circumstances for Implementation

Seasonal storage of Salinas River flows is one of four alternative projects that may provide additional water to the Subbasin. The project will only be implemented after all four alternative projects have been refined. If needed, the most cost-effective project of the four will be selected to supply additional water to the Subbasin.

Significant hydrogeologic studies are necessary to substantiate the Salinas River recharge rates in the area south of Chualar to make sure that any groundwater extracted during the summer will be recharged by winter flows. Additionally, Agreements will be necessary with individual landowners to put extraction wells on their property and operate the extraction wells for the benefit of the Valley.

Legal Authority

The SVBGSA can acquire water for recharge under California Water Code section 10726.2 (b) which give the SVBGSA authority to "Appropriate and acquire surface water or groundwater …" as well as "the spreading, storing, retaining, or percolating into the soil of the waters for subsequent use"

Implementation Schedule

The implementation schedule is presented in Figure 9-31. It is anticipated to take approximately five years to implement.

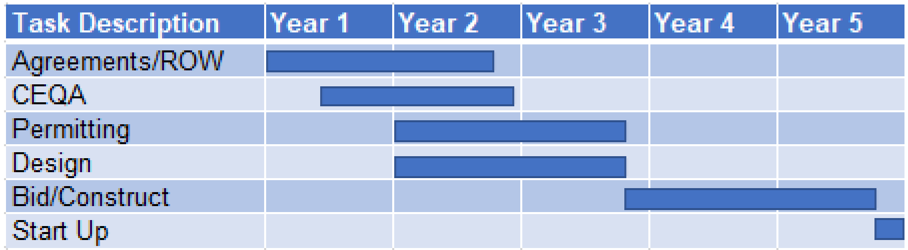


Figure 9-31. Implementation Schedule for Seasonal Storage in the Upper 180/400-Foot Aquifer Subbasin

Estimated Cost

Estimated capital cost includes well construction, well pumps & motors, wellhead piping infrastructure, land access. Estimated capital cost does not include conveyance infrastructure for direct discharge to river channel or to coastal distribution network, contingency or administrative costs. Estimated capital costs are $7,845,000. Estimated annual O&M costs are $723,000; note these costs do not include treatment. Based on a project yield of 3,000 AF/yr. of extracted water and estimated recharge volume made available, the unit cost of water is $370/AF.

9.5 Other Groundwater Management Activities

Although not specifically funded or managed by this GSP, a number of associated groundwater management activities will be promoted and encouraged by the GSAs as part of general good groundwater management practices.

9.5.1 Promote Agricultural Best Management Practices

Agricultural best management practices (BMPs) should be promoted throughout the basin to conserve water. BMPs include using efficient irrigation systems, such as drip irrigation, and replacing frost protection sprinklers with alternative frost protection methods.

9.5.2 Continue Urban and Rural Residential Conservation

Existing water conservation measures should be continued, and new water conservation measures promoted for residential users. Conservation measures may include the use of low flow toilet fixtures, or laundry-to-landscape greywater reuse systems. Conservation projects can reduce demand for groundwater pumping, thereby acting as in-lieu recharge.

9.5.3 Promote Stormwater Capture

Stormwater and dry weather runoff capture projects, including Low Impact Development (LID) standards for new or retrofitted construction, should be prioritized and implemented. The SWRP outlines an implementation strategy to ensure valuable, high-priority projects with multiple benefits. While not easily quantified and therefore not included as projects in this document, stormwater capture projects may be worthwhile and benefit the basin.

9.5.4 Support Well Destruction Policies

Properly destroying unused wells in accordance with local and state regulations prevents the migration of poor-quality groundwater between aquifers. While well destruction does not directly address the sustainable management criteria included in this GSP, controlling the migration of poor-quality groundwater allows more efficient use of existing resources.

9.5.5 Watershed Protection and Management

Watershed restoration and management can reduce stormwater runoff and improving stormwater recharge into the groundwater basin. While not easily quantified and therefore not included as projects in this document, watershed management activities may be worthwhile and benefit the basin.

9.6 Mitigation of Overdraft

The water charges framework is specifically designed to promote pumping reductions. Should adequate pumping reductions not be achieved to mitigate all overdraft, funds collected through the water charges framework will support recharge of imported water, either through direct recharge or in-lieu means. Therefore, the water charges framework in association with the projects and management actions listed in this chapter will mitigate overdraft through a combination of pumping reduction and enhanced recharge.

The historical Subbasin overdraft estimated in Chapter 6 is 12,600 acre-feet per year; the projected 2030 overdraft is 8,100 acre-feet per year, and the projected 2070 overdraft is 8,600 acre-feet per year. This overdraft can be mitigated by either reducing pumping or recharging the basin, either through direct or in-lieu means, with additional water supplies. The priority projects include more than ample supplies to mitigate existing overdraft, as presented in Table 9-5.

Table 9-5. Total Potential Water Available for Mitigating Overdraft

Project	Potential Yield (AF/yr.)
Invasive Species Eradication	6,000
Optimize CIP	5,500
Modify Monterey One Water Plant	1,100
Expand CSIP Area	9,900
Maximize Existing SRDF	11,600
Seawater Intrusion Barrier	-11,000[1]
SRDF Winter Flows	17,700
Total	**-58,201**

[1] The seawater intrusion barrier extracts 22,000 acre-feet per year, half of which comes from the inland side of the barrier

