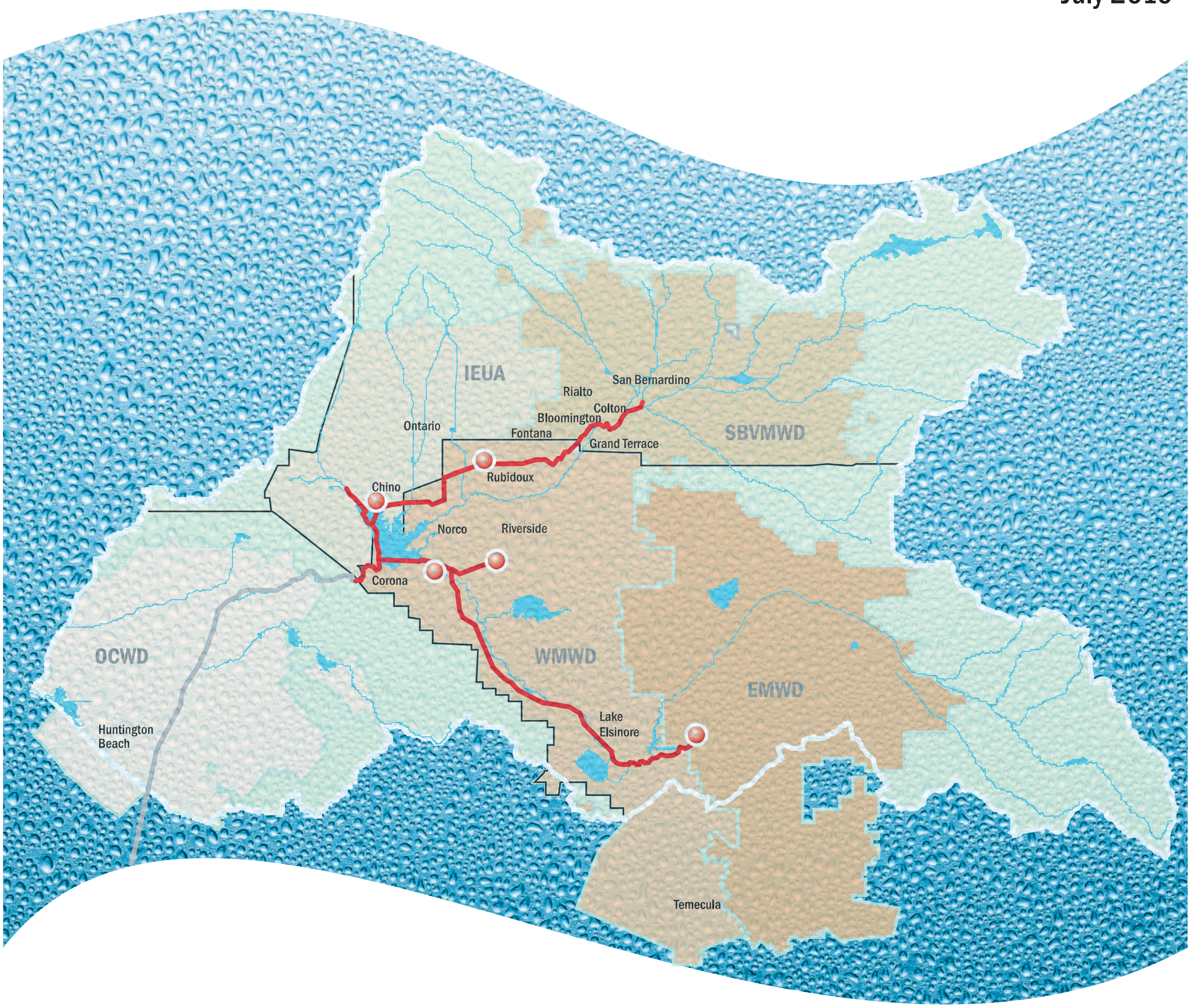
SANTA ANA WATERSHED PROJECT AUTHORITY

Santa Ana Watershed Salinity Management Program

Summary Report

July 2010



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July 12, 2010

Mr. Richard Haller
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Subject: Santa Ana Watershed Salinity Management Program Summary Report

Dear Rich:

The enclosed document presents the conclusions and recommendations as well as a summary of the findings resulting from the CDM team's work on the subject program. The document also references the three final Technical Memoranda prepared under the study that provide a detailed presentation of our work on the project.

We have sincerely appreciated the support and interest provided by SAWPA staff and Commission as well from SAWPA Member Agencies and other interested parties during the development of this study. We look forward to other opportunities to be of service to SAWPA.

Very truly yours,

Donald J. Schroeder, P.E.
Vice President
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Summary Report

Introduction

From its original inception as the Santa Ana Watershed Planning Agency (now the Santa Ana Watershed Project Authority- SAWPA) in 1968, through over 40 years of growth and leadership on a wide variety of water quality and resource management issues currently expressed in the "One Water One Watershed" theme, facilitating salt management has remained one of SAWPA's most important objectives. Significant progress has been made over the years through implementation and operation of the SARI line, groundwater desalters and other projects and activities with salt reduction and water conservation as primary goals. Nonetheless, it is still apparent that there is a significant long-term salt imbalance in the watershed. Not only is the magnitude of the challenge still large, dynamic changes in local and statewide issues have, if anything, increased the challenge. The original underlying assumption in basin planning that there would be substantial quantities of low TDS imported State Project Water available to the watershed for direct use and groundwater recharge is no longer valid. Expansive urban growth, while expected, has been even faster than anticipated. Water reuse is now a large part of local agencies plans.

The SARI system, the fundamental link for exporting salts from the basin has been subject to various physical, institutional and economic challenges. While much has been accomplished, much more can and should be done. This Salinity Management Program study is intended to assist the SAWPA staff and Commission and other stakeholders by reconfirming the role of the SARI system and envisioning additional actions that can be taken on a watershed basis to achieve the desired salt balance in an effective and cost-efficient manner.

Camp Dresser & McKee Inc., in conjunction with Wildermuth Environmental Inc. and Carollo Engineers conducted this Salinity Management Program Study under a Task Order issued by SAWPA. The Study was divided into three phases:

- Phase 1 – Salt Management Plan
- Phase 2 – SARI Planning
- Phase 3 – SARI Operations

At the end of each phase of the study, the consultant team prepared a draft Technical Memorandum, provided a briefing to the SAWPA Commission, and prepared a final Technical Memorandum based on comments received. This Summary Report presents the key conclusions and recommendations of the overall study and a brief summary of the three Technical Memoranda. The final detailed Technical Memoranda are included as appendices to this Summary Report.

Conclusions and Recommendations

A number of conclusions were reached as a result of the study:

- Significant progress has been made in the watershed toward achieving salt balance goals but substantial additional capital investment is still required.
- If all future projects already in planning within the watershed are implemented, the salt imbalance will be further reduced; in addition, these projects, plus a limited number of additional actions, are projected to result in maintaining drinking water RMCLs, groundwater basin objectives, and wastewater discharge objectives for TDS in the Upper Basin.
- New brine from a number of proposed Indirect Potable Re-use treatment systems will allow more water reuse and salt export within the watershed but will result in a significant new source of flows to the SARI system.
- Projects proposed to further concentrate brine waste streams from groundwater desalters can significantly reduce demands on, and /or extend capacity in the SARI system. Such systems could potentially add complexity to SARI O&M including scale and solids build-up in the pipe; however, if chemical softening is included in the projects the increase in TDS resulting from these projects should not have an adverse impact on the system.
- Effluent limits on BOD, TSS and perhaps DOC should be considered by SAWPA to control the "solids imbalance" problem caused by inorganic coagulation.
- Cost is an important factor related to the continued and increased use of the SARI, especially for indirect dischargers and industry.
- Indirect dischargers (i.e. discharges to truck dump stations) contribute a disproportionally large percentage of the total system BOD and TSS loading with a small quantity of flow.
- There is sufficient SARI hydraulic capacity in the near term with the additional improvements currently in planning; long term there may be insufficient capacity without further concentration of brine discharges beyond current practices.
- The current SAWPA policy that all domestic connections are temporary was confirmed. These temporary connections containing reclaimable wastewater are to be re-directed to a local POTW. The hydraulic capacity will be needed for brine wastes and the high BOD and TSS strength of these discharges impacts the operation of the system.
- The economics of the current system configuration versus other alternatives evaluated is highly dependent on the future purchase price for additional OCSD treatment and disposal capacity.

- The addition of brine concentration projects to all or most of the groundwater desalters is strongly encouraged in order to avoid the possibility that the total future flows in the system would exceed 30 mgd. This condition would exceed the maximum available capacity for treatment at OCSD and exceed the hydraulic capacity of several segments of the SARI pipeline. Such projects also recover significant additional potable water supplies that are critical to the watershed.

- The cost of acquiring additional capacity in the OCSD system up to 30 mgd has a major impact on the economics of continuing the current operation.

- The option of constructing a parallel pipeline through Orange County to discharge brine directly to the ocean outfall could potentially offer some major cost advantages over continuing to discharge to the treatment system. However, there are a number of challenging permitting, environmental and institutional issues that would need to be solved for this option to be feasible.

- After the completion of near term rehabilitation projects, the expected remaining useful life of all of the existing SARI reaches will be greater than 40 years.

Significant next steps that SAWPA and the member agencies are encouraged to take based on conclusions include:

- Evaluate the need to limit BOD, TSS, and perhaps DOC concentrations to reduce solids formation and the solids imbalance problem.

- Establish criteria for chemical softening in future brine producing projects to control the scaling and inorganic solids generation problem.

- Continue negotiations with OCWD for securing additional treatment capacity which may be needed within the next five years and seek potential relief in the escalation of future costs; consider re-evaluating the feasibility of direct ocean discharge option depending upon the outcome of negotiations.

