

Chapter 1

Salt Management Plan History and Overview

1.1 Introduction

Zone 7 has prepared this Salt Management Plan to serve as a cornerstone of Zone 7's overall groundwater management efforts. This Salt Management Plan (SMP) identifies and evaluates all significant salt loading to, and removal from, the groundwater basin. This plan is intended to be used by Zone 7, other local agencies and regulators to determine the anticipated effects of various actual and proposed projects on the water quality of the Livermore-Amador Valley surface water and groundwater resources.

This SMP was developed over a period of several years through a cooperative effort involving Zone 7 staff, Zone 7 consultants, a Technical Advisory Group (TAG) comprised of local potable water retailers, and the Groundwater Management Advisory Committee (GMAC). This SMP was developed in accordance with the Master Water Recycling Permit and Basin Plan guidance and requirements. As part of the SMP effort, Zone 7 staff developed additional surface and groundwater monitoring and modeling tools that validated prior methodologies for calculating salt loading inputs to, and exports from, the main groundwater basin. The models also provided the capability to more accurately project potential impacts on both groundwater at municipal well sites and delivered water quality for alternative operational strategies.

This chapter presents a brief history of the SMP and the regulatory framework behind it. This is followed by a summary of the 1992 Water Recycling Study that identified the basic SMP concept in the context of maintaining sustainable groundwater quality while facilitating recycled water projects. The chapter concludes with a brief description of the contents of the remaining eleven chapters in this SMP.

1.2 SMP History and Regulatory Framework

The Zone 7 Water Agency serves as the overall water quality management agency for the Alameda Creek Watershed above Niles. Zone 7 has the primary responsibility for managing the Livermore-Amador Valley surface and groundwater resources. It has historically managed the main groundwater basin (main basin) by maximizing surface water deliveries, artificially recharging the Main Basin with low total dissolved solids (TDS) imported surface water, restricting groundwater pumping, and restricting wastewater disposal and water recycling within the watershed. This historic management strategy, implemented by Zone 7 staff through the annual water operations plan, has been successful in maintaining a sustainable and reliable water supply.

However, as in other arid areas that rely on imported water for a significant portion (75-85%) of the local supply, this strategy has allowed a gradual, but continuing degradation in groundwater mineral (salts) quality. Salts have been accumulating in the Main Basin due to these management practices, irrigation, and natural sources at a long-term average net salt loading rate of approximately 2,200 tons/year. The 2,200 tons per year, which is projected to increase to 5,400 tons per year by the year 2010 or sooner, is equivalent to about a 10 mg/L per year increase in TDS in the groundwater. The 5,400 tons per year does not include potential loadings from new agricultural irrigation projects or recycled water irrigation projects.

Recycled water represents a significant potential resource for the Valley. While opportunities for such beneficial reuse have been studied extensively over the past 30 years, few projects have been implemented. This is due in large part to the fact that recycled water contains two to three times the amount of salts (TDS) as does typical Zone 7 treated water and concerns about the additional salt loading impacts on the Main Basin.

Zone 7, Livermore, and Dublin San Ramon Services District (DSRSD) conducted a Valley-wide water recycling study (*Livermore-Amador Valley Water Recycling Study - May 1992*) that found that properly treated recycled water can provide a safe and cost effective source of additional water supply and wastewater disposal for the Valley. The study also found that use of demineralized recycled water could also help improve the salt balance and groundwater quality.

Zone 7 subsequently adopted Resolution No. 1548 which affirmed the conclusions of the May 1992 Water Recycling Study and stated Zone 7's intent to work cooperatively with Livermore, DSRSD, and other entities to encourage the proper and orderly development of water recycling projects and thereby avoid degradation of groundwater quality.

The Regional Water Quality Control Board (RWQCB) in December 1993 issued the Master Water Recycling Permit (Order No. 93-159) to Zone 7, DSRSD, and Livermore. The Master Permit specifies the requirements to be met prior to implementation of additional recycled water irrigation or recycled water groundwater recharge projects in the Valley. The key Permit requirement is for development and implementation of a Salt Management Plan to fully offset both current salt loading and any future salt loading associated with recycled water use. SMP requirements include defining basin characteristics, refining salt balance calculations, identifying water quality objectives, developing a SMP monitoring program, evaluating alternative salt management tools and strategies, and developing a SMP implementation plan and schedule.

