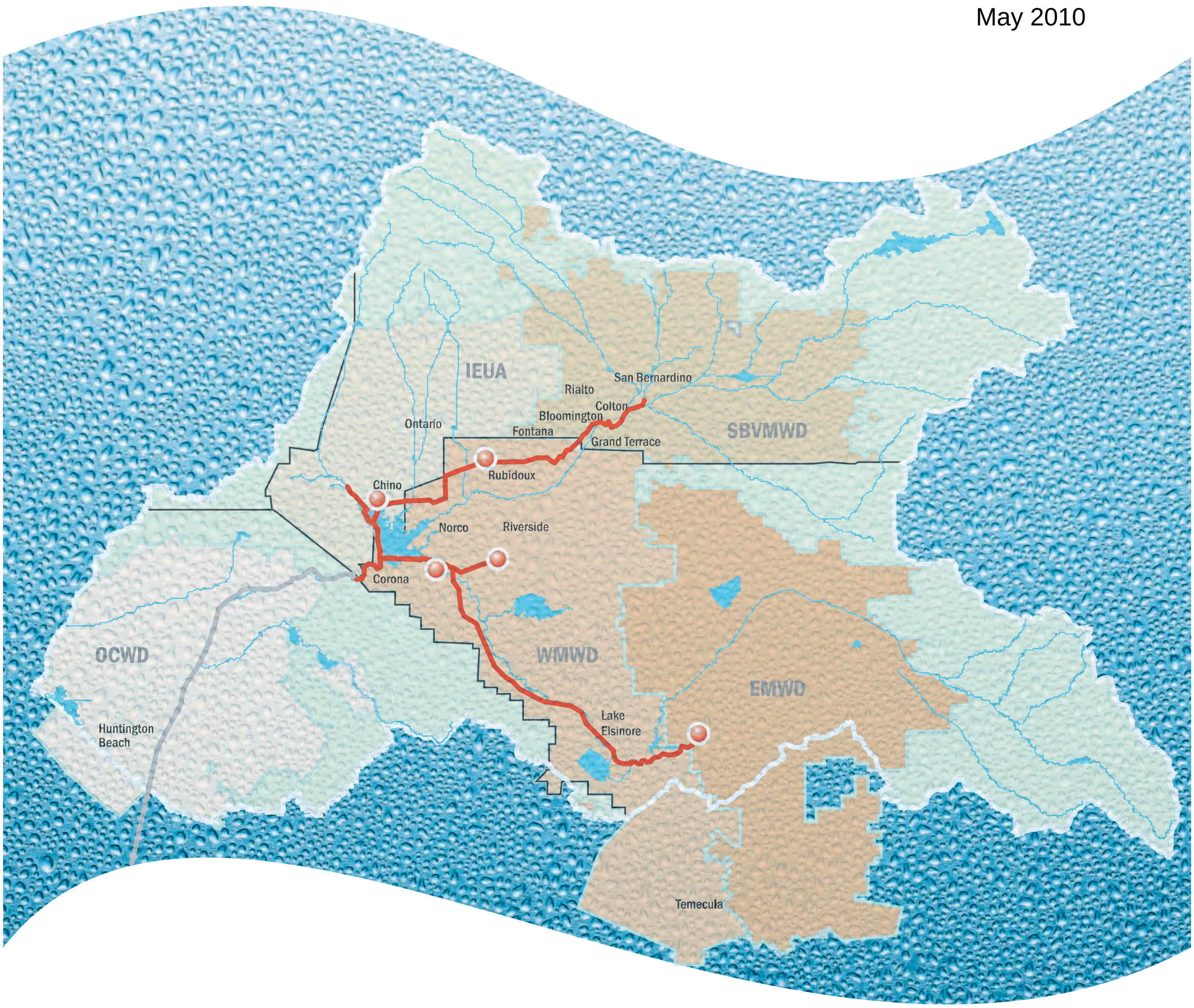
SANTA ANA WATERSHED PROJECT AUTHORITY

SAWPA

Santa Ana Watershed Salinity Management Program

Phase 3 SARI Operations Technical Memorandum

May 2010



CDM

carollo
Engineers...Working Wonders With Water™

WILDERMUTH™
ENVIRONMENTAL INC.

92220 Cleveland Avenue, Suite 100
Rancho Cucamonga, CA 91730
tel: 909.579.3500
fax: 909.980.5185

May 17, 2010

Mr. Richard Haller, Project Manager
Executive Manager of Engineering & Operations
Santa Ana Watershed Project Authority
11615 Sterling Ave.
Riverside, CA 92503

Subject: Santa Ana Watershed Salinity Management Program
Phase 3 SARI Operations Technical Memorandum

Dear Rich:

The enclosed document presents the information and findings resulting from the CDM team's work on Phase 3 of the subject program. The document incorporates comments received on the draft Technical Memorandum.

We look forward to completing subsequent phases of the study.

Very truly yours,

Donald J. Schroeder, P.E.
Vice President
Camp Dresser & McKee Inc.

Contents

Appendices

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List of Acronyms

ARV	air release and vacuum
CCTV	closed circuit television
CIP	Capital Improvement Program
CIW	California Instute for Women
CMLC	Cement Mortar Lined and Coated
CPPD	Cellular Digital Packed Data
CSS	Conveyance System Structure
DAM	Data Acquisition Module
EMWD	Eastern Municipal Water District
FOG	fat, oils and grease
ft/s	feet per second
gpm	gallons per minute
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HDPE	high density polyethylene
HMI	Human Machine Interface
IEUA	Inland Empire Utilities Agency
JPA	Joint Powers Authority
MAS	Maintenance Access Structure
MVPP	Mountain View Power Plant
mgd	million gallons per day
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OCSD	Orange County Sanitation District
OPC	Opinion of Probable Cost
OWOW	One Water One Watershed
PVC	Polyvinyl Chloride
RCP	reinforced concrete pipe
RCPP	reinforced concrete pressure pipe
RIX	Rapid Infiltration and Extraction
ROW	right of way
RPMP	Reinforced Polymer Mortar Pipe
SARI	Santa Ana Regional Interceptor
SAWPA	Santa Ana Watershed Project Authority
SBVMWD	Sab Bernardino Valley Municipal Water District
SBWRP	San Bernardino Water Reclamation Plant
SSMP	Sewer System Management Plan
SSO	Sanitary Sewer Overflows
TDS	total dissolved solids
VCP	vitrified clay pipe
WMWD	Western Municipal Water District
YVWD	Yucaipa Valley Water District

Section 1 Introduction

1.1 Background

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" (OWOW) 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 Santa Ana Regional Interceptor (SARI) line, groundwater desalters and other projects and activities with salt reduction as a primary goal. 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 to envision 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 is performing this Salinity Management Program Study under a Task Order issued by SAWPA. The Study is divided into three phases:

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

At the end of each phase of the study, the consultant team will prepare a draft Technical Memorandum, assist SAWPA staff in a briefing to the SAWPA Commission, and prepare a final Technical Memorandum based on comments received. In Phase 3, a final Executive Summary report will also be prepared based on the three completed Technical Memoranda.

This Technical Memorandum presents the results of Phase 3 of the study.

1.2 Scope of Work

The scope of Work for this third phase of the Salt Management Program is summarized as follows:

Task 3-1 Update to Capital Improvement Program

- Estimate the expected remaining useful life of the existing infrastructure.
- Evaluate current operations and identify problematic areas as they relate to proper operation and maintenance, potential risk, and options to maximize use of the system.
- Investigate problem areas
  - Schleisman Siphon (Reach IV-D), which accumulates solids at an unacceptable high rate
  - Plan a simple SCAD system to monitor status and collect data including flow rate and volume from dischargers at key points in the system, including time-adjusted balance between inflows and outflows and the use of fail-safe connections
  - Methodology to clean approximately 6,000 feet of Reach IV-E, between maintenance access structures (MASs) 4E-0020 and 4E-0110, which has accumulated a considerable amount of solids
  - Methodology to field-locate and correct record drawings for Reach V to comply with Dig Alert standards
  - Develop recommendations for required repair, rehabilitation, or upgrades of the existing infrastructure required to provide adequate service through the year 2060

Task 3-2 SARI Management and Operations

- Evaluate current management and operations structure implemented by SAWPA
- Evaluate ways to improve efficiency
- Evaluate other alternatives such as performance of more activities by SAWPA, or member agency staff, or more use of contractors.

Task 3-3 Technical Memorandum and meetings

- Summarize data, information, and results, in a Technical Memorandum.

- Conduct one workshop with a stakeholder group and aid SAWPA staff in presenting a summary to the Commission.

- Prepare a final technical memorandum incorporating comments received from the stakeholder group and Commission as part of the Final Report prepared under Task 4.

Task 4 Final Report

- Prepare a draft executive summary of the three technical memoranda prepared.

- Incorporate comments received from SAWPA

- Prepare a final Executive Summary and prepare a Final Report that includes the final technical memoranda

This draft Technical Memorandum presents the findings of Phase 3 activities. This final report, Task 4, will be completed when the Phase 2 and Task 3 sections are complete.

1.3 Report Organization

This Phase 3 Technical Memorandum is organized in six sections as follows:

Section 1 – Introduction

Section 2 – Update to Capital Improvement Program

Section 3 – SARI Management and Operations

Appendix A – Maps of Gravity Reaches with Capacity Issues at Ultimate Conditions

Section 2
Update to Capital Improvement Program

2.1 SARI System Background

The Santa Ana Watershed Project Authority (SAWPA) owns either capacity rights in, or owns outright approximately 93 miles of 16-inch to 84-inch pipeline referred to as the Santa Ana Regional Interceptor (SARI). SAWPA has contracted with CDM to conduct a Planning Study for the SARI reaches upstream of the Orange County Sanitation District (OCSD) service area. These upstream segments are referred to as Reaches IV, IV-A, IV-B, IV-D, IV-E, and V.

In addition to the SAWPA member agency discharges, there are several other dischargers that currently feed into the upstream reaches. These dischargers include a combination of brines from desalination facilities, industrial wastewater, and domestic wastewater. As additional desalination facilities within the service area come on line, new demands will be placed on the system, and the quality and quantity of future flows may change significantly. In addition, the methodology upon which the system rate structure is based could be directly impacted by future changes in system usage. The purpose of the Planning Study is to evaluate the issues and impacts of current and potential future users of the upstream reaches of the SARI pipeline, and provide an associated rate impact assessment.

2.1.1 Summary of Existing Facilities

Figure 2-1 provides a graphic overview of the 93-mile SARI system. Reaches IV, IV-A, IV-B, IV-D, IV-E; and V are referred to as the upstream reaches. The total length of these upstream reaches is approximately 72 miles. Reaches I, II, and III are approximately 21 miles in length, are owned and operated by OCSD, and are not included in this study. There is also a 9-mile lateral pipeline owned by EMWD that connects Lake Elsinore to the Menifee area.

Reaches IV, IV-A, IV-B, IV-D, and IV-E include approximately 49 miles of pipeline ranging from 16 to 48-inches. Pipeline materials include polyvinyl chloride (PVC) pipe, reinforced concrete pipe with PVC lining (RCP), vitrified clay pipe (VCP), high density polyethylene pipe (HDPE), PVC lined reinforced concrete pressure pipe (RCPP), concrete encased steel pipe, and cement mortar lined and coated (CMLC) steel pipe.

Reach V is a low-pressure force main approximately 23 miles long, and is constructed of PVC and HDPE pipeline ranging in diameter from 24 to 30-inches. The line contains blow-off valves and air-relief valves. A pressure sustaining station is located at the upstream end of the reach.

The SARI system is entirely a gravity pipeline; there are no pump stations on it. 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).

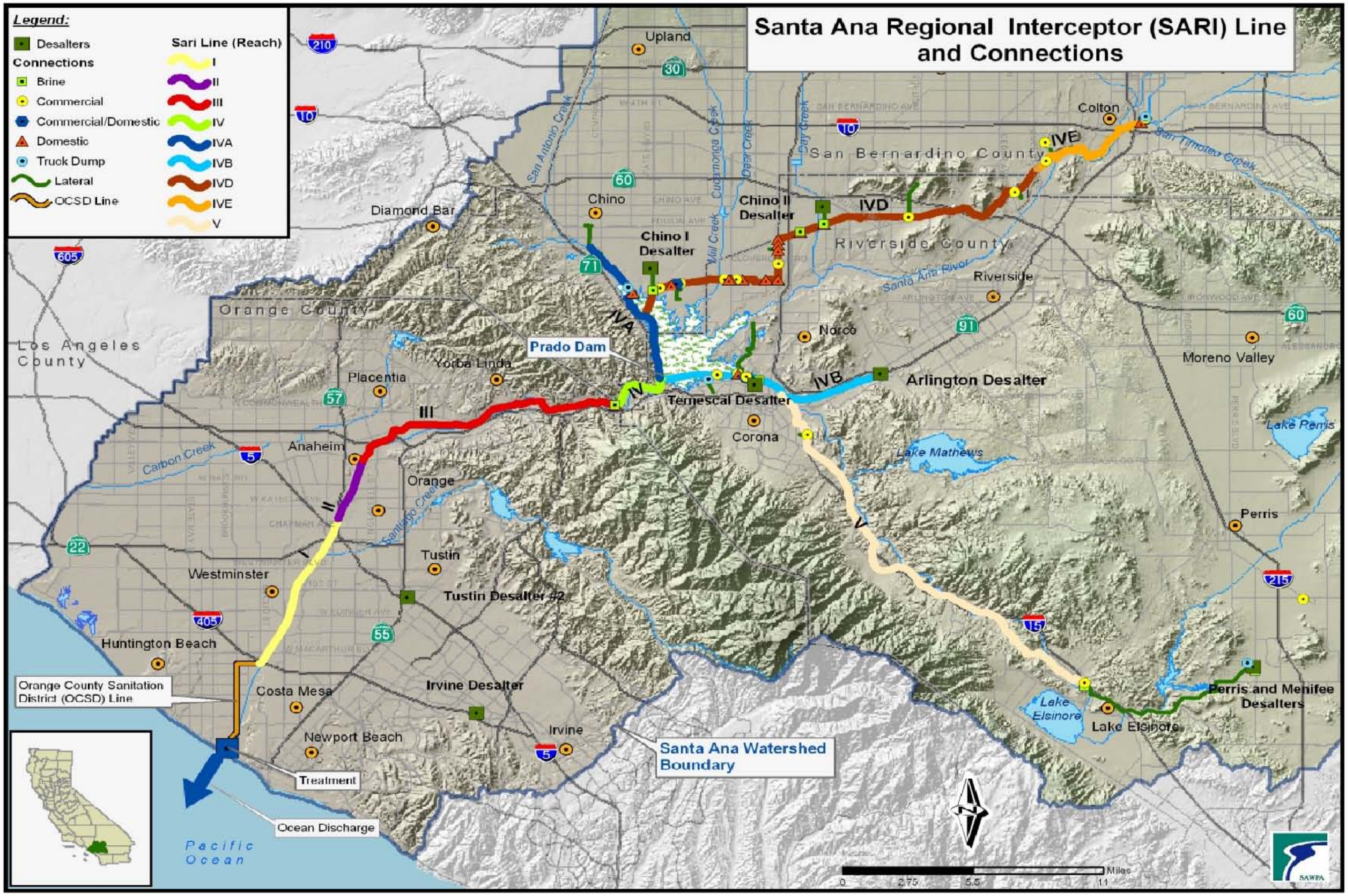


Figure 2-1
SARI System Map

2.1.2 Expected Remaining Useful Life of Existing Facilities

The 2002 Upper SARI Planning Study estimated the remaining useful life of the SARI facilities. The study assumed that with non-corrosive soil conditions; proper design, manufacturing and installation; and proper maintenance, the performance of existing VCP, PVC lined RCP, unlined RCP, HDPE, and RCPP could provide 75 years of service for wastewater with normal domestic strength. The 2002 study also assumed that since the existing CMLC steel siphons are continuously flowing full, CMLC steel pipe could also be expected to last between 50 and 75 years.