- Work closely with Member Agencies and local water supply agencies to find mutually beneficial approaches to encourage and accelerate development of brine concentration projects for groundwater desalter projects.

Salinity Management Plan

Phase 1 addressed the current setting and future planning activities that either affect or are directed at the management of salinity in the Santa Ana Watershed, and developed scenarios to maximize SARI's use as an effective salt management tool.

SAWPA owns and operates a pipeline system within San Bernardino and Riverside Counties of California, referred to as the Santa Ana Regional Interceptor (SARI). The SARI line accepts brine and other wastewater discharges within the Santa Ana Watershed. The interceptor was initially constructed to provide export and ultimately ocean disposal of highly saline discharges from groundwater desalination facilities, power plants, and industrial users, in order to protect the inland water quality in the upper Santa Ana River Watershed. Due to the initially low flows of these higher salinity wastewaters, the SARI line has temporarily accommodated lower salinity domestic wastewaters to provide revenue and maintain system flows closer to design capacities. This also has provided a service to member agencies to allow time for planning for future wastewater conveyance and treatment facilities.

The SARI pipeline conveys the wastewater to the Orange County Sanitation District (OCSD) system, where the water is treated and ultimately discharged through an ocean outfall. OCSD charges SAWPA and SAWPA then charges agencies discharging to the SARI line with predetermined rates established to cover the charges from OCSD, pipeline maintenance, and other related costs incurred by SAWPA. Four of the five SAWPA member agencies, located in the Upper Basin, own and use capacity in the SARI system. OCWD no longer owns capacity.

The current capacity of the SARI line is nominally 30 mgd, while the current average utilization is approximately 11.4 mgd (as of August 2009). The SARI line exports over 75,000 tons of salt per year from the Upper Santa Ana River Watershed. The SARI line is entirely a gravity pipeline and is shown in Figure 1.

Currently, the main improvement planned for the SARI line is an eastward extension of Reach IV-E from San Bernardino to Yucaipa. The construction of the line is planned in three phases, with the third phase projected to be completed by early 2012. An extension of the brine pipeline system, within EMWD, at the upstream end of Reach V is currently being designed to serve the planned Perris II Desalter, which is also in design stage.

An agency or business wishing to discharge into the SARI System usually contracts for needed pipeline, treatment and disposal capacity with the appropriate member agency. Permit requirements for discharge are set by OCSD/SAWPA and may be administered by SAWPA or by the contracting member agency. Upon payment of a connection fee, the discharger may use the system within the bounds established by both contract and an appropriate discharge permit. Day to day operations and maintenance of all of the system with the exception of upper Reach IV-A is carried out by staff of WMWD under a contract arrangement with SAWPA. Operations and maintenance of upper Reach IV-A north of the RP-2 plant is conducted by staff from IEUA. Local Permitting and Pretreatment programs with respect to discharges to the SARI line are implemented by each member agency for discharges within its service area. Financial management of the system is the responsibility of SAWPA. Certain operation and maintenance functions such as laboratory services are contracted out.

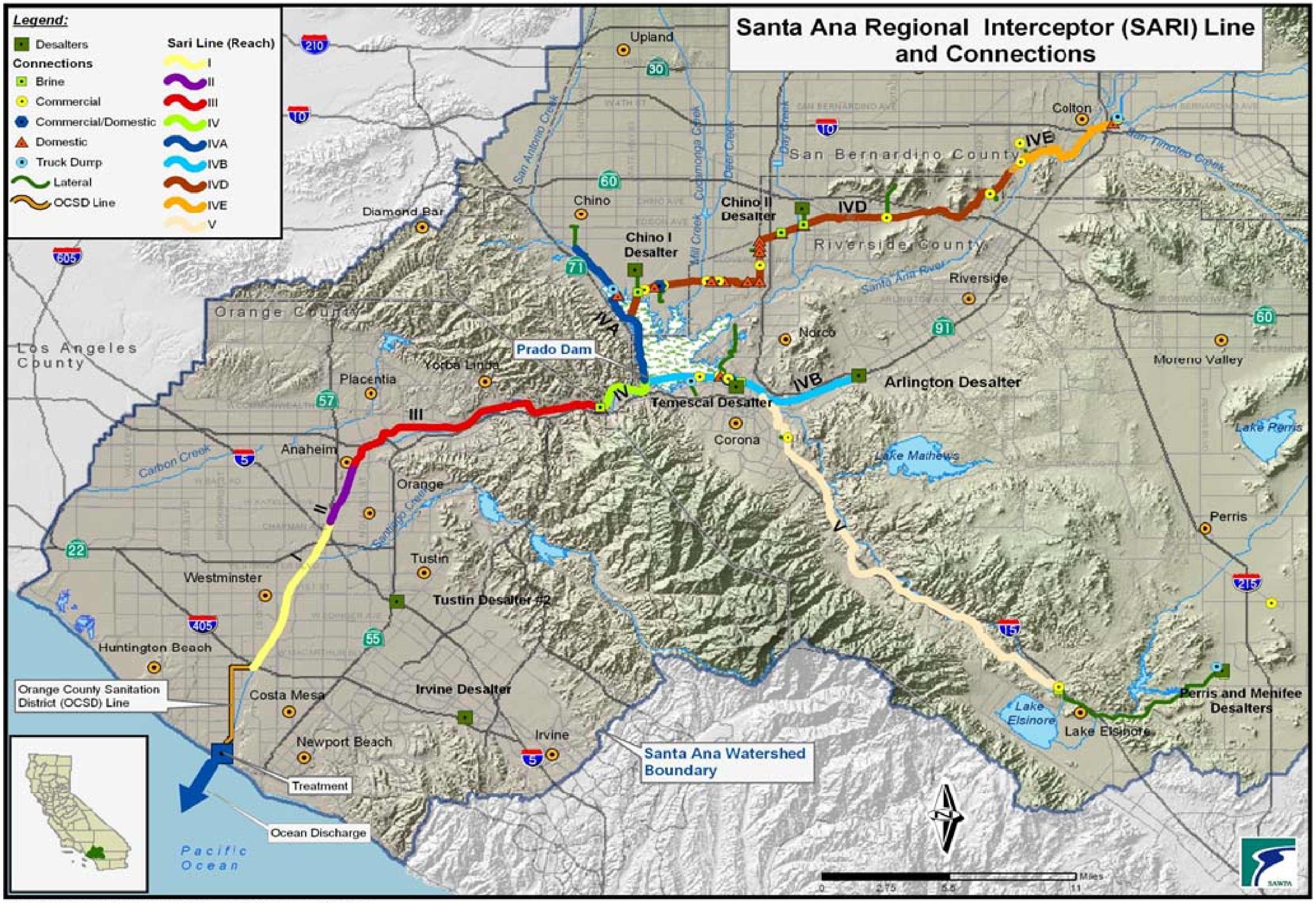

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Figure 1
SARI System Map

Existing or near-term discharges to the SARI line included in the baseline basin TDS projections are grouped by the following categories:

- Groundwater Desalters
  - Chino I and Chino II Desalter including a planned expansion of the Chino II Desalter
  - Arlington Desalter
  - Temescal Basin Desalter
  - Perris I Desalter
  - Menifee Desalter
- Nitrite Removal/Ion Exchange projects
  - Rubidoux CSD Anita B. Smith Ion Exchange Facility
  - Jurupa CSD Roger D. Teagarden Ion Exchange Facility
  - Chino Hills Ion Exchange Facility
- Domestic wastewater, industrial direct connections and waste haulers who discharge at dump stations
  - Five directly connected industrial discharges
  - Six temporary domestic discharge connections
  - Approximately 50 indirect dischargers/wastehaulers

The need for future salt removal from the watershed is directly linked to future water demands and supply plans from the water-supply agencies in the watershed, as well as the agencies' wastewater discharge and reuse plans. This is true because groundwater is a key component of the water-supply plans for most agencies in the watershed. Water demand and supply plan projections and projections of wastewater disposal/reuse were used to assist in the development of salt budget and projection tools for the groundwater basins. Together, these projection tools were used to describe future salt management requirements (i.e. where, when, and how much future desalting may need to be implemented for the greatest benefit).

An extensive effort was conducted to develop projections of salt removal as described in Sections 3-5 of the Task 1 Technical Memorandum. The future salt removal needs of the watershed will be driven by four main regulatory limits:

- The TDS objectives within the Basin Plan.

- The EPA secondary MCL for TDS in the potable water supply.
- The TDS discharge limits in the NPDES permits for each POTW.
- Projected recycled water TDS concentrations that exceed Basin Plan water quality objectives, preventing its use for irrigation or recharge in management zones with no assimilative capacity.

The analysis incorporated water and wastewater agencies' planning information and information on known or planned desalination projects and was projected through the year 2060. Key findings included:

- Several groundwater basins are projected to exceed the Maximum Benefit objectives established by the Regional Board and would require further actions such as more groundwater desalting.
- A few water supply agencies could potentially require additional desalting or alternative water supplies to avoid exceeding the California DPH secondary maximum contaminant level (MCL) for TDS.
- Several municipal wastewater agencies are projected to have TDS levels that would exceeds the existing discharge limit, thus is assumed that some action would be triggered. In these cases, either a portion of the water supply or a portion of the POTW effluent can be desalted to achieve the discharge limit. The assumption made in this analysis is that desalting a portion of the POTW effluent is the more likely scenarios as this requires a much smaller volume of raw water and, therefore, produces a smaller volume of brine than treating the potable supply.

This analysis was compared with future projects identified through discussion with the various agencies to determine whether the future projects would meet the projected needs or whether there would be additional "unmet" needs that would result in additional brine flows to the SARI line.

Future projects that are already in some form of conceptual or detailed planning were identified and compared to these to the projected salt needs to determine whether the planned projects would meet the needs or whether other potential approaches to address any remaining "gap" that the analysis suggests might also be needed. This information was then used to forecast the role that the SARI system and/or other options for salt removal or reduction will need to serve in the future as shown in Figure 2.