APPENDIX 9-A
ALL MANAGEMENT ACTIONS CONSIDERED FOR GROUNDWATER SUSTAINABLITY PLAN

Management Action	Description	Category
Voluntary Land Purchase/Retirement	Reduce agricultural groundwater pumping through voluntary program that compensates landowners for permanently retiring irrigated land. New land use should be for beneficial use.	
Voluntary Fallowing	Reduce agricultural groundwater pumping through voluntary program to fallow historically-irrigated land for a full year.	
Agricultural Land and Pumping Allowance Retirement	Water charges revenues may be used by the SVBGSA to acquire and retire irrigated land and/or pumping allowances (potentially including carryover credits and recharge credits) to reduce pumping. All acquisitions will be completed on a voluntary basis from willing sellers at negotiated market prices. The SVBGSA would cease irrigation on acquired land to reduce pumping.	Priority
Partial Season Irrigation	Reduce agricultural groundwater pumping through voluntary program to shorten the length of the irrigation season. In practice, this may mean growing fewer crops within a given season.	
Deficit Irrigation	Apply less water than is required for optimal yield to reduce agricultural groundwater pumping.	
Crop Conversion	Transition to less water-intensive crops to reduce agricultural groundwater pumping.	
Individual Transferable Quotas	Reduce groundwater pumping by establishing total allowable pumping allocations among individual pumpers, and authorize quota trading to minimize the economic effects of lower pumping volumes.	
Conservation Credits	Incentivize water conservation by awarding groundwater pumping credits based on reduction in use. Can be carried over for use in future years.	
Quota/Credit Buyback	Reduce annual groundwater pumping by purchasing/leasing quotas and/or conservation credits.	
Incentives for Replenishment	Offer payments and/or conservation quotas for recharge of available surface water. All or a portion of the recharge will be maintained in the aquifer.	
Land Use Restrictions/Easements	Limit future agricultural or urban groundwater pumping by restricting land use or purchasing conservation easements in targeted areas.	
Mandatory Restrictions in CSIP Area	Mandate reduced groundwater pumping in the CSIP Area by passing an ordinance preventing any pumping for irrigating agricultural lands served by CSIP.	Priority
Water Export Limitations	Limit water export from the Subbasin when it is in over-draft conditions.	
Metering/Monitoring	Measure groundwater withdrawals at individual wells to support quantification of individual transferable quotas, conservation credits, and implement withdrawal fees/tiered pricing.	
Nacimiento Water Release Management	Modify reservoir operations	
SW Education/Outreach & Municipal Enforcement	Additional education and outreach efforts for Commercial and Industrial Facilities w/ enforcement by municipalities for violators or IGP non-filers.	
Withdrawal Fees/Tiered Pricing	Charge fees per acre-foot pumped (flat, increasing block, and/or by water use type) to incentivize reductions in groundwater pumping.	
Water Conservation and Stormwater Pollution Education & Outreach	Change perceptions about water use and stormwater discharges to incentivize efficient stormwater capture.	
Fast Track Water Related Project CEQA/Permitting	Streamline permitting process to realize water enhancement projects.	
Modify watershed management practices to optimize runoff, storage and recharge	Controlled vegetation management using goat herds and prescriptive burns.	
Well and Hydrant Flushing Capture	Capture and repurpose "wastewater" associated with flushing activities.	
Forebay/Upper Valley recharge enhancements using re-operated reservoirs	Re-operate reservoirs to allow pulse flows in the Salinas River that provide additional recharge in the unconfined aquifers of the Forebay and Upper Valley.	Priority
Support and Strengthen MCWRA Restrictions on Additional Wells in the Deep Aquifer	MCWRA Ordinance 5302 restricts drilling new wells in the Deep Aquifer in an Area of Impact that is generally northwest of Davis Road. SVBGSA will work with the MCWRA to strengthen the ordinance to prevent any new wells from being drilled into the deep aquifer until more is known about the Deep Aquifer’s sustainable yield	Priority
Irrigation Efficiency	Implement on-farm technology to improve irrigation efficiency and reduce groundwater pumping.	
Municipal Water System Leak Detection & Repair	Address municipal water system losses to reduce groundwater pumping or support additional recharge. For systems w/ over 12% water loss annually. (16% is average w/ 75% generally assumed to be recoverable)	
Urban Conservation (indoor/outdoor)	Mandate or incentivize urban conservation	
Municipal Water Conservation Efforts	Widespread adoption of water-saving appliances and fixtures, along with replacement of lawns with water-efficient landscapes, may reduce total residential water use by 30-40 percent in areas not currently implementing these strategies.	
Recycled Water Incentives - Industrial Facilities	Wineries, Produce Production, Breweries, & Other water intensive industrial facility types. Recycle process wastewater and site storm water for onsite reuse.	
Artificial Turf replacement inside City Limits	Subsidize as an incentive.	
Encourage proactive agricultural practices to benefit water quality and limit evaporation	Fertilizer use efficiency/management, use of cover crops, healthy soils, vegetation treatment.	

