https://www.waterboards.ca.gov/rwqcb5/water_issues/basin_plans/cvwb_jt_pub_wkshp/salt_staff_rpt.pdf

Overview of Salinity Issues in the Central Valley

1.0 Nature of the Problem

The salinity impairment of surface and groundwater in the Central Valley is a subset of a more far-reaching problem shared by most of California, other arid western states, and much of the developed world. As surface and groundwater supplies become scarcer, and as wastewater streams become more concentrated, salinity impairments are occurring with greater frequency and magnitude. Such impairments in the past have led to the fall of civilizations. These impairments will not be resolved by purely technical solutions. Solution of the salinity impairment in the Central Valley will depend upon development and successful implementation of effective land use, water supply, and water quality policies, in conjunction with the removal of institutional barriers.

A discussion of the technical nature of the problem must begin with a clear understanding of what salt is. Salt or salinity is typically used interchangeably with total dissolved solids (TDS) or electrical conductivity (EC). TDS is the dissolved portion of solids in water, including colloidal and small, suspended particles that will pass through a membrane filter of about 1.2 μm (Tchobanoglous and Schroeder, 1985). These solids include both volatile and nonvolatile compounds. The volatile component consists of organic materials such as naturally occurring proteins, carbohydrates, and lipids, and numerous synthetic organic compounds. The non-volatile component consists of both ionic and non-ionic substances. The major nonionic substance in water is silica. The major ionic substances in water are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and nitrate. It is these ionic substances that impart an ability of the water to conduct an electrical charge, which we call the electrical conductivity (EC) of water. It is the high concentration of ions and therefore high EC in water that can adversely affect crops and other beneficial uses. The specific mix of ionic substances is also important to gage a water's effect on a use.

2.0 Sources of Salt

Sources of salt can be categorized according to the *type* of entity discharging the salt; e.g. from agricultural, municipal, industrial, or natural discharges. Source can also be categorized according to its origin: 1) evapoconcentrated from supply water; 2) added through dissolution of naturally occurring salts; or 3) through an explicit addition of salts, e.g. fertilizers or in food processing. To complicate matters, most discharges are likely a mix of all three. For example, an agricultural discharge may contain evapoconcentrated salts from supply water, plus naturally occurring salts from soils upon which the irrigation water is applied and nutrient salts added as fertilizer. In addition, the source of salt may result from a mix of surface and groundwater. The relative importance and mix of sources is affected by the geography of the area. For example, although fundamentally the same, the relative mix of sources is different in the Tulare Lake, San Joaquin River, and Sacramento River Basins.

In general the largest sources of salts are derived from agricultural activities that mobilize salts in soils and add imported salts from supply water. This is most pronounced in the San Joaquin River and Tulare Lake Basins that have vast areas of naturally occurring salts in soils, and receives a large quantity of salt in imported supply water. This degradation is not as apparent in the Sacramento River basin because of relatively low salinity soils and much larger dilution flows than in the southern basins. An incremental increase in Sacramento River salinity, however, exacerbates salinity problems in the southern basins and for all Delta exporters because of larger salt loads in their supply water.

The magnitude of these salt sources can be illustrated. The State Water Project (SWP) and the Delta Mendota Canal (DMC) import, on average 1.4 million tons of salt per year to the Tulare Lake and San Joaquin River Basins (SJVDIP, 1998). Increased salt loads and elevated water table elevations in the San Joaquin River Basin are causing groundwater accretions to the San Joaquin River to contribute, on average, 30 percent of the annual salt load in the river (CVRWQCB, 2004). Shallow groundwater, collected in subsurface drains and conveyed to the San Joaquin River also accounts for another 17 percent of the average annual total salt load in the river.

Salinity impairments in surface and ground water are exacerbated locally from other sources including discharges to land associated with municipal wastewater disposal, septic tanks, oil field brines, confined animal facilities, food processors, and many other sources. Locally and regionally complex interactions of surface and groundwater make assessment and mitigation of salinity problems difficult. Salts added to groundwater from different sources, for example, will have short and long-term impacts on surface water salinity. Elevated salinities in groundwater accretions of a gaining stream, such as in the lower San Joaquin River and Lower Kings River, lead to increases in surface water salinities. Conversely, salts added to surface water can have short and long-term effects on groundwater quality, as when surface water is used as an irrigation supply. This use of higher salinity surface water will increase the salinity of shallow groundwater. Many of these long-term effects can occur at exceedingly slow rates, over a number of decades. Because these changes occur very slowly, surface and groundwater impairments can be difficult to measure and quantify.