An extensive list of planned projects was compiled through discussions with SAWPA member agencies and/or sub-agencies which included groundwater desalters and ion exchange plants as well as substantial indirect potable reuse projects in which municipal wastewater would be reused for groundwater recharge requiring partial demineralization of the wastewater to meet CDPH regulations and thereby producing a brine stream. Details on the anticipated projects are presented in Section 6 of the

Technical Memorandum. In addition, projections were developed for future direct or indirect industrial dischargers and waste haulers.

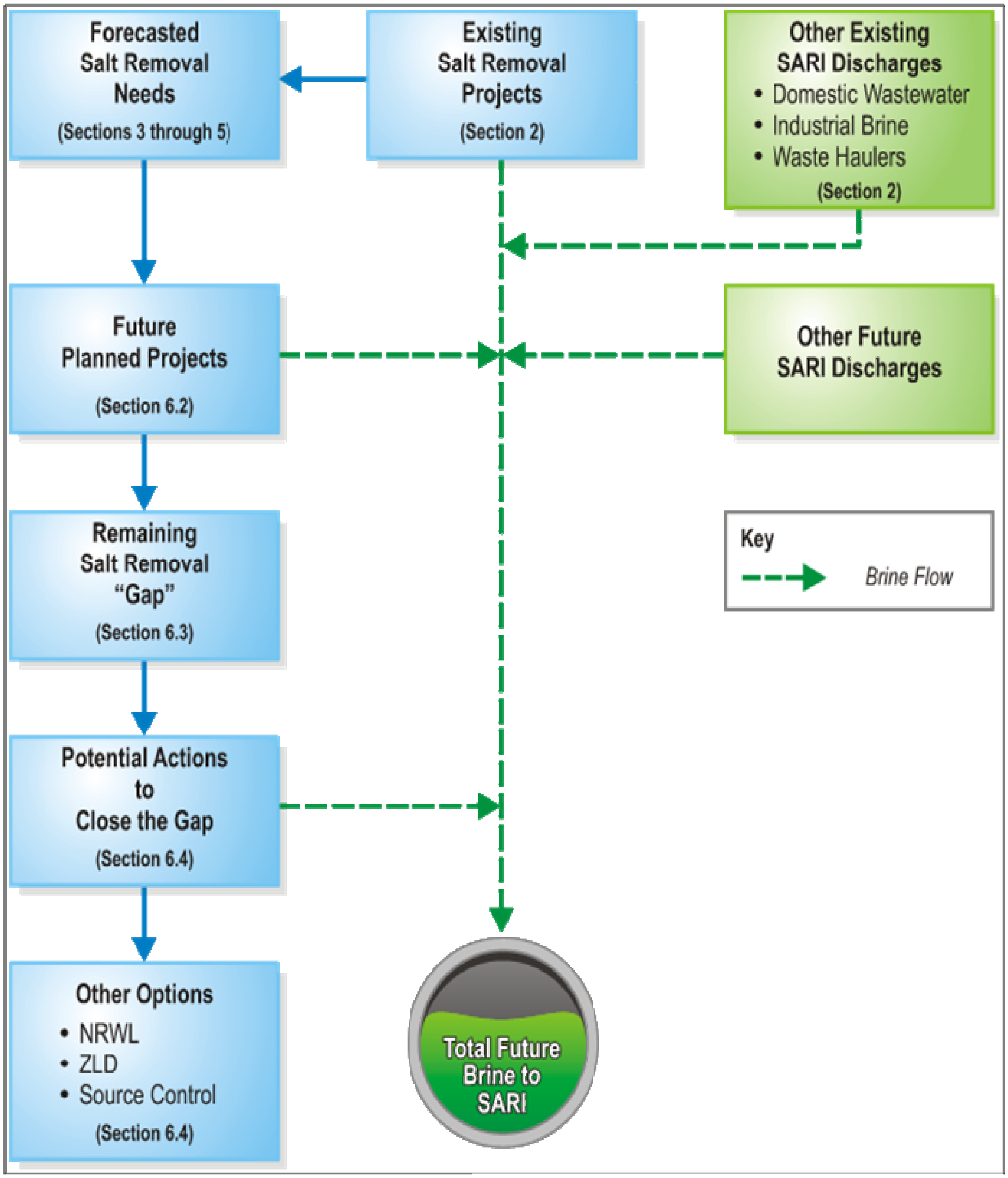

Figure 2
Salt Management-Removal Overview

The potential for brine flow reduction through brine concentration projects on groundwater desalters is discussed as well as a review of the potential impact of water conservation and an evaluation of various Best Management Practices that could result in reductions in salt load to be managed.

Evaluation of future salt removal needs within the Upper Watershed, as expected, identified and quantified a substantial amount of additional future salt reduction needs across most of the Upper Watershed in order to ensure that water and wastewater agencies will be able to provide acceptable drinking water and meet wastewater NPDES permit requirements consistent with current regulatory objectives. At the same time, there are a significant number of future potential projects already identified within the watershed for which agencies are in various stages of planning, from very early conceptualization to detailed planning and design, that if and when implemented will address many of the needs. Even with these contemplated projects, it is forecasted that there would still need to be some additional future measures taken in some areas to meet the objectives. The timing of these needs will vary and likely extend over many years.

If the rate of brine that could potentially be generated from all these future projects was similar to that from existing projects, effectively assuming single pass reverse osmosis with no significant further concentrating, the maximum estimated potential flow could exceed the nominal maximum capacity of the existing SARI system by close to 25 percent as shown in Table 1, even if all domestic wastewater were eventually to be removed from the line. At the same time, there are several other options including source control, brine concentration and possible additional use of the NRWL that could reduce the maximum potential flow rate.

Table 1
Summary Potential Future Brine Export Needs

Project	Salt Load (tons/yr)			Brine Flow (mgd)				
	Current/ Near Term	Future	Total	Current/ Near Term	2010 - 2015 Increase	2015 - 2025 Increase	Beyond 2025 Increase	Total
Water Supply Desalting	131,392	38,144	169,536	10.08	0.32	5.00	--	15.40
Wastewater & Recycled Water Desalting	8,760	69,170	77,930	1.20	0.80	11.55	0.00	13.55
Unspecified Desalting (1)	--	24,006	24,006	--	--	--	3.74	3.74
Other								
Domestic Wastewater	--	Remove	0	2.27	0.00	Remove (-2.27)	0.00	0.00
Direct Industrial Connection & Waste Haulers (2)	--	--	0	0.69	0.50	1.00	0.60	2.79
Total	**140,152**	**131,320**	**271,472**	**14.24**	**1.62**	**15.28**	**4.34**	**35.48**

(1) Based on future projected volume of brine to meet the salt "gap" from Table 5-3 less brine associated with future wastewater desalting projects as discussed above
(2) From 12-02-09 Draft Brine Line (Industrial/Commercial) Demand Anlysis

SARI Planning

Phase 2 evaluated planning issues relating directly to the use of and the needs for the SARI system for various purposes (e.g. direct and indirect industrial discharges, temporary domestic discharges and fail-safe discharges); reviewed the role of brine minimization and wastewater desalination technologies on the SARI system needs, and evaluated a wide range of future configuration options to serve the projected needs.

The customers discharging to the SARI line currently consist of direct dischargers (those with actual lateral connections to the SARI line), and indirect dischargers (those that utilize the truck dump stations). The direct dischargers either own or lease the pipeline, treatment, and disposal capacity in the SARI system. The direct dischargers can be broadly categorized into desalter brine, industrial wastewater, and domestic wastewater dischargers.

In addition to the direct dischargers, SAWPA also has agreements with a number of agencies that have fail-safe connections to the SARI system for use in case of an emergency. Table 2 summarizes the SARI capacity right ownership.

Table 2
SARI Capacity Right Ownership SAWPA Salinity Management Study TM2

Agency	Pipeline Capacity Right (mgd)	OCSD Treatment Capacity Right (mgd)
SAWPA	0.000	0.295
SBVMWD	7.198	0.804
EMWD	5.946	3.548
IEUA	4.130	2.250
WMWD	11.624	6.753
Chino Desalter Authority	3.67	3.35
Total Capacity (mgd):	**32.568**	**17.000**

As of July 2009, about 12 mgd (averaged monthly flow from July 2008 to October 2009) of the current SARI capacity was utilized by the direct and indirect dischargers. The list of dischargers and their typical discharge volumes are listed in Table 2-2 of TM-2. These include desalters and ion exchange plants (8.7 mgd), direct industrial dischargers (1.45 mgd), domestic wastewater dischargers (1.36 mgd), and indirect dischargers/waste haulers (0.28 mgd).

There are fail-safe connections, which are discharges that if and when used on an intermittent basis, consist of domestic wastewater in the event of an emergency resulting from failure of a pump station or other system component. The average cumulative flow from these discharges from 2007-2009 was approximately 0.25 million gallons per month.

Although the SARI line was constructed to provide disposal of high salinity discharges to outside of the upper Santa Ana River watershed, the pipeline has historically accepted many domestic wastewater and low salinity flows, which made up the majority of the SARI line flow as recently as 2005. During more recent years, with the completion of several brackish water desalters and the removal of several domestic wastewater connections, the percent of water coming from low salinity flows has steadily declined. By early 2009, over 75 percent of the SARI line flow came from municipal desalination facilities and power plants, with only 12 percent from low salinity dischargers with total dissolved solids (TDS) less than 1,000 milligrams per liter (mg/L). As the flows to the SARI line have changed, problems have begun to be observed with the formation of suspended solids within the pipeline that cannot be accounted for based on the quality of the discharges into the system. As a result, SAWPA initiated two phases of Water Quality Studies and a Solids Control Study. The studies concluded that large quantities of TSS were being generated within the pipeline from the interactions of desalination brine and high BOD wastewaters. This increase in TSS between what entered the pipeline (TSS of dischargers) and what exited (TSS at county line) is referred to as a TSS imbalance.