APPENDIX 9-B
ALL PROJECTS CONSIDERED FOR GROUNDWATER SUSTAINABLITY PLAN

Project	Description	Category
Expansion of Castroville Seawater Intrusion Project (CSIP)	Expand the use of recycled wastewater for irrigation, offsetting the need for groundwater and slowing seawater intrusion. Potential source waters include agricultural wash water from Salinas' industrial ponds, Salinas' stormwater, Reclamation Ditch, Tembladero Slough, Blanco Drain and Monterey stormwater. Wastewater from additional municipalities in the Salinas Valley would increase the amount of water available to CSIP.	Preferred
Destroy 8 Wells in the 180/400-Foot Aquifer Subbasin	Destroy the highest priority wells that threaten to allow seawater intrusion to move between aquifers. This will slow or eliminate seawater migration and intrusion into the 400-foot and deep aquifers.	
Pursue Destruction of Additional 134 wells	Destroy the longer list of wells that threaten to allow seawater intrusion to move between aquifers. This will slow or eliminate seawater migration and intrusion into the 400-foot and deep aquifers.	
Seawater Intrusion Barrier - Injection Wells	Push seawater intrusion towards the coast by injecting water into the 180- and 400-foot aquifers. A number of injection wells would be required; as well as sufficient water (recycled) to supply the injection wells.	
Seawater Intrusion Barrier - Extraction Wells	Pull seawater back towards the coast by extracting saline groundwater from the 180- and 400-foot aquifers. Extracted water would either be disposed of in the ocean or desalinated for potable/agricultural use.	Preferred
High river flow capture and injection at mouth of Salinas River	Capture Salinas River water immediately prior to entering ocean and inject it into the 180 and 400 foot aquifers to reduce seawater intrusion. The stormwater may need to be temporarily held in large storage ponds located near the coast before it can be injected.	
Stormwater Capture and Treatment (Municipal)	Municipal agencies build decentralized stormwater recharge projects that increase groundwater recharge instead of allowing stormwater to flow into the Salinas River.	
Stormwater Capture and Treatment (Agricultural and Industrial)	Agricultural and Industrial users build decentralized stormwater recharge projects that increase groundwater recharge instead of allowing stormwater to flow into the Salinas River. This could be set up similarly to Pajaro Valley Water Agency's "net metered recharge" program.	
Rain Collector Dry Wells	A variation on the preceding recharge projects using dry wells instead of recharge basins.	
Installation of Small River Bed infiltration Basins	Small basins adjacent to the Salinas river that slow or retain high river flows for improved infiltration	
Aquifer Storage & Recovery in Salinas Valley	Temporarily inject and store available water in aquifers, either seasonally or during wet years, and recover water during dry season or dry years. Source of water not identified.	
Recharge local runoff from the Eastside	Recharge local runoff from the Gabilan Range and divert it to groundwater recharge basin(s) before it reaches the Salinas River.	Preferred (Move to Alternative)
Inject Diverted Carmel River Water	Use an existing water right held by MPWMD on the Carmel River for 15,000 AF/yr., transport the water to the Salinas Valley, and inject the water into the Salinas valley subbasins for maintenance of groundwater levels, improvement of water quality, and prevention of further seawater intrusion.	Alternative
Use the Upper Portion of the 180/400-Foot Aquifer Subbasin for Seasonal Storage	Conventional groundwater extraction well facilities would be constructed in the upper (i.e., southern) portion of the 180/400-Foot Aquifer Subbasin to provide improved off-peak irrigation season groundwater storage and peak irrigation season supplemental water for supply and environmental needs.	Alternative
Surface spreading or direct injection of Water Right Permit 11043 using SVWP diversions	Use Water Right 11043 to supply recharge ponds or injection wells in the North County. Water would be conveyed from the two Salinas Valley Water Project diversions. A temporary water storage system may be needed prior to injection.	
Surface spreading or direct injection of Water Right Permit 11043 using an eastside conveyance system	Use Water Right 11043 to supply recharge ponds or injection wells in the North County during high winter flow conditions using a dedicated pipeline from San Antonio Reservoir to North County. A temporary water storage system may be needed prior to injection.	
Conjunctive Use Transfer	Build groundwater pumping and conveyance facilities in mid-valley to deliver groundwater to the East Side and 180/400-Foot Aquifer subbasins to offset coastal pumping and seawater intrusion.	
Other Conjunctive Use - Small-scale near-source diversions and blending of surface water.	Divert Salinas River water at a small scale at appropriate locations in the 180/400 Foot Aquifer subbasin to blend with groundwater, reducing groundwater pumping.	
Add dry season conveyance pipeline to reduce need for dry season river flow	A significant amount of dry season river flow is lost to non-native riparian vegeatation. This water loss could be eliminated if dry season flows were conveyed in a pipeline instead of in the river.	
Extract winter flows using Radial collector(s) and inject into 180- and 400-Foot Aquifers	Divert winter flows from the Salinas River using a radial collector and inject the water into the 180/400-Foot Aquifer Sub-basin for maintenance of groundwater levels, improvement of water quality, and prevention of further seawater intrusion.	Alternative (May move to Preferred)

Project	Description	Category
Interlake Connection and Regional Water Conservation Project - Interlake Water Tunnel & San Antonio Spillway Modification	Build a tunnel that diverts water from Nacimiento Reservoir to San Antonio Reservoir, capturing high Nacimiento flows. This project is forecast to deliver up to 21,000 acre-feet per year of new water. This water could be used for Salinas River stream maintenance, delivered in lieu of groundwater pumping, or be injected as a seawater intrusion barrier. Delivering this water in lieu of groundwater pumping will require integration with one of the conjunctive use projects listed above.	
Build Jerrett Dam	The Jerrett dam site is on the Nacimiento River, upstream of Nacimiento Reservoir, on Fort Hunter Liggett Military Reservation property. The dam could be constructed to impound 145,000 acre-feet of water that could be released to the Nacimiento Reservoir. This water could be used for Salinas River stream maintenance; delivered in lieu of groundwater pumping, or be injected as a seawater intrusion barrier. Delivering this water in lieu of groundwater pumping will require integration with one of the conjunctive use projects listed above.	
Arroyo Seco Dam	Construct a dam in the Arroyo Seco River Watershed creating additional surface water storage that could be used in lieu of groundwater pumping. Delivering this water in lieu of groundwater pumping will require integration with one of the conjunctive use projects listed above. Location of this dam and reservoir is unknown.	
Identify Additional Surface Water Storage/Recharge Sites throughout Valley	Create additional surface water storage and recharge locations, such as Carr Lake.	
Groundwater recharge of recycled water	Use recycled wastewater from Monterey One Water for surface spreading or direct injection in the 180/400-foot aquifers to replace groundwater pumping.	
Optimize CSIP	Automate irrigation systems in CSIP to irrigate based on availability rather than on demand. This ensures that all CSIP water is used when it is available.	Preferred
Seasonal storage of of M1W winter effluent	Build storage for treated effluent not used during wet weather to offset pumping in dry season.	
Modify Monterey One Water Recycled Water Plant	Under the M1W Recycled Water Plant Modifications Project, the SVRP will be improved to allow delivery of tertiary treated wastewater to the CSIP system when recycled water demand is less than 5 mgd.	Preferred
Capture of wastewater from River Road and Toro and Pipe to Hitchcock	Increase wastewater availability by connecting new sources to M1W	
Discontinue WWTP Effluent to Ocean: 100% Recycling of all effluent	Recycle 100% of effluent leaving M1W treatment plant for enhanced availability of recycled wastewater to reduce pumping.	
Winter potable reuse water injection	Treat additional secondary wastewater effluent through an expanded Advanced Water Purification Facility (AWPF) at M1W's RTP, and injecting it into the 180/400-foot aquifer subbasin for maintenance of groundwater levels, improvement of water quality, and prevention of further seawater intrusion.	Alternative
Arundo Eradication Phase III	Eradicating Arundo lessens evapotranspiration, leaving more water in the aquifers and the river. Phase III, funded by an additional grant from the Wildlife Conservation Board, will treat an additional 350 acres downstream of Phase II (King City to Soledad). The goal of the program is to eradicate Arundo within 20 years (~1500 acres over 90 miles of river).	Preferred
Arundo Eradication Additional Phases	Eradicating Arundo lessens evapotranspiration, leaving more water in the aquifers and the river. Eradicate Arundo within 20 years (~1500 acres over 90 miles of river). ~1550 acres remaining after Phase III (Soledad to Coast)	
Sedimentation Clearing and Channel Management	Maximize surface water conveyance by removing sediment buildup in the river channels.	
Study additional vegetation evapotranspiration mitigation opportunities	Require vegetation with lower water uptake for all projects.	
Monterey Peninsula Water Supply Project	Take advantage of the MPWSP slant well pumping to pull seawater intrusion back towards the coast.	
Deepwater Desalination	Slow seawater intrusion by replacing groundwater pumping with imported desalinated water. Potential to produce up to 25,000 acre-feet per year. Requires a pipeline from Moss Landing.	
Brackish Water Treatment for Wellheads	Desalinate brackish well water for irrigation, reducing fresh water pumping and allowing more fresh water to push the seawater intrusion front towards the coast. The source of brackish water is still to be determined.	
Desalinate water from the seawater barrier extraction wells	Treat water extracted from the seawater intrusion barrier and allow for its reinjection in the 180-Foot Aquifer and 400-Foot Aquifer	Alternative
Improve SRDF Diversion	The SRDF Diversion improvements include installing a radial collector well to provide additional diversion capacity at the SRDF. The project includes installing additional water storage for the proposed 85 cfs capacity of the SRDF.	Preferred
11043 Diversion Facilities	Construct extraction facilities at both diversion locations and pump the water to the eastside where the water can then be infiltrated into the groundwater basin at known pumping depressions.	Preferred