3.0 Impact of Salt on Beneficial Uses

Salt can impact a number of beneficial uses. Agricultural water supplies with elevated concentrations of total salts reduce yield and quality of crops. Individual salts such as boron and sodium can also harm crops. A secondary Maximum Contaminant Level (MCL) has been set for electrical conductivity to protect drinking water supplies and industrial users often have to treat water supplies to protect processes that are sensitive to total salinity and/or individual ions. Elevated salt levels also shorten the useful life of water heaters, pipes, and other water supply systems.

4.0 Waste Discharges of Salt and Other Salt Degradation

All natural waters contain salt and the process of using the water results in waste discharges with elevated salt concentrations. Human waste contains both inorganic salt and organic material some of which breaks down to salt, so salinity in municipal wastewater systems is higher than the water supply. Industrial processes often add or concentrate salt that in turn is disposed of through municipal or individual disposal systems. Salt in water used for irrigation and wetlands is concentrated through evaporation and transpiration.

5.0 Institutional Links for Salt Control

The mix of surface and groundwater interactions, in conjunction with the peculiar geography of California must be considered along with the political, legal, and administrative constraints when determining a long-term solution to the salt problem. The salinity problem is complicated by the presence of an extensive institutional bureaucracy that applies mostly to surface water. In contrast, it is a lack of institutional mechanisms to manage groundwater resources that further complicates the salinity impairment in the Central Valley.

5.1 Surface Water Storage, Conveyance, and Use

The salinity impairment in the Central Valley is affected most by the surface water export, storage, delivery, and use. Surface water export, storage, and conveyance facilities in California are the purview of the United States Bureau of Reclamation (USBR), the US Army Corps of Engineers (COE), California Department of Water Resources (DWR), and many local water, drainage, and reclamation agencies. The development and operation of these water supply projects have contributed to changed flow paths, reduced flow in many water bodies, changes in salt dilution capacity of many water bodies, and changes in salt distribution within the Valley. For example, storage and conveyance facilities of the USBR have contributed to:

- Elevated water table elevations in the Tulare Lake and San Joaquin River Basins
- Increased salinity in surface and groundwater in the Tulare Lake and San Joaquin River Basins
- Low flows in the San Joaquin River
- Re-export of SJR salt loads into the CVP service area

There is a recognition of the competing interests of these agencies and the need to address the myriad water quality, supply, environmental, flood control, and other problems in the Delta that have resulted from the level of water development, export, and use in the Valley. Due to the dependence on this water supply by other regions of the State, State-federal cooperation was formalized in June 1994 with the signing of a Framework Agreement by the state and federal agencies with management and regulatory responsibility in the Bay-Delta Estuary. This on-going cooperation continues under the auspices of the California Bay-Delta Authority (Bay-Delta Authority), established in 2003 as the new governance structure. The Bay-Delta Authority was formed to promote

cooperation between State and federal agencies to achieve, among other things, broad water quality improvements. Though partially successful, the Bay-Delta Authority has not succeeded in removing institutional barriers on a scale that are needed to implement a successful salinity control program in the Central Valley (see institutional barriers below).

5.2 Groundwater Use

Unlike surface water, there are few statewide institutional mechanisms to manage groundwater resources. Groundwater is pumped in areas that have little or no access to surface water supplies or to augment existing supplies. Except for very limited applications, pumping of groundwater is outside the jurisdiction of the State Water Resources Control Board (State Water Board). At present there is no oversight of groundwater pumping and its impacts in the Central Valley by the State Water Board.

With few new surface water storage projects under development, there is increasing reliance on groundwater and conjunctive use of surface and groundwater supplies. DWR has identified conjunctive use, water banking, and water transfers as viable alternatives for increasing California's overall water supply and has implemented programs to improve the management of groundwater resources in the state. The goal of its Conjunctive Water Management Program (CWMP) is to increase statewide water reliability through planned, coordinated management and use of groundwater and surface water resources.

By their very nature, conjunctive use projects can have an adverse affect on overall salinity because water applied to the ground will dissolve and mobilize additional salts as it moves through soils and is stored in aquifers. In most cases, pumped groundwater is of poorer quality than surface water supplies, thus pumped groundwater, when used as an irrigation or municipal supply, can contribute significant additional salt loads to surface water.

An example of a conjunctive use project that can have adverse impacts on salinity is the pumping of groundwater wells into the Mendota Pool to augment surface water supplies. This pumped groundwater is generally of significantly higher salinity than the surface water sources in the pool.