While early analyses suggested that some of this TSS imbalance could be attributed to biogrowth within the pipeline, converting dissolved BOD to TSS, it was ultimately concluded that the two primary sources of solids generation were precipitation of inorganic solids and coagulation of organic solids. Precipitation of inorganic solids appears to be caused by supersaturated conditions of sparingly soluble salts (primarily calcium, magnesium, and silica). Coagulation of organic solids appears to be caused by the blending of flows containing high dissolved organic constituents with high TDS flows. SAWPA is continuing to study the formation of VSS to identify the conditions under which it is most likely to form and to identify the water quality parameters needed to predict its formation. While BOD has been used as the primary parameter for monitoring organic material in the SARI line, other parameters, such as carbonaceous oxygen demand (COD), total organic carbon (TOC), and dissolved organic carbon (DOC), are being evaluated.

To qualitatively evaluate the impact on overall water quality of combined SARI flow from different types of dischargers, mathematical projections were made using a water quality spreadsheet model and then removing each type of discharger and evaluating the calculated changes. The current water quality and overall flow was considered as a baseline case. Figure 3 summarizes the changes in BOD and TDS, reflecting the removal of different types of dischargers.

Interestingly, if all domestic wastewater contributions were removed by disconnecting both fail safe connections and domestic dischargers, approximately 5 percent BOD reduction would be observed in the SARI line. If the wastehaulers were disconnected in addition to the domestic and the fail safe connections, the BOD level would drop by 61 percent. If the only flow that were to be left in the SARI line were brines from desalters and ion exchange users, and power plants, BOD level would drop to 6.0 mg/L. From this exercise, it is evident that the largest contributors to the

BOD level in the SARI line are the wastehaulers, even though the flow volume is only approximately 0.28 mgd.

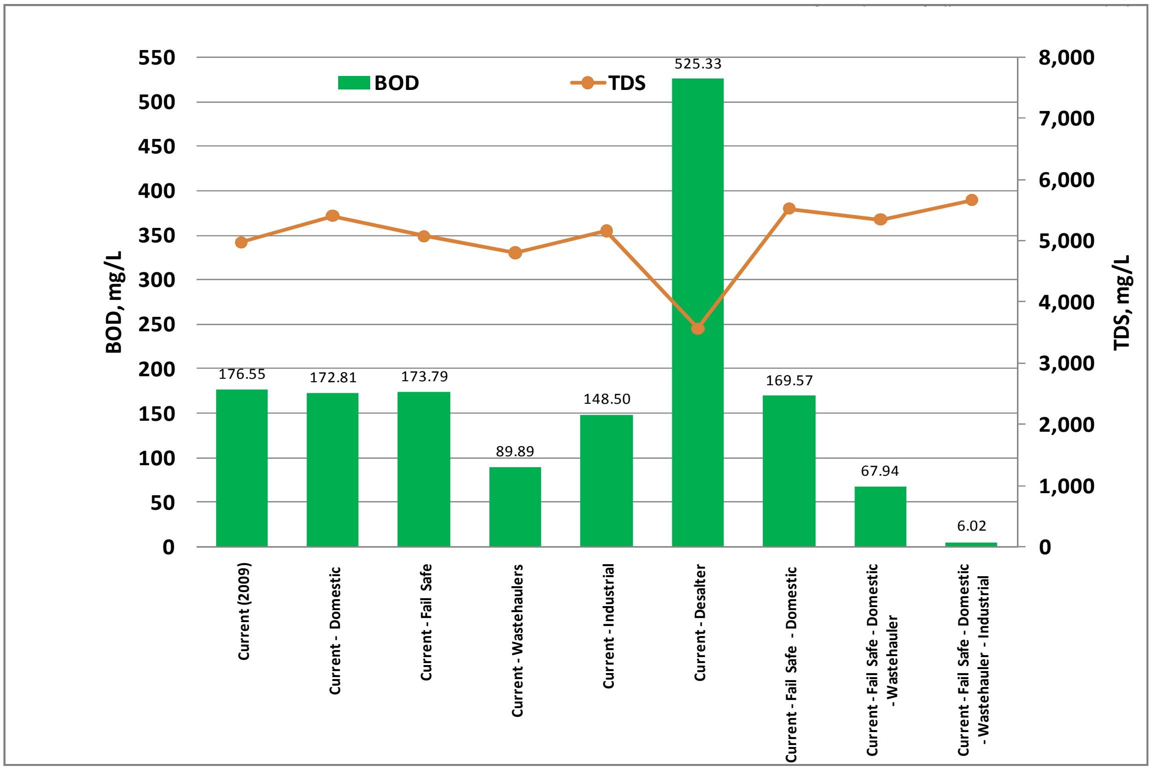

Figure 3
Impact on Discharger Type Connection on Overall SARI Water Quality

Based on the future projects identified in TM-1 and TM-2, existing water quality data, and future water quality data assumptions, as described in TM-2, predictions were made of the potential impact of future projects on the BOD and TDS concentrations of the wastewater discharged to the SARI line. Future projects are illustrated in Figure 4.

The discharges most potentially problematic for continued issues in the future with inorganic precipitation and generation of VSS are the industrial discharges containing high concentrations of BOD, TSS and TDS. Solids generation of both types in the SARI pipeline would be promoted by allowing continued discharge of these wastewaters. Discharge of the wastewaters containing low concentrations of organic material such as those from power plants, commercial entities, and industrial entities discharging ancillary utility flows with low organic and high TDS levels would presumably contribute less to VSS creation, however, would likely result in contribution to inorganic precipitation within the pipeline. Effluent discharge limits on BOD and TSS/VSS should be considered by SAWPA to minimize organic concentrations in the wastewater accepted for discharge.

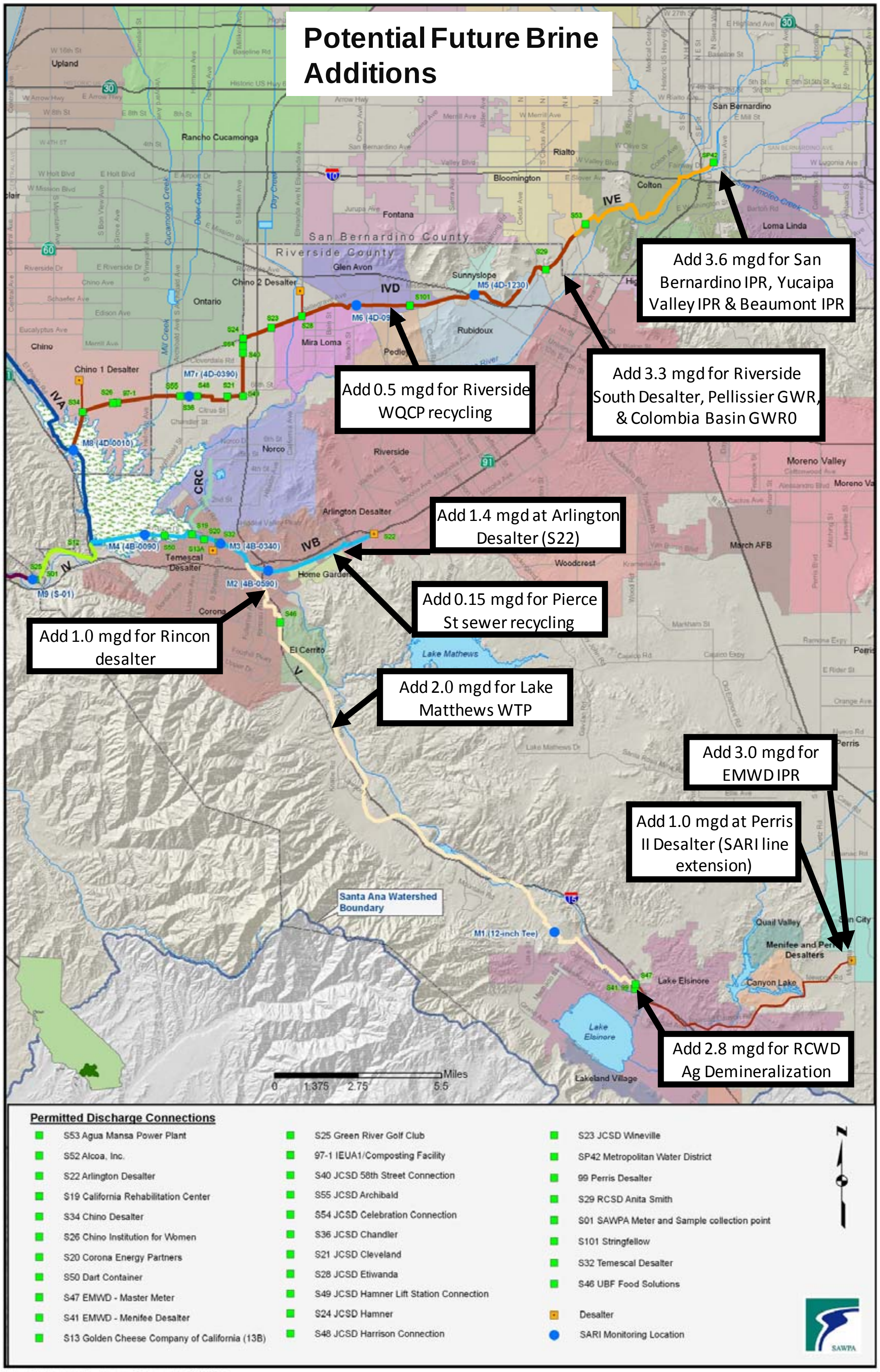

Figure 4
Potential Future Brine Additions

Effluent limits would require dischargers to conduct source reduction programs or pretreat wastewater to the specified levels. Target effluent limitations could potentially be identified through evaluation of the effects of lowered organic concentrations in pilot trials conducted in certain reaches of the SARI line.