Table 2-1 has been updated from the 2002 study and summarizes the length, material of construction, age, and the estimated remaining useful life of each upstream reach. Part of the SARI system has not been cleaned due to access constraints, current cleaning equipment limitations, and cost consideration. However, SAWPA significantly has 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.

Examples of SAWPA's proactive maintenance approach of the past several years are the cleaning of Reach IV-E between structures 4E-0250 and 4E-0120 in the vicinity of La Cadena Boulevard in Colton. In addition, several of the siphons are cleaned every 3 months.

SAWPA also has programmed the upcoming rehabilitation of Reach IV from structures 4A-0010 to 4A-0170 and from 4A-0180 to 4A-0680, and Reach IVB from structures 4B-0010 to 4B-0150 in the Prado Dam area. Contract documents for the rehabilitation of the unlined RCP in these reaches are currently under development. 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. Two different technologies are proposed to be used for the rehabilitation: cured-in-place pipe and sliplining with Fiberglass Reinforced Polymer Mortar Pipe (RPMP). For the sliplining method, the annular space between the new RPMP pipe and the host pipe will be grouted. Table 2-2 shows the extent of the project and the type of technology planned to be employed for rehabilitation.

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.

Table 2-1
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 2-2
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 Sliplining	RPMP	36
Reach IV-B	RCP (Unlined)	15,950	4B-0150 to 4B-0010	36	Segmental Sliplining	RPMP	30
Total Rehabilitation		***57,528***					

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

2.2 Specific Problem Areas

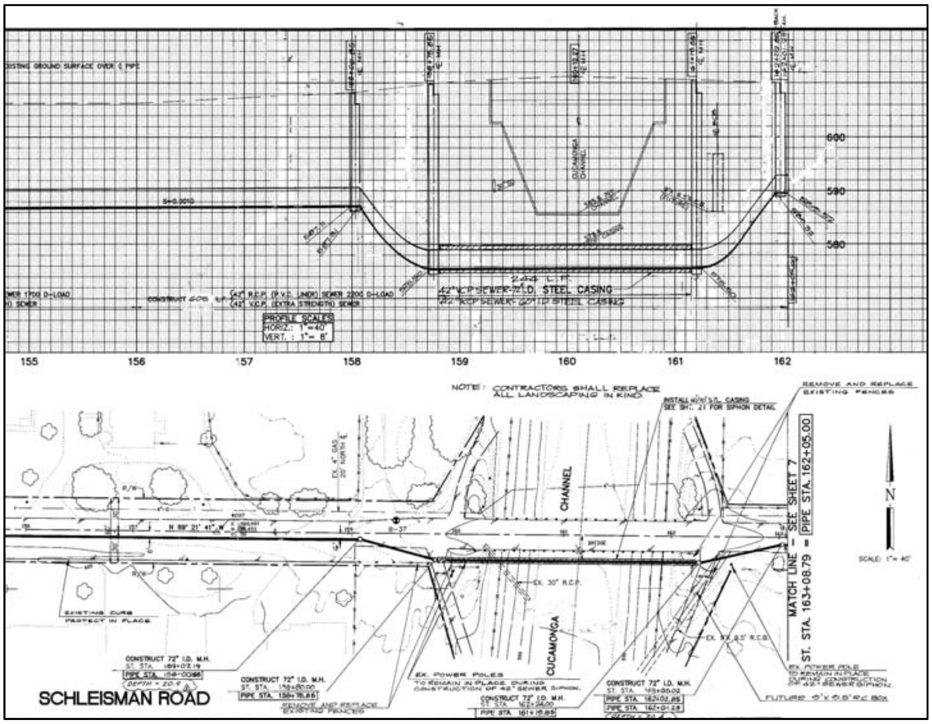
2.2.1 Schleisman Siphon (Reach IV-D)

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 within a 60-inch ID, ¾-inch thick steel casing; it was 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. Figure 2-2 shows the location of the siphon and Figure 2-3 shows record drawings of the siphon.

Figure 2-2
Schleisman Siphon

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. Past FOG issues are thought to be caused by the domestic discharges from connections from the Jurupa area, which have many restaurants that connect to the Jurupa system. SAWPA is able to maintain MASs 4D-340 and 4D-350, since they are located off the road.

According to SAWPA's hydraulic model, existing flow in the Schleisman siphon is between 2.9 and 3.2 MGD. Velocity in the siphon varies between a minimum of 0.5 feet per second (ft/s) and a maximum of 0.9 ft/s, which is not sufficient to achieve a cleaning effect (minimum cleaning velocity is between 2 and 3 cfs). The siphon was designed and constructed with only one 42-inch diameter barrel that is 244 feet long, and the approaches in and out of the siphon are 83 feet and 75 feet long respectively.



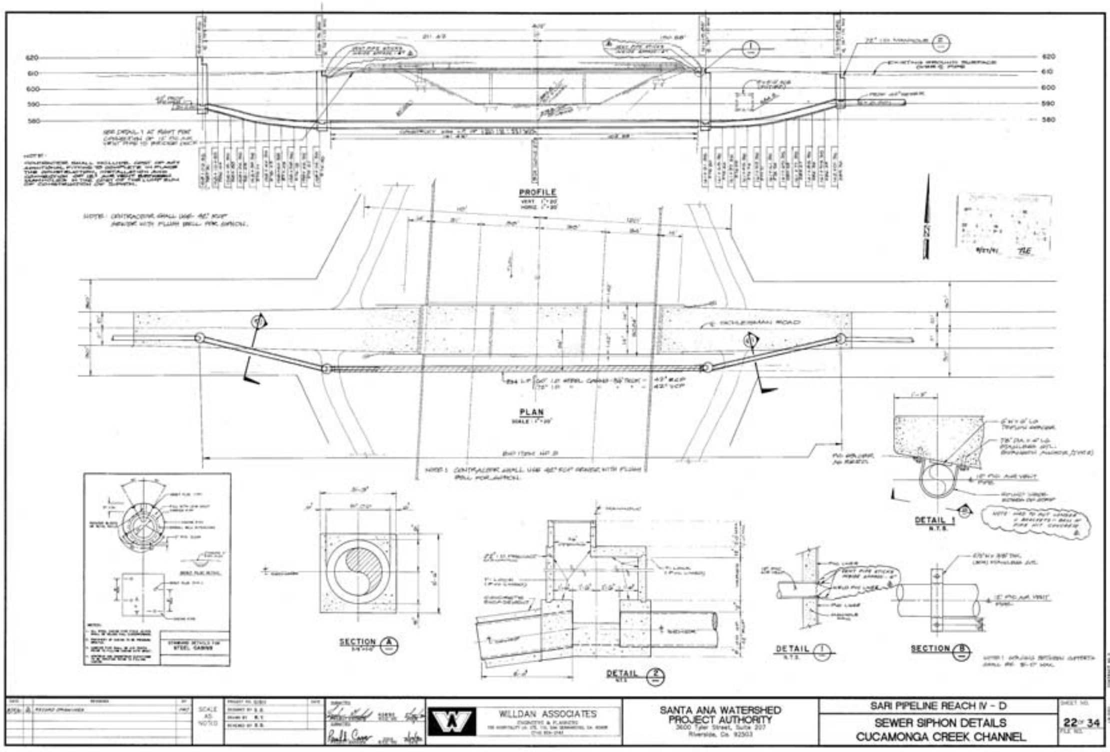


Figure 2-3
Schleisman Siphon Record Drawings

The 2002 Upper SARI Planning study suggested the addition of a parallel siphon of similar or smaller diameter that could be used in emergencies or during routine maintenance of the primary siphon. Factors for the design of inverted siphons that may not have been part of the current design and that should be considered for potential improvements are:

- Most inverted siphons contain at least two or three barrels: a small pipe to carry low flows and provide greater velocity for scouring, a mid-size pipe for larger flows, and a larger barrel to carry peak flows. Some even include another pipe capable of carrying the entire flow in case of any emergency.

- Size of the pipe(s) should be such that the flow in the siphon has a minimum velocity of 3 fps to provide for scouring and prevent sediment deposition.

- Access structures are needed at each end. They need to be large enough to provide for maintenance (i.e., cleaning by pigging or other methods). Both access structures should have tamper-proof manhole covers

- The siphon needs to be designed with smooth curves of adequate radius, preferably less than 22 degrees, to allow passage of cleaning equipment.

- The inlet chamber can be designed with a sump to trap sediment and heavy objects and prevent the buildup of sediment in the siphon.

Working with SAWPA staff, 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, which has an internal diameter of 32.4-inches. This scenario would include either constructing a new siphon, or modifying the existing one. The model run showed that using present condition average flow of 2.4 MGD, the velocity in the siphon, between MASs 4D-0360 and 4D-0330, reaches about 1.2 fps, which is an improvement over existing conditions, but not a sufficient nor desired velocity for self-cleaning. When the model was run using ultimate conditions (average of 11.2 MGD), the velocity in the siphon increased to about 3 fps, which is considered sufficient velocity for cleaning of the line. 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 (32.4-inch internal diameter). The estimated planning-level construction cost for this option is approximately $ 1.67 million.

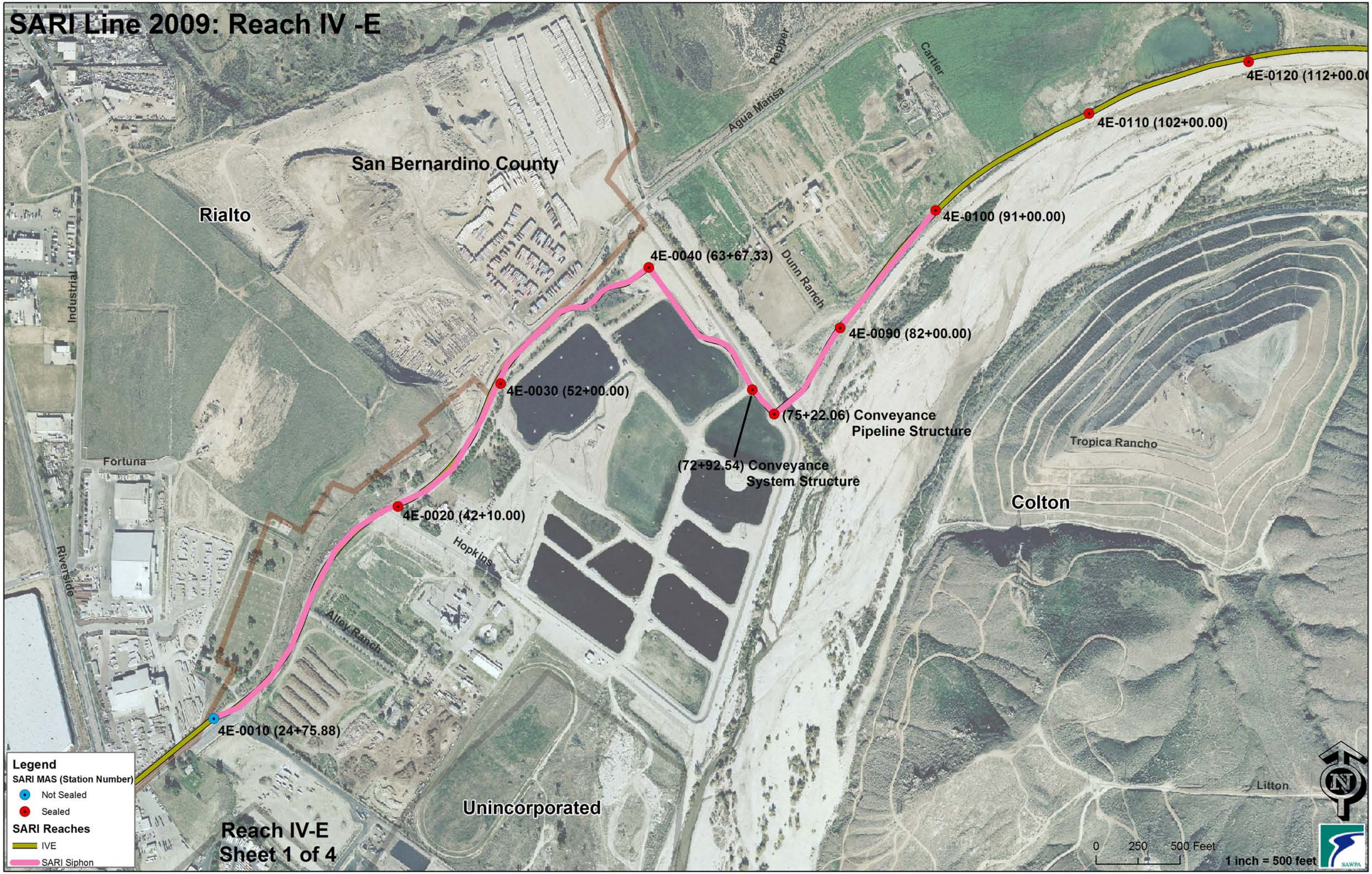
2.2.2 Cleaning of a Portion of Reach IV-E near RIX

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. The portion of the line is located between MASs 4E-0110 and 4E-0020, is 36-inch diameter reinforced concrete pipe (RCP) and is shown in Figure 2-4.

Flow direction is from MAS 4E-0110 at station 91+00 to MAS 4E-0020 at station 24+75.88. This segment of the line has a positive slope from 4E-0110 to the Conveyance System Structure (CSS) at station 72+92.54; from there it turns into a siphon from the CSS to 4E-0040, and then it flows again positively to 4E-0020. According to SAWPA, the line is pressurized in this reach and it is estimated that there are approximately 200,000 gallons of liquid stored between 4E-0010 and 4E-0040, and 250,000 gallons between 4E-0040 and 4E-120.

This portion of the line receives brine flow from four upstream sources: the Mountain View Power Plant (MVPP) at a rate between 190 and 300 gallons per minute (gpm); Enertech at a rate of 113.5 gpm; the E.I. Colton Power Plant at a rate of 4.83 gpm; and the San Bernardino Truck Dump Station at a rate of 6.2 gpm (based on monthly average flows). There is also an existing MWD connection that previously contributed approximately 25 gpm, but the line has since been disconnected and no longer contributes flow to the SARI. One more connection is planned for the future; a new line from Yucaipa Valley Water District (YVWD), which will initially discharge 1 MGD into the SARI and ultimately 5 MGD. The MVPP has the ability to shut down flow to the SARI for a maximum of three (3) days, as they have a storage reservoir that will hold the flow for this amount of time.

In late 2008 and early 2009, SAWPA performed cleaning of Reach IV-E upstream of the 4E-0110 - 4E-0020 reach. The cleaning started at 4E-0250 and ended at 4E-0110, for a length of approximately 13,300 feet. In addition, cleaning was also performed from MAS 4E-0010 towards 4E-0020 for as much as it could be done; 850 feet were cleaned. The method used was to shut down the line for 8-hours per day and use Vactor trucks to jet the line, retrieve the flow at the downstream end, and then use bins of approximately 10 cubic yards of capacity to allow for the sediment to settle. The cleaning was performed using a total of 160 vactor hours and 104 water truck hours. About 3 days were spent cleaning the La Cadena siphon (between 4E-0180 and 4E-0190.). The cleaning of the 4E-0250 - 4E-0110 reach took approximately 6 weeks and about 90-100 tons of solids (after they were allowed to dry) were retrieved from the line and disposed of at the Regional Inland Municipal Refuse Facility operated by the City of Colton at a rate of $43.60 per ton. The total cost to clean the reach was approximately $96,000.



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In the first quarter of 2009, using the services of a contractor, SAWPA performed sonar inspection of the reach from 4E-0020 to 4E-0110. CCTV inspection could not be done due to line flowing full. The sonar inspection provided, for each reach of pipe inspected, measurements and estimated calculations on cross sectional area restriction or reduction, the average depth of debris in the pipe, and the total volume of debris. Table 2-3 summarizes the amount of debris estimated by the sonar inspection. The numbers in red italics indicate areas of the reach that could not be accessed by the sonar inspection due to the sharp bends in the line and limited access to these points. These amounts of debris were estimated assuming the same amount of average depth of debris in the line as the adjacent reaches.

