# Hilmar Supplemental Environmental Project

**Submitted to the California Regional Water Quality Control Board**
**Central Valley Region**

**In Compliance With Order No. R5-2006-0025**


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## Disclaimer

The opinions, conclusions, and recommendations expressed herein are not binding on the Regional Board or any other entity. This study was undertaken as part of a settlement of an enforcement action by the Regional Board against Hilmar.

## Preface

This study was conducted by a multidisciplinary team including economists, hydrogeologists, engineers and policy analysts.  The study is reported in three volumes. Volume I was authored by David Sunding and Mark Berkman. Volume II was authored by Yoram Rubin, Pascual Benito, Gretchen Miller, John McLaughlin, Zhangshuan Hou, Slawomir Hermanowicz, Ulrich Mayer, and Dmitriy Silin. Volume III was authored by David Sunding, Mark Berkman, Stephen Hamilton, Todd Anderson, Michael Kavanaugh, Jatal Mannapperuma, and David Zilberman.

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# Executive Summary

This study constitutes a Supplemental Environmental Project (SEP) authorized as part of a settlement agreement between Hilmar Cheese (Hilmar) and the Central Valley Water Quality Control Board, (Regional Board).[1] It is intended to enhance the understanding of the role the food processing industry has on salinity discharge to ground and surface waters of the San Joaquin Valley and to provide a framework, methods of analysis, and data to further analyze salinity policy alternatives.

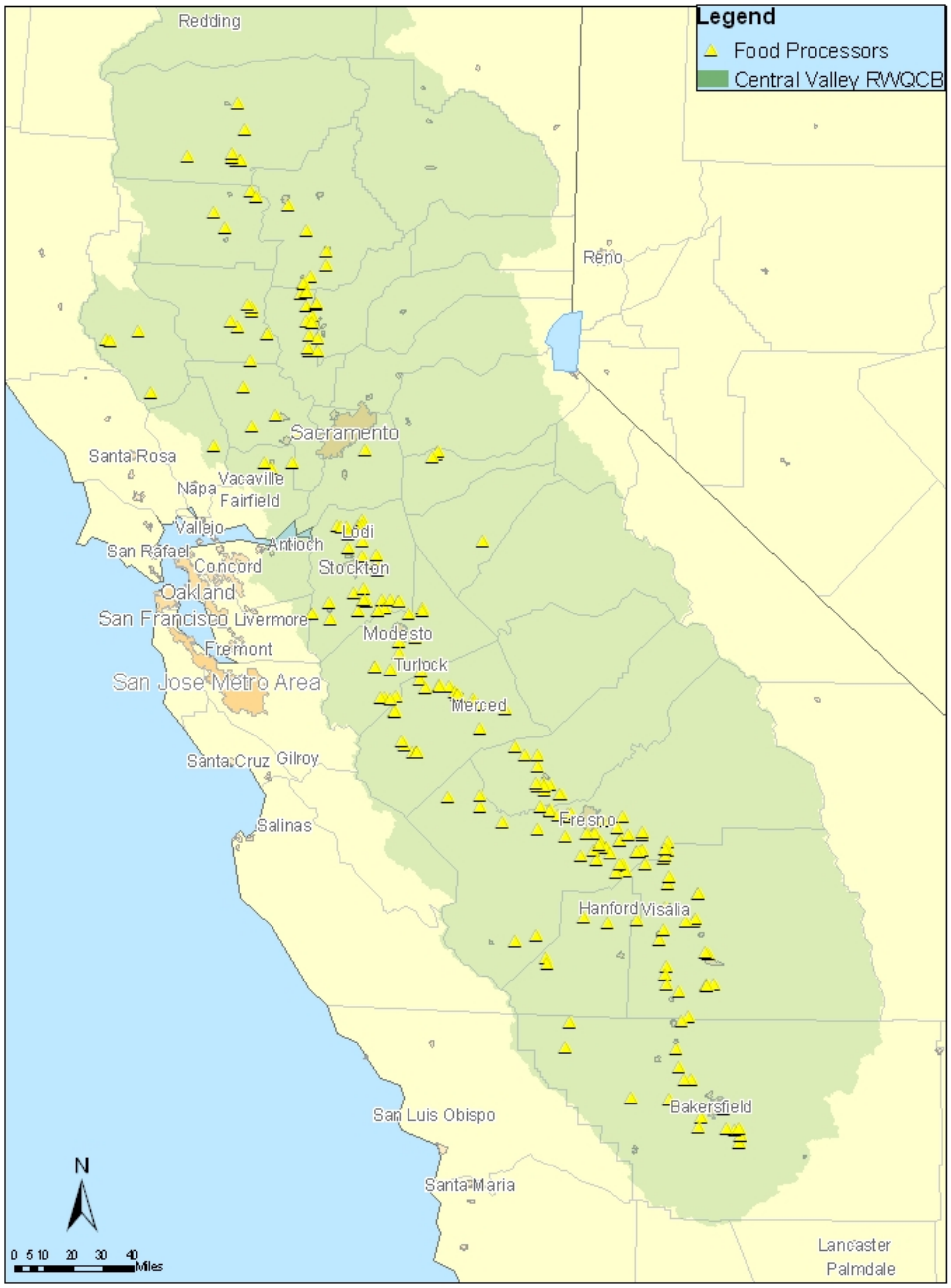
The study is organized into three volumes. Volume I introduces the problem, discusses the current framework for regulation of salts, and lays out the framework for study and comparison of alternatives. Volume II presents a study of the physical aspects of salinity discharge, including detailed analyses of the food industry waste water discharge by chemistry, geography and industrial affiliation, and analyses of flow and transport processes in the unsaturated and saturated zones in the Central Valley. In addition, it provides an inventory of environmentally sensitive sites in the Central Valley and analysis of the potential impact of salinity discharge on these sites. Volume III contains the results of the economic and engineering analyses of alternatives to land application. The volume also describes some general data sets and models prepared as part of this study that may assist the Regional Board in its water quality planning efforts outside the representative area, and for contaminants other than salts.

*Framework for Analysis*

Food processing is an important economic activity in the California. Understanding how to manage saline wastewater discharges from this industry can provide important lessons about alternatives for management of point source discharges of salts from other sources, and can also aid in the development of a comprehensive salt management policy for the entire San Joaquin Valley, including salts from nonpoint sources. The figure below shows the location of food processors in the Central Valley.

[1] California Regional Water Quality Control Board Central Valley Region, Order No. R5-2006-0025 Ratifying the 16 March Settlement Agreement Between Central Valley Regional Water Quality Control Board and Hilmar Cheese Company, Inc and Hilmar Whey Protein Inc Merced County.