The RWQCB Water Quality Control Plan (Basin Plan) contains water quality objectives (WQO) for the surface water and groundwater in the Valley. Water quality objectives are set by the RWQCB to protect beneficial uses of water of the State. The groundwater TDS objective is defined as ambient or 500 mg/L, whichever is lower. The 500 mg/L WQO is based on the USEPA and California Department of Health Services (DHS) drinking water

secondary Maximum Contaminant Level (SMCL) value for potable supplies. Ambient conditions are defined as the water-bearing zone with the highest quality water.

The Basin Plan Implementation Plan describes in detail the RWQCB's programs and specific plans of action for meeting WQOs. The Basin Plan has a specific section devoted to the Livermore-Amador Valley (p. 4-21 to 4-23). That section summarizes the conclusions of the 1992 Master Water Recycling Study and the content and requirements of the 1993 Master Water Reuse Permit. General policy guidance regarding the SMP is provided in the Basin Plan where it is noted that the SMP will be developed "*based on the concept that the effect of each individual project is best assessed in the context of the cumulative effects of all such projects, as well as the effects of groundwater management policies and natural conditions.*" The Basin Plan also supports the SMP use of a "*mass-balance approach for assessing cumulative impacts.*" This has commonly been called the "salt bubble" approach. A small area of salty water above "ambient" would be acceptable if offset by areas of non-salty water.

Additional Basin Plan guidance (p. 4-23) states that the SMP define "*a project or set of projects that will:*

- *Minimize the current trend toward increasing Main Basin groundwater salinity due to subsurface groundwater inflow or natural recharge;*
- *Fully mitigate the effects of salt loading due to water recycling on the Main Basin groundwater resource;*
- *Ensure that water imports and water recycling will not contribute to the degradation of groundwater quality; and*
- *Protect groundwater beneficial uses."*

The Basin Plan Implementation Plan (p. 4-21) acknowledges the balancing of uses that needs to occur in managing the Livermore-Amador Valley groundwater basin:

"... The Regional Board supports efforts to concurrently improve the salt balance in the Main Basin, to improve the local water supply, and to reduce the need for wastewater export through recycled water irrigation, groundwater recharge, and other basin management practices."

Other policy guidance relative to salt management is provided in the State's non-degradation policy, SWRCB Resolution 68-16. This Resolution independently requires that existing water quality not be degraded so as to unreasonably impact beneficial uses. As excerpted below:

"...existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." Controllable sources and discharges including recycled water use are to be controlled to assure that "*the highest*

water quality consistent with maximum benefit to the people of the State will be maintained.”

Irrigation related impacts on groundwater quality are recognized as different from impacts of other constituents. A separate section of the Basin Plan (p. 4-35) provides additional guidance on interpreting the non-degradation policy relative to irrigation impacts where it notes:

“An increase in the concentration of soluble salts contained in percolation irrigation water is an unavoidable result of consumptive use of water.” ...

“Maintenance of a favorable salt balance, that being a reasonable balance between the import and export of salts from individual basins, must be considered to control increases in mineral content. This is especially applicable for the Livermore and Santa Clara Valley groundwater basins.”

“The ultimate consequences of regulatory action for irrigation operations must be carefully assessed. The “no-degradation” concept in connection with salt levels is not appropriate in all circumstances.”

“A concept of minimal degradation might be considered in some areas. It would need to be coupled with management of the surface and underground water supplies in order to assure acceptable degradation effects.”