Project	Description	Category
Forebay/Upper Valley recharge enhancements using Water Right Permit 11043	Use Water Right 11043 for additional stream recharge or flood plain recharge in the unconfined aquifers of the Forebay and Upper Valley.	

APPENDIX 9C: MODELING AND ANALYTICAL TOOLS FOR ANALYZING PROJECT BENEFITS

9C.1 Introduction

Chapter 9 of the GSP includes a set of projects and management actions designed to achieve and maintain sustainability in the 180/400-Foot Aquifer Subbasin over the SGMA implementation horizon. To assess the benefits of individual projects, and combinations of projects, to achieve sustainability, quantitative analyses were performed through simplified groundwater model simulations. These simulations included predicted climate change conditions with and without the proposed projects. In addition, a simplified analytical analysis was developed to evaluate the potential design for a seawater intrusion barrier and its capability to stop seawater intrusion.

A numerical groundwater flow model allows for a simplified mathematical representation of the subbasin. Estimated future flow conditions such as pumping rates and recharge rates are model inputs, and an estimate of the resulting groundwater levels and groundwater flow rates are the output from the model.

The purpose of the groundwater flow model analysis is to develop an estimate of the basin conditions after twenty years of GSP implementation for major projects identified in Chapter 9. Comparing model outputs from various future scenarios provides a means of estimating the project impacts on water levels and groundwater flow rates.

9C.2 Background

The groundwater flow model for simulating project impacts should ideally have the following characteristics:

- Model code should be open-source and publically available
- Data to develop and calibrate the model should be readily-available
- The model should have been calibrated to historical and current data

The USGS has been working closely with MCWRA and other stakeholders in the Salinas Valley since 2016 to develop the Salinas Valley Integrated Hydrologic Model (SVIHM) (MCWRA, 2017). The SVIHM is a combined groundwater and surface water flow model based on a publicly available MODFLOW model code. The SVIHM covers the entire Salinas Valley Groundwater Basin. As described by the USGS, the purpose of the SVIHM is tightly aligned with the numerical analysis needs of the GSP, including:

- Assessing water budgets, groundwater level elevations, and the extent of sweater intrusion,
- Assessing potential future conditions in the Salinas Valley, including analysis of future scenarios

The SVBGSA anticipated that the SVIHM would be the primary tool for developing water budgets and assessing project impacts for the 180/400-Foot Aquifer Subbasin GSP. The USGS and MCWRA both believed that the SVIHM model would be completed and available for the GSP, and the SVBGSA entered into an agreement with MCWRA and USGS to use the SVIHM model for GSP development. However, due to unforeseen circumstances, the SVIHM was not available for developing the180/400-Foot Aquifer Subbasin GSP. The USGS did provide a version of the SVIHM to estimate the future water budgets with climate change assumptions. However, this model was not available for assessing project impacts.

Because the SVIHM was not available, the SVBGSA developed a simpler modeling tool for assessing projects and actions. Although the SVIHM remains the preferred model for long-term use by the SVGSA for GSP implementation, the GSP deadline for the 180/400-Foot Aquifer Subbasin GSP required that an alternative model be developed quickly as a screening tool for purposes of assessing project benefits. This screening tool, referred to as the North Salinas Valley (NSV) Model, is a simplified alternative model that is limited to the northern portion of Salinas Valley, and is only intended to be an initial screening tool to evaluate certain individual and combined projects and actions on the 180/400-Foot Aquifer Subbasin.

When the SVIHM model is released for use by the USGS, the SVBGSA will use the SVIHM to confirm and reassess the water budgets and project benefits for the 180/400-Foot Aquifer Subbasin. The SVBGSA expects that the SVIHM will be available sufficiently in advance of the January 2022 deadline for the other Salinas Valley subbasin GSPs, and therefore the SVIHM model will be used develop the other subbasin GSPs and integrate the proposed projects in a valley-wide, programmatic approach.

9C.3 NSV Groundwater Model Description

Recognizing that the SVIHM will be used when it becomes available, the approach to developing the NSV model was to keep the model simple and to rely on previously developed models for the model input data.

The NSV Model uses the MODFLOW 2000 model code (Harbaugh et. al, 2000), a public domain finite-difference model code developed by the USGS that is widely used and well documented. The model was developed using the Visual MODFLOW graphical user interface (Waterloo Hydrologic, version 4.6.0.168) for ease of data manipulation and output visualization.

9C.3.1 Model Domain

Figure 9C-1 illustrates the model domain and the distribution of active cells in relation to the 180/400-Foot Aquifer Subbasin, other subbasins of the northern Salinas Valley, Monterey Bay, and the bounding mountains. Although the results of model simulations are only needed for the 180/400-Foot Aquifer Subbasin, the model was constructed across the entire valley width because some of the subbasin boundaries are transitional, or not easily defined hydrogeologic boundaries. Therefore, the model includes all of the Eastside, Langley, Monterey, and Seaside subbasins. A small strip of the Forebay subbasin is included to ensure that the entire southern boundary of the 180/400-Foot Subbasin is included in the model.