Food Processors in the Central Valley

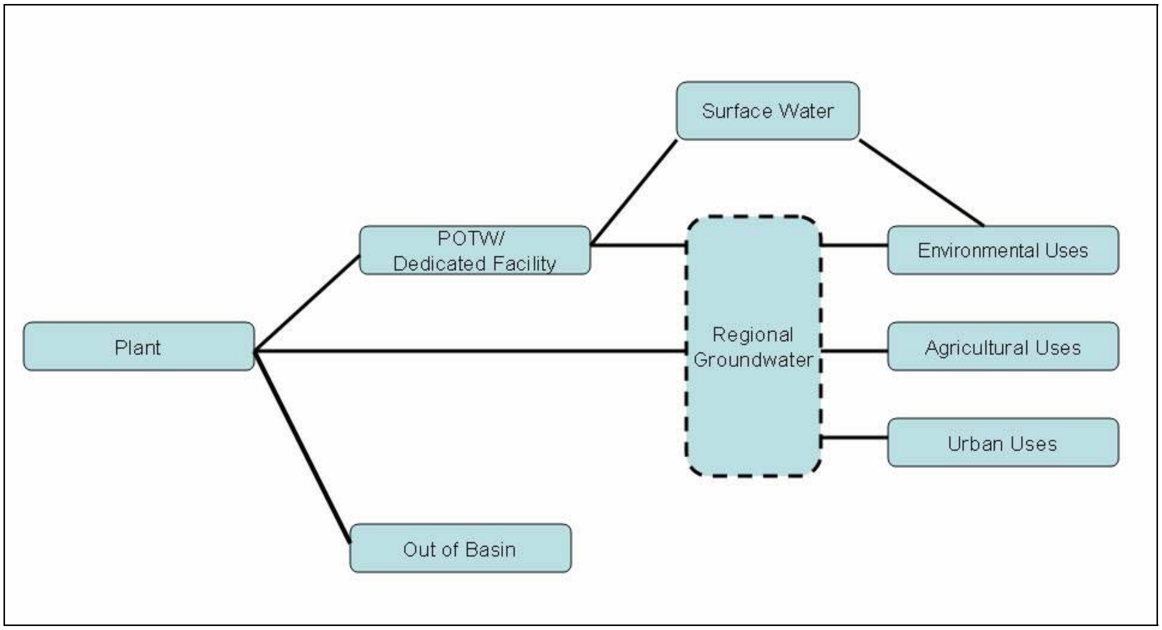



There are a large number of food processing facilities in the region, owing to the fact that California is the nation's leading agricultural state. The figure illustrates that food processing occurs in or near all of the major metropolitan areas in the Central Valley. Because groundwater is an important source of agricultural and municipal water supplies, salts emanating from food processing facilities must be analyzed in the context of regional water use and treatment systems. This circumstance calls for a multidisciplinary and comprehensive approach to salt management, an approach taken in this SEP study.

The study analyzes and compares four basic approaches to management of saline wastewater discharges from the food processing industry. There are

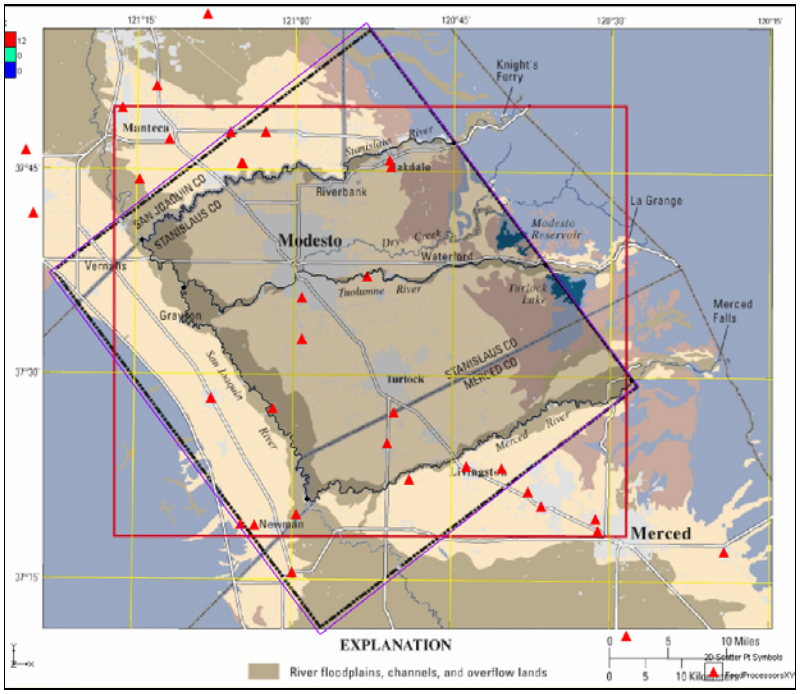
- Land application
- In-plant measures
- Regional solutions
- Out-of-basin alternatives

The framework for comparison of alternatives can be understood with the aid of the following figure which shows the flow of wastewater from food processing plants, through environmental media, and which ultimately affect the benefits obtained from groundwater consumption.




Land application of food processing wastewater, for example, flows through groundwater and may affect groundwater users regionally. Diverting these wastes to a local POTW may also affect regional groundwater, but in a different way and at a different location. Out of basin alternatives include a brine line and deep well injection.

The numerical analysis of salt management alternatives is conducted for a representative area centered on the city of Modesto, commonly referred to as the lower San Joaquin River basin. This area was selected for analysis since it has a significant number of food processing facilities (some of them quite large) and relies heavily on groundwater for local water supplies to support its rapidly growing population. Groundwater and environmental conditions in the area have also been characterized in great detail by the USGS and other agencies. The representative area is shown in the following figure.




Using data for the representative area on groundwater use, groundwater movement, soil and other environmental conditions, configuration of food processors, and the cost of various treatment alternatives, the impacts of alternatives are compared. The timeframe for the comparison is 30 years.

*Physical Modeling of Land Application*

Volume II presents the models developed by the SEP study team for tracing the movement of salts from food processing facilities through the vadose and unsaturated zones. Land application is by far the most common method of wastewater disposal, either at the facility or via a local POTW. The Volume concentrates on a detailed analysis how land application affects the salinity of regional groundwater resources.