Table 2-3
Estimated Amount of Debris from 4E-0020 to 4E-0110

Upstream MAS		Downstream MAS		Length (ft)	Length of Run in Sonar Report (ft)	Estimated Accumulated Debris (cu. ft.)	Maximum Cross Sectional Restriction (%)	Average Debris Depth (ft)
Number	Station	Number	Station					
4E-0110	102+00	4E-0100	91+00	1,100	1,089.9	829.14	22.7	0.49
4E-0100	91+00	4E-0090	82+00	900	901.7	621.82	21.7	0.46
4E-0090	82+00	CPS 75+22.06	75+22.06	677.94	400.8	504.39	32.9	0.70
4E-0090	82+00	CPS 75+22.06	75+22.06		267.1	336.13		0.70
CPS 75+22.06	75+22.06	4E-0040	63+67.33	1,154.73	1,154.7	1,453.14		0.70
4E-0040	63+67.33	4E-0030	52+00	1,167.33	1,167.3	1,469.00		0.70
4E-0030	52+00	4E-0020	42+10	990	850.0	530.02	23.3	0.43
4E-0030	52+00	4E-0020	42+10		140.0	87.30		0.43
TOTALS				5,990.00	5,971.50	5,830.94		
						100.00	pcf (assumed)	
						583,093.92	Pounds	
						291.55	Tons	
						29.15	10% Allowance	
						321.00	**Tons (rounded)**	

As shown in Table 2-3, it is estimated that to fully clean the reach, over 300 tons of debris would be need to be extracted from this portion of Reach IV-E. If the debris is not toxic, it could be disposed of at the Regional Inland Municipal Refuse Facility operated by the City of Colton.

There are several issues related to the reach from 4E-0020 to 4E-0110. First, access to this reach of the SARI is very challenging, so SAWPA has not been able to fully inspect and clean the pipe, thus it is possible that there may be offset joints and/or other problems that are potentially allowing infiltration of sediment into the pipe. Second, even though the line flows full (with about 0.5 mgd), it flows at very slow velocity (about 0.42 fps), thus it does not have enough velocity to provide for cleaning of the pipe (it is estimated that 15 mgd would be required to achieve cleaning velocities). Third, the SARI has several sharp bends in this reach, making it hard for cleaning equipment to go through the line without accessing at the MASs of the bend. Last, the RIX basins apparently had plugging issues in the past and some or most of the flow from the basins may have been discharged to the SARI, thus contributing large quantities of sediment to the line.

Three options that could potentially be used to clean the 4E-0110 - 4E-0020 portion of reach IV-E are described below. They include jetters and Vactors, Sewer Hog and Grit Gator, and temporarily adding flow from San Bernardino and Colton plants.

Jetters and Vactors

This option involves employing a method similar to the one used in 2008 to clean Reach IV-E between 4E-0250 and 4E-0110. This method would require shutting down flow from the dischargers to Reach IV-E for several days (in 12-hour periods or a maximum of 3 days in order to allow discharge from the Mountain View facility), 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. There are several large capacity jet-vacuum systems such as GapVax, Clean Earth, Guzzler, etc. that could be used to clean this reach. Their typical cleaning range is 800-1,200 lf, thus it may require working from both ends of the reach. Some large capacity jet-vacuum trucks are shown on Figure 2-5.

Figure 2-5
Large Capacity Jet-Vacuum Trucks

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. The settled solids could then be disposed of at an appropriate facility. The quality and composition of the sediment deposited in this reach, whether it is organics, inorganics, calcium, etc., would need to be determined in order to determine an appropriate to use. Jar testing with sediment samples taken from the MAS is recommended to select the most appropriate settling aid polymer or combination of polymers.

Sewer Hog and Grit Gator

Brenford Environmental's Sewer Hog and Grit Gator system could potentially be well suited for cleaning this reach. The sewer hog/grit gator system has been used to clean 18-inch diameter pipe and up. The biggest pipe cleaned to date using this equipment is a twenty-two feet (22') in diameter, one hundred thirty feet (130') deep, four thousand feet (4000') long, and CSO tunnel in Atlanta, Georgia, with 15 feet of debris. This closed-loop system provides complete containment, thereby, eliminating risks of waste spills and emissions during transportation and thus meeting (and sometimes exceeding) most applicable local, state, and federal emission standards. Filters and baffles can be added to add flexibility to specific projects.

The Sewer Hog is probably the largest and most powerful jetter in the market; it utilizes active flow in the lines as the water source and returns the filtered water back to the system. The unit is mounted on a skid approximately 24 feet long by 8 feet wide. A 600 hp engine powers the jetter, generating water at 350 GPM at 2,000 psi to a 150 # nozzle via twin 1-1/4-inch hoses. The jetter nozzle can be adapted to have 10 to 30 jets.

An intense downward spray is generated by the nozzle, suspending the materials, and the high volume flow, up to 350 gpm, forces them down the sewer pipe to the manhole where a 6-inch submersible pump directs the debris and water up to the dewatering box. The sand and grit is captured in the dewatering box and water is returned to the sewer line mostly free of debris. In cases where hydrant water is not available, the decanted water is reused to power the jetter. The Sewer Hog has a maximum sand removal capability of 5 cubic yards per minute. Line segments up to 4,000 feet can be cleaned without repositioning the equipment.

The Grit Gator is an enclosed sealed unit that captures sand, grit and water pumped from waste collection systems by the Sewer Hog. The positive pressure created by pumping removes and transfers the waste into the Grit Gator's surface dewatering box. The separation box can process about 1500-2500 GPM of sand and water at 80 percent solid concentration. The majority of the sand and grit are filtered out and water is simultaneously decanted back to the source pipe. The Grit Gator's access hatch is designed to withstand the internal pressures, providing a sealed system that reduces fumes, odors, and spills. This allows the unit to process waste at a higher speed than open containers.

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.

Temporarily add Flow from San Bernardino and Colton

The San Bernardino Municipal Water Department operates the San Bernardino Water Reclamation Plant (SBWRP), a 33 MGD regional secondary wastewater treatment facility that provides services to the City of San Bernardino, City of Loma Linda, East Valley, San Bernardino International Airport, Patton State Hospital, and unincorporated San Bernardino County areas. The WRP uses primary and secondary treatment processes to meet the discharge standards specified in the National Pollutant Discharge Elimination Permit (NPDES) issued by the State of California Regional Water Quality Control Board.

Treated wastewater from the WRP discharges to an offsite tertiary treatment facility operated jointly by the cities of San Bernardino and Colton. The Rapid Infiltration and Extraction (RIX) facility receives approximately 33 MGD of secondary treated wastewater from the WRP and approximately 7 MGD from Colton's treatment facility. The RIX employs natural bio- filtration through the use of percolation basins and ultra-violet disinfection to meet the California Title 22 tertiary standards, and the discharge standards specified in a separate NPDES permit issued to the RIX facility. RIX treated wastewater meets or exceeds required discharge standards and is often superior in quality to effluent produced through conventional tertiary facilities.

During the study phase of this project, CDM and SAWPA staff discussed the possibility of injecting flow to the SARI line. Flow would come from the effluent discharged from the SBWRP and the Colton WRP. Flow from the SBWRP could be up to 20 MGD; flow from the Colton WRP could be up to 5 MGD.

Working with SAWPA and using the existing Info SWMM hydraulic model of the SARI line, several flow injection scenarios were tested in order to try to achieve an effective cleaning velocity in the pipe (around 2.5 fps or higher). The model was then used to see the impact of the flow injection downstream of the system, in order to avoid excessive surcharge and potential overflows.

The model results showed that it would be possible to inject about 7,000 gallons per minute for two to three hours (equivalent to 10 MGD). The flow would be injected at the large structure where the SBWRP and Colton effluent lines converge before they discharge to the RIX facility. This structure is also the location for SAWPA's MAS 4E-0140.

Potential issues to consider if this approach was used are:

- Discharge from the WRPs is considered domestic flow and contains nutrients. From past SAWPA studies, it has been determined that the combination of sewage nutrients and the chemistry of the brine in the SARI has caused bio-growth in the SARI line. However, due to the limited duration of the operation, this may not be a major concern.

- It is possible that this option to clean this specific reach will push the sediment from this area of reach IV-E to one or more locations downstream in the system, thus moving the problem or creating the potential for overflows due to a blockage.

- The sediment could go back into suspended status, thus sending a large amount of TSS to the OCSD system and creating the potential for increased treatment charges by OCSD.

2.2.3 Reach V Field Location and Record Drawings

Reach V is a low-pressure line constructed of PVC and HDPE pipe ranging in diameter from 24 to 30 inches. The line is approximately 23 miles long and contains blow-off valves and air-relief valves, but no MASs were installed in Reach V until one MAS was constructed at Station 42+00 in Temescal Canyon Road after the pipeline had been in service. Another MAS was constructed near the intersection of Coal and Nichols Road. One more 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, but there have been some instances where field locating efforts have not matched the existing record drawings.

Potential methods for locating the PVC and HDPE line could be to use 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. These technologies are described below.

Ground penetrating radar (GPR)

GPR is a non-destructive method of scanning and profiling an area in order to ascertain the existence and location of underground utilities, tanks, or other structures. It is especially useful for determining the presence and location of non-metallic lines which do not respond to electromagnetic locating methods.

Use of GPR can be helpful in indentifying hazards or as one step in the process of positively identifying and recording the location of utilities. It is often times used prior to Vacuum Excavation to help ensure that all hazards have been identified.

There are some limitations to GPR as it is affected by soil type and conductivity as well as the diameter and depths of the pipes underground. The deeper the pipe, the larger in diameter it must be in order to be "seen" by the radar unit.

GPR is potentially the most cost effective method for locating Reach V and should be used whenever conditions allow. This method does not require accessing the pipeline or disruption of service. The area above the pipeline will need to be safely accessed by locating personnel so this method cannot be used at freeways crossings, river crossings, canal crossings, etc.

GPR has previously been used by SAWPA with little to no success. It is suspected that soil type(s) and depth of the pipe may have been the issue.

Electromagnetic Locating

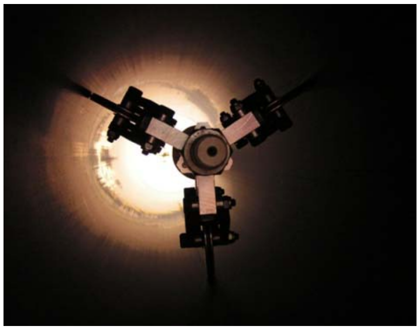
This method consists of two instruments. An electromagnetic field is created around a sonde (sometimes referred to as a "smart pig") which is a transmitter. The sonde is placed into the pipeline and a receiver is used to locate the electromagnetic field as the sonde travels through the pipe. The sonde can be attached to an inspection camera, a rodder, or pulled through with mule tape or rope installed in the pipeline. This method requires exposing and cutting into the pipeline. The sonde may also be propelled through the line using the existing flow pressure.

Distance between access points may vary according to the type and size of sonde used and would need to be determined by the specific contractor and/or vendor. It is estimated that at approximately every mile, a pot hole would need to be made with vacuum excavation equipment to expose the top of the pipe and obtain a set of reference GPS coordinates. This reference coordinate would be used to ensure the accuracy of the sonde. The area above the pipeline needs to be safely accessed by locating personnel so this method cannot be used at freeways crossings, river crossings, canal crossings, etc.

Geospatial's Smart Probes™

Geospatial's Smart Probes are "un-tethered" which means there is no requirement for a communication cable to be attached to the Smart Probe™, allowing greater flexibility in the utilization of the technology. All data is stored within each probe, thus there are no depth limitations. Geospatial's Smart Probe technologies allow the digital mapping of pipelines as small as 1.5 inches (3.8 cm) to as large as 96 inches (243.84 cm) in diameter. In addition, they are designed in numerous body styles, some of which may permit the negotiation of extremely tight (90 degree) bends. Geospatial has developed custom body styles specifically designed for potable water pipelines and others for small fiber optic/telecommunications conduit. The Smart Probes™ are capable of operating in any pipeline medium. More information about this technology is available on their website at www.geospatialcorporation.com.

The Smart Probe™ can be attached to an inspection camera, a rodder, or pulled through the pipeline with mule tape or rope installed in the pipeline. This method requires exposing and cutting into the pipeline. Access spacing may vary according to the type and size of smart probe used and would need to be determined by the specific contractor and/or vendor. It is estimated that an access port may be needed every mile or so. The area above the pipeline does not need to be accessed by locating personnel so this method can be used at freeway crossings, river crossings, canal crossings, etc.



Acquired data can be stored on a laptop PC or immediately viewed and evaluated in the field. If required, digital "plan and profile" sectional drawings of the pipeline can be produced, overlaid on the existing plan view of the site and viewed in the field. Alternatively, the digital data can be transferred via the Internet to any location for evaluation by associated decision-makers, or stored and entered into the appropriate GIS/CAD database by the program administrator for future reference and use.

The Geospatial method relies upon initial survey data for start and finish points and interpolates between those two known points. The system operates on a targeted "tolerance" from these starting and ending points. This tolerance is approximately 0.25 percent within the Horizontal Plane and 0.10 percent within the Vertical Plane per linear foot being mapped. The tolerance can be impacted by the actual pipeline condition. However, Geospatial's QA/QC procedures tend to mitigate these impacts. Therefore, it is not only important to have appropriate access points (MASs) to insert the Smart Probe equipment, but also to have the access points properly surveyed and spaced to increase the accuracy of the measurements. The preferred spacing of access points is 2,000 feet; this would provide a horizontal accuracy of ±5 feet or better. Generation of plan and profile drawings is typically part of the locating contract. Because the Smart Probe technology maps the internal geometry of the pipe, it is able to determine horizontal and vertical lines and arcs within the pipeline along with bending radii. Figure 2-6 shows sample plan and profiles developed using Geospatial's Smart Probe technology.

Note that all the locating methods previously presented 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.