The finite difference grid varies in cell dimensions range from approximately 50 ft to 2,600 feet (Figure 9C-1).

9C.3.2 Model Layers

The NSV Model uses 8 model layers to represent the full aquifer thickness of the northern Salinas Valley. Figure 9C-2 shows a simplified diagram illustrating the model layers and the hydrostratigraphic layers they represent. Model layer 1 is used only to represent sea level in the area of Monterey Bay and is inactive through the rest of the model. Model layers 2, 4, 6, and 8 represent the Shallow water-bearing sediments, the 180-Foot Aquifer, the 400-Foot Aquifer, and Deep Aquifers respectively. Model layers 3, 5, and 7 represent the intervening aquitards between water bearing zones.

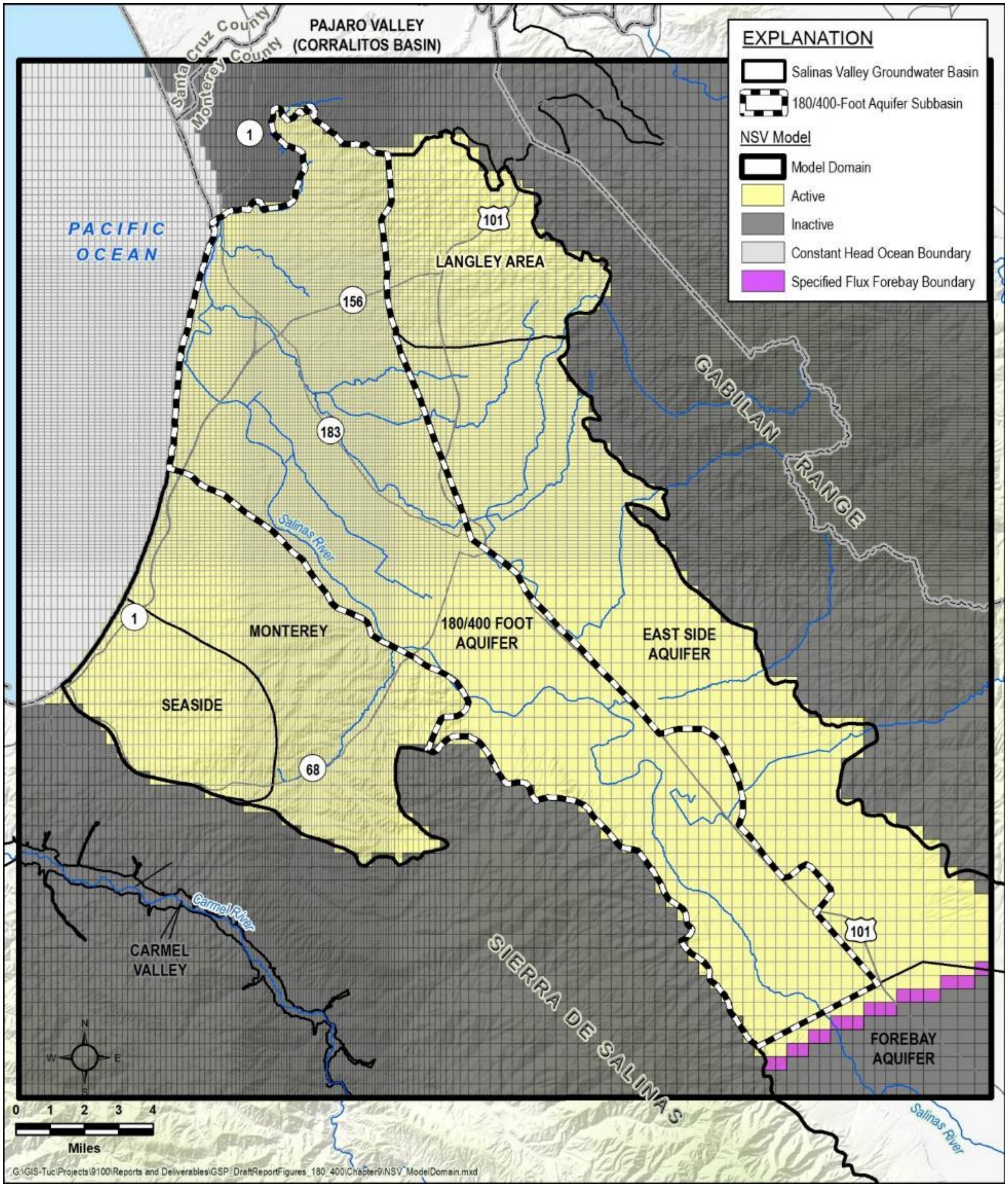
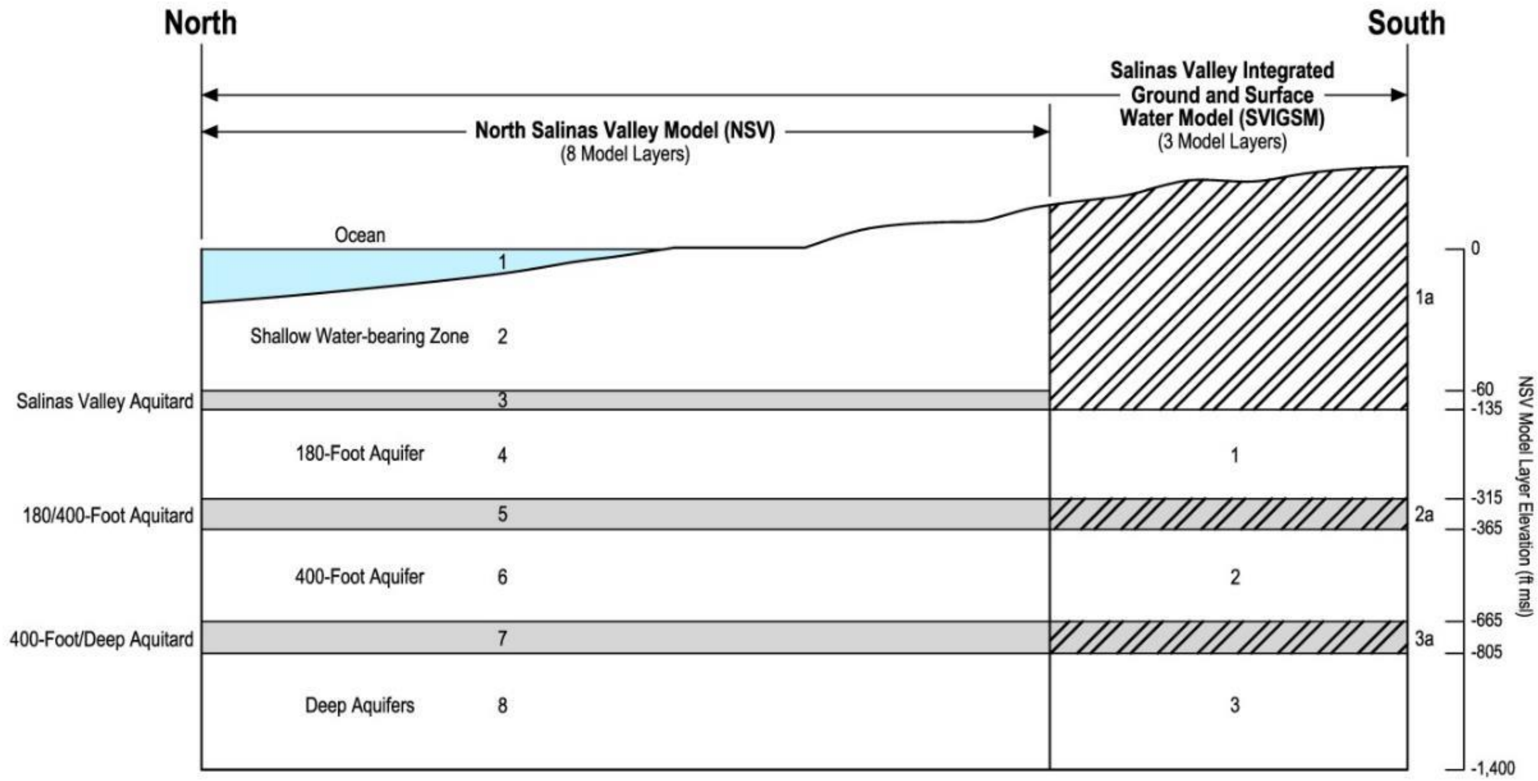