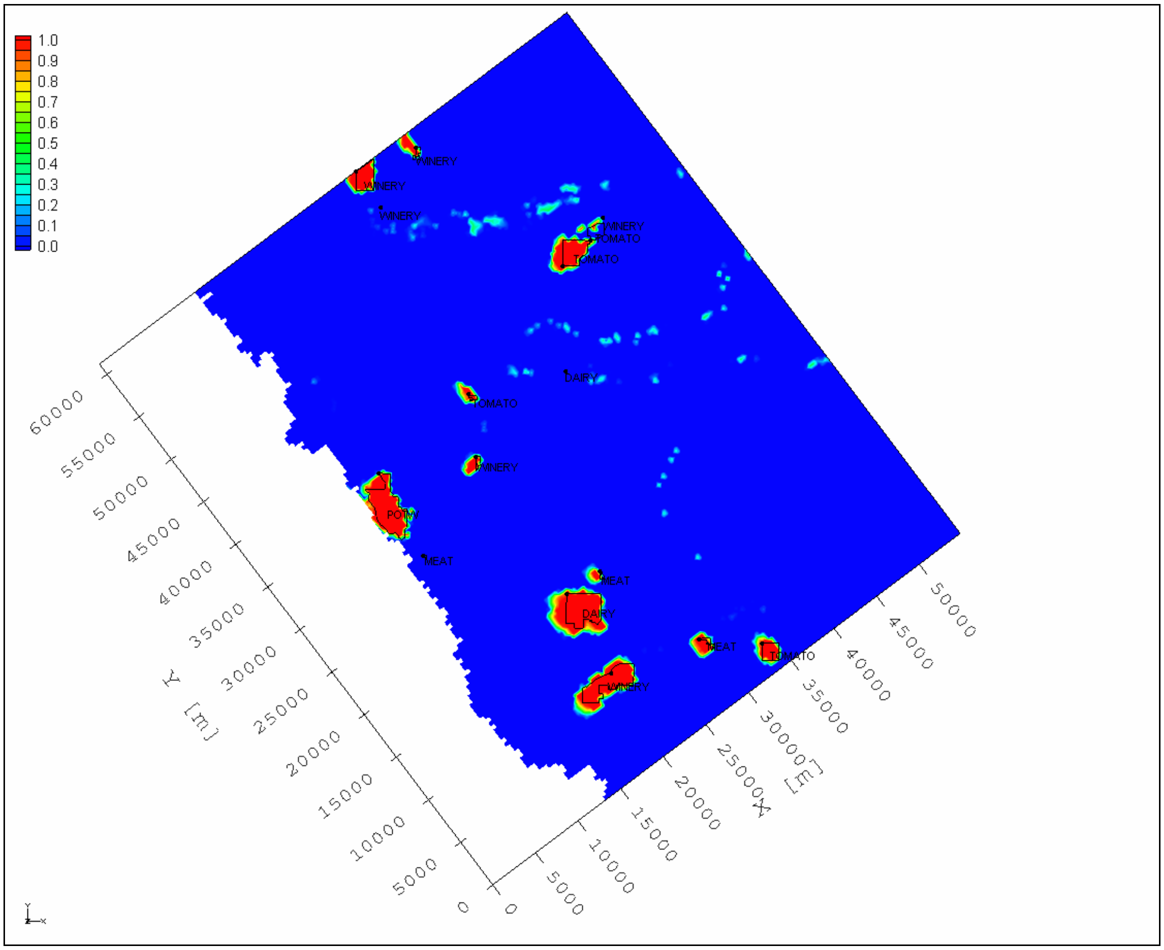
The term "salinity" encompasses multiple individual ion species and is commonly represented as either electrical conductivity (EC) or fixed dissolved solids (FDS). FDS is a direct measure of the concentrations of ionic species in the waste, while EC measures their charge. The major ions compromising salinity are chloride ($Cl^-$), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), potassium ($K^+$), sodium ($Na^+$), ammonium ($NH_4^+$), nitrate ($NO_3^-$), sulfate ($SO_4^{2-}$), and phosphate ($PO_4^{3-}$). Two carbonate species ($CO_3^{2-}$ and $HCO_3^-$) are also significant contributors.

Waste Discharge Requirements (WDRs) issued by the Central Valley Regional Water Quality Control Board to the food processing facilities and periodical monitoring reports for California Central Valley food processors were obtained from the Regional Water

Quality Control Board offices in Fresno and Sacramento. The files were copied and subsequently scanned for use on the project. These reports were condensed to create templates recording all chemical constituents reported by the food processors; the templates were populated with water quality and volume data for 2003, 2004 and 2005.

Volume II contains a detailed physical and chemical analysis of land application and the movement of salts through the unsaturated zone. This investigation indicates that the unsaturated zone has a limited capacity to attenuate salts. Thus, salts will break through to the saturated zone in the vicinity of land application sites. As a result, it is expected that the salinity at the water table at these areas will be equal to the salinity of the effluent, and possibly higher, over the long term. Site conditions can mitigate or even eliminate the effects of nitrogen compounds on groundwater quality, whereas in the case of salinity, site conditions have only a limited and temporary ability to reduce salinity.

While even carefully managed land application can noticeably affect the salinity of groundwater, an important finding of this study is that the degradation to groundwater quality due to land discharge is likely to occur only in the close vicinity of the discharge sites. This general finding is illustrated by the following figure that displays changes in groundwater salinity around the various land application sites in the representative area around Modesto. This map shows the probability that land application results in a change in groundwater salinity of 500 mg/l after 30 years. The color scale represents probability with blue indicating 0% probability of exceedance, and red indicating a 100% probability. The details underlying the calculations are described at length in Volume II.




Whereas solutes can migrate downstream of the land discharge sites over distances of thousands of meters, depending on local hydogeological conditions, increases in FDS concentrations larger than 500 mg/L compared to background concentrations are limited to the groundwater underneath the discharge sites and over distances of the order of magnitude of hundreds of meters downstream of the land discharge sites. The probability for observing increases in concentrations of such magnitude over larger distances were found to be close to zero.

What explains the limited spatial extent of the spreading of solutes underneath the discharge sites? The answer is a combination of effects, including the reduction in concentrations due to dispersion, and in a few locations the buffering effects of the vadose zone. Groundwater pumping in the representative area also creates a strong vertical downward pointing pressure gradient in the shallow aquifers which leads to vertical migration of solutes, deeper into the earth. This fact limits the spatial extent salt migration, but at the same time it also leads to development of areas of high salt concentration just underneath and downstream of the land discharge sites. Such hotspots will be sustainable as long as vertical gradients of sufficient magnitude persist.

In the event that pumping in the deeper formation ceases or due to pumping from deeper formations or due to reversal of the vertical gradient due to change in hydrologic conditions the containment effect of groundwater extraction in the representative area can diminish. In this case, salts can migrate over a much larger area than modeled here. However, this migration will be noticeable primarily in the upper aquifer where there is relatively little groundwater pumping and hence only minor impacts on water users. With time, vertical migration of solutes, albeit at a slow rate, may cause salts to move deeper.

*Economic Impacts of Land Application and Analysis of Alternatives*

Volume III of the study contains an analysis of the economic losses resulting from land application in the representative area. Such estimates are essential to gauge the significance of the problem that exists under status quo practices, and provide a benchmark for comparison with other salt management alternatives. Economic impacts from changes in groundwater salinity were calculated using current and forecasted water demands in the representative area. Current water use patterns were assembled from a variety of sources, including municipalities and irrigation districts in the study region. Future water uses were derived using a land use forecasting model developed as part of this study. The land use change model predicts the probable location of future development in the San Joaquin Valley conditional on population growth estimates generated by regional governmental associations.

There are two basic conclusions resulting from the economic analysis of land application in the representative area. First, the current and future annual losses resulting from land application are small, around $400,000 annually. These losses include effects experienced by urban water users and farmers using groundwater for crop irrigation. Second, the effects of land application occur largely within the confines of the land application sites themselves. They are thus internalized by the food processors owning or renting these sites, and do not represent an external effect that contributes to a collective problem.

The limited impact of land application reflects the groundwater modeling described earlier. The downward gradient in the representative area groundwater limits the real extent of salt migration. For similar reasons, the environmental impacts of salts in food processing wastewater are also expected to be minimal. Section II.5 of the report shows the location of environmentally sensitive sites in the representative area in relation to various food processing facilities. While there are areas of critical habitat, wildlife refuges and other environmental amenities located within several miles of food processing facilities, there is little evidence that salts will migrate to these sites over the time frame of the analysis, assuming that current patterns of groundwater use continue.

While land application does not appear to pose a general or significant threat to groundwater users in the representative area, it is still of interest to examine the configuration, effectiveness and relative cost of measures to manage salts from the food processing industry. The first such set of measures is aimed at reducing salt discharges through the use of technologies and management practices at food processing plants. These include supply water treatment, end-of-pipe treatment and process changes.

Another class of salt management alternatives collects food processing industry wastewater and treats it at a central location. Two such alternatives considered in this study are collection and treatment at a POTW, and at a dedicated facility owned and operated by the food processing industry. While the treatment technologies applied at such facilities are well accepted, access to existing POTWs may be problematic.