5.3 Water Rights and Water Quality

The right to use surface water is the primarily the purview of the State Water Board thru its Division of Water Rights and some individual water users who established water rights almost a century ago. There are no controls by the State Water Board or the Regional Board on groundwater use in the Central Valley. The Regional Board regulates waste discharges that could affect water quality of both surface water and groundwater, with oversight from the State Water Board. Both the USEPA and the State Water Board have approval authority over water quality standards, basin plans and various other water quality programs including Total Maximum Daily Loads (TMDLs) developed for salt in the San Joaquin River and other waters listed on the 303(d) list of impaired waters.

The State Water Board also has authority over water quality and water rights in the Delta. In response to concerns by the Secretary of the Interior that existing salinity standards for the Delta did not adequately protect municipal, industrial, agricultural, and fishery uses, the State Water Board (newly created by the amalgamation of the State Water Rights Board and the State Water Quality Control Board) adopted a water quality control policy for the Delta through Resolution 68-17 in 1968. This policy supplemented a water quality control policy for the Delta that was developed by the Central Valley Regional Board and adopted by the State Water Board in June 1967. The State Water Board has continued to exercise its authority over water rights and water quality in the Delta through development of the 1995 Water Quality Control Plan for the for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan), implemented through Water Right Decision 1641.

The Bay-Delta plan includes, among other things, salinity standards for the San Joaquin River near Vernalis and other locations in the South Delta. Decision 1641, issued in March 2000, conditioned the permits under which the USBR delivers water to the Tulare Lake and San Joaquin River Basin to require that the USBR meet the 1995 Bay-Delta salinity objectives at Vernalis. Decision 1641 also directed the Regional Board to develop and adopt salinity objectives and a program of implementation for the main stem of the San Joaquin River upstream of Vernalis.

Regulation of water quality in the Central Valley is primarily the responsibility of the Central Valley Regional Board. Because of the nature of the water distribution system and the potential need to export and discharge salts, other Regional Boards have a vested interest in the water quality programs developed for the Central Valley. The Central Coast, Los Angeles, Colorado River, Santa Ana and San Diego Regional Boards (Regions 2, 3, 4, 7,8, and 9, respectively), have a vested interest in Central Valley salinity issues because of their dependence on water supply imports from the Delta. The San Francisco Bay and Central Coast Regions (2 and 3, respectively) would be affected by any decision to increase saline discharges that would result from the out-of-valley disposal of salts from the Central Valley. Specific elements of the Central Valley Regional Board's regulatory efforts are described in section 6.0 below.

5.4 Institutional Barriers

The myriad of State, federal, and local agencies that control distribution and use of water, along with uncontrolled private use of all groundwater and some surface waters results in a major institutional barrier for effective control of the salinity impairment in the Central Valley. Just between Regional Boards, there are conflicting interests with regard to out-of-valley disposal of salts. For example, a case could be made in the Central Valley for the protection of the agricultural beneficial use of water in the Tulare Lake and San Joaquin River Basin through the development of an out-of-valley drain and disposal into the Delta. Any such drain would not only have possible negative impacts on beneficial uses within the Delta but also within the Bay Area Region, downstream of the Delta. Ultimate disposal in the Ocean is not favored by the Coastal regions thus blocking any significant long-term disposal options.

The Bay-Delta Authority has been successful in promoting cooperation between State and federal agencies on a number of water quality issues including its contribution to solutions for the dissolved oxygen impairment in the San Joaquin River. The Bay-Delta Authority, however, has not been successful in removing institutional barriers to achieve major water quality improvements for salinity in the Central Valley. Political considerations at the inception of CALFED, removed from discussion or consideration, the evaluation of both an out-of-valley drain for disposal of salts, and a peripheral canal. Some version of one or both of these large projects would improve water quality of Central Valley supplies while allowing for greater export of salts from the San Joaquin River and Tulare Lake Basins.

Once a comprehensive policy direction is achieved on how to manage salinity, the real work then needs to begin at the local agency level. At the local level, water, irrigation, drainage, and reclamation districts, provide water supply, drainage service, and flood control to their members, who include municipalities and farms. It is on the scale of these individual municipalities and farms, in cooperation with their local districts, that local on-the-ground improvements in water management that results in improvements to water quality, including salinity, can be achieved. Water districts can, and have, for example, provided district-wide infrastructure to reduce the discharge of salts in surface agricultural discharges.