Figure 9C-1. NSV Model Domain and Boundary Conditions



Note: Numbers indicate model layer.
SVIGSM "a" model layers have the vertical hydraulic conductivity and thickness input into the model
Not drawn to scale

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Figure 9C-2: Simplified Diagram of Model Hydrostratigraphic Layers (modified from Geoscience, 2015).

9C.3.3 Hydrogeologic Properties

The model layering and assigned material properties of the NSV model are based on the North Marina Groundwater Models (NMGWM) that were developed by Geoscience (2015) and Hydrofocus (2017) and the SVIGSM model that was updated by Luhdorff and Scalmanini Consulting Engineers (LSCE, 2015) for the Monterey Peninsula Water Project (Environmental Science Associates [ESA], 2015 and 2018). Table 9C-1 summarizes the hydraulic conductivity distribution in the NSV model.

Table 9C-1: NSV Model Hydraulic Conductivity Distribution

Layer	Location	Horizontal Hydraulic Conductivity (feet/day)	Vertical Hydraulic Conductivity (feet/day)
1	Ocean	100	100
2	Shallow Water-bearing Zone	25	0.65
3	Salinas Valley Aquitard	5	0.055
4	180-Foot Aquifer in the 180/400-Foot Aquifer Subbasin	100	0.45
4	180-Foot Aquifer in the East Side Subbasin	10	0.1
5	180/400-Foot Aquitard	7.5	0.075
6	400-Foot Aquifer in the 180/400-Foot Aquifer Subbasin	70	0.7
6	400-Foot Aquifer in the East Side Subbasin	15	1.5
7	400-Foot/Deep Aquitard	2.75	0.0275
8	Deep Aquifers – basin center	37.5	0.275
8	Deep Aquifers – basin margins	10	0.1
2,4,6, and 8	Border between 180/400-Foot Aquifer Subbasin and East Side Subbasin	1	0.1

9C.3.4 Model Boundaries

The model's boundary conditions are based on the hydrogeologic conceptual model for the 180/400-Foot Aquifer Subbasin and are illustrated in Figure 9C-1:

- The southern boundary of the model has a specified flow boundary in layers 4 and 6, representing the northern flow of groundwater from the Forebay Subbasin into the 180/400-Foot Aquifer and the East Side Subbasins. The groundwater flow across this boundary was initially set at a constant annual rate based on average flows from the SVIHM future water budget. The groundwater was later adjusted to match observed water levels as described below.
- The eastern and western boundaries of the model are no-flow boundaries reflecting the negligible flow of groundwater into the basin from the mountain fronts.
- The northern boundary of the model corresponds to the coastline of Monterey Bay and is simulated by specifying a constant water level of 0.5 ft MSL for of the cells in model layer 1 over the Monterey Bay. The representation allows the seawater intrusion flux to be dependent on water levels in the groundwater basin.

The SVIHM includes internal boundaries that divide the model into subareas known to as farms. In this usage, the word farm does not necessarily imply a particular owner, crop type, or land use. Rather, the word farm is used to identify an area for which the model produces a unified water budget. The SVIHM includes 31 farms; 19 of those intersect the NSV model, as shown in Figure 9C-3. Farm ID 31 represents the Monterey Bay area within the model domain.