The study also examines disposal of wastewater to a brine line. This option is more expensive than either of the two in-region central treatment alternatives. The average cost of salt disposal via a brine line varies with the configuration and length of the line. As the line is extended, more food processors can be added which reduces average cost, but requires extra investment in capacity and construction costs. The minimum-average cost configuration is a line running 220 miles through the representative area to the Fresno area.

Deep well injection is examined as an alternative out-of-region salt management approach. Brine is effectively removed from the region by disposing it where it cannot reach groundwater that is or can be reasonably expected to serve a beneficial use. The technology has been used since the 1950's and provides a low cost means of disposal. It is, however, a highly regulated activity and requires very specific geologic conditions that may not be readily available to some food processors.

The costs of these in-plant and regional treatment measures are generally well above the negative impacts of land application. For example, consider the POTW alternative that has relatively lower costs of salt removal than the other regional alternatives. For this alternative, the capital and operating costs of the POTW option range from $13 to $34 million annually for the entire representative area. The negative impacts of land application are around $400 thousand annually, again for the entire representative area. Although this suggests that the costs of substantial restrictions on existing food processing wastewater discharge is unwarranted in the representative area by the limited benefits that would arise, it is possible that this will not be the case throughout the Regional Board's jurisdiction.

*Salinity Management Strategy*

Based on these results and a review of salinity management strategies implemented in California and elsewhere as well as those suggested by economic theory, a policy that recognizes the case specific nature of each food processor is attractive. Consequently, uniform discharge limits, market based solutions such as discharge taxes or a cap and trade policy across the entire Basin, or a single regional facility are not likely to provide a reasonable balancing of groundwater protection and the impact of such protection. This is not to say that there may be subregions within the Basin where a regional solution may make sense including a regional disposal facility or a cap and trade approach.

*General Findings*

The Regional Boards are required to consider economic factors when assessing the reasonableness of alternative water quality objectives. The tools exist to base this analysis on actual and reasonably foreseeable water uses rather than on blanket statements about protection of beneficial uses and anti-degradation objectives. Advances in GIS technology, groundwater modeling and economic analysis make it possible to determine changes in groundwater quality and use at a highly disaggregated level.

As part of the effort to measure the benefits of water quality improvements, the study developed and implemented a detailed model of land use change for the entire Central Valley. This statistical model is used to forecast patterns of urbanization at a detailed level. The study also presents the results of a comprehensive review of groundwater demand in the San Joaquin Valley. Working with the Urban Water Management Plans prepared by the water purveyors in the region, the study team developed a series of detailed regional forecasts for groundwater demand. Several urban areas in the San Joaquin Valley are planning to use groundwater more intensively as they are forced to deal with the consequences of growth. Other areas are initiating a shift toward the use of surface water for a larger share of supplies. These trends have important implications for groundwater quality regulations since they influence the benefits of such interventions.

The physical modeling undertaken for this study shows convincingly that there is not a single inventory of salt in the San Joaquin Valley. Rather, the problem of salt management is a local one, particularly for point sources such as food processing facilities. The tools identified and demonstrated in this study allow the Regional Board to undertake accurate and effective, site-specific analysis of salt management alternatives. Because the costs and benefits of salt management vary widely throughout the San Joaquin Valley, there is no single salt concentration of discharge that is appropriate or reasonable in every instance.

# VOLUME I

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## Figures

## I.1 Introduction

This study constitutes a Supplemental Environmental Project (SEP) authorized as part of a settlement agreement between Hilmar Cheese (Hilmar) and the Central Valley Water Quality Control Board, (Regional Board).[2] Consistent with the requirements for a SEP, the study is intended to enhance the understanding of the role the food processing industry has on salinity discharge to ground and surface waters of the San Joaquin Valley and to provide a framework, methods of analysis, and data to further analyze salinity policy alternatives.[3]

### *A. Background*

The Regional Board has been concerned about increasing salinity concentrations in both surface and groundwater for some time, but has limited guidance and information on which to develop policy that meets the requirements of Porter Cologne and the state's anti-degradation policy.[4] Porter Cologne and the anti-degradation policy direct the Board to consider the tradeoffs between controlling salinity levels and benefits to the "people of the state". The Board, however, is not provided specific guidance on how it should make such tradeoffs. The Board is further hampered by very limited information regarding existing and future salinity levels and their impacts. The Board and food processors are also constrained by limited information regarding the costs and effectiveness of salinity discharge control technologies making it difficult to establish best practical pollution control technologies (BPCTs).

In May 2006, the Board issued a report entitled, "Salinity in the Central Valley, An Overview," summarizing these concerns and noting the need for a comprehensive salt management plan. The report highlighted the lack of complete information necessary to complete such a plan. A previous staff report, "Regulation of Food Processing to Land" (January 2005) had presented information regarding the contribution of food processors to salinity levels in the Central Valley. This report also demonstrated the limited information available for policy making. The Board staff suspected that as many as 57% of food processors were either degrading or polluting groundwater and that another 19% were confirmed to have done so. These designations, however, were based on limited information.

Most recently the Board issued management guidelines for salinity in waste discharge requirements.[5] This document again demonstrates the limited information currently

[2] California Regional Water Quality Control Board Central Valley Region, Order No. R5-2006-0025 Ratifying the 16 March Settlement Agreement Between Central Valley Regional Water Quality Control Board and Hilmar Cheese Company, Inc and Hilmar Whey Protein Inc Merced County.
[3] State Water Resources Control Board, "Water Quality Enforcement Policy," February 19, 2002, Section IX, pp.42-47.
[4] State Water Resources Control Board Resolution 68-16 Statement of Policy With Respect to Maintaining High Quality Waters in California.
[5] Source: Memorandum from Executive Management Group, "Management Guidance for Salinity in Waste

available to the Board and to food processors to determine the need for and level of salinity discharge limits. The Guidelines require a case-by-case evaluation and in many cases require a site specific analysis of discharge, groundwater impacts, and discharge control options (BPCTs).

Consequently, this SEP is designed to help all parties advance the salinity management policy review by providing a framework, methods of analysis, and data. Importantly, no policy recommendations are made.

### *B. Study Organization*

The study is organized into three volumes. Volume I introduces the problem, discusses the current framework for regulation of salts, and lays out the framework for study and comparison of alternatives. Volume II characterizes food processing wastewater and models the regional groundwater impacts of land application of these wastes. This volume contains detailed models of the vadose zone and the saturated zone. These models describe the various physical and chemical processes that occur with land application of food processor wastewater. Volume III contains the results of the economic and engineering analyses of alternatives to land application. The volume also describes some general data sets and models prepared as part of this study that may assist the Regional Board in its water quality planning efforts outside the representative area, and for contaminants other than salts. There are also several technical appendices and an appendix presenting peer reviewer comments and our responses.

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Discharge Requirements," California Regional Water Quality Control Board Central Valley Region, April 26, 2007.

## I.2 Current Framework for Regulation of Wastewater Discharge from the Food Processing Industry

In this section the current regulatory guidance regarding salinity discharge from the Regional Board is reviewed. The current numerical and narrative salinity discharge limits established by the Basin plans are also described. There is also a brief discussion of expected future regulation.