1.3 Valley-Wide Water Recycling Study and Master Permit

Since the 1960's both the water and wastewater agencies in the Livermore-Amador Valley independently studied water recycling, focusing on landscape and agricultural irrigation. The volume of water recycling at that time was limited, primarily because of concerns over its impact on groundwater in the Valley's Main Basin. Of particular concern were soluble constituents such as TDS and nitrate. The Valley's interest in protecting the groundwater also dates back to the 1970's, when in-basin disposal of secondary-treated wastewater was practiced. Until 1980, the City of Pleasanton used spray-irrigation to dispose of treated effluent, the City of Livermore discharged filtered secondary effluent to Arroyo Las Positas and used percolation ponds and spray irrigation, and the Dublin San Ramon Services District (DSRSD) discharged treated effluent to the Alamo Canal which subsequently flows into the Arroyo de la Laguna and Alameda Creek.

Numerous studies of alternative wastewater treatment and disposal alternatives were conducted during the 1970's given concerns over impacts of on-going and proposed future wastewater discharges on the groundwater basin and on downstream (Niles Cone) beneficial uses. These studies and related investigations led to the San Francisco Regional Water Quality Control Board (RWQCB) to include in the 1975 Basin Plan TDS and chloride water quality objectives for the surface waters of the Alameda Creek watershed above Niles to protect the waters from degradation by controllable sources. A 250 mg/L

90-day arithmetic mean TDS objective was set based on the calculated long-term average concentration of the imported surface water brought into the Valley and released into the Arroyos to recharge the Main Basin and the Niles Cone. It was also set to serve as basis for prohibiting wastewater discharges to surface waters.

These objectives could not be achieved most months of the year in surface waters that were impacted by wastewater discharges. These objectives led the various disposal and reuse studies to focus on options for advanced treatment (demineralization) or export to San Francisco Bay. The 1970's studies and Basin Plan objectives led to construction of the Livermore Amador Valley Water Management Agency (LAVWMA) export pipeline that transported all treated municipal effluent from Livermore and DSRSD to a deepwater outfall in San Francisco Bay south of the Oakland airport. Export of the Valley's treated effluent to San Francisco Bay via LAVWMA began in 1981.

During the 1970's, increasing development was occurring and developers were proposing to build packaged wastewater treatment plants with onsite effluent disposal. Concerns over the adverse water quality impacts, particularly from salts and nitrates resulting from such practices, led to development of the *Zone 7 Wastewater Management Plan*. This 1982 plan prohibited the use of packaged treatment plants and required effluent applied above the Livermore-Amador Valley Main Groundwater Basin to have no more than 250 milligrams per liter total dissolved solids and less than 10 mg/L nitrates. The plan also included groundwater quality objectives of ambient or 500 mg/L, whichever is lower for the Main Basin based on non-degradation and compliance with the secondary Maximum Contaminant Level (MCL). The San Francisco Bay Regional Water Quality Control Board incorporated these plan objectives and policies into the *1984 Basin Plan*.

The 1975 Basin Plan, and subsequent Basin Plans, contained the following statement: *“Wastewater discharges that cause the above surface water limits to be exceeded may be allowed if part of an overall water-wastewater resource operational program developed by those agencies affected and approved by the Regional Board.”* The Regional Board considered the 1982 *Wastewater Management Plan* to fulfill in part the requirement for a *“water-wastewater resource operational program.”* This SMP was developed in part to fulfill this requirement.

In 1989, recognizing the limit to water resources, Zone 7, DSRSD and the City of Livermore formed an ad hoc Tri-Valley Task Force on Water Recycling. The task force had a broad-based membership that included business, development and community leaders. Review of water recycling projects already being conducted elsewhere led to the acknowledgment and acceptance of water recycling as a viable water resource component for the Valley. The task force concluded that a regional water recycling study was needed and recognized the value of a “master water reuse permit.”

In early 1991, to implement the recommendations of the Tri-Valley Task Force, the Zone 7 Water Agency initiated a wide-ranging water recycling feasibility study in conjunction with DSRSD and Livermore. The study identified a feasible water-recycling

program for the entire Livermore-Amador Valley that had the potential to meet future water demands as well as enhance groundwater quality.