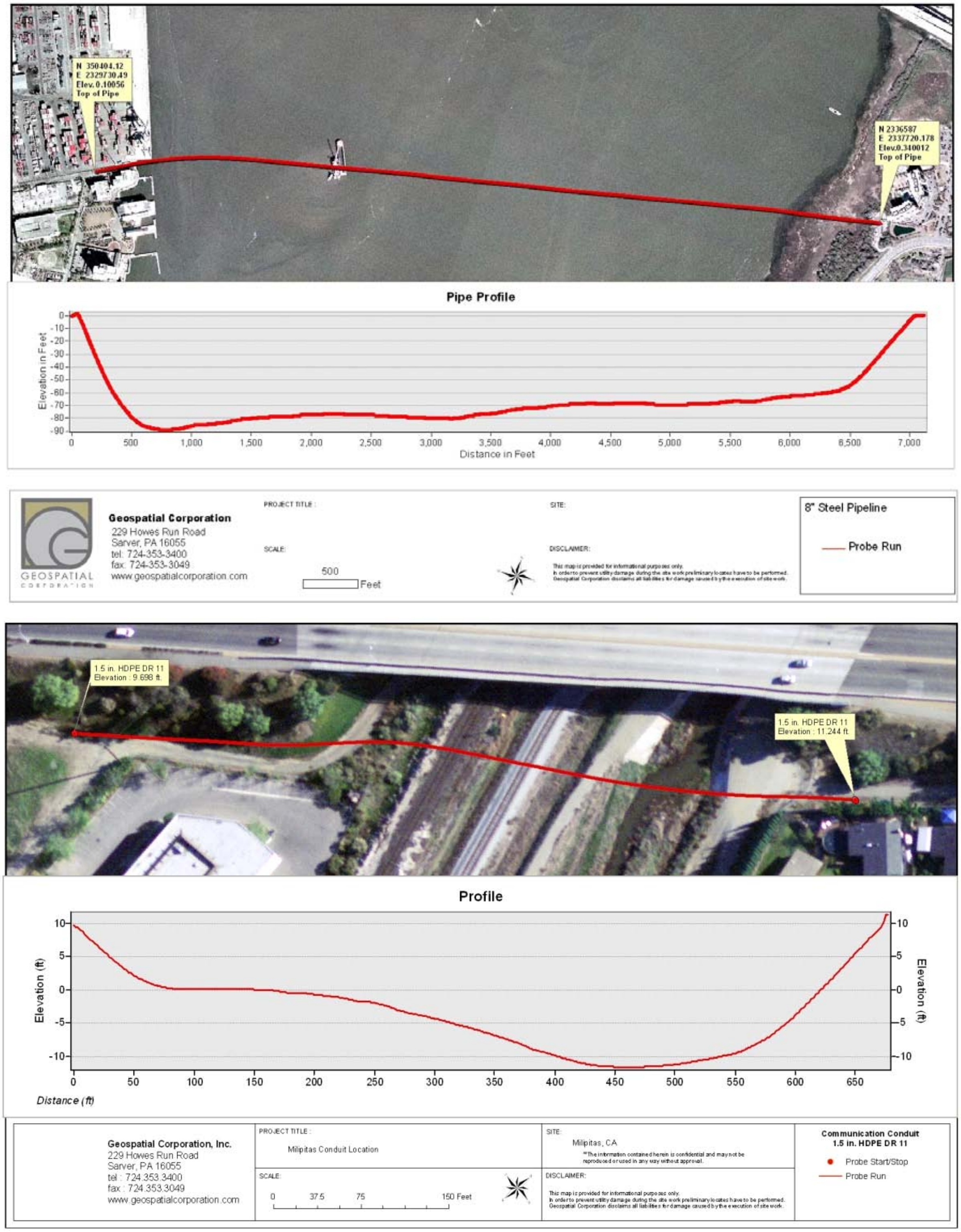


Figure 2-6
Sample Deliverables using Smart Probe Technologies

Vacuum Excavators would need to be used periodically to verify the accuracy of each of the above mentioned methods. Vacuum excavation provides a non-destructive method for safely and efficiently locating and exposing underground utilities. Once a small hole is cut in the surface, pressurized air is used to break up the soil while a high pressure vacuum unit is used to remove the debris depositing it into the storage tank. This method has become the industry standard for digging very precise potholes with virtually no risk of damaging the targeted utility.

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.

2.2.4 SCADA System Planning

The purpose of the SAWPA proposed SCADA system plan is 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 intent of the review conducted under this task is to develop 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. This report does not include conducting site surveys. Information used in this report is based on CDM's 2002 Flow Meter Automated Data Collection Project Field Investigation and Pre-design report and additional data provided by SAWPA staff. In the development of the SCADA concept, reasonable assumptions are made where data gaps exist.

A summary of the collected data and base information for this part of the evaluation is included in Table 2-4 below. The summary details all 26 sites and the status of available power, flow meter type, and the volume of flow at each site on a daily basis. It further illustrates the type of water, facility type (if available) and any related comments for the sites. Of the 26 sites, 13 were identified to have data sheets from the 2002 report. The Menifee and Perris Desalters and the Inland Empire Energy Center are assumed to have one meter site located at the existing Pressure Sustaining Station in Reach V in the City of Lake Elsinore.

The SCADA system concept will be based on the following criteria:

- Site priority based on flow usage.
- Sites and phases dependent on the cost per site and total capital cost.

- Expandability to accommodate new connections which includes the future addition of the Yucaipa Valley Water District (YVWD) 13 mile extension master flow meter.

Installations are assumed to not occur at the prisons (Chino Institution for Women, and CA Rehabilitation Center), Green River Golf Club, and Bonview as these are scheduled for elimination. EMWD will only have one site at the master meter located at the Pressure Sustaining Station. Furthermore, the Chino II Desalter East will be separated into 3 separate sites each with its own RTU and flow meter; however, the total flow for the desalter will remain as noted in Table 2-4.

The desalters, EnerTech, and Mountainview Power Plant have existing SCADA systems which are accessible to SAWPA. In addition to the required flow meters, access up to five flow meters on the system trunk lines is included in the conceptual approach. The Engineer's Opinion of Probable Cost will be used to develop the phasing concept estimate for inclusion in the SAWPA CIP.

Proposed Data Telemetry Recommendation

CDM has researched several technologies to determine the most practical approach to meet the specific needs of SAWPA. The most practical, easy to maintain, expandable and simplest technology is the use of a cellular telephone network in correlation with a reliable Web-based communication system.

This technology uses Cellular Digital Packet Data (CPPD) which is an open IP-based standard for the transmission of data over cellular communications. This is a wireless technology that sends information over a dedicated cellular network channels to a dedicated telephone line. The end user can easily access and view the secured data from any internet-connected appliance via a secure web site. Online data can reveal the status of all RTU's in the system, view reports, trending, graphs, configuring parameters, and can be provided with application templates for simple installation. The SAWPA O&M staff would be able to receive and acknowledge messages by text or voice calls to any combination of land lines, cell phones, emails, or pagers, depending on the preference of SAWPA. Cost is based on throughput and a yearly service fee from the cellular provider. Data rates are up to 2.4 Mbps. Poll time required is less than a minute, appropriate for this application. It should be noted that reduced network access and slow down of the polling rates can take place during flooding or earthquakes. Cellular network communications have a lower level of security and the data could be compromised. The risk however is not considered great enough to discard this approach. Private information is protected over the internet by having all pages encrypted with 128-bit encryption utilizing SSL (Secure Sockets Layer) with an SSL Certificate from a major Certificate Authority (CA). Only one service provider can be selected.

Table 2-4
Summary of Sites

AGENCY	NAME	WASTEWATER TYPE	FLOW (MGD)	FACILITY TYPE SERVICE	FACILITY TYPE DESALTER	Data Sheet Available	Power Available	Meter Installed	Flowmeter type	Site ID	Comments
EMWD	Menifee Desalter	Brine	1.0121		X	Y	Y	Y	Magnetic	S-41	Data sheet available
	Perris Desalter	Brine	0.7406		X	N	Y	Y	Magnetic	S-99	New. Need information
	Inland Empire Energy Center	Brine	0.215			N	Y	Y	Magnetic	905	New. Need information
		Subtotal	1.9677								
IEUA	Chino Desalter	Brine	2.0022			Y	Y	Y	Flume	S-34	
	Chino Institution for Women	Domestic/Industrial	0.3196								required
	IEUA S05 (Master Meter)	Industrial	0.2604			Y	Y	Y	Magnetic	S-05	
	Bonview (Chino Preserve Development	Domestic	0.2444		X	N	Y	Y	Flume	S-220	New. Need information
	Green River Golf Club	Domestic	0.0118								required
		Subtotal	2.8384								
SBVMWD	Mountainview Power Plant	Brine	0.3739			N	Y	Y	Magnetic	S-35	New. Need information
	Agua Mansa Power Plant	Brine	0.019			N	Y	Y	Magnetic	S-53	New. Need information
	EnerTech	Industrial	0.046			N	Y	Y	Magnetic	S-62	New. Need information
		Subtotal	0.4389								
WMWD	UBF Food Solutions	Industrial	0.001			Y	Y	Y	Magnetic	S-46	No longer a discharger
	RCSD Anita Smith	Brine	0.0123			Y	Y	Y	Magnetic	S-29	
	DFA Distilled Water Plant	Industrial	0.0428	X		N	Y	Y	Flume	S-63	New. Need information
	Dart Container	Industrial	0.0555			N	Y	Y	Magnetic	S-50	New. Need information
	Corona Energy Partners	Brine	0.0755			Y	Y	Y	Magnetic	S-20	New. Need information
	Stringfellow	Industrial	0.0972			N	Y	Y	Flume	S-101	New. Need information
	JCSD Hamner	Domestic	0.0541			Y	Y	Y	Flume	S-24	Data sheet available
	JCSD Wineville	Domestic	0.086			Y	Y	Y	Flume	S-23	Data sheet available
	JCSD Celebration	Domestic	0.1047			N	Y	Y	Magnetic	S-54	New. Need information
	JCSD Etiwanda	Domestic	0.8625			Y	Y	Y	Flume	S-28	Data sheet available
	California Rehabilitation Center	Domestic	0.6364								required
	Chino II Desalter West	Brine	0.0846		X	Y	Y	Y	Flume	S-28	New. Need information
	Arlington Desalter	Brine	1.0823		X	Y	Y	Y	Magnetic	S-22	New. Need information
	Chino II Desalter East 1	Brine	-		X	Y	Y	Y	Magnetic	S-23	New. Need information
	Chino II Desalter East 2	Brine	-		X	Y	Y	Y	Magnetic	S-23	New. Need information
	Chino II Desalter East 3	Brine	1.2772		X	Y	Y	Y	Magnetic	S-23	New. Need information
	Temescal Desalter	Brine	1.8239		X	Y	Y	Y	Magnetic	S-32	Data sheet available
		Subtotal	6.296								
		Total Flow (MGD)	**11.541**	**0.0428**	**6.2651**						

*Three trains, each has a meter

Remote Terminal Units (RTU)

The purpose of the SCADA RTU is to convert the electrical signal from the flow meters to a digital signal that can be converted to digital format and transmitted via a telecommunications network to a host computer or to an online Internet based database. A small programmable logic controller or a smart data acquisition module (DAM) could be used for this purpose. A DAM is a data handling device that accepts analog and digital signals, has programmable capabilities and has communication capabilities, all in one device. Both devices provide data manipulation to scale and totalize the flow meter field data. CDM recommends the use of smart programmable technologies. The industry standard is the use of a PLC based RTU. For the purpose of determining the opinion of probable cost, the DAM based RTU is considered; during the design phase a more detailed comparison can be performed to determine ways to reduce the capital cost required for the installation.

The new RTU panels will consist of a DAM and a cellular modem in a combined unit. The data collected at each site will include 8 digital inputs and 2 universal inputs which may include flow meter actual reading, calculated flow total and an intrusion alarm. The RTU would operate on 120VAC power that will be converted down to 24VDC for the cellular unit. For the sites that do not have 120VAC power available the RTU can be operable in a reduced solar power mode and will not power down in the solar power mode allowing it to remain connected at all times and can last up to 5 days with cells charged. Upon power failure, an incorporated sealed lead-acid backup battery contained within the enclosure would provide 24 hours nominal backup time. The battery would maintain RTU operation continuously until it reaches a fixed discharge level or until power is restored. The RTU will not power down during power failure, allowing it to be contacted via the web site at any time, even during power failures. The RTUs used in the remote sites will be suitable for -30 to 70°C operation and dusty environments. The RTU cabinets are assumed to be based on NEMA 4X enclosures for all installations.

SCADA System Human Machine Interface (HMI)

The recommended HMI system is a standalone PC based computer connected to the Master Control Unit (MCU) communicating with the field RTU’s. The RTU units will communicate with the MCU via cellular modems as previously described. Assuming the SAWPA headquarters building has cellular service, the cellular RTU will have its own antenna mounted on the panel or within the equipment at the office. If the system has a fiberglass RTU, the antenna can be mounted inside the panel. If the building has metal casing or structures, SAWPA may need to mount an antenna outside, but this would not likely be the case. Regardless, the cellular antenna is very small and compact.

The data collected by the RTU’s will be stored in the system computer hard drive and available to be displayed in graphic form and in text reports. The HMI will include several screens showing the system locations and a data historian to store, manipulate and deliver management reports. The system will be “web enabled” to allow the transfer of the collected data to other SAWPA system users. The web site associated with the RTU would be implemented on a quintuple-redundant multiple server system with immediate failover, load leveling and hot standby firewall. Servers would be located in the SAWPA server room, which includes a seamless UPS.

The SCADA HMI package considered in this conceptual approach is Wonderware Intouch 10. This software package is designed for the collection of remote data and is easily configurable to display the flow data information, generate graphs, reports and is easily expandable.

Engineer's Opinion of Probable Cost (OPC)

The estimated capital cost includes construction cost and installation of RTU panels for each site, hardware, software, configuration of the HMI computer, start-up and testing of the system. The cost assumes that the data from the JCSD system RTUs can be transmitted via the new RTUs proposed herein. The Opinion of Probable Cost (OPC) is based on the following:

- (1) Host computer and PLC
- (1) MCU with cellular modem
- (27) RTUs with cellular modem
- (11) Flow meters
- (1) Design, Programming and Testing of Integration
- (1) Cellular Maintenance cost

In order to establish a cost estimating baseline, four unit cost cases have been developed to cover the main flow meter applications. Assumptions are made in each case to simplify the approach. The cases are included in Table 2-5.

Table 2-5
Description of Cases

Case Number	Flow Meter Installed	Power Available	New RTU	Comments
Case 1	Y	Y	Y	Desalters and dischargers that already have their own SCADA and flow meters. Assumption for these is that power is available, and data can be accessed by simply installing an RTU that can be accessed via cell phone.
Case 2	Y	Y	Y	Other discharges with existing flow meters. Assumptions that some modifications or maintenance to the flow meter and installation of a new RTU are required.
Case 3	N	Y	Y	Dischargers with no flow meters (or requiring replacement). Assumptions are to install new flow meters, new RTU, but an electrical service exists.

Table 2-5 (continued)
Description of Cases

Case Number	Flow Meter Installed	Power Available	New RTU	Comments
Case 4	N	N	Y	New RTU's and new flow meters in the pipeline system. Pipe lines in the system are assumed to be 42"with no available electrical service. Solar power units will be installed to power the RTU's and flow meters. Meters will be flumes in large concrete structures with a bypass line.

The different sites have been separated into the cases as shown in Table 2-6. This will designate the level of work necessary for each site and will further allow SAWPA to determine the cost for each site.

For each case, CDM selected the type of materials and labor necessary for the upgrades for that site. Installation of the RTU, field wiring, setup and other necessary costs were considered to adequately approximate the cost for each case. The unit costs for each case are itemized in Table 2-7.