### *A. Overview*

Food processor wastewater discharge is regulated by the State Water Resources Control Board (SWRCB) through the regional water boards including the Central Valley Region Water Quality Control Board (CVWQCB). Regulatory efforts are governed by the Porter-Cologne Water Control Act (Water Code Section 13000 et. sec.). Regional Boards as well as the State Board have several regulatory options to address food processor waste including adoption of: 1) waste discharge requirements (WDR); 2) conditional waivers; 3) water reclamation requirements; 4) monitoring or technical report requirements; and 5) clean up and abatement orders. The Regional Board is currently reviewing its salt policy and recently issued guidelines for enforcement of existing and new WDRs.

The CVWQCB adopted water quality control plans, referred to as Basin Plans, which set forth water quality objectives and implementation policies for discharge constituents including salinity. The CVWQCB has issued two such plans: The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins and The Water Quality Control Plan for the Tulare Lake Basin.[6] Both plans provide numeric and narrative water quality objectives regarding salinity. Both plans adopt state drinking water standards which include maximum contaminant levels (MCLs) for salt constituents. The Plans also describe the application of water quality objectives and incorporate State Water Board Resolution 68-16, commonly referred to as the anti-degradation policy. The anti-degradation policy prescribes conditions that must be met before water quality degradation is allowed.

### *B. Current Numerical and Narrative Limits*

The Basin Plans adopt the state drinking water standard for salinity. The secondary drinking standard for EC calls for a recommended level of 900 umhos/cm with an upper limit of 1600 umhos/cm and a short term limit of 2200 umhos/cm. The Plans also provide numeric limits on salinity for specific water bodies or segments of water bodies.[7] There

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[6] The Basin Plans are periodically amended. The Sacramento and San Joaquin Basin Plan is in its 4th edition and has been amended as recently as February 2, 2007. The Tulare Lake Basin Plan is in its 2nd edition, revised in January 2004.

[7] See Table III-3 in the Sacramento –San Joaquin River Basin Plan and Tables III-2 and III-3 in the Tulare

are no general numeric limits for groundwater discharge. Food processors who deliver their wastes to publicly operated treatment works (POTWs) do not face salinity effluent standards directly, but the discharges to POTWs are regulated under the National Pollutant Discharge Elimination System (NPDES). Food Processors who discharge directly to waters of the U.S are also regulated by the NPDES. The California Water Boards incorporate specific effluent limitations in WDRs, which are U.S. EPA adopted industry specific effluent limitation guidelines. This is the case for Dairy Products Processing and for Canned and Preserved Fruits and Vegetables.[8]

The Regional Board staff looks to the anti-degradation policy imposed by Resolution 68-16 for guidance regarding salinity effluent limits. While no specific values are established, the staff has indicated that, "all dischargers that have an effluent greater than receiving water salinity or where the mass or concentration of salinity in the discharge increases," require an anti-degradation analysis.

This analysis determines whether water quality that meets or exceeds water quality objectives will be degraded by a particular discharge. If so, best practical treatment or discharge control must be imposed that assures that: "a) pollution or nuisance will not occur and b) the highest water quality consistent with the maximum benefit to the people of the state will be maintained".[9] Consequently, the cost of degradation must be balanced against benefits associated with the activities leading to the discharge as well as the costs of treatment or control. Degradation cannot "unreasonably" affect beneficial uses or fail to adhere to water quality control plans.

The Regional Board staff's most recent memorandum on salinity discharge provides some further guidance regarding limits.[10] The Staff has identified limits that will trigger investigation on further controls depending on the type of beneficial use affected. For example, if the beneficial use agricultural irrigation is at issue then a salinity effluent equal to or greater than 700 umhos/cm (450 mg/L TDS) triggers a salinity control study. This study will establish an appropriate numeric limit. If municipal beneficial use is at issue, then a salinity effluent greater than or equal to 900 umhos/cm (500 mg/L TDS) requires a study within two years and possibly an anti-degradation study. If the effluent is greater than (900 umhos/cm) one of the three MCLs identified above (eg, municipal, agricultural, or specific water body related) will be applied as soon as possible. Final limits may change subject to a study to be conducted by the discharger within two years. An anti-degradation study may also be required.

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Lake Basin Plan.

[8] Memorandum from the Office of Chief Council, State Water Resources Control Board, "Questions and Answers About Water Quality Regulation and the Food Processing Industry," January 23, 2006

[9] Resolution No. 68-16.

[10] Memorandum from P. Creedon et.al. to Program Managers, "Management Guidance for Salinity in Waste Discharge Requirements, April 19, 2007

The recent guidance also discusses interim standards for what are termed: performance-based interim effluent limits; increment based interim effluent limits/goals; and non-municipal interim effluent limits. The first covers circumstances where source identification and control studies are in progress. The limit caps the current effluent salinity level until such studies are complete. The second applies to POTWs.
The third indicates that staff will consider prescribing an interim effluent limit of 1000 umhos/cm for any non-municipal discharge that exceeds 1000 umhos/cm. The Guidance document notes that, although the limit is only a guide it "does appear to be a determination by the Board of what constitutes 'best practical treatment' under the Anti-degradation Policy." There is no elaboration on this point. No balancing of benefits and treatment costs is presented in support of these limits.

A flow diagram that accompanies the Guidance Memorandum is attached as Figure 1 to summarize the limit screening process the Regional staff will use. As the diagram suggests, every source will be reviewed on a case-by-case basis. The Regional Board staff also noted in this document that the Board's salinity policy is being reevaluated, but did not offer a date for its completion.

A staff presentation to the Board following the release of the Guidance Memorandum provided further clarification as to how the interim standards were to be applied.[11] According to the presentation, there appear to be two critical policy decisions driving the process. First, the presentation identified the central premise of the Guidance memorandum as:

> Any salinity above background discharged to land or water increases the "inventory" of salt in the Region

Second, although the process provides for an anti-degradation analysis, there is no provision for balancing the benefits and costs of degradation. Indeed, the presentation notes that, "The discharge should not cause loss of beneficial use in the receiving water." Thus, no degradation is allowed under the interim policy.

Concerns have been raised regarding these policy decisions and other definitions affecting Board enforcement. The California League of Food Processors (CLFP), for example has noted that although neither the Water Code nor the anti-degradation policy defines explicitly what is meant by best practical treatment and control (BPTC). The League, by reference to decisions on several recent WDR applications, observed that the State Water Board has typically required evidence from the discharger comparing proposed methods of control with existing proven technology and with methods employed in similar situations, as well as the impact of discharge with and without BPTC on groundwater.[12] Another definitional issue that has been raised regards wastewater classification. Wastewater is classified based on the risk imposed on water quality