The comprehensive *Livermore-Amador Valley Water Recycling Study* was completed in May 1992. It is a planning level study that looked at the prior 20 years of effort and looked at how agency or project linkages could be made to facilitate a Valley-wide recycling program. The study noted that two principal changes had occurred to make water recycling in the Valley potentially more attractive than in the past. The first was the acknowledgment that water resources in California were becoming increasingly scarce. Opportunities to implement major water resources development projects were viewed as limited. Even during non-drought periods, water supplies are stressed. During periods of drought, Zone 7 does not receive its contractually committed allocation of water from the State Water Project. Potential shortfalls in water supply early in the next century were identified.

The second reason for increased interest in water recycling was that reverse-osmosis treatment was no longer considered an innovative or experimental treatment process but a “conventional” one. The cost of operating reverse osmosis (RO) treatment facilities also had improved, making it a potentially economically viable option for water supply in the Livermore-Amador Valley. The improved technology and economy of advanced treatment processes provided additional water recycling options for the Livermore-Amador Valley in the 1992 study.

Two advisory groups reviewed the work products during the study and provided suggestions and recommendations at key milestones. The Technical Advisory Group (TAG) consisted of staff members from the County of Alameda, Alameda County Water District, DSRSD, the cities of Livermore and Pleasanton, the Regional Water Quality Control Board and Zone 7. The Policy Advisory Group (PAG) consisted of the TAG and members of the governing boards or councils from sponsoring agencies (DSRSD, City of Livermore, RWQCB and Zone 7).

Study Objective

The primary objective of the study was to “investigate the feasibility of water recycling in the Livermore-Amador Valley while continuing to protect and enhance the water resources in the Main Groundwater Basin.” To meet this objective, the *Livermore-Amador Valley Water Recycling Study* consisted of a number of major tasks:

- The water recycling investigations in the Valley that were completed since the 1970's were reviewed and documented in technical appendices.
- The potential role of recycled water in meeting water supply needs was identified. Potential groundwater recharge methods were investigated and identified. Groundwater management and maintenance of groundwater quality were also addressed.

- An assessment of the market for direct non-potable reuse of recycled water was made. Specific water recycling alternatives were developed and evaluated. Key potential projects were identified.
- The permitting requirements and institutional/policy considerations were identified and reviewed. An implementation “plan” was developed.

The study “determined that water recycling--through groundwater recharge and direct (non-potable) reuse--is a viable method of supplementing limited water supplies in the Valley and that it can assist in meeting wastewater disposal needs as well. The steps for project implementation have now been identified.” The Executive Summary of study report provides the key findings. Chapter 10 of the study report outlines the implementation “plan.”

Project Alternatives

Two main water reuse categories were studied:

- Landscape irrigation through direct reuse
- Groundwater recharge for municipal use, including indirect potable reuse

Eleven separate projects were initially identified. Seven of the project alternatives were evaluated in detail and three were recommended as “key” projects that would be the basis for developing a long-term water recycling program for the Valley. Capital and operation and maintenance costs were estimated to be near \$1,000 acre-feet in 1992 dollars. Although cost was considered a major criterion for recommending projects for implementation, the study identified other considerations. These included long-term impacts on groundwater quality, ability to meet current and probable future regulatory requirements, risk to public health, institutional (implementation) issues, public acceptance and environmental impacts. Following a review of cost and non-cost factors, the study concluded that cost remained as the most important selection criterion for the seven identified projects.

Program Implementation

The study included discussions of program implementation, permitting requirements, policy considerations and financing and cost-sharing options. For large-scale projects involving two or more agencies, it was anticipated that institutional arrangements for carrying out the projects would be determined by the agencies themselves. The study recommended an implementation plan that included three non-technical and three technical elements:

Non-Technical Elements:

- 1) Development of a policy framework for implementation of the Water Recycling Program and specific water recycling projects.
- 2) Selection of institutional arrangements to define the roles and responsibilities of the Valley agencies that will participate in the Water Recycling Program.
- 3) Determination of the financing and funding mechanisms to pay for construction and operation of the reclamation projects, and the selection of cost-sharing arrangements to pay for each agency's appropriate share of the cost.