6.0 Regional Board Regulatory Efforts

The following discharger categories are examples of operations that may generate waste with salinity levels that adversely impact the uses of the receiving waters:

- Biosolids
- Dairies
- Food processing facilities
- Irrigated agriculture
- Agricultural subsurface drainage systems such as the Grassland Bypass Project
- Mines
- Municipal wastewater treatment plants
- Oilfield brines
- Power plants
- Wetlands

The actual threat depends on the characteristics of the waste and the uses of the receiving waters. Regional Board regulatory programs address all these dischargers, but the degree to which salt has been addressed may vary from program to program and from site to site.

6.1 Basin Plan Policies

There are three basins in the Central Valley and the salinity control policies vary by basin, as discussed below. As a result of water transfers, salinity control efforts in one area often impact water quality not only in other Central Valley basins, but also other regions of the state.

The initial basin planning effort in 1975 looked intensively at groundwater salinity in the Tulare Lake Basin and concluded that salt buildup in the groundwater would eventually eliminate many, if not all, of its beneficial uses. As a result, the Board established a controlled groundwater degradation policy, with the goal of extending the useable life of the groundwater aquifer for the longest term possible. The Basin Plan also encourages proactive management of waste streams to control and manage salts to avoid creation of hotspots of degradation.

The San Joaquin River Basin is no less salt affected, but the focus is on surface water quality protection in the San Joaquin River. The Board's policy has been to promote the maximum export of salt from the Basin, so long as water quality objectives have been met. At this time, salinity in the river is so high that a TMDL has been developed to meet the objectives at Vernalis and a second phase of this TMDL is being developed for upstream stretches of the river.

In the Sacramento River Basin, salt buildup and salinity control have rarely been an issue. The Board has focused on point source discharges to be sure that local salinity hotspots do not develop.

7.0 What Others are Doing

Regional Board staff has been tracking and participating in a number of activities initiated by other entities that will have an effect on the salinity impairment in the Central Valley. These include, but are not limited to:

- Draft EIS on the United States Bureau of Reclamation's San Luis Unit Drainage Feature Re-evaluation
- San Joaquin River Recirculation Study
- San Joaquin River Water Quality Management Group Summary Recommendation for San Joaquin River Water Quality Management
- State Water Board's Periodic Review of Bay-Delta Plan and Cease and Desist Order
- South Delta Improvement Project
- Current In-Valley Disposal of Ag Drainage

7.1 Draft EIS on the United States Bureau of Reclamation's San Luis Unit Drainage Feature Re-evaluation

The USBR recently circulated a draft environmental impact statement (DEIS) outlining seven action alternatives to provide drainage service to the San Luis Unit and Northerly Area (the part of the adjacent Grassland Drainage Area not included in the San Luis Unit) of the Central Valley Project. The study addresses agricultural subsurface drainage from approximately 730,000 acres of farmland on the west side of the Tulare Lake and San Joaquin River Basins. The options are to build a drain to discharge agricultural subsurface drainage offshore of Point Estero, near San Luis Obispo (Ocean Disposal); build a drain for discharge at Chipps Island or Carquinez Strait (the Bay-Delta disposal alternatives); or recirculate, concentrate and dispose drainage byproducts (salts) within the area of origin, the west side of the San Joaquin River and Tulare Lake Basins. The In-Valley alternatives differ from each other in the degree of land retirement called for, from the original proposal (2004) that identified only the 44,000 acres of land already retired or scheduled for retirement as part of the package to the maximum land retirement alternative that would retire 308,000 acres of the 379,000 drainage impaired acres in the study area.

The common elements to all alternatives under consideration are the installation and/or expansion of drainage reuse areas and retirement of at least 44,000 acres. Drainage will be collected from the fields and sent to one of 16 reuse areas to irrigate salt tolerant crops. The drainage from the reuse areas will then be collected and sent to Point Estero or, if the ocean disposal alternative is not selected, to a treatment facility. Four regional treatment facilities are proposed for Bay-Delta and In-Valley alternatives. The concentrated drainage collected from the reuse areas will first undergo reverse osmosis treatment to remove salt. The product water will be blended back with irrigation supplies and the brine will undergo further biotreatment to remove selenium. After biotreatment the brine will either be discharged to the Bay-Delta or to an evaporation basin.