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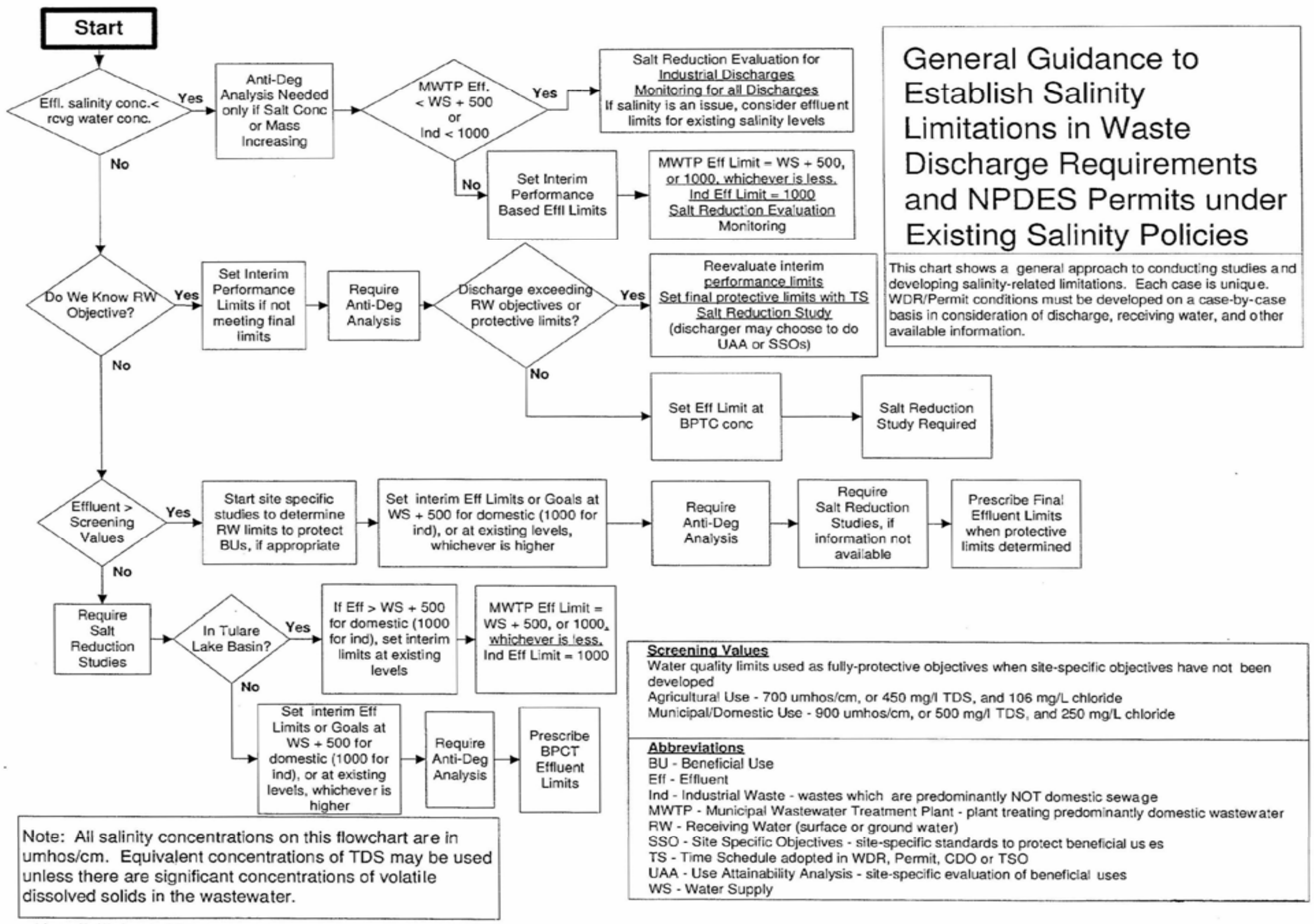
[11] Central Valley Water Quality Control Board Staff, "Salinity and the Water Board, Part 2" PowerPoint Presentation (www. swrb.ca.gov/rwqb5/water_issues/salinity/committees

[12] The California League of Food Processors issued a "Manual of Good Practice for Land Application of Food Processing/Rinse Water," March, 17 2007, pp. 3-4 and 3-5.

according to Title 22 of the California Code of Regulations. Wastes are classified as either hazardous or non hazardous. Although food processing waste water has generally been defined as non hazardous, a hazardous definition would lead to further regulation under Title 22.




Source: Memorandum from Executive Management Group, "Management Guidance for Salinity in Waste Discharge Requirements," California Regional Water Quality Control Board, Central Valley Region, April 26, 2007.

**Figure 1**

### *C. Enforcement*

As noted above, the Board has five regulatory options: 1) it may impose waste discharge requirements (WDRs); 2) conditional waivers; 3) water reclamation requirements; 4) monitoring or technical report requirements; and 5) clean up and abatement orders. Violation of these requirements or orders can lead to enforcement action by the Board. [13] Under some circumstances the Board can issue an administrative civil liability (ACL) where a monetary penalty is imposed. There are specific procedures to set the amount of this penalty.[14] More specifically, nine steps are outlined to determine the amount. The first three steps create a base amount of liability. This base amount includes two components – an initial liability and a beneficial use liability. The initial liability is set based on several factors including the extent and severity of the violation and the sensitivity of the receiving water. The beneficial liability is based on the loss of beneficial use (agricultural, municipal, environmental etc) attributable to the violation. The sum of these components is the base amount. This amount is then adjusted in the next six steps for such factors as the discharger's conduct, the economic benefit enjoyed by the discharger by failing to comply, the discharger's ability to pay and the staff's costs.

### *D. Future Regulation*

The Regional Board is clearly concerned about the contribution of food processors to the broader salinity problem faced by the region.[15] The Regional staff believes that most food processors are likely to violate the non-degradation policy. The Regional staff released a report in 2005 that indicated that 19 percent of food processing plants (42) were discharging at levels that will degrade groundwater and that another 57 percent were suspected of doing so.[16] There was, however, no elaboration on how these determinations were made. Based on this report the staff later concluded that:

> …the Central Valley Region's previous reliance on industry derived loading rates and soil attenuation to treat and dispose of food processing waste and protect groundwater quality was a flawed strategy, and that is appropriate to require individual and scientific accountability such that land application at any given site can be conducted consistent with all applicable State plans, policies and regulations.[17]

The Regional Board staff has also raised concerns that an economic incentive currently exists to rely on groundwater discharge. The Staff asserts that many food processors avoid discharge control expenses by relying on land application and thus gain an

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[13] State Water Resources Control Board, "Water Quality Enforcement Policy, February 19, 2002.
[14] Ibid, pp. 34-41.
[15] See for example, Central Valley Regional Water Quality Control Board, "Salinity in the Central Valley," May 2006.
[16] Staff Report, "Regulation of Food Processing Waste Discharges to Land," January 28, 2005;
[17] Staff Report, "Update Regarding the Regulation of Food Processing Waste Discharge to Land," March 16, 2006, p. 3.

advantage over other facilities that must pay to use POTWs. Presumably the Staff seeks to implement a policy that imposes the same requirements on all food processors. Since the current process takes a case-by-case approach, it is not clear that there will be a uniform impact on all food processors even if more stringent groundwater discharge requirements are imposed. However, the case by case review recently articulated in the March 2007 Guidance Memorandum and the on-going basin plan review could lead to more stringent waste discharge limits and uniform requirements in the future. The CLFP has observed that the Boards already appear predisposed to impose the most stringent limits, noting that the Boards have "tended to require dischargers to meet water quality objectives that are protective of all beneficial uses of groundwater, as opposed to focusing on the existing and probable anticipated uses of the groundwater body in question".[18]

Finally, Regional Board documents and presentations indicate that the notion that a regional salt inventory exists. This has important implications for future regulations. A Regional inventory in places that impact the food processors salt water or groundwater quality vary chiefly by concentration and volume rather than specific beneficial use. Similar discharges have similar impacts on the salt inventory and hence groundwater use.

[18] California League of Food Processors, 2007, p. 3-4.