To minimize the solids precipitation problem currently plaguing the SARI pipelines due to the chemical reaction between high TDS brines and high BOD wastes, it is becoming increasingly clear that in the future brine flows and high BOD wastewater flows should not be comingled, especially in the upper reaches of the SARI line where travel time is long. Precipitation associated with the combination of organic constituents in the industrial discharges with the dissolved inorganics in the desalter flows remains a significant issue to be addresses when considering industrial discharges. The commercial and industrial discharges with higher organic constituent concentrations have levels of TDS similar to the effluent wastewater from desalters in many cases, however, the mix of constituents may be different and in some cases concentrations are much higher. While the flows of industrial wastewater are smaller in volume, SAWPA may wish to consider surcharges on some inorganic ions such as calcium and silica to help recover a share of the maintenance costs associated with pipeline cleaning necessary due to solids precipitation. Limiting TDS levels in industrial wastewater to levels similar to those in desalter flows may be considered, however, this would likely create disincentives for industrial operations.

Based on the planned projects that will develop in the short-, intermediate, and long-term within the Santa Ana watershed, technologies that most likely be implemented to minimize brine flows include:

- Desalter Brine Minimization
- Wastewater Recycling Technologies

The incentives for considering brine minimization projects include reduced flow and therefore reduced costs to the SARI line and recovery of additional potable water. The selection of a desalter brine minimization technology is typically dictated by the water quality of the primary RO desalter reject or "brine". For brine that contains high concentrations of calcium, a chemical softening step is usually required to minimize scaling in the subsequent high recovery RO steps. Scaling precursors including calcium, magnesium, and silica can be reduced significantly by the chemical softening process. In light of the inorganic and organic chemical reactions in the SARI system resulting in solids precipitation within SARI pipelines, chemical softening should be implemented in the design of future brine minimization to help minimize the inorganic component of the solids precipitation process. Provided that chemical softening processes are included in the projects, the incremental increase in TDS resulting from these projects should not have a significant adverse impact on the overall operations of the SARI system.

All of the planned wastewater desalting projects for the Santa Ana watershed discussed in Section 2.3 are water-recycling projects that would create recycled water for non-potable end uses, principally for groundwater recharge. For surface recharge projects, the need for and extent of advanced wastewater treatment is a function of the ratio of recycled water recharge compared to native water recharged in the same location (or the recycled water contribution (RWC), and the need to meet Regional Board Basin Plan Objectives, particularly with respect to TDS and nitrate. All of the proposed IPR projects anticipated using RO treatment and the brine projections are based on the agencies reported plans.

Currently, a range of wastewater flows from non-municipal or industrial operations are discharged to the SARI line, either as individual, permitted connections or via waste hauler discharge at the four "truck dump" stations. Based on analytical results for samples collected during the period 2008 through 2009 made available by SAWPA, the effluent wastewater from the direct discharging facilities represents a wide range of characteristics. Many are relatively high in TSS, VSS and BOD. Similar to the situation with the direct dischargers, discharges to the SARI system via wastehaulers differ in character. Wastewater from many of the commercial entities, contains low organic and suspended solids concentrations (<20 mg/l) and significant concentrations of TDS and hardness. Other entities' discharges have significant levels of BOD, TSS and TDS. Typical BOD levels for some of the discharges range from 5,000 to 69,000 mg/l and typical TSS levels range from 1,065 to 25,140 mg/l. In many cases, the organic solids present in these discharges, as reflected in VSS content, appears to account for a significant fraction of the overall TSS.

As noted earlier there are still a number of temporary domestic dischargers connected to the SARI line. There is currently no set timeline for the phase-out of the domestic wastewater dischargers with the exception of one contract expiration in 2015.. However, it is generally agreed that in the future, all temporary domestic waste dischargers will remove their connections to the SARI line.

Ten existing fail-safe connections to the SARI system are reserved for emergency or overflow purposes. Most have expiration dates in the next few years, but some may need to continue.

By attempting to account for all planned or potential projects and future sources of discharges to the SARI system for the current, near term, intermediate, and long-term conditions as detailed in Section 2.3, it is apparent that the total SARI flow rate could potentially be greater than 36 mgd at some point in the future. This would exceed the nominal hydraulic design capacity of 30 mgd. SAWPA has the contractual right to purchase up to 30 mgd of conveyance and treatment capacity in the OCSD system. OCSD has indicated that they are not obligated to provide any additional capacity beyond this amount under the terms of the agreement. Under this condition, SAWPA would have to attempt to negotiate new agreement terms with OCSD and there is no guarantee that this could be achieved.

Six possible broad system configuration changes were considered and evaluated under this study including:

- Option 1: Baseline Condition – continued discharge to OCSD

- Option 2a: SARI flow reduction via a centralized treatment, concentration, and reclamation plant
- Option 2b: SARI flow reduction via decentralized brine minimization projects installed at each groundwater desalter
- Option 3a: Direct ocean discharge of SARI brine without brine minimization
- Option 3b: Direct ocean discharge of SARI brine with brine minimization projects as described under Alternative 2b
- Option 4: Rerouting all SARI system flows for discharge to Salton Sea

Each configuration is discussed in detail in TM-2 and the included assumptions are listed in Table 3. Order-of-magnitude level cost estimates were developed for capital and operations and maintenance costs as applicable and other significant issues that SAWPA must consider when deciding on a future path to accommodate the expected large increase in salt and flows to be managed were evaluated.

Figures 5 and 6 illustrate the comparative total cost components of each of the options expressed as an increasing net present worth value, to allow a comparison of the previously described system configuration options based on a 30-year present worth analysis from 2010 to 2040. The only difference between the two cases is the assumed future inflation rate of purchasing capacity in the OCSD system. It is anticipated that the current rate increase for capacity purchase of 17.6 percent/year is most likely not sustainable and therefore an alternate interest rate of 5 percent was selected to test the sensitivity of the costs to a lower escalation rate. The only exception to these table and figures is that the Salton Sea option is not presented here since there is insufficient information at this time on which to develop a total cost analysis for that option. The analysis was carried this far out to extend beyond the vast majority of growth in flows and anticipated project implementation time lines for any of the options. The salt projection tool and salt export needs were extended to 2060 under TM-1, but the incremental needs beyond 2040 are small and it is assumed that the required infrastructure would be implemented by or before 2040.

Several important observations can be drawn from this comparison as follows:

- The in-line brine minimization concept would require a far greater total investment than any of the other options
- The least cost option would be to construct a new bypass pipeline to direct SARI system flows directly to the Ocean Outfall with or without any upstream brine minimization projects. However, there is a potential risk with emerging contaminants that may require pre-treatment. This unknown has not been accounted for in this evaluation. Also, the current issues with respect to solids imbalance and creation of TSS/VSS in the line would have to be fully resolved so as not to create any problems with discharge quality.

Table 3
SARI System Configuration Changes

SARI System Configuration Changes		Description	Maximum projected SARI Flow Rate (mgd)	Ultimate Disposal Location	Pros	Cons or Challenges
Baseline Condition - Continue to discharge to OCSD, no brine minimization		Assumes continue with current configuration with all future expansion activities in the watershed	37	All flow to OCSD for treatment with ocean discharge	No new separate treatment facility or parallel interceptor needed	- Would need to purchase up to 20 mgd of additional treatment and disposal capacity and up to 7 mgd of additional interceptor capacity - No assurance that OCSD would accept more than 30 mgd flow - SAWPA may need to cap the dischargers at 30 mgd (i.e. not fully meeting water quality objectives to remove salt from the watershed) and may lose potential revenue
Continue Discharge to OCSD, Reduced flow through Brine Minimization	Centralized In-line Plant Brine Minimization	Assumes all SARI flows will be diverted from the line at a centralized facility where the total volume undergoes biological treatment, followed by chemical softening, MF/RO and a disinfection step. Concentrate waste from centralized treatment plant will go back to SARI pipeline.	37	12 mgd of concentrated waste flow to OCSD for treatment with ocean discharge; remainder available for reuse in watershed	- Near-term need to purchase additional temporary capacity from OCSD up to 37 mgd through approximately 2025, but could then sell back both new temporary and existing capacity down to 12 mgd. - Potentially 24 mgd of recovered water available to reuse in watershed - Reduce O&M costs to OCSD by reducing overall SARI flow volume	- Recovered water from future wastewater recycling flow contributions is unsuitable for direct potable reuse applications - 25 mgd produced may not be near points of use - Very high capital and O&M costs for new treatment facility, major siting challenges - Major increase in SAWPA responsibilities
	Decentralized Brine Minimization at groundwater desalters	Assumes all groundwater desalters will implement further concentrate management via a secondary RO process to reduce discharges into SARI	26	26 mgd flow to OCSD for treatment (5 mgd of desalter brine + 21 mgd of all other discharger wastes)	- 10 mgd of potable water can be used directly from recovered desalter brine - Maximum flows are below 30 mgd - SAWPA does not have responsibility for additional treatment plant if concentration plants are owned/operated by desalter agencies - Scaling precursors (Ca/Mg/Si) will be reduced and minimize inorganic/organic co-precipitation within pipeline - Water is created where it is needed/used - Reduce O&M costs to OCSD by reducing overall SARI volume	- Requires member agency buy-in and participation with local brine concentration facilities SAWPA will need to purchase additional 9 mgd of treatment capacity from OCSD
Direct Ocean Discharge	With Brine Minimization	- Assume all groundwater desalters will concentrate their respective brines before discharging to the parallel ocean discharge pipeline. - Assume SAWPA will require all BOD dischargers to pretreat the BOD concentration to below 30 mg/L. This meets the ocean discharge permit limits.	26	26 mgd to Ocean Outfall	- 10 mgd of potable water can be used directly from recovered desalter brine - SAWPA would not need to rely on OCSD for treatment, could sell capacity back, but will continue to use the OCSD outfall - Inorganic scaling precursors will be reduced decreasing solids generation in the pipeline	- Major additional regulatory requirements and hurdles for ocean discharge permits and new pipeline alignment - SAWPA will need to require all their BOD dischargers to pre-treat their waste, or else all discharged flows containing BOD will still need to go to OCSD - No additional potable water recovered from desalters for the watershed - SARI pipeline continue to be susceptible to solids generation and accumulation - New 25 mile pipeline required from below Prado to the Outfall
	Without Brine Minimization	- Assume all groundwater desalters will discharge their respective brines without further concentrating. - Assume SAWPA will require all BOD dischargers to pretreat the BOD concentration to below 30 m/L. This meets the ocean discharge permit limits.	37	37 mgd to Ocean Outfall	- Member agency desalters would not need to further concentrate their respective brine streams - SAWPA would not need to rely on OCSD for treatment, could potentially sell capacity back (assuming BOD wastes are pretreated), but will continue to use the OCSD outfall - Inorganic scaling precursors will be reduced decreasing solids generation in the pipeline	- Major additional regulatory requirements and hurdles for ocean discharge permits and new pipeline alignment - SAWPA will need to require all their BOD dischargers to pre-treat their waste, or else all discharged flows containing BOD will still need to go to OCSD - No additional potable water recovered from desalters for the watershed - SARI pipeline continue to be susceptible to solids generation and accumulation - New 25 mile pipeline required from below Prado to the Outfall
Salton Sea Alternate Discharge		- Eliminate discharge to OCSD treatment by routing all SARI flow to Salton Sea Assumes 125 miles of linear pipeline from south of Prado to Salton Sea	30-37	Salton Sea	- SAWPA would bypass OCSD completely - Additional water with low TDS provided to Salton Sea	- Very large new infrastructure costs and maintenance - Major Permitting requirements and issues relative to treatment requirements for discharge - Crossing various jurisdictions will require extensive negotiations - Major mitigation and regulatory requirements