Comments prepared by staff pointed to a number of problems with these plans. Source control is delegated to the water users, who are expected to voluntarily implement efficient irrigation and drainage management practices. Retired land and reuse areas require careful management to avoid adverse impacts and the DEIS provides no means of assuring consistent and responsible management. The technical and economic feasibility of the treatment technologies under consideration is unproven on agricultural drainage at this scale. And evaporation basins, even when operated correctly, will have some adverse effect. Out of Valley alternatives require a huge commitment of resources at the outset, so the Bureau appears to favor an In-Valley alternative because of the greater flexibility in a phased approach. However, flexibility is only useful if the key elements of the alternative work as well as they must to prevent adverse effects.

Out-of-Valley alternatives discussed in the DEIS included ocean and Bay-Delta disposal. Ocean disposal would occur within the jurisdiction of the Central Coast Regional Board. Bay-Delta disposal would occur near the boundaries of the Central Valley and San Francisco Regional Boards. It would most likely affect waters within the jurisdiction of the San Francisco Bay Regional Board.

7.2 San Joaquin River Recirculation Study

In August 2005, USBR and the California Department of Water Resources conducted a short-term pilot study involving the release of up to 300 cfs from the Delta-Mendota Canal (DMC) to the San Joaquin River near the town of Newman. This project was conducted in response to State Water Board Water Right Decision 1641, with the primary purpose of evaluating the water quality benefits of increasing flow in the river by pumping water from the south Delta, transporting it via the DMC, and releasing it near Newman. The impact of the project on salinity levels was closely monitored and the report summarizing the results has just been released.

7.3 San Joaquin River Water Quality Management Group Summary Recommendation for San Joaquin River Water Quality Management

The San Joaquin River Water Quality Management Group (SJR Group) is a group of federal, state, and local agencies that has formed to develop a plan to meet water quality objectives for salinity at Vernalis and dissolved oxygen in the Stockton Deep Water Ship Channel. Development of this plan was prompted, in part, by the preparation of TMDLs to achieve compliance with these objectives.

7.4 State Water Board Periodic Review and Cease and Desist Order

The State Water Board is currently in the midst of a periodic review of the 1995 Bay-Delta Plan that was implemented through Water Right Decision 1641. Among other things, this periodic review would consider whether or not changes are needed in salinity standards in the SJR near Vernalis and other locations in the Southern Delta. The State Water Board has also just recently issued a notice of public hearing to receive evidence relevant to determining whether to adopt draft Cease and Desist Orders against the USBR and DWR with regard to their potential violation of conditions in their water rights permits that require the USBR and DWR to meet salinity standards in the southern Delta. The USBR and DWR, per Water Right Decision 1641, are jointly and severally responsible for meeting water quality objectives, including salinity objectives in the Southern Delta.

7.5 South Delta Improvement Project

The USBR and DWR are proposing the South Delta Improvements Program to:

1. increase the maximum allowable diversion capacity of the joint state and federal water projects
2. provide an adequate water supply for South Delta Water Agency; and
3. improve conditions for San Joaquin River Salmon in the southern portion of the Delta

The SDIP, through construction and operation of permanent operable barriers in the Delta, will have potential effects on salinity in the southern Delta and exported water.

7.6 In-Valley Disposal of Ag. Drainage

There is currently agricultural drainage from sub-surface "tile" drains being disposed of in the Tulare Lake and San Joaquin River Basins. The drainage is collected from broad areas for discharge into un-lined evaporation basins or to land disposal areas at application rates set to prevent ponding. The drained areas served vary from farms to whole districts. Under this type of management, relatively smaller land areas are sacrificed for the benefit of a broader area. There is currently about 4,000 acres of land receiving drainage at this time, with regulated disposal operations spread across three counties. These operations are still considered interim measures since eventually the salt in the sacrificed areas must be disposed of. These operations also require extensive management to prevent wildlife (waterbird) impacts, primarily from selenium.

8.0 Future Needs

A sustainable solution to salinity impairments of both surface and groundwater in the Central Valley will include a variety of policies and actions, many of which include major elements that are outside the direct authority of the Regional Board. A sustainable solution will therefore need to include considerable coordination of efforts with the State Water Board, other Regional Boards, the CBDA, and State and federal resource agencies including the DWR, USBR, USFWS, CDFG, and NMFS.

The Regional Board will be able to make marginal improvements in water quality by continuing to exercise its authorities through development and refinement of TMDLs, and development and implementation of policies for the consistent regulation of salt in discharges to land and water. These marginal improvements, however, will be of little consequence in the absence of the Regional Board and the State Water Board taking on a leadership role to foster needed changes in the statewide plans and policies needed for a comprehensive and sustainable solution to the Central Valley's salinity impairment.

9.0 References

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