## I.3 Framework for Analysis of Wastewater Management Alternatives

### *A. Introduction*

This section describes the framework employed in this study. It is an attempt to demonstrate how the legal and regulatory requirements faced by the Regional Board can be met using state-of-the art hydrology modeling, economic modeling, and engineering knowledge regarding salinity management.

### *B. Overview*

The Porter-Cologne Act requires the Regional Boards to consider and balance the economic and environmental benefits and harms associated with water quality standards. The Clean Water Act does not prohibit such a balancing; rather, guidance interpreting the CWA encourages the consideration of costs in developing such standards.

State law directs that water quality objectives must take into consideration that water quality which *reasonably* is achievable in light of social and economic factors. Section 13000 of the California Water Code states that "activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is *reasonable* (italics added), considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible."

Section 13001 of the California Water Code goes on to require that "The state board and regional boards in exercising any power granted in this division shall conform to and implement the policies of this chapter and shall, at all times, coordinate their respective activities so as to achieve a unified and effective water quality control program in this state."

Section 13241 of the California Water Code also requires that economics must be considered in setting water quality objectives. It states that "Each regional board shall establish such water quality objectives in water quality control plans as in its judgment will ensure the reasonable protection of beneficial uses and the prevention of nuisance; however, it is recognized that it may be possible for the quality of water to be changed to some degree without unreasonably affecting beneficial uses." The Section goes on to state that the factors to be considered should include a range of economic, hydrologic, and environmental variables, and shall also include consideration of the need for housing and the need to develop recycled water sources.

This section presents an approach to considering the reasonableness of water quality regulations that takes into account the particular factors listed above. The approach is described within the context of this SEP study: regulation of saline wastewater discharges from the food processing industry. Later sections of the study will particularize many of the factors discussed in this introductory chapter.

### *C. The Optimal Amount of Pollution Abatement*

A simple diagram, familiar to all environmental economists, will help to illustrate the tradeoffs involved in setting optimal water quality objectives. Figure 2 considers the marginal benefits and costs of pollution abatement (which is a proxy for environmental quality – the more abatement, the higher the resulting level of environmental quality). In this context, the term “marginal” refers to the value of the incremental unit. That is, for a given amount of abatement, the marginal benefit curve shows the benefit of the next unit of abatement. The marginal benefit of abatement is equal to the marginal cost of pollution. This type of analysis considers the welfare of both producers who pay for abatement, and “consumers” of environmental quality who benefit from clean water.

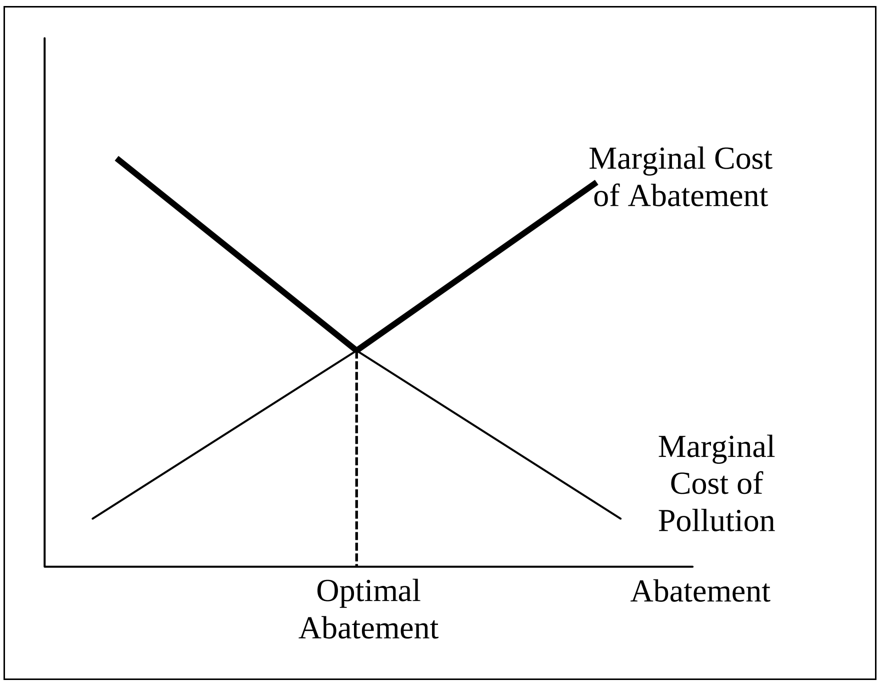


**Figure 2**

The socially optimal amount of pollution occurs when the marginal benefit of abatement is equal to its marginal cost. At the optimum, what producers pay to achieve the last unit of abatement is equal to the marginal benefit of improving the quality of the environment. This social equilibrium occurs at the point of minimum cost, as shown in Figure 2. That is, the optimal amount of pollution control occurs at the level of abatement minimizing the sum of the marginal costs of pollution control and pollution itself. Thus, for each salt management alternative considered, this study assesses both the marginal cost of implementation and the marginal cost of pollution.

Of course, the Regional Boards are not required by Porter-Cologne to adopt water quality objectives that are socially optimal, or that pass a strict benefit-cost test (although most environmental economists would argue that it would be better for the State if they were). However, they are required to develop standards and regulations that are reasonable and balanced.

The reasonableness of water quality objectives can be assessed by considering the same types of factors that were described above, namely the benefits achieved by the action as compared to the costs. Once these are adequately understood and quantified, the Regional Board can make a statement that "An expenditure of $X is reasonable to achieve a benefit of Y," where Y need not necessarily be measured in monetary terms. Similarly, the Regional Board can show that it has balanced economic and other factors by considering the potential costs of achieving the water quality objective as compared to the benefits of the standard based on current and future uses of water in the area.

### *D. Schematic Analysis*

The approach to analysis of regulation described and implemented in this study can best be presented with the aid of a schematic (Figure 3) which shows the flow of water from food processing plants, through environmental media, and which ultimately affect the benefits obtained from groundwater consumption.