Technical Elements:

- 4) Acquisition of a permit from the San Francisco Regional Water Quality Control Board to begin implementation of the Water Recycling Program. A "blanket" permit, which will allow a variety of individual projects to be constructed by the Valley agencies, will provide the most flexible approach.
- 5) Development of a Salt Management Plan which will (1) identify specific water quality goals (for total dissolved solids) for the Main Groundwater Basin, and (2) provide a framework for selection of water recycling projects (and other salt management techniques) to attain these goals. The Salt Management Plan will be required as part of the permitting process.
- 6) Implementation of an improved groundwater monitoring program to provide the data that will be needed for implementation of water recycling projects in accordance with proposed regulations, Basin Plan and Zone 7 policies, and the (to be developed) Salt Management Plan.

Permitting and Regulatory Considerations

Permitting requirements were determined through discussions with San Francisco Regional Water Quality Control Board staff. The Regional Board staff indicated support for a blanket or master permit, provided a salt management plan was developed to ensure that all projects are undertaken in a manner that ensures the long-term protection and enhancement of the groundwater quality. The master permit would allow phased implementation of all potential uses identified as part of the overall program adopted by the responsible agencies. New projects could be implemented subject to Agency approval instead of requiring new permits or permit amendments as each project in the recycling is brought on-line. The production of demineralized and non-demineralized recycled water would be authorized under one permit for distribution to appropriate agencies and projects. Flexibility would be allowed in determining which discharger supplies which users. Table 6-8 in the study report outlined how water-recycling projects could be accommodated within the Basin Plan and Zone 7 Policies and Guidelines. The study concluded that well-established technologies and procedures exist to comply with the policies and guidelines.

Institutional Arrangements

The study indicated that the water-recycling program would require participation by several entities. It was expected that any large-scale project would require two or more of the Valley water and wastewater agencies. At the time of the study, it was anticipated that institutional arrangements for carrying out recycling projects among the agencies would be determined by the agencies themselves. The following was concluded:

- The three principal agencies, Zone 7, DSRSD and City of Livermore, would seek a Valley-wide “blanket” permit for implementing a Water Recycling Program. Zone 7 was identified as the “lead” agency with principal responsibility for obtaining the permit and enforcing its terms and conditions.
- A memorandum of understanding would be negotiated to develop the permit application.
- The agencies would develop a salt management plan to ensure the water recycling projects are undertaken within a framework that provides for maintenance and enhancement of Valley groundwater resources.
- Each agency would adopt a Resolution of Intent that commits the agency to seek advancement of water recycling programs and projects.
- Following acquisition of the blanket permit, the agencies would develop an agreement to implement the Water Recycling Program. Key elements of the agreement would be cost-sharing arrangements, responsibility for ownership and operation of facilities, and implementation of the Salt Management Plan.
- Each agency would develop policies with respect to its own interests in water recycling projects, e.g. policies that encourage or mandate water reuse and development of pricing structures for recycled water.

Master Water Recycling Permit with Salt Management Plan Requirement

Following completion of the May 1992 *Livermore-Amador Valley Water Recycling Study*, the Valley agencies worked together with RWQCB staff to develop language for the recommended Master Water Recycling Permit. The Regional Water Quality Control Board (RWQCB) issued the permit, Order No. 93-159, to Zone 7, DSRSD and Livermore on December 15, 1993. The permit language captured the findings and recommendations of the 1992 Study. The permit was issued in conformance with California Water Code Section 13523.1 governing Master Reclamation Permits. A Master Permit, issued to the recycled water purveyors, eliminates the requirement that the RWQCB issue individual permits to all users. Users are regulated instead in accordance with rules and regulations developed and enforced by the permittee(s).

The Master Permit specifies requirements to be met prior to implementation of additional recycled water irrigation or groundwater recharge projects in the Valley. The permit was connected to the SMP, which would provide the framework within which local decisions

could thereafter be made determining the qualities, quantities and locations of permitted recycled water use. The SMP was to fully offset the current salt loading, as well as any future salt loading associated with new recycled water use. The SMP requirements, as specified in the Master Permit, include defining basin characteristics, refining salt balance calculations, identifying water quality objectives, developing a SMP monitoring program, evaluating alternative salt management tools and strategies, and developing a SMP implementation plan and schedule.