Table 2-6
Discharger Cases

Agency	Name	Site Id	Flow (Mgd)	Flowmeter Type	Case Number
EMWD	Menifee, Perris Desalter & Inland Empire Energy Center	S-41	1.9677	Magnetic	CASE 1
WMWD	Temescal Desalter	S-32	1.8239	Magnetic	CASE 1
WMWD	Chino II Desalter East 1	S-23	1.2772	Magnetic	CASE 1
WMWD	Chino II Desalter East 2	S-23	-	Magnetic	CASE 1
WMWD	Chino II Desalter East 3	S-23	-	Magnetic	CASE 1
WMWD	Arlington Desalter	S-22	1.0823	Magnetic	CASE 1
SBVMWD	Mountain View Power Plant	S-35	0.3739	Magnetic	CASE 1
WMWD	Chino II Desalter West	S-28	0.0846	Flume	CASE 1
SBVMWD	EnerTech	S-62	0.046	Magnetic	CASE 1
IEUA	IEUA S05 (Master Meter)	S-05	0.2604	Magnetic	CASE 2
WMWD	JCSD Celebration	S-54	0.1047	Magnetic	CASE 2
WMWD	Corona Energy Partners	S-20	0.0755	Magnetic	CASE 2
WMWD	Dart Container	S-50	0.0555	Magnetic	CASE 2
SBVMWD	Agua Mansa Power Plant	S-53	0.019	Magnetic	CASE 2
WMWD	RCSD Anita Smith	S-29	0.0123	Magnetic	CASE 2
WMWD	UBF Food Solutions	S-46	0.001	Magnetic	CASE 2

Table 2-6 (continued)
Discharger Cases

Agency	Name	Site Id	Flow (Mgd)	Flowmeter Type	Case Number
IEUA	Chino Desalter	S-34	2.0022	Flume	CASE 3
WMWD	JCSD Etiwanda	S-28	0.8625	Flume	CASE 3
WMWD	Stringfellow	S-101	0.0972	Flume	CASE 3
WMWD	JCSD Wineville	S-23	0.086	Flume	CASE 3
WMWD	JCSD Hamner	S-24	0.0541	Flume	CASE 3
WMWD	DFA Distilled Water Plant	S-63	0.0428	Flume	CASE 3

Table 2-7
Cases and Programming/Automation/Integration Opinion of Probable Cost (OPC)

CASE 1 New RTU, Existing Flow Meter Design & Construction		
ITEM:	**Materials and Labor**	**Cost**
1	RTU with Cellular Modem	$8,000
2	Field Wiring from Electrical Equipment to RTU	$3,000
3	Setup, Planning, Mobilization	$2,100
4	Miscellaneous Work and Materials	$2,000
5	Cellular Service 1 year	$500
	OPC Per Site =	**$15,600**
CASE 2 New RTU, Existing Flow Meter, Meter Maintenance Design & Construction		
ITEM:	**Materials and Labor**	**Cost**
1	RTU with Cellular Modem	$8,000
2	Flow Meter Maintenance	$1,000
3	Field Wiring from Electrical Equipment to RTU	$3,000
4	Setup, Planning, Mobilization	$2,100
5	Miscellaneous Work and Materials	$2,000
6	Cellular Service 1 year	$500
	OPC Per Site =	**$16,600**
CASE 3 New RTU, NEW Flow Meter Design & Construction		
ITEM:	**Materials and Labor**	**Cost**
1	RTU with Cellular Modem	$8,000
2	Flume Flow Meter	$3,000
3	Field Wiring from Electrical Equipment to RTU	$3,000
4	Setup, Planning, Mobilization	$2,100
5	Miscellaneous Work and Materials	$2,000
6	Cellular Service 1 year	$500
	OPC Per Site =	**$18,600**
CASE 4 New RTU, New Flow Meters in SARI, Solar Power Design & Construction		
ITEM:	**Materials and Labor**	**Cost**
1	RTU with Cellular Modem	$8,000
2	Flume Flow Meter (1)	$112,000
3	Flume Installation Bypass Line	$10,000
4	Field Wiring from Electrical Equipment to RTU	$4,500

Table 2-7 (continued)
Cases and Programming/Automation/Integration Opinion of Probable Cost (OPC)

CASE 4 New RTU, New Flow Meters in SARI, Solar Power Design & Construction		
ITEM:	**Materials and Labor**	**Cost**
5	Solar Power Unit 100 Watts	$5,000
6	Setup, Planning, Mobilization	$2,100
7	Miscellaneous Work and Materials	$4,500
8	Cellular Service 1 year	$500
	OPC Per Site =	**$146,600**

Programming/Automation/Integration		
ITEM:	**Materials and Labor**	**Cost**
1	Wonderware Programming and Integration	$12,000
2	Wonderware InTouch License, Active Factory, Client Access	$5,600
3	Industrial Computer	$11,000
4	UPS	$1,500
5	Setup, Planning, Mobilization	$1,500
6	Miscellaneous Work and Materials	$1,000
	OPC =	**$32,600**

(1) $37,00 for flow meter. $75,000 for installation in a structure.

Considering the number of sites per case, estimated costs can be appropriately determined for the project by multiplying the number of sites with the cost per case and adding the cost of Programming/Automation/Integration for the main control unit. Table 2-8 features the OPC for each case determined from Table 2-7 above and the number of sites for each specific case. The last column allocates the cost for the Programming/Automation/Integration for SAWPA. The total opinion of probable cost for the SAWPA SCADA system was estimated to be $755,020.

Table 2-8
Total Opinion of Probable Cost

CASE 1 OPC		**CASE 2 OPC**		**CASE 3 OPC**		**CASE 4 OPC**		**P/A/I**	
$15,600	9 Sites	$16,600	7 Sites	$18,600	6 Sites	$146,600	5 Sites	$32,600	1 Site
$140,400		$116,200		$111,600		$733,000		$32,600	
TOTAL SAWPA COST = $1,134,000 (rounded)									

In order to use capital resources efficiently, CDM recommends that SAWPA consider a phased approach to the construction and installation of the flow metering telemetry stations. The project would begin with the installation of the main control unit and operator workstation as the first phase. Phasing the rest of the project would depend on the flow usage of each site, with higher priority given to the sites with larger flow volumes. Table 2-9 illustrates the separate suggested phases of the project.

Table 2-9
SCADA System Phases

PHASE	DESCRIPTION
Phase 1	Construction and installation of main control unit, operator workstation, setup, integration of programming and automation
Phase 2	Construction and installation of first 7 discharger sites with the highest flow.
Phase 3	Construction and installation of next 7 discharger sites with medium flow.
Phase 4	Construction and installation of last 6 discharger sites with low flow.
Phase 5	Construction and installation of 5 trunk line RTU's.

Table 2-10 indicates three levels of flow usage for the discharges that will need any installation or construction. Since the Chino II Desalter has three trains with three separate meters but only the total flow is known, all three trains will be included in Phase 2, 3 and 4.

Table 2-10
Discharger Flow Priority

	Agency	Name	Site Id	Flow (Mgd)	Flowmeter Type	Case Number
PHASE 2	IEUA	Chino Desalter	S-34	2.0022	Flume	CASE 3
	EMWD	Menifee, Perris Desalter & Inland Empire Energy Center	S-41	1.9677	Magnetic	CASE 1
	WMWD	Temescal Desalter	S-32	1.8239	Magnetic	CASE 1
	WMWD	Chino II Desalter East 1	S-23	1.2772	Magnetic	CASE 1
	WMWD	Chino II Desalter East 2	S-23	-	Magnetic	CASE 1
	WMWD	Chino II Desalter East 3	S-23	-	Magnetic	CASE 1
	WMWD	Arlington Desalter	S-22	1.0823	Magnetic	CASE 1
	WMWD	JCSD Etiwanda	S-28	0.8625	Flume	CASE 3
	SBVMWD	Mountainview Power Plant	S-35	0.3739	Magnetic	CASE 1
PHASE 3	IEUA	IEUA S05 (Master Meter)	S-05	0.2604	Magnetic	CASE 2
	WMWD	JCSD Celebration	S-54	0.1047	Magnetic	CASE 2
	WMWD	Stringfellow	S-101	0.0972	Flume	CASE 3
	WMWD	JCSD Wineville	S-23	0.086	Flume	CASE 3
	WMWD	Chino II Desalter West	S-28	0.0846	Flume	CASE 1
	WMWD	Corona Energy Partners	S-20	0.0755	Magnetic	CASE 2
	WMWD	Dart Container	S-50	0.0555	Magnetic	CASE 2
PHASE 4	WMWD	JCSD Hamner	S-24	0.0541	Flume	CASE 3
	SBVMWD	EnerTech	S-62	0.046	Magnetic	CASE 1
	WMWD	DFA Distilled Water Plant	S-63	0.0428	Flume	CASE 3
	SBVMWD	Agua Mansa Power Plant	S-53	0.019	Magnetic	CASE 2

Table 2-10 (continued)
Discharger Flow Priority

	Agency	Name	Site Id	Flow (Mgd)	Flowmeter Type	Case Number
PHASE 4	WMWD	RCSD Anita Smith	S-29	0.0123	Magnetic	CASE 2
	WMWD	UBF Food Solutions	S-46	0.001	Magnetic	CASE 2

Legend:	
High Flow	
Medium Flow	
Low Flow	

CDM suggests SAWPA plan construction of the SCADA system in the phases discussed above; therefore, CDM has developed the probable costs per phase, as shown on Table 2-11. Each phase OPC is established by using the number of cases 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. From Table 2-10 above, there are seven Case 1 sites, no Case 2 sites, two Case 3 sites, and no Case 4 sites for phase 2.

Table 2-11
Phase OPC

	Case 1 OPC	Number of Sites	Case 2 OPC	Number of Sites	Case 3 OPC	Number of Sites	Case 4 OPC	Number of Sites	Programming Automation Integration	PHASE OPC
Phase 1 OPC	$15,600	0	$16,600	0	$18,600	0	$146,600	0	$32,600	$32,600
Phase 2 OPC	$15,600	7	$16,600	0	$18,600	2	$146,600	0	$0	$146,400
Phase 3 OPC	$15,600	1	$16,600	4	$18,600	2	$146,600	0	$0	$119,200
Phase 4 OPC	$15,600	1	$16,600	3	$18,600	2	$146,600	0	$0	$102,600
Phase 5 OPC	$15,600	0	$16,600	0	$18,600	0	$146,600	5	$0	$733,000
									TOTAL SCADA OPC =	**$1,134,000**

2.3 Recommendations for Repair, Rehabilitation or Upgrades

The following sections present recommendations for repair, rehabilitation or upgrades of the SARI system. Estimated planning-level costs of construction for each item are 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.

2.3.1 Capacity Issues

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. The data included approximate location of the projects and the flow or total flows that would be contributed by the projects. SAWPA then ran the hydraulic model and, using the model results, developed a table showing all gravity segments that observe a d/D greater than 0.75, indicating a capacity issue; if d/D is 1 or greater, the segment is surcharged or under pressure.

Table 2-12 shows the model results and the estimated cost to construct a line parallel to the existing SARI line for each segment with a d/D of greater than 0.75. The costs were estimated using a cost of $25 per diameter-inch per foot and adding a 30 percent contingency to the resulting cost. Maps of the reaches are shown in Appendix A.

A second model run 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 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.

2.3.2 Age (Reach of Useful Life)

Looking at the remaining useful life presented in Table 1, with the assumption that the pipes will last 75 years; and assuming that the rehabilitation of approximately 57,500 feet of unlined RCP in Reaches IV-A and IV-B is performed in the near term (2010-2011), there appears to be no need to replace or rehabilitate other pipes in the system within the next 40 years based on age alone. There are also 5,500 feet of VCP pipe in Reach IV-B that could also be considered for rehabilitation in order to extend their life expectancy and avoid potential infiltration issues in the future due to the joints in the pipe.

Table 2-12
Gravity Reaches with Capacity Issues at Ultimate Conditions

From MAS	To MAS	Length (ft)	Diameter (inches)	Slope	Flow (mgd)	Flow Class	Depth (ft)	Velocity (ft/s)	d/D	Surcharged d/D	Parallel Diam (in)	Estimated Cost ($)
4B-0220 & 4B-0210	CRC Lat.	469.63	15	0.001	0.665	Backwater	1.25	0.839	1.000	1.232	12	183,200
4-0020	4-0010	1,149.93	42	0.003	35.112	Free Surface	2.713	6.79	0.775	0.775	24	896,900
4-0030	4-0020	1,267.55	42	0.003	34.898	Free Surface	2.728	6.71	0.779	0.779	24	988,700
4-0040	4-0030	1,234.38	42	0.002	34.913	Free Surface	3.108	5.983	0.888	0.904	24	962,800
4-0080	4-0070	975.00	48	0.001	34.898	Free Surface	3.541	4.59	0.885	0.885	24	760,500
4-0090	4-0080	973.66	48	0.001	34.889	Free Surface	3.757	4.406	0.939	0.939	24	759,500
4-0100	4-0090	1,100.75	48	0.001	34.879	Free Surface	3.925	4.314	0.981	0.995	24	858,600
4-0110	4-0100	1,260.06	48	0.001	34.875	Exceeds Capacity	4	4.294	1.000	1.084	24	982,800
4-0120	4-0110	1,223.08	48	0.001	34.871	Exceeds Capacity	4	4.293	1.000	1.196	24	954,000
4-0130	4-0120	499.45	48	0.001	34.875	Exceeds Capacity	4	4.294	1.000	1.273	24	389,600
4-0140N	4-0130	712.80	48	0.002	34.875	Backwater	4	4.294	1.000	1.216	24	556,000
4A-0070	4A-0060	1,124.00	36	0.001	17.25	Free Surface	2.28	4.63	0.760	0.760	18	657,500
4A-0090	4A-0080	1,112.00	36	0.001	17.249	Free Surface	2.345	4.503	0.782	0.782	18	650,500
4A-0100	4A-0090	701.00	36	0.001	17.246	Free Surface	2.264	4.664	0.755	0.755	18	410,100
4A-0110	4A-0100	1,004.00	36	0.001	17.244	Free Surface	2.345	4.5	0.782	0.782	18	587,300
4A-0120	4A-0110	992.00	36	0.001	17.241	Free Surface	2.381	4.435	0.794	0.794	18	580,300
4A-0130	4A-0120	788.00	36	0.001	17.238	Free Surface	2.391	4.415	0.797	0.797	18	461,000
4A-0140	4A-0130	501.00	36	0.001	17.234	Free Surface	2.255	4.68	0.752	0.752	18	293,100
4A-0140*	4A-0130	515.00	36	0.001	17.236	Free Surface	2.339	4.51	0.780	0.780	18	301,300
4B-0420	4B-0410	415.00	36	0	15.106	Free Surface	2.824	3.387	0.941	0.960	18	242,800
4B-0430	4B-0420	225.00	36	0	15.106	Exceeds Capacity	3	3.307	1.000	1.083	18	131,600
4B-0540	4B-0530	953.00	18	0.003	2.483	Free Surface	1.184	2.569	0.789	1.112	12	371,700
4B-0730	4B-0720	507.00	16	0.002	2.673	Free Surface	1.333	2.963	1.000	1.204	12	197,700
4B-0740	4B-0730	490.00	16	0.005	2.673	Free Surface	1.106	3.342	0.829	1.002	12	191,100
4B-0790	4B-0780	1,700.00	16	0	2.672	Free Surface	1.036	3.554	0.777	2.976	12	663,000
4B-0850	4B-0840	517.00	16	0.004	2.672	Free Surface	1.333	2.963	1.000	3.768	12	201,600
4B-0860	4B-0850	500.00	16	0.004	2.672	Free Surface	1.333	2.963	1.000	3.185	12	195,000
4B-0870	4B-0860	500.00	16	0.004	2.672	Free Surface	1.333	2.963	1.000	2.630	12	195,000
4B-0880	4B-0870	300.00	16	0.005	2.673	Free Surface	1.333	2.963	1.000	2.168	12	117,000
4B-0890	4B-0880	578.70	16	0.009	2.672	Free Surface	1.031	3.57	0.773	1.258	12	225,700
4E-0170	4E-0160	974.00	36	0.001	4.44	Free Surface	2.504	1.09	0.835	0.865	18	569,800
4E-0180	4E-0170	1,365.00	36	0.001	4.442	Free Surface	2.471	1.104	0.824	0.824	18	798,500

***Corresponds to 515 ft upstream of MAS 4A-0130**
Maps are included in Appendix A

NOTES:

1. ***Assumes no brine concentration***
2. ***List includes only gravity segments; no siphons.***
3. ***Depending on location of each particular segment, maximum values are reached at different times during the day. Data corresponds to maximum observed values during the model run.***
4. ***Estimated costs shown assume parallel pipes. Costs calculated using $25/diameter inch/foot plus a 30% contingency.***

CDM

2.3.3 Schleisman Road Siphon

As discussed earlier, it is recommended that SAWPA extends the approaches of the Schleisman siphon to 250 feet and slipline the siphon with a 36-inch diameter HDPE pipe (32.4-inch internal diameter.) As stated in section 2.2.1, SAWPA's hydraulic model was run using ultimate conditions, 11.2 MGD average, the velocity in the siphon increased to about 3 ft/s, which is considered sufficient velocity for cleaning of the line. The estimated cost of construction for this option, not including the cost of design, project administration and permitting, is approximately $1.7 million.

2.3.4 Cleaning Reach IV-E between MASs 4E-0110 and 4E-0020

It is recommended that the reach between MAS 4E-0110 and MAS 4E-0020 be cleaned using vactors and jetters. Water trucks will also be needed in order to have sufficient water for the jetters to operate properly. It is estimated that it may cost approximately $310,000 to clean the line and dispose of sediment and debris.

2.3.5 Develop Record Drawings for Reach V

SAWPA recognizes that it is extremely important to develop accurate record drawings of Reach V. The 23-mile line contains blow-off valves and air-relief valves, but there are no access points except for only two (2) MASs.