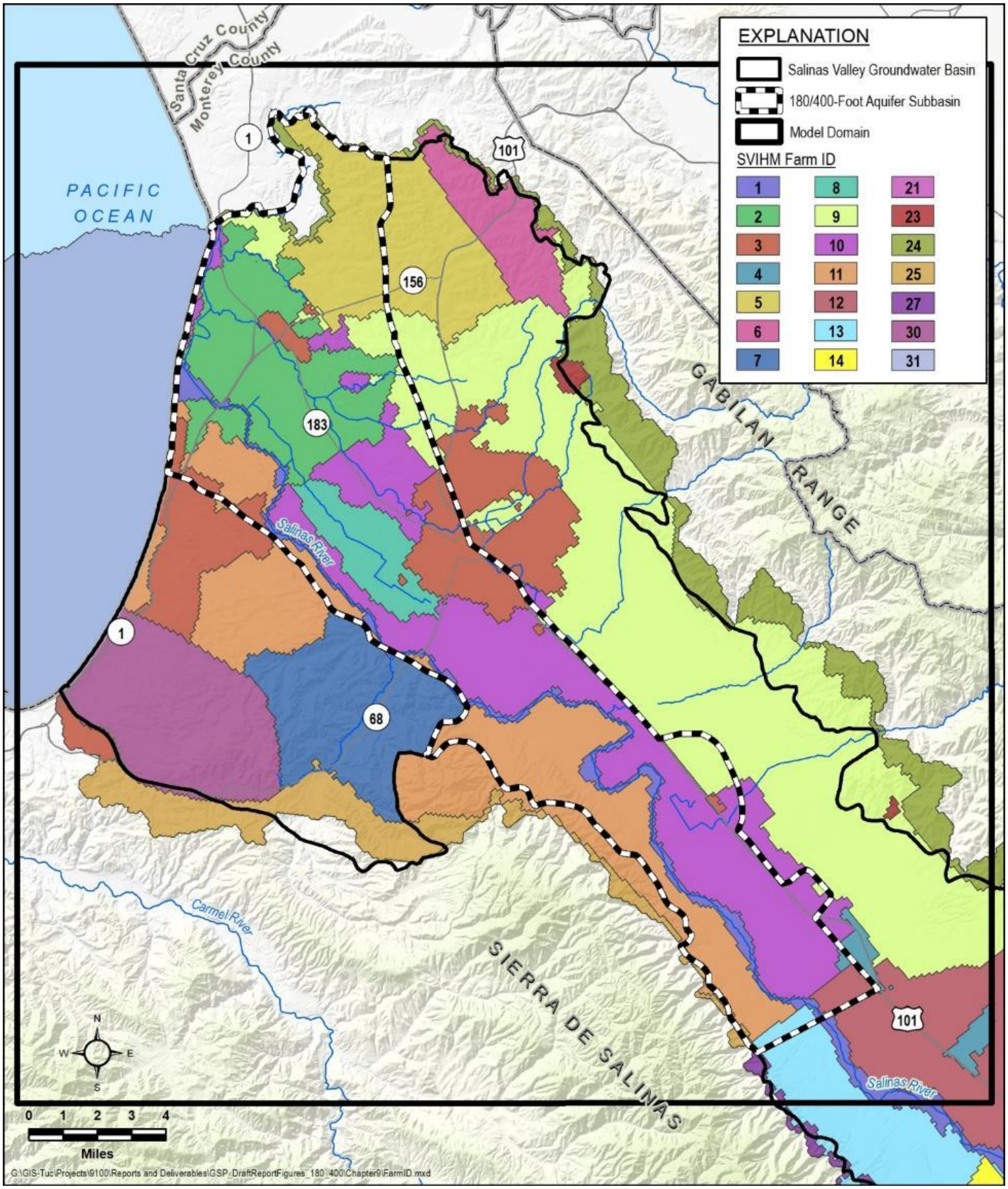

Figure 9C-3. Map View of Farm IDs Within the NSV Model

9C.3.5 Pumping and Recharge

Pumping and recharge values in the NSV model represent average projected baseline conditions. The distributions of pumping and recharge in the model were based on values exported from a version of the SVIHM operational model that incorporates estimated climate change adjustments for the year 2030. For the simplified NSV Model, all pumping and recharge was simulated as constant values reflecting the averages of the 47-year modeling period of SVIHM. Although SVIHM is not yet available for use in simulating the project benefits on a fully transient basis, the estimated pumping and recharge rates in SVIHM were considered the most applicable available estimates for use in the NSV model. The NSV model applies the average annual pumping and recharge rates to 50 annual stress periods representing 50 years of projected conditions.

Groundwater pumping rates were input to the model in two groups to differentiate agricultural and municipal pumping estimates:

- Agricultural pumping rates were estimated using the SVIHM model. This model uses the USGS Farm Package that generates net pumping rates per acre based on land use and crop type. Pumping per acre is specified for each farm ID. Figure 9C-3 illustrates the farm ID designations used in the model input.

- Specified individual municipal wells were input at specific locations and depths in the model with a specified pumping rate for each well based on historical pumping records. These wells are in addition to the groundwater pumping represented by the farm ID pumping, and represent the known pumping for urban use from both municipal and industrial sources.

- Domestic pumping estimates are considered negligible and are not included in the model.

Groundwater recharge was input to the model in two ways:

- The same farm ID designations used for input of pumping were used to specify average annual areal recharge rates per acre, with a specific value assigned to each farm ID based on land use. These recharge estimates were derived from SVIHM output. This recharge value represents the combined influences of precipitation, excess irrigation, and leaking pipelines.

- Salinas River recharge was specified as an averaged per acre value along the Salinas River riparian corridor. A total recharge rate of 70,000 AFY was specified for the Salinas River, based on the average value estimated in SVIHM for the projected water budget.

Farm ID 1 represents the riparian corridor and was used to input the river recharge rate into the model.

Table 9C-2 shows the average annual pumping and farm recharge rates by Farm ID.

Table 9C-2: Average Annual Pumping and Recharge Values by Farm ID

Farm ID	Municipal Pumping (AFY)	Farm (agricultural) pumping (AFY)	Farm Recharge (AFY)
1	0	0	2,400
2	819	6,500	13,400
3	35,600	0	900
4	3,500	0	24
5	1,600	110	5,700
6	130	90	1,800
7	1,000	440	2,300
8	0	7,300	4,300
9	1,800	55,000	35,000
10	3,100	50,000	27,000
11	6,600	10,500	9,900
12	426	4,500	2,300
13	0	2,300	1,200
21	76	110	69
23	0	0	86
24	0	0	340
25	100	2	960
27	0	0	20
30	2,300	0	3,400
Total	**57,200**	**136,400**	**111,800**

Note: values are rounded to the nearest 100 AFY, and do not necessarily add up to the shown totals.

9C.3.6 Model Adjustments

After the model was constructed based on the NMGWM layering and material properties, and the pumping and recharge rates were input from the SVIHM, the model was run with starting water level conditions approximated to the water level contours of Fall 2017. Based on this initial model simulation, the groundwater flow entering the model at the southern boundary was adjusted to 10,000 AFY so that the simulated water levels were approximately in equilibrium with the observed water levels. No other model calibration was performed.