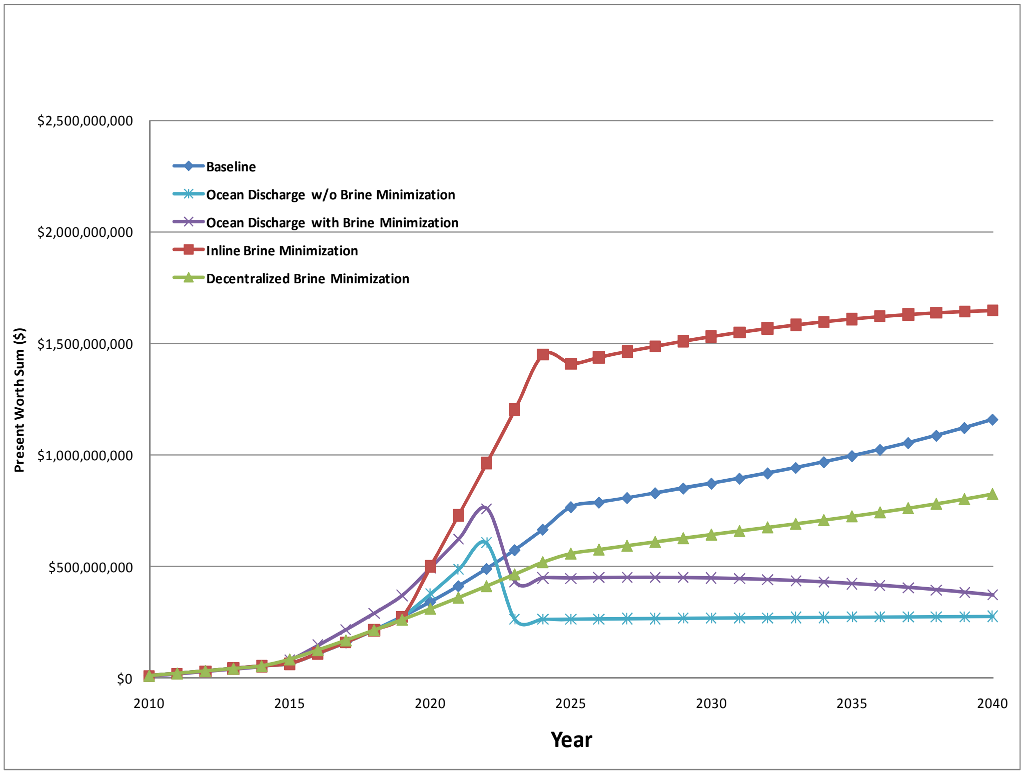

Figure 5
30-Year Present Worth Analysis Comparison for Proposed System Configuration Changes (Capital Inflation Rate=17.6%)

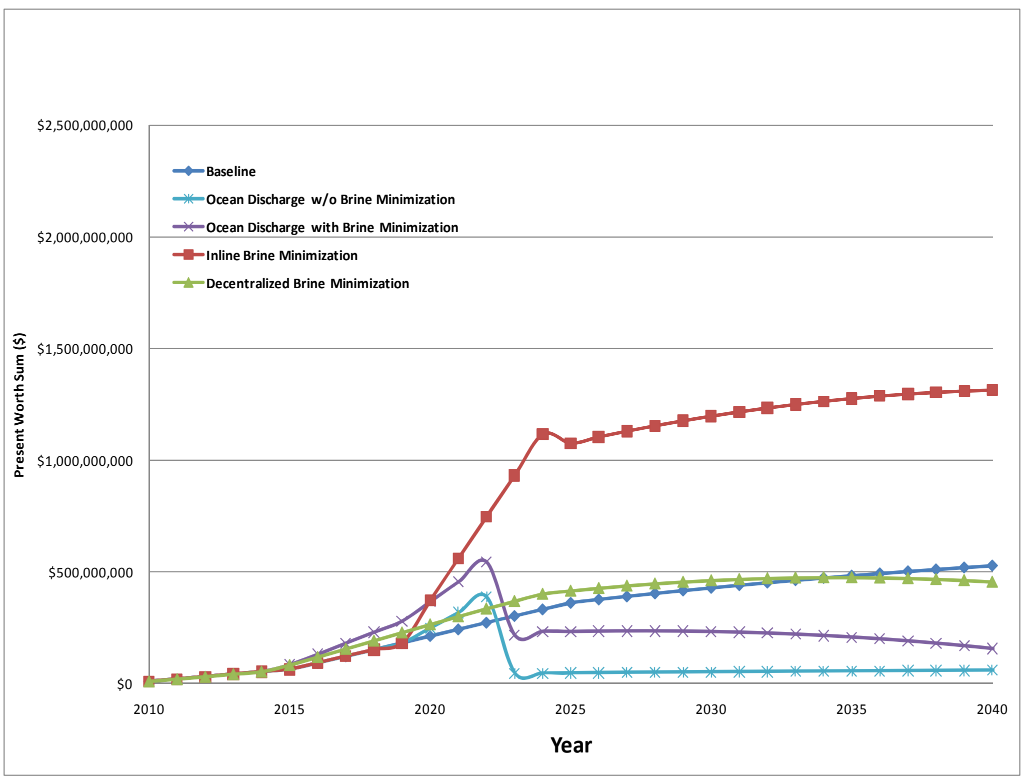

Figure 6
30-Year Present Worth Analysis Comparison for Proposed System Configuration Changes (Capital Inflation Rate=5%)

- The net present worth of the baseline and brine minimization options are highly dependent upon the future escalation rate that would be applied to future purchase of treatment capacity at OCSD. If the rate increase is extended indefinitely at the current 17.6 percent value, the net present worth of either option would be almost twice as much as if the rate of inflation was at 5 percent. Furthermore, using the higher escalation rate, the brine minimization option has a substantially lower net present worth value as it relies on purchasing less capacity. At the lower escalation rate, the brine minimization option would still have a lower value, but the relative difference would not be nearly as great. At full build-out and operation of all assumed projects, the net present worth would be slightly lower for the brine minimization option. Finally, at a lower inflation rate, the differences between remaining in the OCSD system, rather than pursuing a direct ocean discharge option are much smaller.

While there are some fairly clear differences in the costs of implementing the different options, there are also a number of other significant issues that SAWPA must consider when deciding on a future path to accommodate the expected large increase in salt and flows to be managed. Key factors included environmental, permitting, institutional, and legal issues and are summarized in the following subsections.

As a result of the evaluations presented in TM-2, the following conclusions can be made.

- This Study addresses long-range planning options for SAWPA and the member agencies to consider accommodating the future growth in probable demand for export of salt. These long range options assume that the type and nature of flows expected can be conveyed to the point of discharge or reused without major impacts within the SARI pipeline system itself. Therefore, it is extremely important that causes and solutions be developed soon to address the current problems that SAWPA is experiencing with solids imbalance, precipitation and scaling. This study does not focus on identifying these near term solutions, but the outcome investigations currently being conducted could potentially affect the type, quality and/or location of flows that are accepted into the system.

- It is assumed that essentially all of the remaining domestic discharges including emergency connections into the SARI system will be eliminated and re-directed to local wastewater treatment facilities over time. This is important primarily to free up capacity that is projected to be needed for the growth in brine flows for which the SARI system was planned. In addition, this will be essential pre-requisite if SAWPA were to consider the direct ocean discharge option.

- The SARI system can continue to accommodate high TDS industrial discharges into the system. However, there may need to be changes and or more significant restrictions on the quality of discharges with respect to TSS, BOD, or other precursor indicators that may contribute to the TSS imbalance problem. Also, as noted above for domestic discharges, if SAWPA were to consider the direct ocean discharge option in the future, it would be necessary to place limits on the quality of the discharges in addition to whatever outcomes may result from addressing the TSS imbalance issue. It should be noted that at ultimate projected conditions, the dominant flow in the SARI system will be from water supply and wastewater reuse desalting projects, which accomplish the primary goal of exporting salts. Therefore, long term planning decisions should be driven primarily by accommodating these desalting flows in the most cost-effective and implementable approach.