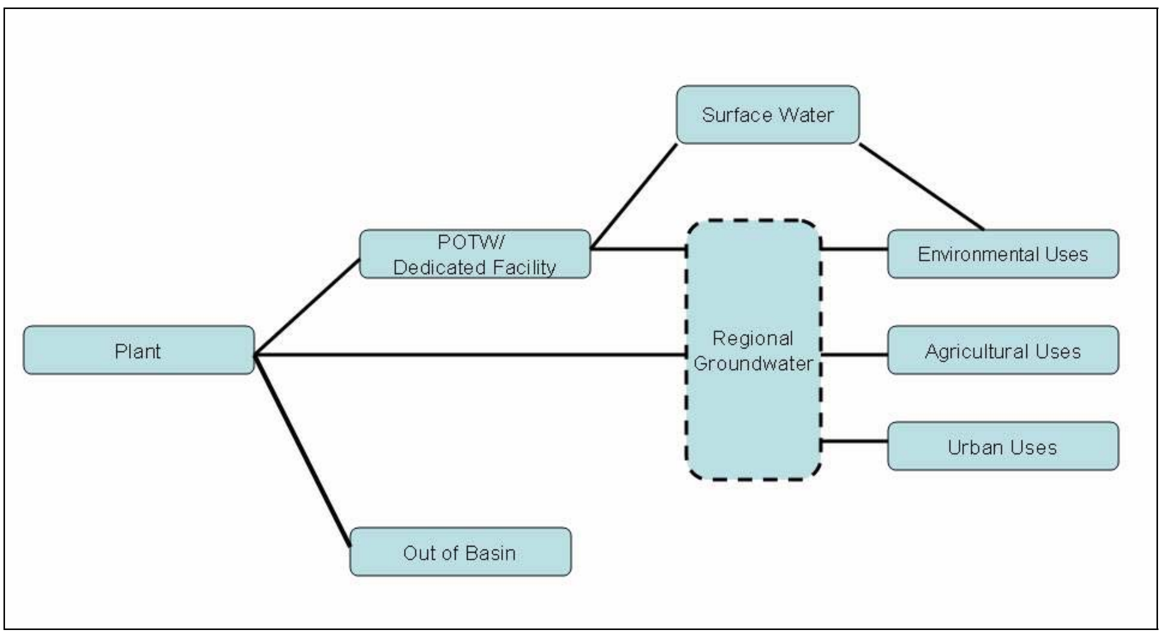


**Figure 3**

This schematic shows the range of factors that must be considered to find the types of balanced, reasonable water quality objectives, and measures to implement those objectives, required by Porter-Cologne. Changing how one part of the system operates may have implications for other parts of the system. For example, suppose that water quality is to be improved to a specified level through more aggressive in-plant measures.

This will increase operating cost to food processors, and reduce their profit.[19] However, these costs are counterbalanced against improvements in groundwater quality that benefit agricultural and urban users. These effects are linked through the movement of food processing industry wastewater through environmental media such as groundwater. To take another example, food processors could be faced with a requirement to discharge their wastes to the local POTW where it would receive some treatment before being discharged to land. Such an intervention would again increase upstream costs of operation and reduce profits (since POTWs would simply pass along their costs to dischargers). Again, there would be benefits on the other side of the ledger related to improvements in regional water quality.

Each element of the schematic is considered in this SEP study. Working left to right, the first box of the diagram refers to activities at food processing facilities. Water is consumed during the production process and is also present in inputs to the production of the final good. The amount of salt released from the factory can be controlled through the adoption of technologies or management practices, or through input substitution. These alternatives and their associated costs are considered in Section III.5.

Next, wastewater is discharged to one of several locations. Most commonly, wastewater is applied to land near the production facility. This disposal method is the subject of extensive analysis in this study. Sections II.2 and II.3 describe a highly detailed model of land application and the fate of wastewater in the vadose zone. Section II.4 considers how land application alters regional groundwater quality over time. Section III.4 discusses the regional economic costs of land application by measuring the lost benefits of water consumption resulting from degraded water quality. Because land application, either directly or via POTWs, is the current practice, there are relatively few incremental costs to producers associated with this option.

Alternatively, wastewater can be conveyed from the plant to a POTW. Likewise, it could be conveyed to a centralized processing facility owned and operated by one or more food processors. Sections III.6 and III.7 consider these two options, and contain an analysis of their capital and operating costs. These Sections also contain a discussion of the costs of pollution that occur under these alternatives.

A somewhat different alternative is disposal out of basin. Two such possibilities are considered in this study: a brine line to either the ocean or the Delta (Section III.8), and deep well injection (Section III.9). The capital costs associated with construction of a brine line are enormous, and this study does not opine on the feasibility, either political or regulatory, of such an option. However, we have attempted to consider only the most cost-effective configurations of an industrial brine line in the San Joaquin Valley – one that would work in a manner similar to the Sana Ana Regional Interceptor in Southern

[19] Note that in a highly competitive market, firms do not have the option of passing their costs along to consumers. As discussed in Section III.3, food processors in the Central Valley face competition from processors in other regions, states, and countries. Consequently raising prices will in most instances result in loss in market share.

California. There is also limited experience in the Central Valley with deep well injection, although Section III.8 considers the track record to date.

Following disposal, salt and other contaminants emanating from food processing facilities are transported through the environment. In the case of land application from either a food processing facility or POTW, salts can be transmitted to the saturated zone, where they may affect the quality of groundwater throughout the region. Again, this possibility is the subject of intensive analysis in this study, presented in Sections II.2 through II.4.

The right-hand portion of the schematic shows several uses of water: urban, agricultural and environmental use. Salts resulting from food processing may reduce the economic benefits of water use. In the case of agriculture, for example, irrigation with saline water may reduce crop yields and profitability. In the case of residential use, saline water can reduce the useful life of appliances or simply have an unpleasant taste. These effects are the marginal costs of pollution, or conversely, the marginal benefits of abatement. Section III.2 presents an analysis of how the demand for water quality can be monetized, allowing a straightforward comparison with the marginal costs of pollution control. Section II.5 discusses potential environmental effects of salt discharge from the food processing industry.

It is worth emphasizing that the analysis of salt management alternatives is conducted not on the basis of a set of hypothetical beneficial uses, but rather on current and expected future water use patterns. That is, management alternatives are assessed on the basis of *actual* water use, an approach that we argue should be more widely adopted with respect to water quality regulation.

## *E. Relationship of the Study to the Factors Listed in State Law*

Section 13241 of the California Water Code lists several factors that should be considered when developing water quality objectives. These factors include the following:

(a) Past, present, and probable future beneficial uses of water.
(b) Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto.
(c) Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area.
(d) Economic considerations.
(e) The need for developing housing within the region.
(f) The need to develop and use recycled water.

The study considers the current and potential future uses of water when evaluating salt management alternatives. Section III.1 describes groundwater and surface water use in the San Joaquin Valley over the period 2007 – 2030. This section presents a model to forecast land use changes in the region and uses this model to predict changes in sectoral water demands by location. The model also considers projections of housing demand developed by the various Metropolitan Planning Organizations in the Valley, and uses these projections to develop the predicted changes in water usage. Section III.2 describes how the demand for water quality varies among the sectors considered in the analysis. This analysis is important as salinity may have quite different implications for urban and agricultural consumers, for example.

Sections II.2, II.3 and II.4 of the study describe a highly detailed hydrogeologic model of the Lower San Joaquin River area, encompassing much of San Joaquin County and including the cities of Modesto and Turlock. Local environmental conditions play a key role in the analysis of changes in groundwater conditions as they affect the fate and regional transport of contaminants resulting from food processing activities. The hydrogeologic model also captures detailed information about water pumping and recirculation occurring in the study area. Thus, the scientific analysis portion of this SEP study is consistent with the factors listed in Section 13241.

Consistent with this same Section, economic considerations also play a key role in the study. For various salt management alternatives considered, we calculate associated capital and operating costs for a range of food processing activities. Costs are expressed on an absolute basis, as well as in terms of cost per unit of salt removed from the region. This metric is a useful and informative way to compare alternatives achieving the same level of environmental quality.

In addition to considering compliance costs, the study also examines the output and employment implications of water quality regulation of the food processing industry. While such measures are not part of a classical economic welfare analysis of regulation, they are a valid way to represent economic impacts, and are usually of great interest to policy makers. Output and labor impacts are calculated using a model that captures competitive conditions facing the California food processing industry, and linkages between food processing and the rest of the economy.

In sum, this study contains information on how to assess the impact of water quality objectives on the various factors listed in Section 13241.  In this sense, we hope that this SEP study will have value beyond its conclusions regarding food processing industry waste, and can serve as a model for the type of analysis that should be undertaken when developing water quality regulations and objectives in California.