It is recommended that additional MASs be installed in Reach V at approximately 2,000 to 2,500 feet spacing. This will provide proper access for maintenance of the line which may include cleaning, inspection via CCTV or other means, insertion of a Geospatial's Smart Probe for locating the line, etc.

Once the MASs are installed, record drawings of Reach V can be developed using a combination of the Smart Probe, electromagnetic sonde and vacuum excavation, tying to GPS coordinates. Plan and profile information can then be tied to SAWPA's GIS system.

The estimated planning-level cost for the construction of 40 MASs in Reach V, similar to the one constructed in 2009 on Temescal Canyon Road, is $5.3 million. The estimated cost for locating the line and developing plan and profile drawings of Reach V is $950,000. The total estimated cost is $6.26 million.

Develop Record Drawings of the SARI Line, Reaches IV, IV-A, IV-B, IV-D, and IV-E

During the development of this technical memorandum, SAWPA came to the conclusion that, in addition to Reach V, the record drawings for the rest of the system are not accurate enough to comply with Underground Service Alert standards. Thus SAWPA would also like to develop plan and profile record drawings of the rest of the SARI line.

Record drawings would be developed in the same manner as Reach V, using a combination of the Smart Probe, electromagnetic sonde and vacuum excavation, tying to GPS coordinates. Plan and profile information can then be tied to SAWPA's GIS system and plan and profile drawings would be developed as part of the overall project. The estimated cost to develop plan and profile record drawings for 49 miles of the SARI, reaches IV, IV-A, IV-D, and IV-E is approximately $2M.

2.3.6 SCADA System Development

As explained in Section 2.2.4, a phased approach to the construction and installation of the flow metering telemetry stations is recommended. Table 2-13 shows estimated cost for this phased approach. It is important to note that these costs do not include the cost for excavation and construction of concrete structures that would contain the flumes in the five areas of the SARI line.

Table 2-13
Phase Opinion of Probable Cost

	Case 1 OPC	Number of Sites	Case 2 OPC	Number of Sites	Case 3 OPC	Number of Sites	Case 4 OPC	Number of Sites	Programming Automation Integration	PHASE OPC
Phase 1	$15,600	0	$16,600	0	$18,600	0	$71,600	0	$32,600	$32,600
Phase 2	$15,600	7	$16,600	0	$18,600	2	$71,600	0	$0	$146,400
Phase 3	$15,600	1	$16,600	4	$18,600	2	$71,600	0	$0	$119,200
Phase 4	$15,600	1	$16,600	3	$18,600	2	$71,600	0	$0	$102,600
Phase 5	$15,600	0	$16,600	0	$18,600	0	$71,600	5	$0	$733,000
									TOTAL SCADA OPC =	**$1,134,000**

Section 3
SARI Management and Operations

3.1 Introduction

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.

Information provided in SAWPA's Sewer System Management Plan (SSMP), as well as the 2007 Operations and Maintenance Program Plan, were reviewed to gain an understanding of the current management structure. Staff members from SAWPA and Western Municipal Water District (WMWD) were then contacted to verify that the information presented in the reports was current and accurate. In addition, input from various stakeholders, including SAWPA management staff, WMWD management and operations staff, and others, was sought out to aid in the identification of potential alternatives to improve the existing management and operations structure and has been incorporated into the evaluation process.

It should be noted that 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.

3.2 General Approach

The following sections summarize the results of the work performed as part of this evaluation. To aid the reader, the results are presented by maintenance activity. For each task, a brief summary of the existing maintenance structure is provided for reference, followed by a description of potential alternative to the current structure for consideration and the potential limitations of those alternatives, if any. For some activities, particularly those that are already contracted out, alternatives are not identified and the current approach appears appropriate. For others, one or more alternative approaches are suggested for consideration. A summary of the activities reviewed in this study, and potential alternatives to the current structure, where appropriate, are provided in Table 3-1.

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.

Table 3-1
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, quartelry monitoring	Varies	WMWD, IEUA	1. Shift responsibilities to SAWPA staff member	a. Requires additional SAWPA staff

- 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.

3.3 Review of Individual Activities

3.3.1 Meter Operations and Maintenance Activities

3.3.1.1 Meter Reading

Flow meters are scatted throughout the SARI system to monitor flows from member agencies and permitted dischargers. The various flow meters are currently read by WMWD, Inland Empire Utilities Agency (IEUA) and Eastern Municipal Water District (EMWD) operations personnel, depending on the location of the meter. Currently WMWD staff are reading meters for San Bernardino Valley Municipal Water District (SBVMWD). For the majority of the system, the meters are read manually by WMWD staff. Meter reading associated with SARI Reach IVA is performed by IEUA.

Potential Options to Improve Efficiency

SAWPA is considering the potential of automating the meter readings. Once this is complete, the meter reading process will be far more efficient. In the mean time, SAWPA may consider the following options for reading the meters:

- Contract Out Meter Reading Responsibilities: A specialty contractor or consultant could be hired to perform the task of reading the individual flow meters until the flow meters are equipped with SCADA systems, freeing up existing operations staff to perform other tasks.

- Meter Readings by SAWPA Personnel: The task of reading the various flow meters throughout the system could be delegated to SAWPA personnel. Currently, meter reading responsibilities are performed on a monthly basis by two or three WMWD employees. Several employees are needed in order to read all of the meters within a specified period of time. If the meters are equipped with SCADA systems, however, the number of staff members needed to perform this task could be reduced.

Potential Limitations

- Contract Out Meter Reading Responsibilities: In order to pursue this option, the availability of a local contractor that will perform these duties should be identified. Depending on when the meters are equipped with SCADA systems may also limit the appeal of this option. Should the SCADA upgrade be completed in the near future, it would likely not be a worthwhile option, since the contractor would need to invest time and resources learning the system.

- Meter Readings by SAWPA Personnel: Transferring meter readings to SAWPA staff would require that staff be hired to perform this task. Although one, two, or possibly more staff may be needed to perform this task, meter reading responsibilities are not sufficient to maintain a steady workload for the individual(s) hired. For this reason, additional operations or maintenance responsibilities would likely need to be shifted to SAWPA personnel if this option is pursued.

3.3.1.2 Meter Maintenance and Repair

SAWPA currently contracts with a specialty contractor to service and repair flow meters in the system. These activities are performed as needed with oversight provided by WMWD or IEUA staff.

Potential Options to Improve Efficiency
Flow meter repair is a task best performed by a contractor that specializes in this type of work. No options to improve the efficiency of this maintenance activity were identified.

Potential Limitations
Not applicable.

3.3.1.3 Meter Calibration

Similar to meter repair activities, SAWPA currently contracts with a specialty contractor to calibrate the flow meters in the system. These activities are performed on a yearly basis with oversight by WMWD, IEUA and EMWD staff.

Potential Options to Improve Efficiency
Flow meter calibration is a task best performed by a contractor that specializes in this type of work. No options to improve the efficiency of this maintenance activity were identified.

Potential Limitations
Not applicable.

3.3.1.4 Oversight of Meter Contractor

Coordination and support for the specialty meter contractor is provided by a WMWD staff member during meter maintenance, repair, and calibration.

Potential Options to Improve Efficiency
Providing oversight and coordination to the specialty meter contractor could be delegated to a SAWPA staff member.

Potential Limitations

SAWPA staff would need to be hired to provide meter contractor oversight. Similar to meter reading activities, this task is performed periodically as is not sufficient to maintain a steady workload. Therefore, additional maintenance responsibilities would also need to be shifted to the individual(s) employed by SAWPA.

3.3.2 Pipeline Operations and Maintenance Activities

3.3.2.1 Location and Marking

Coordination with construction projects in the vicinity of the SARI line is a crucial task in order to protect the SARI line from damage or service interruptions. WMWD and IEUA staff members are currently responsible for these duties, including coordination with Underground Service Alert (USA), line marking, and participation in construction meetings.

Potential Options to Improve Efficiency

- Contract Out Line Location/Marking Responsibilities: A specialty contractor could be hired to perform the task of line location and marking on the SARI line.

- Shift Line Location/Marking Responsibilities to SAWPA Staff: The task of line location/marking, as well as participation in construction meetings could be shifted to SAWPA, rather than WMWD and IEUA staff.

Potential Limitations

- Contract Out Line Location/Marking Responsibilities: Currently, a complete and accurate set of record drawings is not available for the SARI line. In order to shift the responsibilities of line location and marking to a private contractor, steps would need to be taken to ensure that all record drawings of the SAWPA line are complete and accurate. Updating the records drawings is potentially a large effort, especially since there are many segments of the SARI line that have curved alignments. An "Order of Magnitude" cost estimate to update the SARI line record drawings is provided in Section 2.

- Shift Line Location/Marking Responsibilities to SAWPA Staff: Transferring this task to SAWPA staff would require that staff be hired. Similar to some of the other options, this task would not be sufficient to maintain a steady workload by itself. Therefore, other maintenance duties would need to be assigned to the individual(s) hired to perform this task. Additionally, this task would require that all SARI record drawings are complete and accurate.

3.3.2.2 Pipeline Inspection and Patrol

WMWD and IEUA staff currently devote a great deal of time "driving the line" to identify apparent problems with the SARI line, such as erosion, spills, or other maintenance issues.

Potential Options to Improve Efficiency
This task could be delegated to a SAWPA staff member. This task is not well suited for an outside contractor. Staff dedicated to the SARI pipeline would be more familiar with the system, and would therefore likely perform the task more efficiently than a private contractor would.

Potential Limitations
Transferring the task to SAWPA staff would require that staff be hired to perform this task. Similar to some of the other options, this task would not be sufficient to maintain a steady workload. Therefore, other maintenance duties would need to be assigned to the individual(s) hired to perform this task.

3.3.2.3 Pipeline/Siphon Cleaning

Pipeline cleaning responsibilities are typically performed by private contractors through SAWPA directly.

Potential Options to Improve Efficiency
SAWPA could pursue the implementation of "on-call" contracts to perform ongoing and as-needed cleaning activities in the future, thereby ensuring the availability of qualified contractors for both routine and non-recurring line cleaning.

Potential Limitations
No limitations to implementing this alternative have been identified.

3.3.2.4 Pipeline CCTV

Pipeline closed circuit television (CCTV) inspection responsibilities are typically performed by private contractors through SAWPA directly.

Potential Options to Improve Efficiency
SAWPA could pursue the implementation of "on-call" contracts to perform ongoing and as-needed CCTV work. This would ensure the availability of qualified contractors as CCTV inspections are needed.

Potential Limitations
No limitations to implementing this alternative have been identified.

3.3.2.5 Cleaning/CCTV Contractor Oversight

Oversight to the specialty pipeline cleaning and CCTV contractors is currently preformed by WMWD and IEUA staff members, who verify that the work performed is acceptable.

Potential Options to Improve Efficiency
This task of providing oversight and coordination to the pipeline cleaning and CCTV contractors could be delegated to a SAWPA staff member.

Potential Limitations
Transferring this task to SAWPA staff would require that additional staff be hired. This task is performed as needed and would not be sufficient to maintain a steady workload. Therefore, other maintenance duties would need to be assigned to the individual(s) hired to perform this task.

3.3.2.6 Maintenance Access Structure O&M

Inspection and maintenance activities for MASs located on the SARI line is typically delegated to a specialty contractor, since many of the manholes qualify as "confined spaces."

Potential Options to Improve Efficiency
SAWPA could pursue the implementation of "on-call" contracts to perform ongoing and as-needed MAS operations and maintenance activities. This would ensure the availability of qualified contractors as maintenance and inspections are needed.

Potential Limitations
No limitations to implementing this alternative have been identified.

3.3.2.7 Potholing

SAWPA currently utilizes outside contractors to perform potholing of the SARI line.

Potential Options to Improve Efficiency
Potholing is an appropriate task to be performed by a contractor that specializes in this type of work. No options to improve the efficiency of this maintenance activity were identified.

Potential Limitations
This section is not applicable as there were no options identified to improve the efficiency of this task.

3.3.3 Valve Operations and Maintenance Activities

3.3.3.1 Valve Exercising and Maintenance

Reach V of the SARI line is a low pressure force main. There are several air release and vacuum breaker (ARV) valves located along this reach. WMWD recently began to implement an ongoing valve maintenance program, in which each of the valves is exercised quarterly. This program identifies problematic valves in need of more frequent maintenance.

Potential Options to Improve Efficiency
A specialty contractor could be hired to perform the task of valve exercising and maintenance along SARI Reach V.

Potential Limitations
The availability of a specialty contractor in the area would need to be verified in order to pursue this option further.

3.3.4 Spill Response Activities

3.3.4.1 SSO Response and Mitigation

Sanitary Sewer Overflows (SSOs) occur from time to time, even in well maintained systems. It is critical that when an SSO does occur, crews are available to respond immediately to mitigate the effects of the spill. Spill response and mitigation activities are currently performed by either WMWD or IEUA, depending on the location of the spill.

Potential Options to Improve Efficiency
A specialty contractor could be hired to respond to and mitigate the effects of SSOs from the SARI line. This would require the implementation of "on-call" contracts to perform as-needed spill response activities. This would ensure the availability of qualified contractors as the need arises.

Potential Limitations
A specialty cleanup crew may not be able to respond to the site of an SSO as quickly and efficiently as the WMWD and IEUA crews are capable of. This is due partly to geography and partly to the availability of the contractor on extremely short notice, as would be required in the event of an SSO.

3.3.5 Right of Way Maintenance Activities

3.3.5.1 Access Clearing

WMWD and IEUA staff are currently responsible for ensuring that the SARI right of way (ROW) is clear of debris, weeds, or other obstructions which limit access to the line. Both WMWD and IEUA periodically contract with spraying/weed control crews to limit the growth of vegetation in the SARI pipeline ROW.

Potential Options to Improve Efficiency
SAWPA could consider contracting with spraying/weed control crews directly, rather than through the member agencies.

Potential Limitations
No limitations to implementing this alternative have been identified.

3.3.5.2 Grading

Grading is performed along the SARI pipeline alignment as need by specialty contractors hired by WMWD or IEUA.

Potential Options to Improve Efficiency
SAWPA could consider contracting with the specialty contractor directly, rather than through the member agencies.

Potential Limitations
No limitations to implementing this alternative have been identified.

3.3.5.3 Tree Trimming

Both WMWD and IEUA periodically contract with tree trimming crews when access to the SARI line is impeded by trees.

Potential Options to Improve Efficiency

SAWPA could consider contracting with the tree trimming crews directly, rather than through the member agencies.

Potential Limitations

No limitations to implementing this alternative have been identified.

3.3.5.4 Contractor Oversight

Oversight and coordination with the spraying crews, grading contractors, and tree trimming crews is provided by either WMWD or IEUA staff, depending on where the work is performed.

Potential Options to Improve Efficiency

The task of providing oversight and coordination to the ROW maintenance contractors could be delegated to a SAWPA staff member.

Potential Limitations

Transferring this task to SAWPA staff would require that additional staff be hired and that enough responsibilities are delegated to the staff hired to maintain a steady workload. Additionally, the ROW maintenance contractors should be contracted with SAPWA directly, rather than through WMWD or IEUA.

3.3.6 Permit Compliance Activities

3.3.6.1 Inspections

WMWD, SBVMWD, and IEUA staffs currently are responsible for ensuring that dischargers into the SARI comply with the terms of their industrial discharge permits. Inspections of dischargers are performed by either WMWD or IEUA staff, depending on the location of the discharger.

Potential Options to Improve Efficiency

The task of inspecting dischargers to ensure permit compliance could be delegated to a SAWPA staff member.

Potential Limitations

Transferring this task to SAWPA staff would require that additional staff be hired, and that enough responsibilities are delegated to the staff hired to maintain a steady workload.

3.3.6.2 Wastewater Sampling

WMWD, IEUA and EMWD staff are currently responsible for collecting wastewater samples at various points throughout the system to test for specific constituents, such as total dissolved solids (TDS) or sulfides.