A key issue identified to successfully implementing a regional water-recycling program was the development and enforcement of a SMP that ensures that water-recycling projects were carried out to protect and enhance the Main Basin groundwater quality. The 1992 water recycling study concluded, and the Regional Water Quality Control Board staff concurred, that Zone 7 would be the most appropriate agency to develop and implement the SMP.

In accordance with the Master Permit, this SMP was developed through a cooperative effort involving Zone 7 staff and consultants; a technical advisory group composed of local potable water retailers; and the Zone 7's citizens committee, the Groundwater Management Advisory Committee (GMAC). In-house data compilation work began in 1994 with the majority of the technical analyses conducted in the 1997 through mid-1999 time frame.

1.4 SMP Chapters Overview

Over the several years that the SMP was being developed, the scope broadened beyond that outlined in the Master Permit. The resultant effort and product could perhaps more accurately be described as approaching the complexity and breadth of a watershed water resource management plan than simply a Main Basin salt management plan. At the request of the potable water retailers, considerable effort was devoted to evaluating impacts of the salt management strategies on delivered water quality. The groundwater model was further refined and the water system operations model (WRMI) developed and calibrated to provide better estimates of impacts on individual wells and delivered water quality at each of Zone 7's turnouts. Greater effort was invested in investigating fringe and Main Basin connectivity given the potential for much larger urban and agricultural development. Efforts were also made to involve ACWD staff in the SMP process even though SMP impacts were believed negligible on ACWD water quality. Great effort was also invested in incorporating the methods, information and policy decisions into Zone 7's water operations practice.

Chapter 2 provides an overview of Zone 7 facilities, demands, and operations, both current and proposed. The water system operations computer model is also described. Chapter 3 provides a condensed summary of Zone 7's current understanding of the hydrogeology of the fringe and Main Basin. The issue of basin connectivity and mixing is addressed in detail along with a description of and output from the groundwater flow and solute transport model. Chapter 4 summarizes the extensive water quality information

collected by Zone 7. Issues of seasonal and spatial variability are addressed. Chapter 5 presents the methodology used by Zone 7 in calculating the water and salt balances. Historic and projected year 2010 salt loadings are discussed. Chapter 6 presents Zone 7's existing monitoring programs and the additions that are intended to be made to even more accurately track salt loading in the future. The surface and groundwater monitoring networks for each drainage basin are described.

Chapter 7 presents the key salt management plan policy issues and options developed through consultation with the TAG and GMAC. Background information is presented on consumer acceptability of different TDS concentrations in delivered water. Chapter 8 describes the range of individual and composite salt management strategies that are evaluated in more detail in the remaining chapters of the SMP. Preliminary Unit Operations and Maintenance (O&M) costs are also presented. Chapter 9 presents the results of the spreadsheet based salt loading calculations under projected year 2010 conditions for the 20 salt management strategies investigated at the screening level. Estimated costs and impacts on delivered water quality are included.

Chapter 10 presents the computer modeling results for four of the most promising strategies identified in the Chapter 9 screening analysis. Projected impacts of potential strategies using demineralized recycled water injection are included. Numerous maps and graphics depicting impacts on groundwater, individual wells, and on retailer turnouts are included. Chapter 11 presents alternatives and recommended approaches for allocating the costs of salt management as a function of the source of the salt: existing M&I, future M&I, untreated, or recycled water. Chapter 12 presents the near-term implementation plan including the most feasible strategies, scaled down to offset current loadings versus the 2010 loadings in prior chapters. The chapter concludes with the specific "2000-2002" implementation plan presented to and approved by the Zone 7 Board in August 1999 and recommended next steps to address future salt loading.

The Report and Study was conducted from an operations standpoint. The goal was to incorporate all recommendations into Zone 7's routine operations. To a large extent this has been accomplished by incorporating the methods, reports and procedures developed in the Salt Management Plan into Zone 7's water resource management.