- Among the long-range options for managing the projected future flows in the SARI line, the most straightforward to implement would be to continue to direct flows into the OCSD system. However, SAWPA and the member agencies should actively pursue the implementation of secondary brine concentration processes at both existing and future groundwater desalting projects. At a minimum, sufficient projects need be implemented to reduce the total growth in discharges to the SARI line to maintain future flows below the 30 mgd capacity allowance. This would avoid the need to negotiate with OCSD for more capacity in the OCSD system, which may not even be possible, as well as avoid the possible need for replacing or paralleling sections of the interceptor that would be under capacity at maximum flows. SAWPA and the member agencies should develop a joint implementation approach as to how to facilitate and encourage these projects.

- The other potentially viable and possibly more cost-effective long-term option still appears to be to considering building a bypass pipeline in Orange County and re-directing SARI line flows to the OCSD outfall system. There is a number of challenging permitting, environmental and institutional issues that would need to be solved for this option to be feasible. In addition, the economic incentive for SAWPA to consider advancing in this direction is highly dependent on future costs for acquiring additional OCSD capacity even up to 30 mgd within the general framework of existing agreements. If the cost of acquiring additional capacity over the next 10-15 years escalates at a high rate, this option would become even more economically viable. Also, if this option were pursued, SAWPA would need to negotiate with OCSD for eventual sellback of treatment capacity that could be returned to OCSD.

- At this time, there is insufficient information to indicate whether considering a complete shift to re-direct brine flows to the Salton Sea could even be possible or in the range of feasibility. The conveyance infrastructure alone would be very large undertaking and costs for this part of the conveyance infrastructure alone could be in the range of $0.5 to $1B depending upon assumptions on timing and inflation rates. The potential extent of pre-treatment and/or other mitigation measures cannot be predicted at this time but could presumably also be in the 0.5 to $1B range. Nonetheless, SAWPA could decide undertake some additional investigation of the major issues including potential impacts, both positive and negative, potential treatment requirements, and other consideration to decide whether to pursue this concept any further.

- If SAWPA elects to continue with the current course of relying on the SARI line and OCSD for treatment and disposal, activities and actions can move forward on a year-by-year basis. However, over the next 10 years, SAWPA will need to closely monitor new discharges and increasing flows to the SARI line, strongly encourage or participate in brine concentration projects, and ensure that the total projected future flows would stay below the 30 mgd maximum flow rate.

SARI Operations

Phase 3 focused on specific long-term operation and maintenance issues affecting the SARI system including:

- Evaluation of useful life
- Recommendations for specific problem issues
- Recommendations for repair, rehabilitation and upgrade
- Review of SARI management and operations

Evaluation of Useful Life

The 2002 Upper SARI Planning Study estimated the remaining useful life of the SARI facilities. For the current study an updated assessment was prepared, as summarized in Table 4. SAWPA has significantly increased efforts for cleaning and CCTV inspection of the system in the past four years and has embarked on several projects to conduct cleaning and to rehabilitate portions of the system in order to improve its performance, although part of the SARI system has not been cleaned due to access constraints, current cleaning equipment limitations, and cost consideration.

SAWPA is preparing to rehabilitate portions of the line in the Prado Dam area as shown in Table 5. The rehabilitation will be done to prolong the service life of the pipelines and to increase the long term structural strength of the pipelines that are within the new Prado Dam seasonal water conservation pool at an elevation of 505 feet. After the completion of these rehabilitation projects, the expected remaining useful life of all of the existing reaches will be greater than 40 years. In addition, there are also 5,500 feet of VCP pipe in Reach IV-B that could also be considered for rehabilitation to extend their life expectancy and avoid potential infiltration issues in the future due to the joints in the pipe.

Recommendations for Specific Problem Issues

Several specific identified problem areas or needs affecting the current and future SARI operations were evaluated and suggested solutions proposed. These included:

- Schleisman siphon cleaning
- Cleaning of a Portion of Reach IV-E near RIX

- Reach V Field Location and Record Drawings
- SCADA System Planning

Table 4
Upper SARI Reaches – Remaining Useful Life

Reach	Material	Length (Feet)	Age (Years as of Dec. 2009)	Estimated Remaining Life
Reach IV (42 to 48-inch)	RCP (PVC Lined)	12,500	34	41
	RCP (PVC Lined)	2,100	1	74
	HDPE	1,400	1	74
	Total Reach IV	***16,000***		
Reach IV-A (18 to 42-inch)	RCP (Unlined)	41,500	28	47
	CMLC Steel (24 and 18-inch siphons)	150	28	47
	Total Reach IV-A	***41,650***		
Reach IV-B (16 to 36-inch)	RCP (Unlined)	16,250	28	47
	VCP	5,500	28	47
	PVC	32,000	13	62
	Total Reach IV-B	***54,000***		
Reach IV-D (39 to 48-inch)	RCP (PVC Lined)	62,700	16-19	56
	VCP	43,800	16-19	56
	HDPE	2,100	16	59
	Total Reach IV-D	***108,600***		
Reach IV-E (39 to 48-inch)	VCP	4,300	17	58
	RCPP	34,000	15	60
	Total Reach IV-E	***38,700***		
Reach V (24 to 30-inch)	PVC	74,000	8	67
	HDPE	47,000	8	67
	Total Reach V	***121,000***		
Grand Total		***379,950***		

Table 5
Reaches IV-A and IV-B Planned Rehabilitation

Reach	Material	Estimated Length (Feet)	MASs *	Existing Diameter (inches)	Rehabilitation Technology	Material	Proposed Diameter (inches)
Reach IV-A Upper	RCP (Unlined)	25,023	4A-0680 to 4A-0180	27	Cured-in-Place	CIPP	27
Reach IV-A Lower	RCP (Unlined)	16,555	4A-0010 to 4A-0180	42	Segmental Slip-lining	RPMP	36
Reach IV-B	RCP (Unlined)	15,950	4B-0150 to 4B-0010	36	Segmental Slip-lining	RPMP	30
Total Rehabilitation		***57,528***					

MAS = Maintenance Access Structure (typically referred to as manhole)

Schleisman Siphon

The Schleisman siphon is part of Reach IV-D of the SARI and is located on Schleisman Road, across the Cucamonga Channel, in unincorporated Riverside County. The siphon is a single barrel 42-inch reinforced concrete pipe, with PVC liner, constructed in 1991. Sediment and fat, oils and grease (FOG) currently collects in the upstream manhole of this siphon, thus requiring the manhole to be cleaned at least once per month. In addition, the location of the siphon and the SARI's location in a heavily traveled area, with maintenance access structures (MASs) in the middle of travel lane of the road, near a bridge, and with a traffic signal light nearby, make the cleaning of the entire length of the siphon extremely difficult.

Various options have been proposed in the past to address this problem. For this study, a new scenario was developed and evaluated with the hydraulic model of the SARI line, which included extending the approaches of the siphon to 250 feet and modifying the diameter of the siphon to use a 36-inch diameter HDPE pipe. This scenario would include either constructing a new siphon, or modifying the existing one. Modifying the existing siphon would not provide a parallel line for low flows or for backup, but construction of a parallel line does not seem to be feasible and would be difficult because of a number complications. This would still mean that SAWPA will have to continue monitoring the operation of the siphon and providing frequent cleaning of this line. The estimated planning-level construction cost for a new parallel siphon is approximately $ 2 million. Another option would be to only construct new approaches into and out of the existing siphon and to slipline the existing siphon with a 36-inch diameter HDPE pipe. The estimated planning-level construction cost for this option is approximately $ 1.67 million.

Cleaning of a Portion of Reach IV-E near RIX

SAWPA wants to develop options to clean a portion of Reach IV-E near the Cities of San Bernardino and Colton's Rapid Infiltration Extraction facilities (RIX) south of Rialto. Due to unfavorable hydraulic conditions and low flows in this reach, and possible past discharges of excessive solids, the line has substantial solids deposition and past cleaning attempts have been only partially successful. It is estimated that to fully clean this portion of Reach IV-E, over 300 tons of debris would need to be extracted from the pipeline. If the debris is not toxic, it could be disposed of at the Regional Inland Municipal Refuse Facility operated by the City of Colton.

Three options that could potentially be used to clean the reach were evaluated including Jetters and Vactors, a system called Sewer Hog and Grit Gator, or flushing by temporarily increasing the flow with effluent from San Bernardino and Colton plants. Using Jetters and Vactors would require shutting down flow from the dischargers to Reach IV-E for up to several days dewatering the line in order to gain access to MASs, and using large capacity jet-vacuum trucks to jet the line, retrieve the flow at the downstream end, and then use large capacity bins (Baker tanks) to capture the cleaning flow and allow settling of the sediment to reduce the water content before disposing of it. A flocculant or coagulant product could be used to enable faster settling of solids in solution. Once the solids have settled, the bins could be dewatered by pumping the water out and releasing it back to the SARI line. During the development of this document, it was determined during a site visit with SAWPA and representatives from Sewer Hog/Grit Gator that this method may not be feasible to be used due to the fact that the sediments in the line may be too fine and may not be able to settle quickly enough in the Grit Gator.

CDM and SAWPA staff discussed the possibility of injecting about 7,000 gallons per minute for two to three hours into the SARI line of secondary effluent discharged from the San Bernardino and Colton WRPs that normally flows to the RIX Facility south of Rialto. The flow would be injected at the large structure where the SBWRP and Colton effluent lines converge before they discharge to the RIX facility. The goal would be to try to achieve an effective cleaning velocity in the pipe (around 2.5 fps or higher. The approach is potentially feasible, but several issues would have to be considered further in order to avoid other potential problems associated with the flushing of the solids downstream.