Potential Options to Improve Efficiency

- Contract out Sample Collection: This task could be contracted out to a private laboratory, which would most likely be the testing laboratory that analyzes the samples.

- Sample Collection by SAWPA Staff: This task could be delegated to a SAWPA staff member.

Potential Limitations

- Contract out Sample Collection: The availability of a testing laboratory or other contractor willing to perform this type of work would need to be verified.

- Sample Collection by SAWPA Staff: Transferring this task to SAWPA staff would require that additional staff be hired and that enough responsibilities are delegated to the staff hired to maintain a steady workload.

3.3.6.3 Laboratory Analysis

Currently, WMWD sends out all wastewater samples it collects to a private testing laboratory for analysis. IEUA analyzes its wastewater samples in its own testing laboratory.

Potential Options to Improve Efficiency

Analysis of all wastewater samples collected from the SARI line could be analyzed through a single testing laboratory that is contracted through SAWPA directly, rather than through a member agency.

Potential Limitations

In order to implement this task, wastewater sampling would likely need to be performed by either a private contractor or SAWPA staff.

3.3.7 Report Preparation Activities

3.3.7.1 Miscellaneous Report Preparation

The preparation of various operations and maintenance reports, such as meter reading and quarterly monitoring reports as well as line cleaning and CCTV monitoring reports, are currently prepared by either WMWD or IEUA staff, depending on the report.

Potential Options to Improve Efficiency

This task could be delegated to a SAWPA staff member.

Potential Limitations

Transferring this task to SAWPA staff would require that additional staff be hired and that enough responsibilities are delegated to the staff hired to maintain a steady workload.

3.3.8 Summary

As part of this evaluation, individual operations and maintenance activities related to the SARI pipeline were reviewed in order to indentify alternatives to the current management and maintenance structure.

For certain activities, particularly those that are already contracted out to specialty contractors, the current approach appears appropriate and potential alternatives were not identified. These activities include meter maintenance and repair, meter calibration, and potholing.

"On-call" contracts could also be pursued for certain activities performed by contractors. These include pipeline/siphon cleaning, CCTV, and manhole operations and maintenance.

Several of the activities currently performed by WMWD and IEUA could be shifted to specialty contractors. These activities include meter reading, location and marking, valve exercising/maintenance, spill response, wastewater sampling, and laboratory analysis. If SAWPA chooses to further pursue these alternatives, the availability of specialty contractors in the area should be verified. In addition, further study would be required to quantify potential cost savings associated with the alternatives and determine their viability.

Certain tasks currently performed by WMWD and IEUA could continue to be performed by WMWD and IEUA, or shifted to SAWPA personnel, which would require additional SAWPA staff. These activities include meter reading, oversight of meter contractor, location and marking, pipeline inspection and patrol, cleaning/CCTV oversight, ROW maintenance contractor oversight, inspections, wastewater sampling, and miscellaneous monitoring report preparation. SAWPA should gauge the staffing needs associated with the activities so that the new SAWPA, WMWD, or IEUA maintenance personnel maintain an appropriate and steady work load.

3.4 Overall Considerations for Future System Management and Operations

The above section provided specific assessments of, and potential modifications to, the way in which some operation and maintenance functions could be enhanced or improved. In light of these observations and the future options identified under Task 2, the program was also reviewed from a broader perspective in order to provide suggestions for improvements in overall implementation.

SAWPA has a unique role as a Joint Powers Authority (JPA). Each member agency has a very different range of responsibilities, authorities and capabilities, while SAWPA staff serves to help carry out the overall mission of the organization. Although SAWPA continues to own and operates some facilities many projects that SAWPA has implemented as an organization over the years such as desalters, and the

Western Riverside County Regional Wastewater Authority Treatment Plant have been subsequently turned over to member agencies and/or other JPA's for operation. This is generally in keeping with the fact that SAWPA's overall role is not fundamentally to act as a wholesale or retail water agency or local or regional wastewater service provider.

The SARI system on the other hand represents the primary facilities that are still directly under SAWPA's overall responsibility for operations. The SARI system is the one truly regional facility that provides benefits to all five member agencies and it will continue to increase in regional importance and value in the future, a primary reason why SAWPA as an agency should continue to maintain overall responsibility for the system.

At the same time, all SAWPA member agencies as well as the individual existing and future local agencies, JPAs, and other direct or indirect dischargers with connections to the system benefit through the operations being as efficient and cost-effective as possible. It is probable that some of the current arrangements as described in the preceding section may not be the most efficient and cost-effective way in which to operate. Furthermore, as the system continues to expand with more projects coming on line in future years, it will be important that the operation be continue to be as efficient as possible.

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.

3.4.1 Minimizing Institutional Barriers

While the SARI system is owned and managed by SAWPA, successful and cost-effective operation of the system can be limited by the nature of SAWPA and the multiple agencies involved in the overall system. Because SAWPA is not primarily a water or wastewater agency with more extensive dedicated operation and maintenance capabilities it does not currently maintain all of the staff and equipment that a more complete operating utility typically has. Thus it has relied on contracts with other member agencies as well as outside specialty contractors to assist with the operation and maintenance of the system. Although it is possible to consider a model in which all responsibilities for SARI operations and maintenance be transferred to SAWPA, this would require hiring of additional staff and acquiring additional equipment. While there are reasons why a shared arrangement may continue, there can be concerns with respect to ensuring that the staff dedicated to SARI activities at any contracting agencies have clear priorities within the agency to carry out SARI-related activities and that the agreements and commitments to do so are clear. This will continue to become even more critical as the use and complexity of discharges to the system increases (see also Section 3.4.2).

With respect to other meeting regulatory requirements, negotiating with Orange County Sanitation District, and other overarching issues, it would make sense for SAWPA as an agency to take continue to take the lead, but SAWPA will need the full support of all member agencies in such issues since the SARI systems will continue to play an ever more important role in the future.

3.4.2 Leveraging Cooperation Opportunities

Based on the findings from Task 2, there are expected to quite a few additional projects coming on line in the next 10 – 15 years, and it is apparent that the flow and quality of the brine that is discharged to the SARI line can have a major impact both on available capacity in the line as well as capacity in the OCSD system and facilities. The findings of Task 2 suggest that the most feasible long term solutions for accommodating all of the future brine and other flows in the SARI line would include implementing brine concentration projects on many if not all of the existing and future groundwater desalters. In addition to preserving capacity in the system, there are other benefits including the softening that would likely be part of the projects that would help with reducing the potential for solids generation in the line, and the value of the recovered water. However, to implement such projects will likely require a high degree of cooperation and creativity both in determining the most appropriate arrangement for ownership and operation of the facilities, developing appropriate cost sharing arrangements, and seeking potential outside funding. Given the significant benefits, all member agencies and local sub agencies should work closely with SAWPA to develop one or more approaches for implementing such projects.

Another area of cooperation that is very important is in managing existing and future industrial and waste hauler dischargers. The recent challenges with solids build-up in the SARI line may result in part from the quality of some of these discharges, in addition to the quality of some of the brine from the desalters. Because both the operational success and the financial stability of the system are highly dependent upon the quality and complex chemistry of the flows in the line, is will be extremely important for all agencies to cooperate closely with SAWPA in permitting, managing and overseeing the nature of individual discharges to the system.

3.4.3 Revising Policies

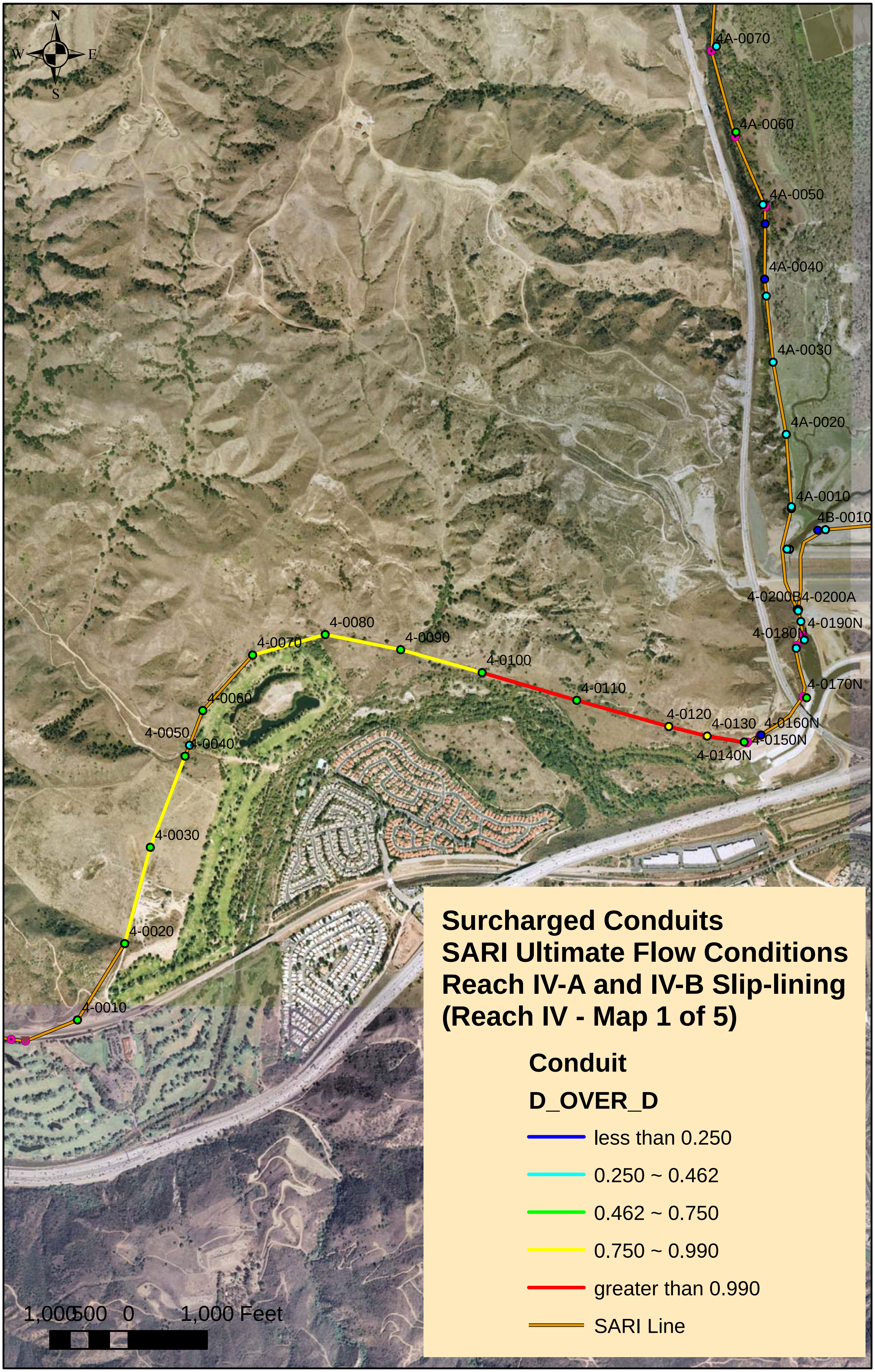
One major issue that needs significant discussion, and decisions on a long-term policy direction is for SAWPA and the Member Agencies to determine how best to implement brine concentration projects that may be essential to accommodating future flows within the overall contractual limitations of the system with OCSD. Despite the apparent benefits, such projects are complex, costly and have multiple issues to consider for them to be successful.

Institutional, financial and policy options could range across a wide spectrum. One model assumes that a local agency or JPA that owns or will own a conventional groundwater desalter would build, own and operate a brine concentration project at the desalter, and then retain complete use of the additional recovered water. To the extent that the project might quality for any loans, grants or subsidies, the local agency would seek and, if available obtain the funding. The financial outcome of constructing and operating the facilities would then be added to the overall cost of the desalter operation and presumably be incrementally added into the cost of the water produced. At the same time, the additional recovered water would have value as a new water supply. In this model essentially all of the additional costs and revenues would be blended into the cost of the end user(s) water supply. Under this model SAWPA's involvement in the local project would be very limited, other than possibly helping with facilitating loan or grant funding. SAWPA would adjust and update the SARI rate structure based on the expected reduced flows and quality anticipated. This model is conceptually straightforward, but because such projects are expected to be relatively costly, the agencies that have been exploring brine concentration projects have not yet made a decision to move forward with a full scale project.

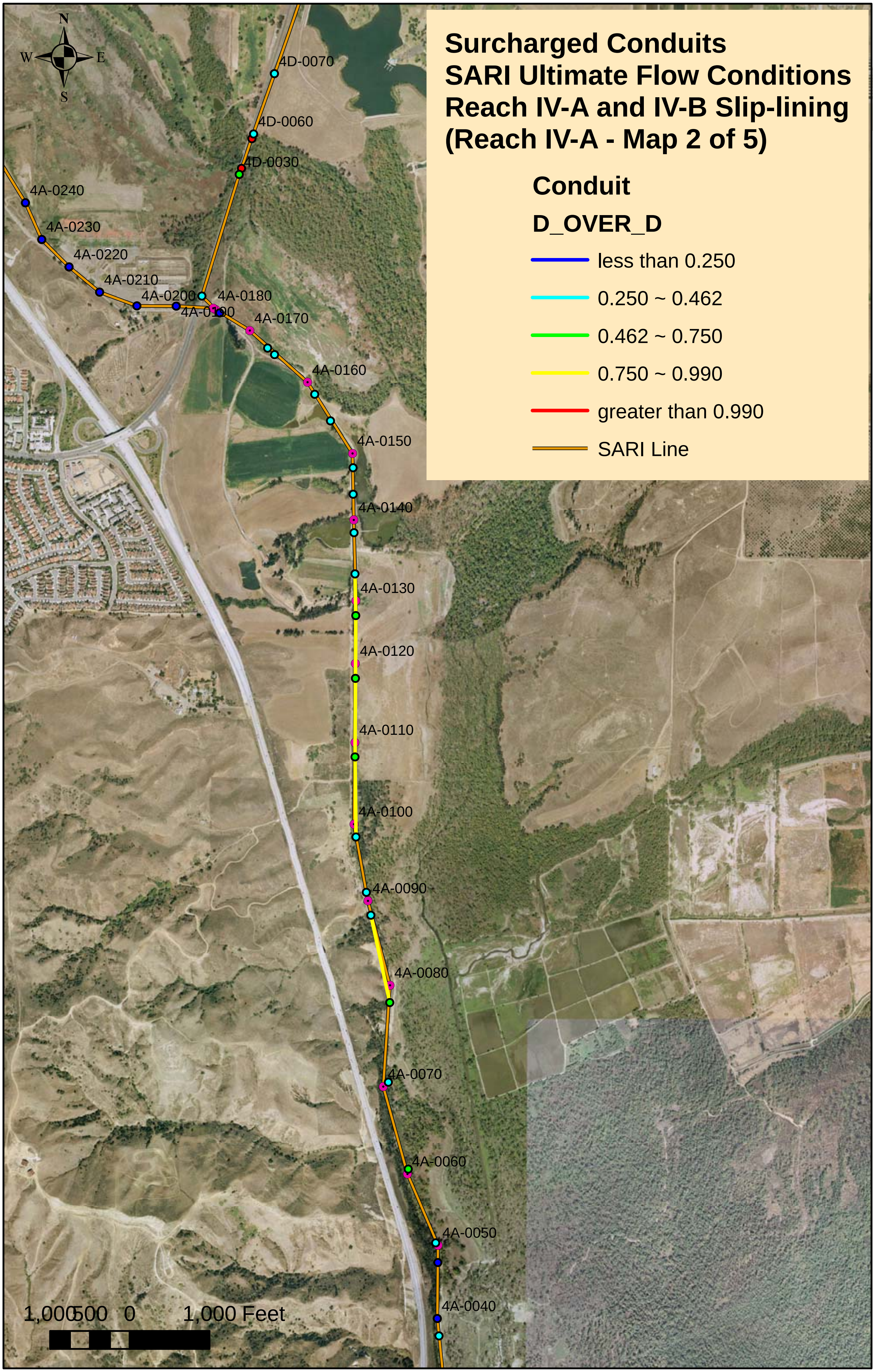
At the other end of the spectrum, SAWPA could potentially consider undertaking a brine concentration project, immediately downstream of a groundwater desalter, as an integral part of the SARI system, and take the lead for project planning, funding, design and construction, with an ultimate decision as to whether the project would stay as a SAWPA owned and operated facility as an project element of the SARI system, or be turned over to a JPA for long term ownership and operation. Integral to any such approach is the determination of how the benefits of the additional water supply accrue. This would also require a more complex update of the SARI rate structure.

Between these two "bookend" models are a variety of hybrid scenarios. It is important that SAWPA, the Member Agencies, and any local agencies that may be involved in such projects work closely as quickly as possible to develop the best overall policy and approach for supporting such projects.

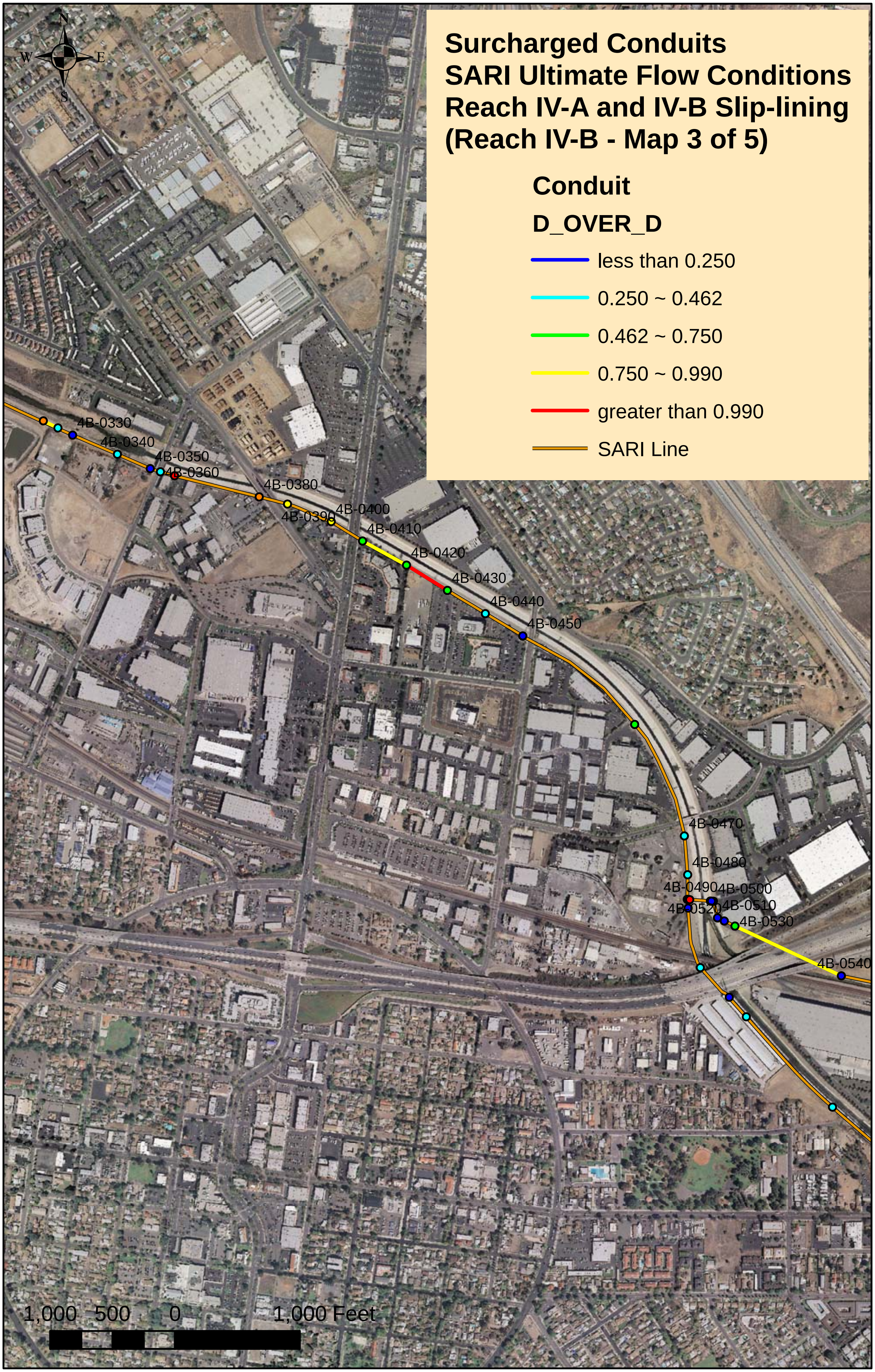
Appendix A
Maps of Gravity Reaches with Capacity Issues at Ultimate Conditions

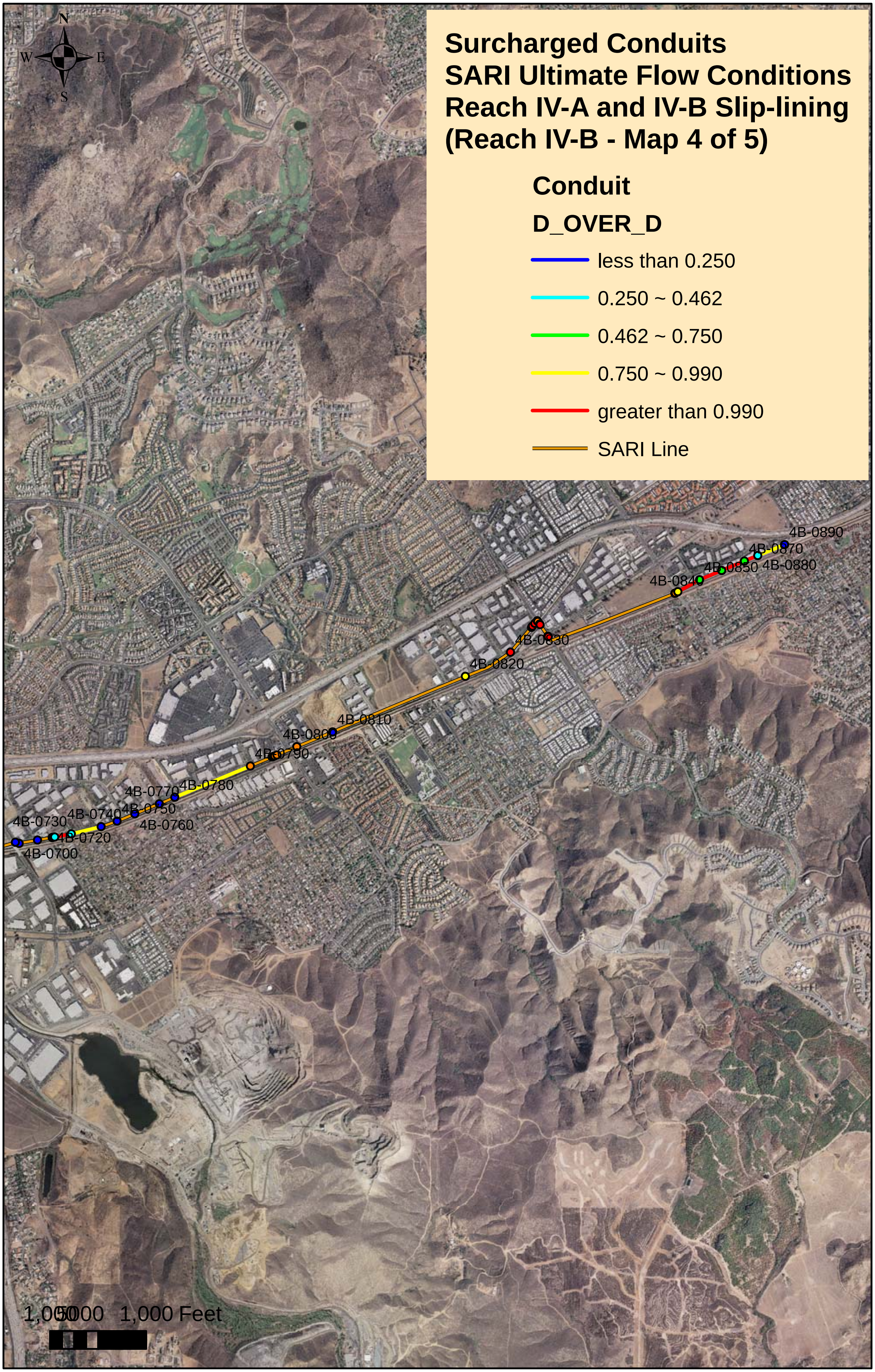


Surcharged Conduits
SARI Ultimate Flow Conditions
Reach IV-A and IV-B Slip-lining
(Reach IV - Map 1 of 5)
Conduit
D_OVER_D
less than 0.250
0.250 ~ 0.462
0.462 ~ 0.750
0.750 ~ 0.990
greater than 0.990
SARI Line
N
S
E
W
1,000
500
0
1,000 Feet
4A-0070
4A-0060
4A-0050
4A-0040
4A-0030
4A-0020
4A-0010
4B-0010
4-0200B
4-0200A
4-0190N
4-0180N
4-0170N
4-0160N
4-0150N
4-0140N
4-0130
4-0120
4-0110
4-0100
4-0090
4-0080
4-0070
4-0060
4-0050
4-0040
4-0030
4-0020
4-0010

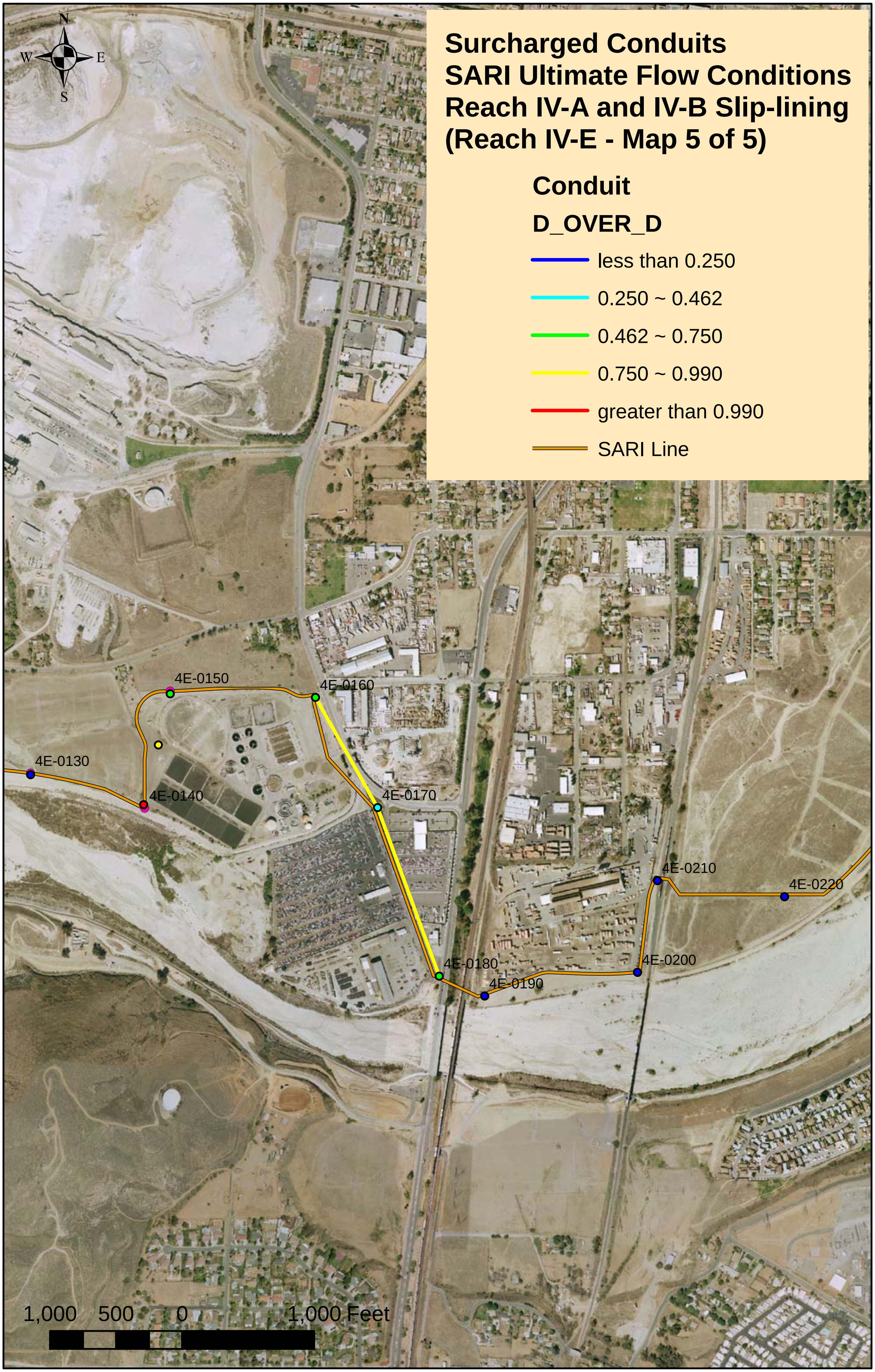


Surcharged Conduits
SARI Ultimate Flow Conditions
Reach IV-A and IV-B Slip-lining
(Reach IV-A - Map 2 of 5)
Conduit
D_OVER_D
less than 0.250
0.250 ~ 0.462
0.462 ~ 0.750
0.750 ~ 0.990
greater than 0.990
SARI Line
N
S
E
W
4D-0070
4D-0060
4D-0030
4A-0240
4A-0230
4A-0220
4A-0210
4A-0200
4A-0190
4A-0180
4A-0170
4A-0160
4A-0150
4A-0140
4A-0130
4A-0120
4A-0110
4A-0100
4A-0090
4A-0080
4A-0070
4A-0060
4A-0050
4A-0040
1,000 500 0 1,000 Feet


Surcharged Conduits
SARI Ultimate Flow Conditions
Reach IV-A and IV-B Slip-lining
(Reach IV-B - Map 3 of 5)
Conduit
D_OVER_D
less than 0.250
0.250 ~ 0.462
0.462 ~ 0.750
0.750 ~ 0.990
greater than 0.990
SARI Line
N
S
W
E
4B-0330
4B-0340
4B-0350
4B-0360
4B-0380
4B-0390
4B-0400
4B-0410
4B-0420
4B-0430
4B-0440
4B-0450
4B-0470
4B-0480
4B-0490
4B-0500
4B-0510
4B-0520
4B-0530
4B-0540
1,000 500 0 1,000 Feet



Surcharged Conduits
SARI Ultimate Flow Conditions
Reach IV-A and IV-B Slip-lining
(Reach IV-B - Map 4 of 5)
Conduit
D_OVER_D
less than 0.250
0.250 ~ 0.462
0.462 ~ 0.750
0.750 ~ 0.990
greater than 0.990
SARI Line
N
S
E
W
4B-0890
4B-0870
4B-0880
4B-0850
4B-0840
4B-0830
4B-0820
4B-0810
4B-0800
4B-0790
4B-0780
4B-0770
4B-0750
4B-0740
4B-0760
4B-0730
4B-0720
4B-0700
1,000 Feet


Surcharged Conduits
SARI Ultimate Flow Conditions
Reach IV-A and IV-B Slip-lining
(Reach IV-E - Map 5 of 5)
Conduit
D_OVER_D
less than 0.250
0.250 ~ 0.462
0.462 ~ 0.750
0.750 ~ 0.990
greater than 0.990
SARI Line
N
W
E
S
4E-0130
4E-0140
4E-0150
4E-0160
4E-0170
4E-0180
4E-0190
4E-0200
4E-0210
4E-0220
1,000 500 0 1,000 Feet