9C.4 Projects and Actions Simulations

The NSV model was used to simulate the effects of potential projects on the Subbasin and develop quantitative estimates of the potential benefits of the projects. Although the GSP anticipates implementing multiple projects to achieve and maintain sustainability, the initial analysis of project benefits is performed on each project individually to assess relative benefits of each project. All of the CSIP improvement projects were combined into a single simulation.

The benefit of each project was estimated by comparing a project simulation to a baseline, no-project simulation and quantifying the differences in water levels and seawater intrusion rates due to the project. The baseline simulation was the same for all projects. Each project was then simulated with specific modifications to the recharge and pumping inputs to create a simple approximation of the project.

For each project, the potential benefit of the project was quantified by two metrics:

- Maps of the difference in water level between the project and baseline simulations
    - At a model simulation period of 20 years
    - Maps generated for each of the 180-ft and 400-ft aquifer model layers
- The difference in seawater intrusion between the project and baseline simulations
    - At a model simulation period of 20 years
    - Flux into the subbasin at the coastline using a zone budget analysis

Table 9C-3 summarizes the project simulations for each of the simulated projects.

Table 9C-3: Simulation of Project Benefits

	Simulated Project/Scenario	Simulation Approach
1	Invasive Species Eradication	Increase groundwater recharge by 12,000 AFY in Farm ID 1 (riparian corridor)
2	All projects within current CSIP area	Turn off all groundwater pumping in Farm ID 2 (CSIP Area) – 7,300 AFY (6,500 AFY from agricultural and 820 AFY from municipal pumping)
3	CSIP Expansion	Turn off all pumping in Farm ID 2 and Farm ID 8 (total of 14,600 AFY)
5	Salinas River Diversion at Chualar (11043 Water Rights)	Inject 5,000 AFY in the portion of Farm ID 3 (City of Salinas) that is in the East Side Subbasin
6	Salinas River Diversion at Soledad (11043 Water Rights)	Inject 5,000 AFY in southern half of Farm ID 9 (East Side Subbasin)
7	SRDF Winter Injection	Inject 8,000 AFY to Farm ID 10 (180/400-Ft Aquifer Subbasin) and 8,000 AFY to portion of Farm ID 3 in the Monterey Subbasin

The anticipated CSIP expansion area for simulations 3 does not correspond to a specific Farm ID in the model. Farm ID 8 was used to simulate CSIP Expansion because it is in the approximately correct location in the basin and the total pumping rate of 7,300 AFY is approximately equal to the anticipated impact of the CSIP Expansion project.

9C.5 Seawater Intrusion Barrier Evaluation

A seawater intrusion barrier could be designed to either to extract groundwater and produce a hydraulic trough that would intercept seawater intrusion, or to inject groundwater and produce a hydraulic mound that would block seawater intrusion. A barrier project would transect the 180/400-Ft Aquifer Subbasin and the Monterey Subbasin, with an estimated length of 8.5 miles and approximately 75% of the barrier within the 180/400-ft Aquifer Subbasin.

A full evaluation of the barrier sizing in consideration of other projects will require use of the full transient SVIHM model. For the initial estimation of barrier size and cost, the seawater intrusion barrier project was evaluated using analytical methods with the goal of estimating the well spacing and flow rates needed for a hydraulic barrier to prevent seawater intrusion.

The seawater intrusion barrier sizing was developed in the absence of any of the other future projects included in the GSP. The effect of the other projects would be to improve the water balance in the Subbasin and decrease the rate of seawater intrusion, thereby decreasing the flow required at the barrier.

An extraction barrier was evaluated using the analytical solution published by Javandel and Tsang (1987). This solution uses the ambient hydraulic gradient, aquifer transmissivity, and pumping rate per well to calculate the optimal distance for three or more wells on a line to prevent water from flowing between the wells. The hydraulic gradient is based on MCWRA Fall 2017 groundwater contours: 0.0006 in the 180-ft aquifer and 0.001 in the 400-ft aquifer. Transmissivity is based on values in the NSV model: 18,000 ft^2/day in the 180-ft Aquifer and 21,000 ft^2/day in the 400-ft Aquifer.

Using these input values, an 8.5-mile long barrier requires total extraction of approximately 30,000 AFY to produce a trough that prevents flow of groundwater through the barrier. This would require extraction of approximately 22,500 AFY from the 180/400-Ft Aquifer Subbasin, with 7,500 AFY from the 180-ft aquifer and 15,000 AFY from the 400-ft aquifer.

The extraction rate for each well is a function of the well spacing and can be adjusted to fit design requirements for the final barrier. For example, an extraction barrier with 9 wells spaced 5,000 feet apart would require approximately 700 gpm per well in the 180-ft aquifer and 1,400 gpm per well in the 400-ft aquifer. For a barrier with 22 wells spaced 2,000 feet apart, the rates per well would decrease to approximately 300 gpm in the 180-ft aquifer and 600 gpm in the 400-ft aquifer.

The injection barrier was evaluated using the Theis equation and the principle of superposition to estimate the height of mounding produced by a line of several injection wells. The Theis equation was used to estimate the height of hydraulic mounding as a function of distance from a single injection well and then the estimated mounding height at each distance along the barrier was estimated as the sum of the influences from all the wells in the barrier.

Input for this analysis required a designation of the height of the mounding, transmissivity, storage coefficient, pumping rate per well, and an estimated time to reach equilibrium conditions. The minimum mounding height was estimated to be 6.75 ft for the 180-Ft Aquifer and 13.75 ft for the 400-Ft Aquifer in order to compensate for seawater density and the depth of the aquifers below sea level. Transmissivity values of 18,000 ft^2/day for the 180-Foot Aquifer and 21,000 ft^2/day for the 400-Foot Aquifer, and storage coefficient of 0.003 are based on the NSV model. The time to equilibrium mounding was estimated as 30 days. Based on these input parameters and an 8.5-mile barrier with 9 wells (5,00-ft spacing), the estimated injection rate is approximately 46,000 AF/yr., with 34,500 AF/yr. of injection in the 180/400-ft Aquifer Subbasin; divided into 8,700 AF/yr. in the 180-Foot Aquifer and 25,500 AF/yr. in the 400-Foot Aquifer).

9C.6 References

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