Reach V Field Location and Record Drawings

Reach V is a low-pressure line approximately 23 miles long and contains blow-off valves and air-relief valves. No MASs were originally installed in Reach V until one MAS was constructed at Station 42+00 in Temescal Canyon Road after the pipeline had been in service and another constructed near the intersection of Coal and Nichols Road. An additional MAS was designed and is proposed to be constructed at the intersection of Temescal Canyon Road and Lake Street, but it has not been constructed. In the past few years there have been several incidents of the line being hit by contractors when excavating; it is suspected that this has happened due to careless excavation by contractors.

Potential methods for locating the PVC and HDPE line were evaluated to better locate Reach V including the use of ground penetrating radar (GPR), electromagnetic locating with a sonde coupled with a topside receiver, Smart Probe™ Mapping with a propelled geospatial probe, or a combination of these methods. To be fully effective, all the locating methods evaluated require some type of access to the line. Thus, it is important that SAWPA considers constructing MASs in Reach V to provide for access and maintenance. Provided that appropriate access is available, the cost to locate the Reach V line using a combination of the Geospatial's Smart Probe, electromagnetic locating, and vacuum excavation, and developing plan and profile drawings, is estimated to be approximately $950,000. This cost does not include constructing access points that are needed for access. Estimated planning-level costs for the construction of 40 MASs spaced approximately every 2,000 to 2,500 feet is $5.3 Million.

SCADA System Planning

The study also evaluated a SAWPA proposed SCADA system to provide remote and automated flow data collection for each of the discharges to allow the preparation of diurnal flow rate curves at the selected sites without the need of operator visits or manual intervention. Automated data collection would reduce staff time and would ensure compliance with permit requirements. Currently SAWPA O&M Staff manually read each existing flow meter at least once per month. The review conducted under this task evaluated 26 sites from which information would be acquired and transmitted, and resulted in the development of a system concept, typical installation details with and without power, a phasing concept, and a reasonable Engineer's Opinion of Probable Cost for inclusion in the CIP.

CDM suggests SAWPA plan construction of the SCADA system in phases and developed the probable costs per phase, as shown on Table 6. Each phase cost estimate is established by using the number of different conditions at each of the sites, multiplied by the number of sites within that phase and adding up the associated costs. For example, Phase 1 only includes the installation and construction for the programming, automation and integration of the main control unit, therefore, the estimated cost for phase 1 is the cost for that section. Phase 2 of the project is the implementation of the high flow usage sites. The remaining phases are described in TM-3.

Table 6
Phase Opinion of Probable Cost

Phase	Cost
1	$32,600
2	$146,400
3	$119,200
4	$102,600
5	$733,000
TOTAL SCADA System costs	**$1,134,000**

Recommendations for Repair, Rehabilitation and Upgrade

The recommendations for repair, rehabilitation or upgrades of the SARI system were identified and estimated planning-level costs of construction for each item were provided. Costs for design and project administration are not included. Prioritization has not been performed at this time; this will be programmed by SAWPA in their Capital Improvement Program (CIP) in the next few years.

In order to identify capacity issues, data was provided to SAWPA staff on all the future projects identified during Phase I of this Salinity Management Program under the "base case". As discussed in the Technical Memorandum for Task 2, the base case assumes all of the ultimate projected flows would have to be accommodated by the SARI system, assuming every identified project is brought on line at projected capacity and no future brine minimization projects are implemented. This would result in flows in excess of the nominal 30 mgd capacity. This situation would occur if there were no significant brine concentration projects and would require that greater than 30 mgd treatment capacity would have to be negotiated with OCSD. Under this assumption, an additional $16M of replacement/upgrade projects would be needed at various locations to address project capacity issues.

Additional modeling was conducted by SAWPA staff based on the flows expected if all of the brine concentration projects for groundwater desalters were to be constructed. Under this run, all reaches of the existing SARI line were projected to be below full capacity, and the projected bottlenecks would be eliminated, thereby not requiring additional improvements for capacity purposes only. This condition would also be realized if a few of the anticipated projects are not actually implemented or implemented at a reduced capacity. Therefore, it is in SAWPA's interest to continue to work with member agencies and project proponents to reduce the impact to the system from future growth to avoid potentially triggering pipeline capacity issues.

Other potential capital cost investments needed to address specific issues and needs are presented in the summary discussion on specific problem issues.

Review of SARI Management and Operations

As part of this study, SAWPA's current operations and management structure for the SARI pipeline was reviewed and evaluated. The purpose of the evaluation was to gain an understanding of how SAWPA and its member agencies operate the SARI pipeline and to identify options that may be considered by SAWPA in its efforts to further improve maintenance of the SARI pipeline. A detailed cost analysis was not performed as part of this task. For this reason, further study by SAWPA is necessary to determine the economic viability of the various alternatives suggested for consideration.

In general, where alternatives were considered to improve efficiency they generally fall into three broad categories including the following:

- Shift Responsibilities to SAWPA staff: Several of the existing operations and maintenance responsibilities could be delegated to SAWPA personnel. For this to be a viable option, SAWPA would need to hire additional staff. In addition, enough responsibilities would need to be delegated to the individual(s) hired to maintain a full workload.

- Shift Responsibilities to Private Contractor: Certain maintenance activities could also be shifted away from the member agencies to private contractors hired through SAWPA. In these cases, it may be necessary to verify the availability of a specialty contractor in the area. Contractor coordination and oversight could be provided by the member agencies or by SAWPA staff.

- Pursue "On Call" Contracts: In some cases, it may be desirable to pursue on call contracts with qualified consultants to perform on-going or as-needed maintenance activities.

A summary of the activities reviewed in this study, and potential alternatives to the current structure, where appropriate, are provided in Table 7.

In addition to the specific suggestions summarized in the table, and described in detail in TM-3, considerations for improving the long term efficiency of operations include minimizing or overcoming institutional barriers that may limit the effectiveness of the overall program, seeking maximum opportunities for cooperation between SAWPA, its member agencies, and other local agencies involved in some aspect of salinity management, and suggesting new or updated policies that may be indicated based on the findings of this study. Specific recommendations are provided in TM-3 with respect to minimizing institutional barriers, leveraging cooperation opportunities, and revising policies.

Table 7
SARI Operations and Maintenance Activities

Current Activities				Potential Alternatives to Improve Efficiency	
Maintenance Activity	**Activity Description**	**Frequency of Activity**	**Responsible Agency(ies)**	**Alternative**	**Limitations of Potential Alternative**
Meter O&M					
Meter Reading	Read Flow Meters	Monthly	WMWD, IEUA	1. Shift responsibilities to private contractor	a. Availability of specialty contractor should be verified
				2. Shift responsibilities to SAWPA staff member(s)	a. Requires additional SAWPA staff
Meter Maintenance and Repair	Maintain/repair meters as necessary	As Needed	Contractor	none identified	none identified
Meter Calibration	Calibrate flow meters in the system	Annually	Contractor	none identified	none identified
Oversight of Meter Contractor	Oversee meter calibration/maintenance	As Needed	WMWD	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff
Pipeline O&M					
Location and Marking (USA)	Identify and mark pipelines for USA	As Needed	WMWD, IEUA	1. Shift responsibilities to private contractor	a. Requires accurate record drawings
				2. Shift responsibilities to SAWPA staff member(s)	a. Requires additional SAWPA staff
					b. Requires accurate record drawings
Pipeline Inspection and Patrol	Patrol pipeline alignment	Daily/Weekly	WMWD, IEUA	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff
Pipeline/Siphon Cleaning	Clean SARI pipeline reaches	Varies	Contractor	1. Pursue "on-call" contracts with cleaning contractor.	none identified
Pipeline CCTV	CCTV SARI pipeline reaches	Varies	Contractor	1. Pursue "on-call" contracts with CCTV contractor.	none identified
Cleaning/CCTV Oversight	Oversight of Cleaning/CCTV contractor	Varies	WMWD	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff
Manhole O&M	Inspection/maintenance of manholes	As Needed	Contractor	1. Pursue "on-call" contracts with confined space contractor.	none identified
Potholing	Potholing of SARI line	As Needed	Contractor	none identified	none identified
Valve Maintenance					
Valve Exercising/Maintenance	Exericise/maintain SARI Reach V valves	Quarterly	WMWD	1. Shift responsibilities to private contractor	a. Availability of specialty contractor should be verified
Spill Response					
SSO response and mitigation	Respond SSOs within SARI line	As Needed	WMWD, IEUA	1. Shift responsibilities to private contractor	a. May not be able to respond as quickly as member agencies
ROW Maintenance					
Access Clearing	ROW Spraying/weed control	As Needed	Contractor	1. Contract through SAWPA (not member agency)	none identified
Grading	Grading of pipeline ROW	As Needed	Contractor	1. Contract through SAWPA (not member agency)	none identified
Tree Trimming	Tree trimming in pipeline ROW	As Needed	Contractor	1. Contract through SAWPA (not member agency)	none identified
Contractor Oversight	Oversight of ROW maintenance contractor	As Needed	WMWD, IEUA	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff
					b. ROW maintenance should be contracted through SAWPA
Permit Compliance					
Inspections	Inspect permitted dischargers	As Needed	WMWD, IEUA	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff
Wastewater Sampling	Collection of samples for analysis	Quarterly	WMWD, IEUA	1. Shift responsibilities to private contractor	a. Availability of specialty contractor should be verified
				2. Shift responsibilities to SAWPA staff member(s)	a. Requires additional SAWPA staff
Laboratory Analysis	Analysis of wastewater samples	Quarterly	Contractor, IEUA	1. Contract out all analysis through SAWPA (not member agencies)	a. Sample collection through SAWPA or contractor
Report Preparation					
Misc. monitoring reports	e.g., meter reading, quarterly monitoring	Varies	WMWD, IEUA	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff