September 2009
Technical Memorandum

Subject: SARI Hydraulic Model

Introduction

As part of the Sewer System Management Plan, SAWPA has the responsibility to update the SARI hydraulic model to reflect current flow conditions into the system. This technical memorandum is divided in two sections: 1) model calibration and 2) various special case scenarios obtained through model runs.

This update to the SARI hydraulic model incorporates approximately 9.2 miles of pipe corresponding to the Eastern Municipal Water District Brine Lateral.

Model Calibration

Data from four SARI portable meters were used: a) Green River, b) Joy, c) Euclid, and d) Pine for the period between July 21 and July 26, 2009 (**Figure 1**.) As can be readily seen in the figure, the Joy meter corresponds to flows from the EMWD (Reach V), and Arlington Desalter (Reach IV-B); the Euclid meter records flow from Reaches IV-D and IV-E; the Pine meter records flows from the upper Reach IV-A; the Green River records all flow flowing through the Upper SARI system.

Indirect dischargers (waste haulers) were assigned an individual flow curve based on hours of operation.

No data measured along the EMWD Brine Lateral was provided.

Discharger data (daily average) was obtained from monthly billing information provided by Western Municipal Water District (**Table 1**.)

Flow curves, or peaking factors, were obtained by obtaining peak to average ratios. Due to the lack of data from individual dischargers, a specific flow curve cannot be applied to each discharger; rather the same flow curve is applied to all dischargers upstream of the portable flow meter location.

Table 1 – Average Daily Flows (MGD)

Junction ID	AVERAGE DAILY FLOW (MGD)	DISCHARGER
4-0010	0	Green River Golf Club
4A-0390	0.263	S05 – IEUA Service Area
4A-0450	0.018	IEUA WH
4B-0090	0	Corona/Green River
4B-0110	0.05	Dart Containers
4B-0120	0.073	WMWD WH

4B-0220	0.639	CRC
4B-0250	0.046	DFA
4B-0260	0.064	CEP
4B-0330	1.669	Temescal
4B-0890	1.065	Arlington
4D-0120	2.06	Chino I
4D-0150	0.285	Bonview
4D-0220	0.357	CIW
4D-0370	0	JCSD Archibald
4D-0380	0	JCSD Chandler
4D-0400	0	JCSD Harrison
4D-0480	0	JCSD Cleveland
4D-0490	0	JCSD Hamner LS
4D-0570	0	JCSD 58th Street
4D-0580	0.142	JCSD Celebration
4D-0590	0.009	JCSD Hamner
4D-0660	0.017	JCSD Wineville
4D-0660	0.157	Chino II West
4D-0750	0.833	JCSD Etiwanda
4D-0750	1.181	Chino II East
4D-1070	0.118	Stringfellow
4D-1460	0.009	RCSD Anita Smith
4E-0020	0.011	Agua Mansa
4E-0040	0.164	Enertech
4E-0390	0.012	SBVMWD WH
4E-0390	0.332	MT_VIEW
E1410	0.057	EMWD WH
E1410	0.966	Menifee
E1410	0.741	Perris
E1410	0.466	IEEC
E1410	0	EMWD Temp
J289	0	International Foods
TOTAL	11.804	

Table 2 provides information of hourly peak factors observed at the SARI portable flow meters. Figure 2 provides a graphical representation of observed peak factors.

Table 2 – Observed Peak Flow Factors (unitless)

TIME	OBSERVED FLOW PATTERN			
	JOY	EUCLID	PINE	GR
1:00 AM	1.0031	0.9839	0.7213	0.9991
2:00 AM	1.0083	0.9697	0.6420	0.9595
3:00 AM	1.0010	0.9474	0.6567	0.9508
4:00 AM	1.0118	0.9351	0.6508	0.9387
5:00 AM	0.9856	0.9287	0.6555	0.9226
6:00 AM	1.0147	0.9374	0.6396	0.9081
7:00 AM	1.0070	0.9624	0.6667	0.9076
8:00 AM	0.9883	0.9956	1.1048	0.8989
9:00 AM	0.9955	1.0038	1.3081	0.9183

10:00 AM	0.9970	0.9943	1.4667	0.9924
11:00 AM	1.0007	0.9903	1.4338	1.0132
12:00 PM	1.0010	1.0229	1.7298	1.0418
1:00 PM	1.0117	1.0707	1.7515	1.0311
2:00 PM	1.0132	1.0729	1.5272	1.0410
3:00 PM	1.0116	1.0481	1.3580	1.0626
4:00 PM	1.0217	1.0298	0.7971	1.0848
5:00 PM	1.0173	1.0060	0.8652	1.0776
6:00 PM	1.0067	0.9962	0.9451	1.0646
7:00 PM	1.0169	1.0305	0.8552	1.0666
8:00 PM	1.0152	1.0414	0.8893	1.0184
9:00 PM	1.0174	1.0271	0.8153	1.0023
10:00 PM	0.9656	1.0253	0.7736	1.0269
11:00 PM	0.9438	0.9950	0.8775	1.0442
12:00 AM	0.9449	0.9856	0.8693	1.0291

Figure 2 - Observed Peak Factors at SARI Portable Flow Meters

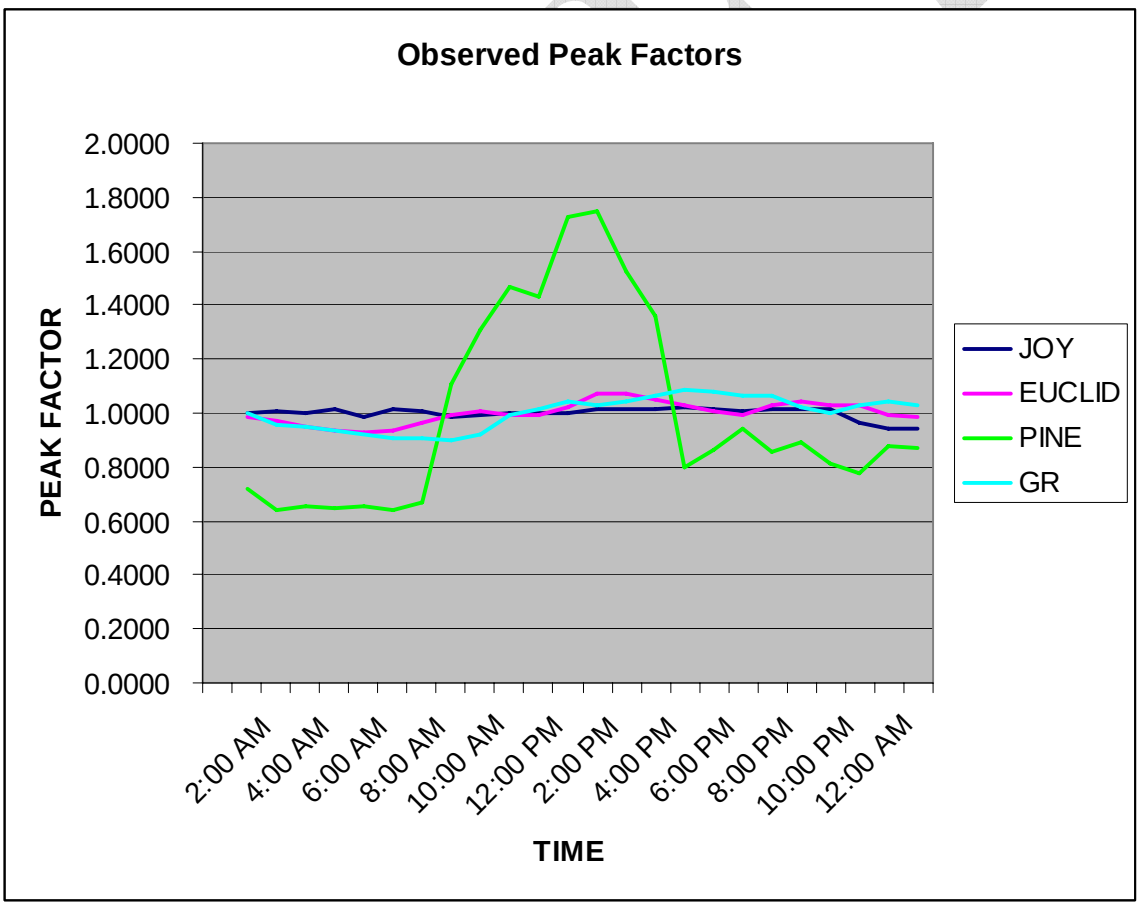


Table 3 provides data obtained from each one of the SARI Portable Flow meters, including dates of obtained data, maximum and minimum flow observed (mgd), and weekly average flow (mgd.)

Table 3 – Portable Flow Meter Data

	Green River	**Joy**	**Euclid**	**Pine**
Start Date	July 20, 2009	July 20, 2009	July 20, 2009	July 20, 2009
End Date	July 26, 2009	July 26, 2009	July 26, 2009	July 26, 2009
Data interval	15 min	5 min	5 min	5 min
Max Value (MGD)	12.89	5.03	7.2	1.53
Min Value (MGD)	7.68	2.27	4.35	0.03
Average	10.25	3.68	5.57	0.20

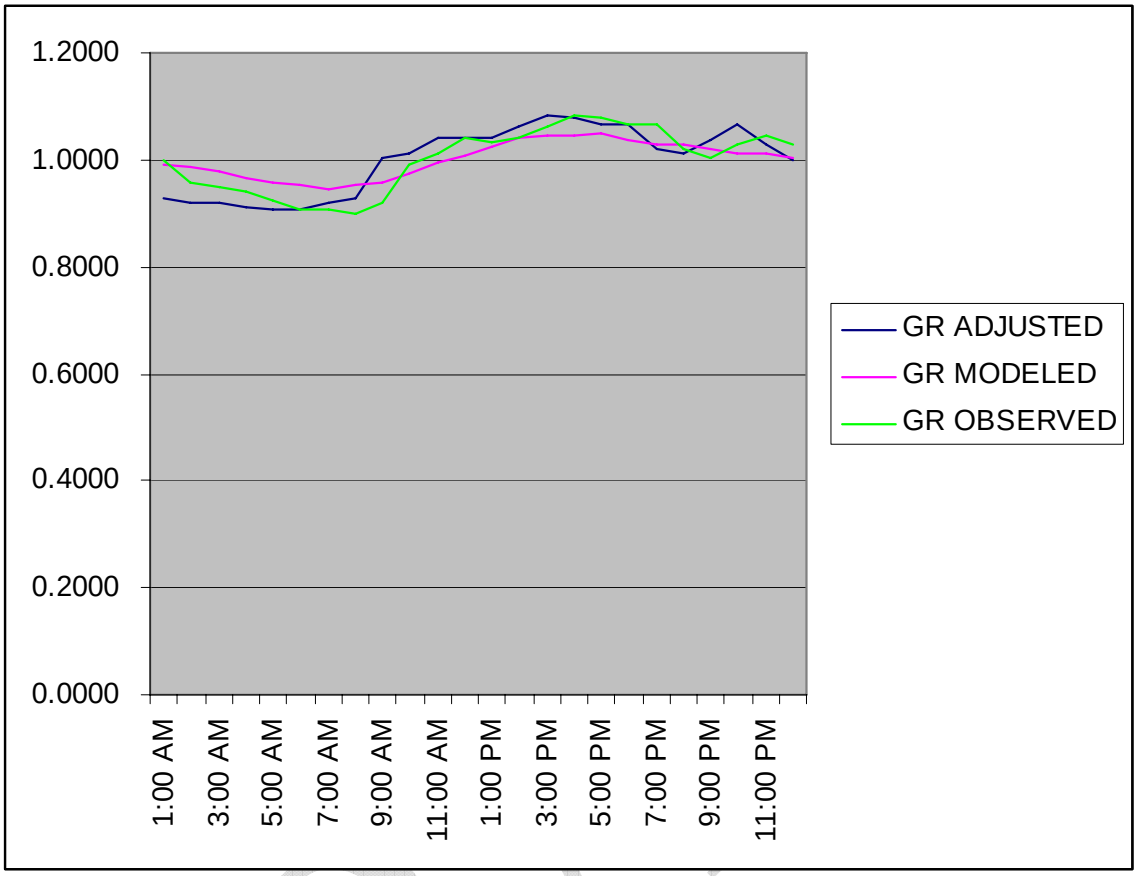
Peak flow values were adjusted at each one of the flow monitoring locations. The following tables compare the adjusted peak flows which provided the input to the model, the values obtained after each model run, and the peak flows observed in the field from the SARI portable flow meters:

Green RiverMeter

Table 4 – Green River Flow Curve Data

TIME	GR ADJUSTED	GR MODELED	GR OBSERVED
1:00 AM	0.9295	0.9893	0.9991
2:00 AM	0.9208	0.9854	0.9595
3:00 AM	0.9187	0.9769	0.9508
4:00 AM	0.9126	0.9656	0.9387
5:00 AM	0.9081	0.9585	0.9226
6:00 AM	0.9076	0.9538	0.9081
7:00 AM	0.9189	0.9465	0.9076
8:00 AM	0.9283	0.9522	0.8989
9:00 AM	1.0024	0.9577	0.9183
10:00 AM	1.0132	0.9725	0.9924
11:00 AM	1.0418	0.9968	1.0132
12:00 PM	1.0411	1.0083	1.0418
1:00 PM	1.0410	1.0234	1.0311
2:00 PM	1.0626	1.0395	1.0410
3:00 PM	1.0848	1.0455	1.0626
4:00 PM	1.0776	1.0444	1.0848
5:00 PM	1.0646	1.0477	1.0776
6:00 PM	1.0666	1.0375	1.0646
7:00 PM	1.0184	1.0279	1.0666
8:00 PM	1.0123	1.0290	1.0184
9:00 PM	1.0369	1.0193	1.0023
10:00 PM	1.0642	1.0098	1.0269
11:00 PM	1.0291	1.0106	1.0442
12:00 AM	0.9991	1.0026	1.0291

Figure 3 – Green River Flow Curves



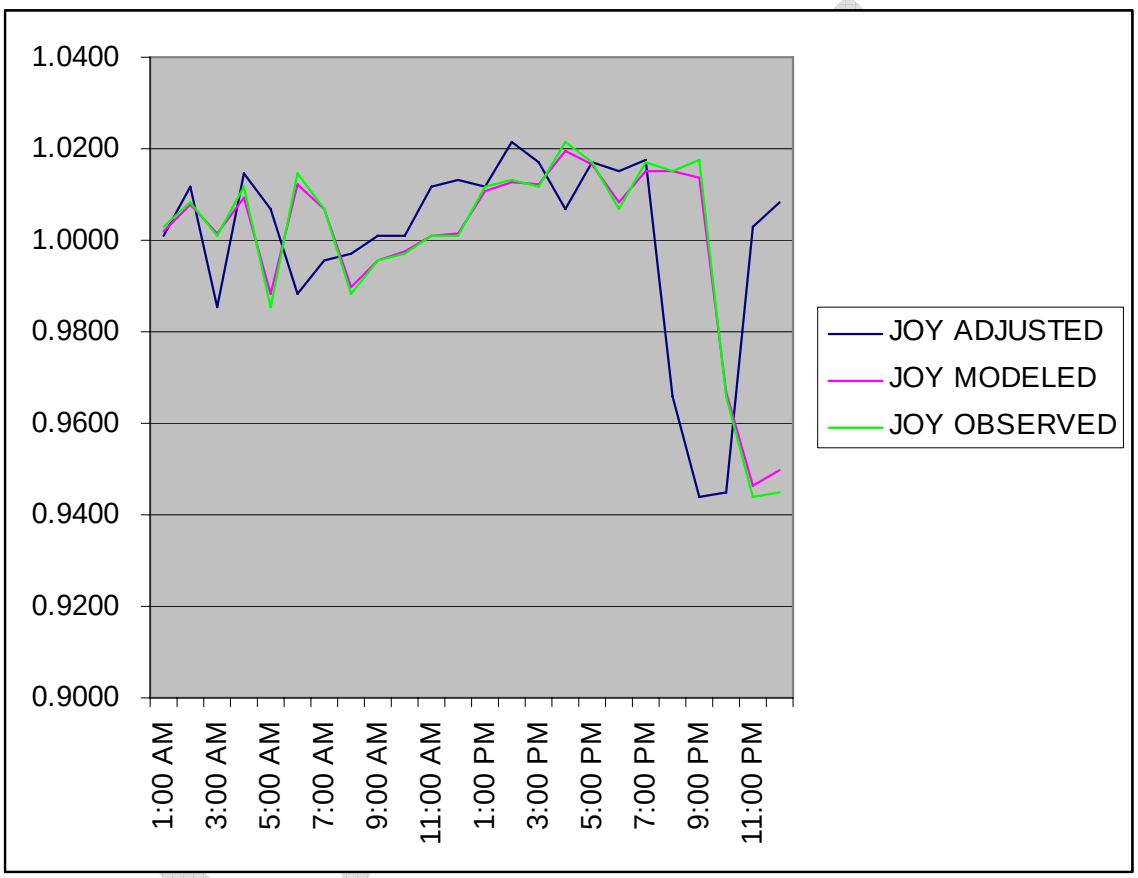
Joy Meter

Table 5 – Joy Meter Flow Curve Data

TIME	JOY ADJUSTED	JOY MODELED	JOY OBSERVED
1:00 AM	1.0010	1.0022	1.0031
2:00 AM	1.0118	1.0076	1.0083
3:00 AM	0.9856	1.0016	1.0010
4:00 AM	1.0147	1.0093	1.0118
5:00 AM	1.0070	0.9885	0.9856
6:00 AM	0.9883	1.0122	1.0147
7:00 AM	0.9955	1.0067	1.0070
8:00 AM	0.9970	0.9896	0.9883
9:00 AM	1.0007	0.9956	0.9955
10:00 AM	1.0010	0.9976	0.9970
11:00 AM	1.0117	1.0007	1.0007
12:00 PM	1.0132	1.0016	1.0010
1:00 PM	1.0116	1.0107	1.0117
2:00 PM	1.0217	1.0125	1.0132
3:00 PM	1.0173	1.0122	1.0116
4:00 PM	1.0067	1.0193	1.0217

5:00 PM	1.0169	1.0167	1.0173
6:00 PM	1.0152	1.0085	1.0067
7:00 PM	1.0174	1.0150	1.0169
8:00 PM	0.9656	1.0153	1.0152
9:00 PM	0.9438	1.0139	1.0174
10:00 PM	0.9449	0.9670	0.9656
11:00 PM	1.0031	0.9462	0.9438
12:00 AM	1.0083	0.9496	0.9449

Figure 4 – Joy Meter Flow Curves



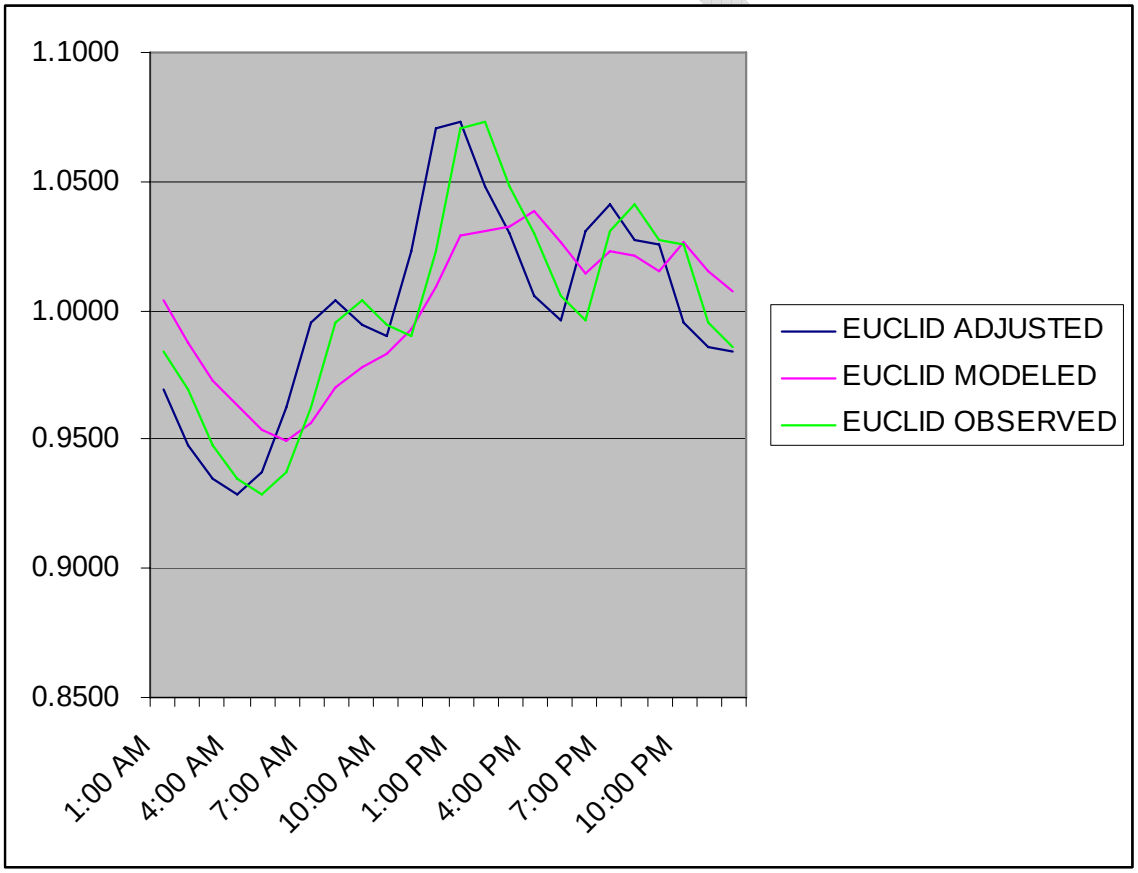
Euclid Meter

Table 6 – Euclid Meter Flow Curve Data

TIME	EUCLID ADJUSTED	EUCLID MODELED	EUCLID OBSERVED
1:00 AM	0.9697	1.0037	0.9839
2:00 AM	0.9474	0.9878	0.9697
3:00 AM	0.9351	0.9725	0.9474
4:00 AM	0.9287	0.9635	0.9351
5:00 AM	0.9374	0.9534	0.9287
6:00 AM	0.9624	0.9493	0.9374

7:00 AM	0.9956	0.9561	0.9624
8:00 AM	1.0038	0.9704	0.9956
9:00 AM	0.9943	0.9782	1.0038
10:00 AM	0.9903	0.9835	0.9943
11:00 AM	1.0229	0.9924	0.9903
12:00 PM	1.0707	1.0095	1.0229
1:00 PM	1.0729	1.0288	1.0707
2:00 PM	1.0481	1.0310	1.0729
3:00 PM	1.0298	1.0326	1.0481
4:00 PM	1.0060	1.0386	1.0298
5:00 PM	0.9962	1.0264	1.0060
6:00 PM	1.0305	1.0141	0.9962
7:00 PM	1.0414	1.0233	1.0305
8:00 PM	1.0271	1.0212	1.0414
9:00 PM	1.0253	1.0150	1.0271
10:00 PM	0.9950	1.0262	1.0253
11:00 PM	0.9856	1.0149	0.9950
12:00 AM	0.9839	1.0076	0.9856

Figure 5 – Euclid Meter Flow Curves

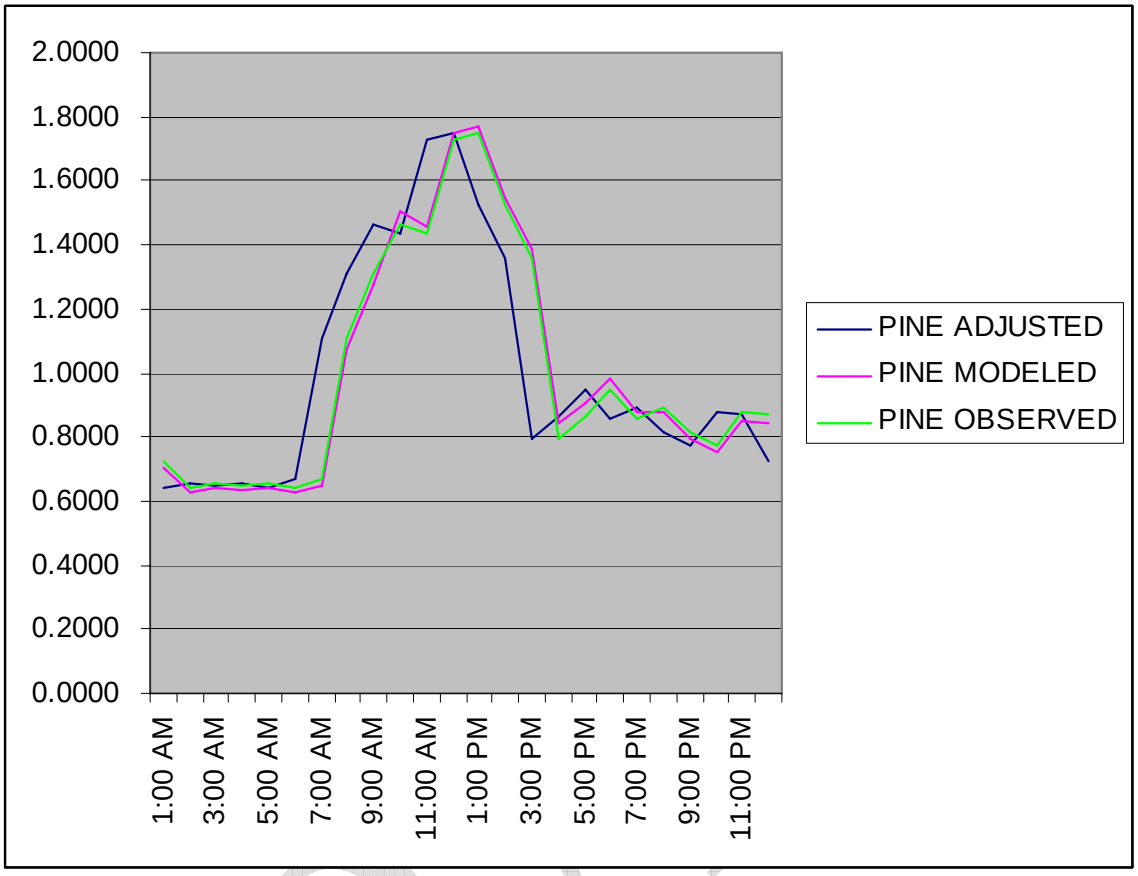


Pine Meter

Table 7 – Pine Meter Flow Curve Data

TIME	PINE ADJUSTED	PINE MODELED	PINE OBSERVED
1:00 AM	0.6420	0.7012	0.7213
2:00 AM	0.6567	0.6237	0.6420
3:00 AM	0.6508	0.6385	0.6567
4:00 AM	0.6555	0.6311	0.6508
5:00 AM	0.6396	0.6385	0.6555
6:00 AM	0.6667	0.6237	0.6396
7:00 AM	1.1048	0.6495	0.6667
8:00 AM	1.3081	1.0740	1.1048
9:00 AM	1.4667	1.2733	1.3081
10:00 AM	1.4338	1.5021	1.4667
11:00 AM	1.7298	1.4578	1.4338
12:00 PM	1.7515	1.7493	1.7298
1:00 PM	1.5272	1.7678	1.7515
2:00 PM	1.3580	1.5501	1.5272
3:00 PM	0.7971	1.3877	1.3580
4:00 PM	0.8652	0.8415	0.7971
5:00 PM	0.9451	0.9079	0.8652
6:00 PM	0.8552	0.9854	0.9451
7:00 PM	0.8893	0.8747	0.8552
8:00 PM	0.8153	0.8784	0.8893
9:00 PM	0.7736	0.7935	0.8153
10:00 PM	0.8775	0.7529	0.7736
11:00 PM	0.8693	0.8525	0.8775
12:00 AM	0.7213	0.8451	0.8693

Figure 6 – Euclid Meter Flow Curves



Average discrepancy between modeled and observed peak factors is presented in the following table:

Table 8 – Discrepancy between Modeled and Observed Peak Values

Flow Meter	Average Discrepancy (%)
Green River	2.68
Joy	0.14
Euclid	2.94
Pine	2.65

Model Scenarios

Several scenarios were modeled after the model was calibrated according to the previous section:

1) Impact of Slip-lining the RCP (Lower Reach IV-A and Reach IV-B)

An evaluation was made to determine the impact to pipeline capacity as a result of installation of a slip-liner in the Reach IV-B and lower Reach IV-A of the SARI system.

For purposes of this scenario, the pipe diameter was reduced by 6 inches to account for a 3-inch thick slip-liner. In addition, the 'n' Manning coefficient was changed from 0.013 to 0.009.

The capacity lost at the segments with the lowest flow capacity is as follows:

Lower IV-A (**0.78 mgd** flow capacity loss) [Between MAS 4A-0100 and 4A-0110]
Reach IV-B (**2.93 mgd** flow capacity loss) [Between MAS 4B-0020 and 4B-0010]

2) EMWD Brine Line flushing

The EMWD service area is connected to the SARI line by approximately 9 miles of 30-inch diameter CML&C pipeline. Prior inspection of the EMWD lateral has shown a scaling problem. EMWD has in the past attempted acid addition and flushing to reduce the scale build-up along the pipeline.

The pressure rating for the CML&C pipeline is 150 psi. The pressure rating for Reach V of the SARI line is 80 psi (both PVC and HDPE pipe.)

Several model scenarios were attempted with varying flows in order determine flushing flows which will not exceed the pressure ratings identified above.

The following parameters were used in the modeling effort:

Table 9 – Modeling parameters

Reach	Diameter(s) [in]	Manning 'n'
EMWD Lateral	30	0.013
SARI Reach V	24, 26, 30	0.01

Based on the flow patterns described in the model calibration section, the maximum pressure along the EMWD brine lateral is achieved at 4:00 pm. Maximum pressure on Reach V is achieved at 7:00 pm on node J10.

The following flow values were used to obtain pressure along nodes (junctions) and velocities along conduits:

Table 10 - Scenario: 12 MGD flushing flow + Base flow

Source	Flow (MGD)
EMWD Waste Haulers	0.057
Menifee Desalter	0.966
Perris Desalter	0.741
IEEC	0.466
Additional flushing flow	12.000
TOTAL	**14.230**

The maximum pressure and velocities as a result of these flows is summarized as follows:

Table 11 – Results of Scenario: 12 MGD flushing flow + Base flow

EMWD Brine Line			
Location (model)	Station	Max. Pressure (psi)	Max. Velocity (ft/s)
Node E0450 (San Jacinto River crossing)	333+00	95.781	
Conduit EL0740 (Along Railroad Canyon Road)	442+50 and 446+00		16.274
SARI Reach V			
Location (model)	Station	Max. Pressure (psi)	Max. Velocity (ft/s)
Node J10 (Riverside Drive [CA-74] crossing)	77+40	77.786	
Conduit 169 (Temescal Canyon Rd. @ I-15)	408+00 and 411+30		18.709

Flusing the EMWD Brine Line and the SARI Reach V flows with 14.23 MGD will result in very high velocities in several parts of the system. Figure A-1 shows velocities across the EMWD lateral and the SARI Reach V for this scenario.

In an attempt to reduce the risk of pipe scouring as a result of high velocities, flushing flows were reduced to 10 MGD (in addition to base flow).

Table 12 - Scenario: 10 MGD flushing flow + Base flow

Source	Flow (MGD)
EMWD Waste Haulers	0.057
Menifee Desalter	0.966
Perris Desalter	0.741
IEEC	0.466
Additional flushing flow	10.000
TOTAL	**12.230**

Table 13 – Results of Scenario: 10 MGD flushing flow + Base flow

EMWD Brine Line			
Location (model)	Station	Max. Pressure (psi)	Max. Velocity (ft/s)
Node E0450 (San Jacinto River crossing)	333+00	86.289	
Conduit EL0740 (Along Railroad Canyon Road)	442+50 and 446+00		16.158
SARI Reach V			
Location (model)	Station	Max. Pressure (psi)	Max. Velocity (ft/s)
Node J10 (Riverside Drive [CA-74] crossing)	77+40	74.724	
Conduit 169 (Temescal Canyon Rd. @ I-15)	408+00 and 411+30		18.592

Figure A-2 portrays the velocities achieved as a result of the 10 MGD flushing flow + Base flow scenario.

Table 14 – Results of Scenario: 8 MGD flushing flow + Base Flow

Source	Flow (MGD)
EMWD Waste Haulers	0.057
Menifee Desalter	0.966
Perris Desalter	0.741
IEEC	0.466
Additional flushing flow	8.000
TOTAL	**10.230**

Table 15 – Results of Scenario: 8 MGD flushing flow + Base flow*

EMWD Brine Line			
Location (model)	Station	Max. Pressure (psi)	Max. Velocity (ft/s)
Node E0450 (San Jacinto River crossing)	333+00	78.716	
Conduit EL0740 (Along Railroad Canyon Road)	442+50 and 446+00		15.976
SARI Reach V			
Location (model)	Station	Max. Pressure (psi)	Max. Velocity (ft/s)
Node J10 (Riverside Drive [CA-74] crossing)	77+40	71.871	
Conduit 169	408+00 and 411+30		17.89

(Temescal Canyon Rd. @ I-15)			

*See Figure A-4, A-5, and A-6 for locations

Figure A-3 portrays the velocities achieved as a result of the 8 MGD flushing flow + Base flow scenario.

The results shown in Tables 11, 13, and 15 assume the pipe is free of scale and has a constant manning 'n' value across all the conduits. In order to model representative field conditions, the model was run with a steady state condition to determine the areas where velocities are under 1.0 ft/s in order to identify areas of potential scaling.

Diameters were reduced by 1, 2 and 3 inches in conduits where flow velocity is less than 1 ft/s. In addition, several Manning 'n' values were assumed to account for different friction coefficients due to pipe scaling.

Table 16 provides a list of scenarios modeled. Note that all of these scenarios assume a flushing flow of 8 MGD in addition to base flow (2.32 MGD), for a total flow of 10.32 MGD.

Table 16 – Flushing Scenarios

Scenario	Reach	Diameter reduction (in)	Manning 'n'
A-1	EMWD Lateral	1	0.013
	Reach V	1	0.01
A-2	EMWD Lateral	1	0.014
	Reach V	1	0.011
A-3	EMWD Lateral	1	0.015
	Reach V	1	0.012
B-1	EMWD Lateral	2	0.013
	Reach V	2	0.01
B-2	EMWD Lateral	2	0.014
	Reach V	2	0.011
B-3	EMWD Lateral	2	0.015
	Reach V	2	0.012
C-1	EMWD Lateral	3	0.013
	Reach V	3	0.01
C-2	EMWD Lateral	3	0.014
	Reach V	3	0.011
C-3	EMWD Lateral	3	0.015
	Reach V	3	0.012

Maximum velocities and pressures are summarized below for each scenario:

Table 17 – Flushing Scenarios Results*

Scenario	Reach	Max. Velocity (ft/s); Conduit	Max. Pressure (psi); Node
A-1	EMWD Lateral	**15.676**; EL0740	**81.783**; E0450
	Reach V	**17.939**; 169	**73.322**; J10
A-2	EMWD Lateral	**15.41**; EL0740	**85.017**; E0450
	Reach V	**17.889**; 169	**74.581**; J10
A-3	EMWD Lateral	**15.15**; EL0740	**88.728**; E0450
	Reach V	**17.865**; 169	**75.977**; J10
B-1	EMWD Lateral	**15.343**; EL0740	**85.127**; E0450
	Reach V	**17.857**; 169	**74.599**; J10
B-2	EMWD Lateral	**15.061**; EL0740	**89.421**; E0450
	Reach V	**17.859**; 169	**76.018**; J10
B-3	EMWD Lateral	**14.778**; EL0740	**93.675**; E0450
	Reach V	**17.777**; 169	**77.704**; J10
C-1	EMWD Lateral	**14.968**; EL0740	**89.946**; E0450
	Reach V	**17.835**; 169	**76.122**; J10
C-2	EMWD Lateral	**14.663**; EL0740	**94.711**; E0450
	Reach V	**17.731**; 169	**77.905**; J10
C-3	EMWD Lateral	**14.377**; EL0740	**100.029**; E0500
	Reach V	**17.657**; 173	**79.874**; J10

*See Figures A-4, A-5, and A-6 for locations

Further, different flow rates were modeled using Scenario C-3 as a base. C-3 was selected as being the most conservative of the scenarios modeled. As it can be seen from the values on Table 17, the maximum flow allowed through Reach V of the SARI is 8 MGD + Base Flow (10.32 MGD total.)

Modeling different flow rates would allow EMWD to stage their line flushing.

Currently, EMWD can provide approximately 6,000 gallons per minute for flushing purposes. This flow is in addition to their base flow originated at the Perris and Menifee Desalters, EMWD truck dump station, and the Inland Empire Energy Center.

Scenario C-3-1: Flow: 2,000 gpm + base flow
Scenario C-3-2: Flow: 4,000 gpm + base flow
Scenario C-3-3: Flow: 6,000 gpm + base flow
Scenario C-3-4: Flow: 5,500 gpm + base flow

Each scenario was run for a total of 6 hours.

The following table summarizes maximum pressure and velocities achieved after each flushing stage:

Table 18 – Maximum Pressure and Velocity after Flushing Stage*

Scenario	Reach	Max. Velocity (ft/s); Conduit	Max. Pressure (psi); Node
C-3-1	EMWD Lat.	12.391; EL0740	75.595; E0450
2,000 gpm	Reach V	14.779; 169	69.57; J10
C-3-2	EMWD Lat.	13.548; EL0740	83.784; E0450
4,000 gpm	Reach V	16.817; 169	74.518; J10
C-3-3	EMWD Lat.	8.335; EL0770	104.735; E0450
6,000 gpm	Reach V	17.905; 173	81.442; J10
C-3-4	EMWD Lat.	8.235; EL0770	99.049; E0450
5,500 gpm	Reach V	17.606; 173	79.576; J10

*See Figures A-4, A-5, and A-6 for locations

Table 19 – Minimum Velocities achieved after Flushing Stage*

Scenario	Reach	Min. Velocity (ft/s); Conduit (s)
C-3-1	EMWD Lat.	1.62; EL0330
2,000 gpm	Reach V	1.987; 62, 65, 66, 67, 74, 75
C-3-2	EMWD Lat.	2.546; EL0270, EL0290, EL0330
4,000 gpm	Reach V	3.098; 61, 62, 65, 66, 67, 73, 74, 75, 82
C-3-3	EMWD Lat.	3.481; EL0270
6,000 gpm	Reach V	3.841; 61
C-3-4	EMWD Lat.	3.252; EL0270
5,500 gpm	Reach V	3.681; 61

*See Figures A-7 and A-8 for locations

Based on this analysis, the recommendation is to flush for 6 hours with a flow of 2,000 gallons per minute, then increase flushing flow to 4,000 gallons per minute for an additional 6 hours; finally, increase flushing flow to 5,500 gallons per minute for another 6 hours.

Total flow required:

Table 20 – Total volume required for flushing

Stage	Flow	Time	Volume (gallons)
1	2,000 gpm	6 hours	720,000
2	4,000 gpm	6 hours	1,440,000
3	5,500 gpm	6 hours	1.980,000
TOTAL		18 hours	4,140,000

A second option is to flush the EMWD lateral with 2,000 gpm for a short period of time on a regular basis. Adding an extra 2,000 gpm increases minimum velocity from 0.72 ft/s to 1.62 ft/s.

Travel time:

Table 21 provides modeled travel time for the three stages described in Table 20. Travel time was modeled at three locations: a) Pressure Sustaining Station, b) Indian Truck Road

(location of SARI main valve), and c) Junction of Reach V and Reach IV-B. In order to determine travel time, a pollutant (Time Tracer) was added at the EMWD discharge point with a 0 decay rate. Figures A-9 through A-17 show travel time for the different scenarios.

Flow (gpm)	Location	Travel Time (hours)
2,000	Pressure Sustaining Station	7
	Indian Truck Road and I-15	13
	Junction Reach V and Reach IV-B	19
4,000	Pressure Sustaining Station	5
	Indian Truck Road and I-15	9
	Junction Reach V and Reach IV-B	14
5,500	Pressure Sustaining Station	3.75
	Indian Truck Road and I-15	6.75
	Junction Reach V and Reach IV-B	10

Recommendations:

In order to improve the accuracy of the hydraulic model, pressure measurements should be taken along Reach V where possible. In addition, one of the SARI portable flow meters could be installed at the MAS at Nichols Road to measure flow and depth. Additional data points along Reach V can improve model calibration.

Files:
All source files kept at P:/projects/Sari/Hydraulic Model/Results/EMWD_flushing

APPENDIX A. FIGURES

Figure A-1 – Conduit Velocities as a result of 12 MGD flushing flow + base flow

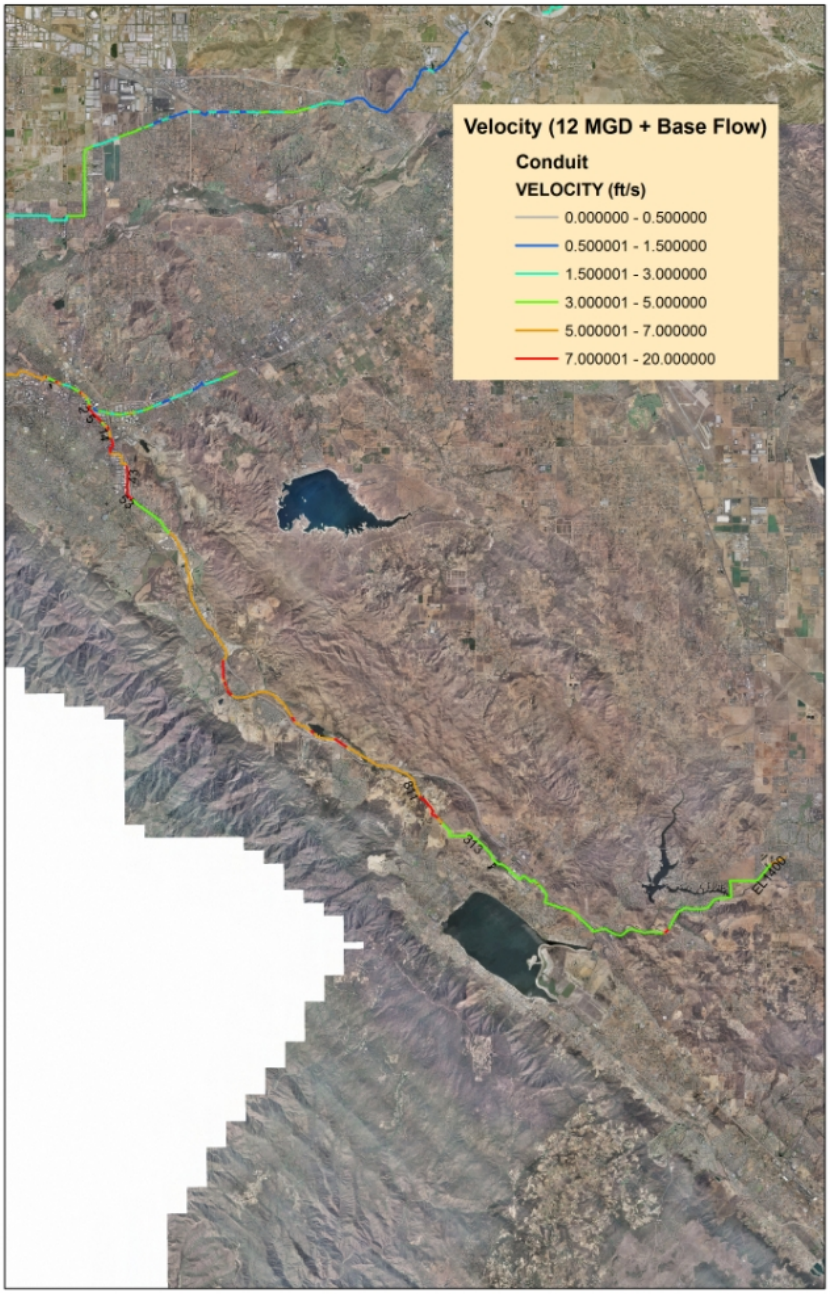


Figure A-2. Conduit Velocities as a result of 10 MGD flushing flow + base flow

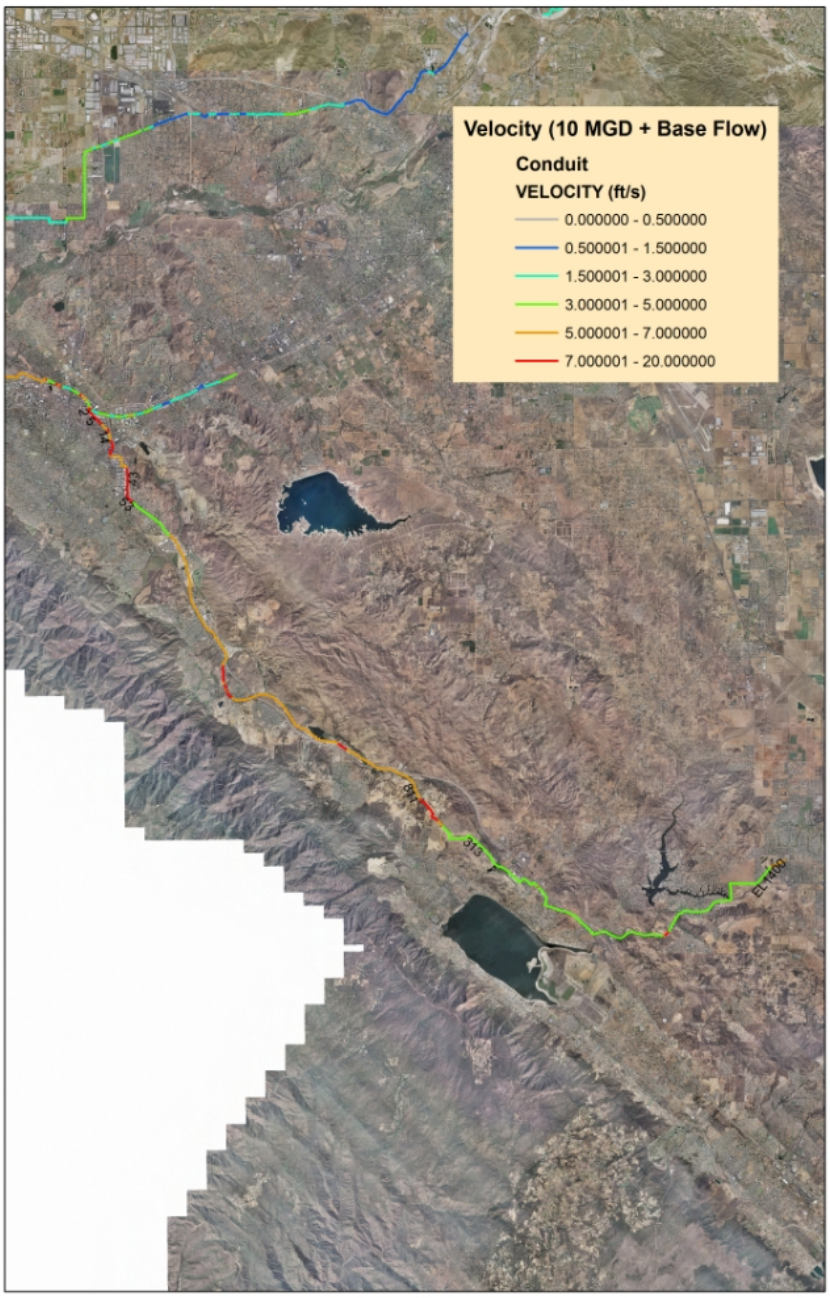


Figure A-3. Conduit Velocities as a result of 8 MGD flushing flow + base flow

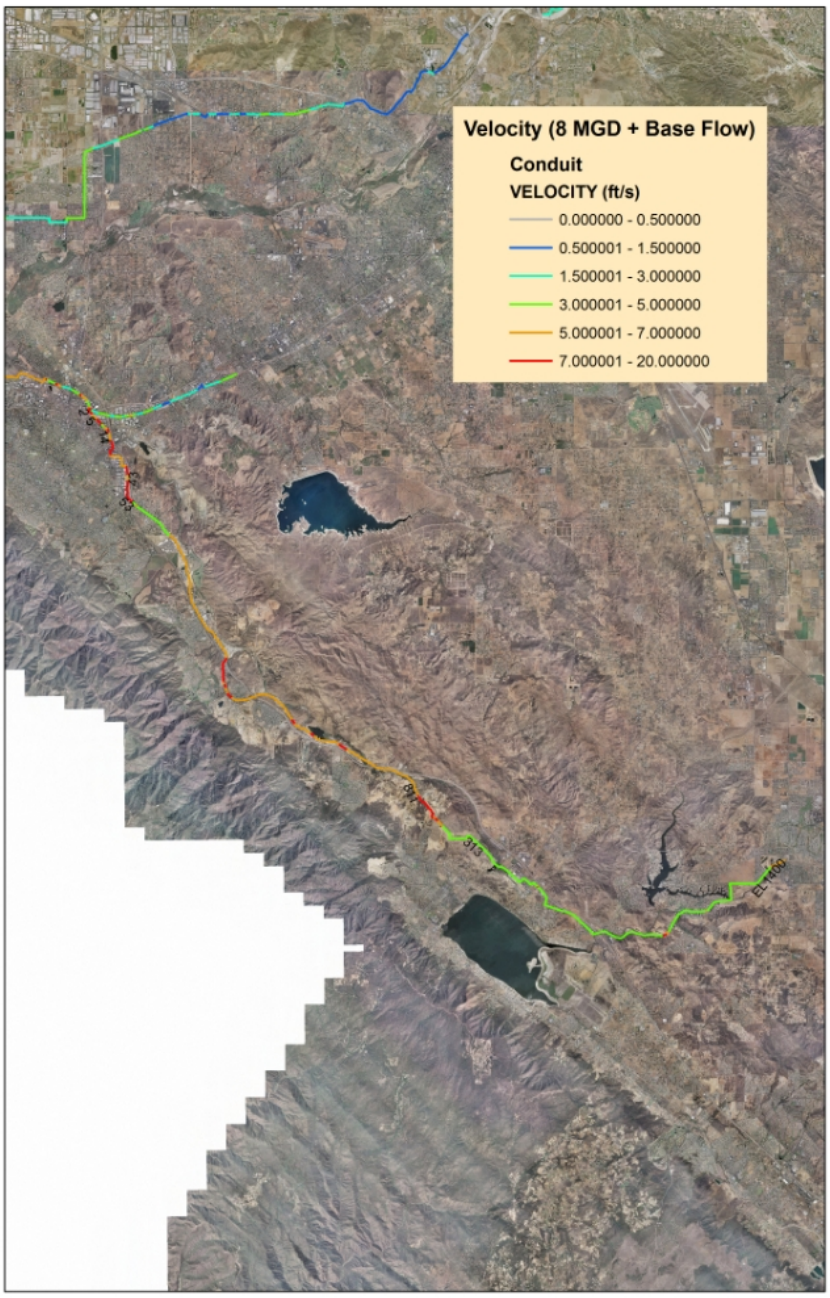


Figure A-4. Junctions with Maximum Pressure

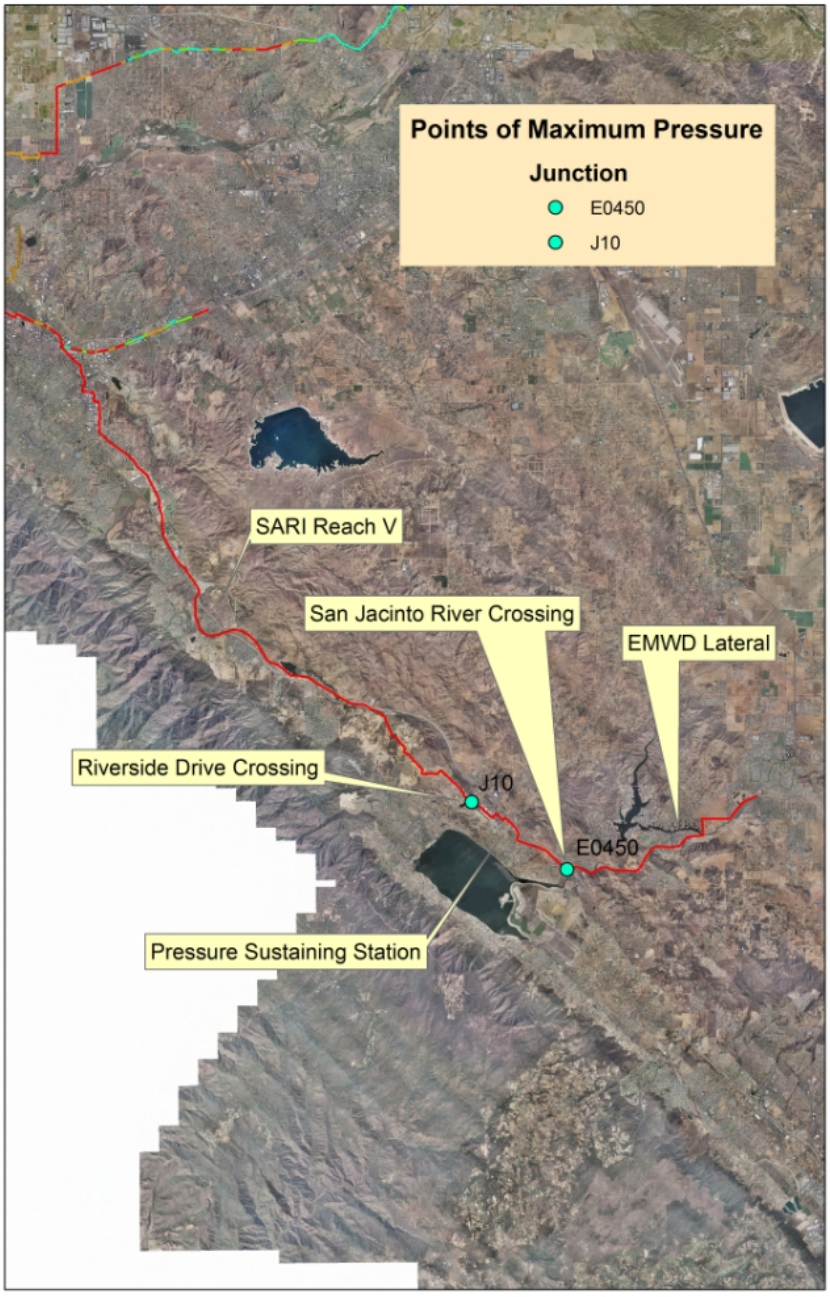


Figure A-5. Conduits with Maximum Velocity (EMWD)

Figure A-6. Conduits with Maximum Velocity (Reach V)

Figure A-7. Conduits with Minimum Velocity (EMWD)

Figure A-8. Conduits with Minimum Velocity (Reach V)

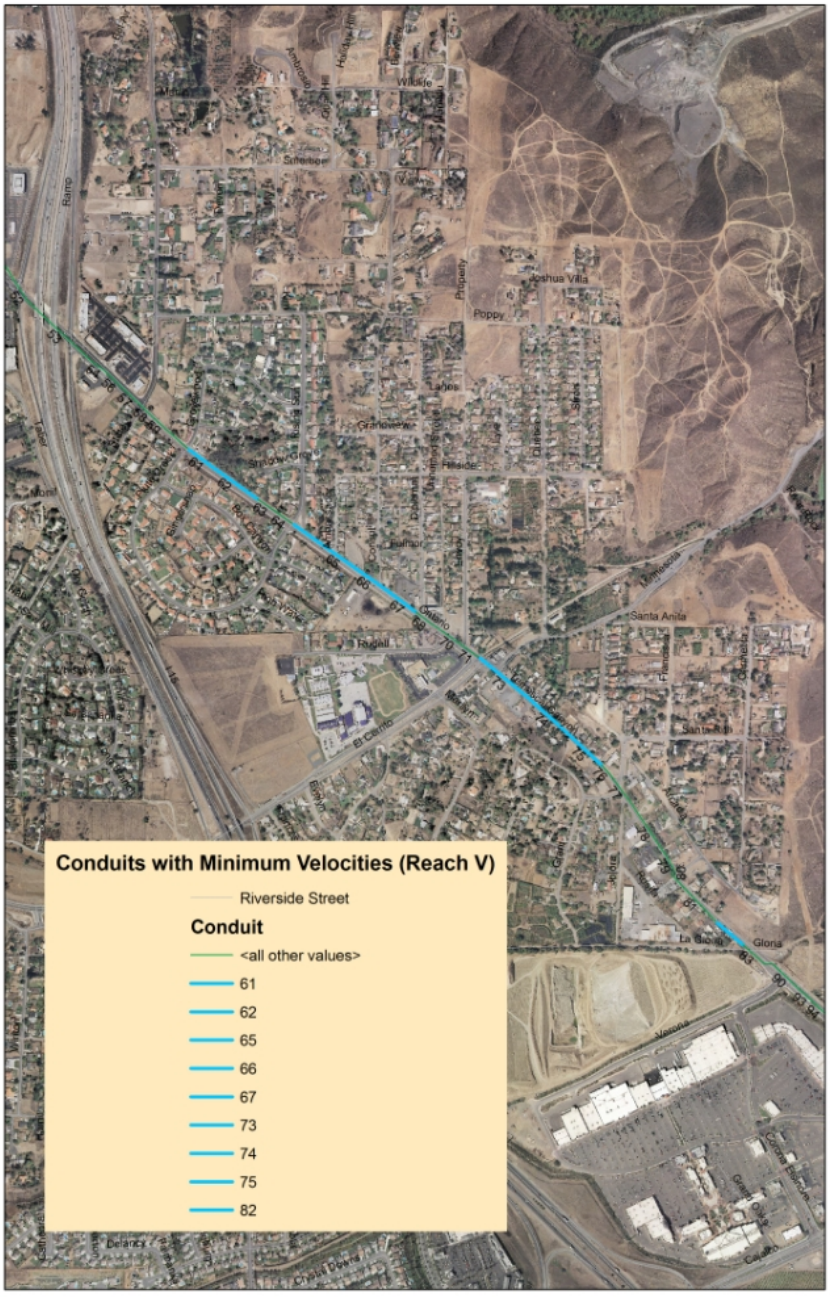


Figure A-9. Travel Time EMWD to PSS; 2,000 gpm (7 hours)

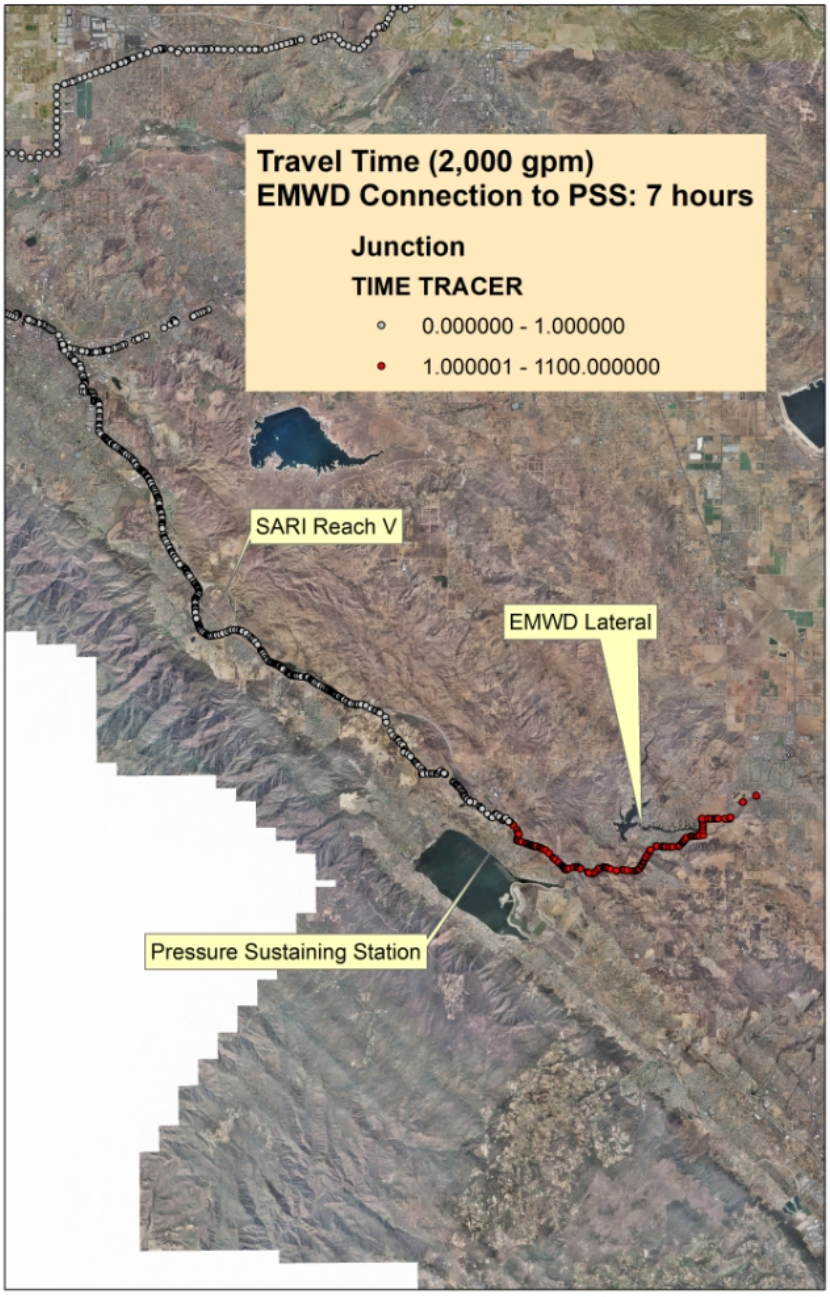


Figure A-10. Travel Time from EMWD to Indian Truck Road; 2,000 gpm (13 hours)

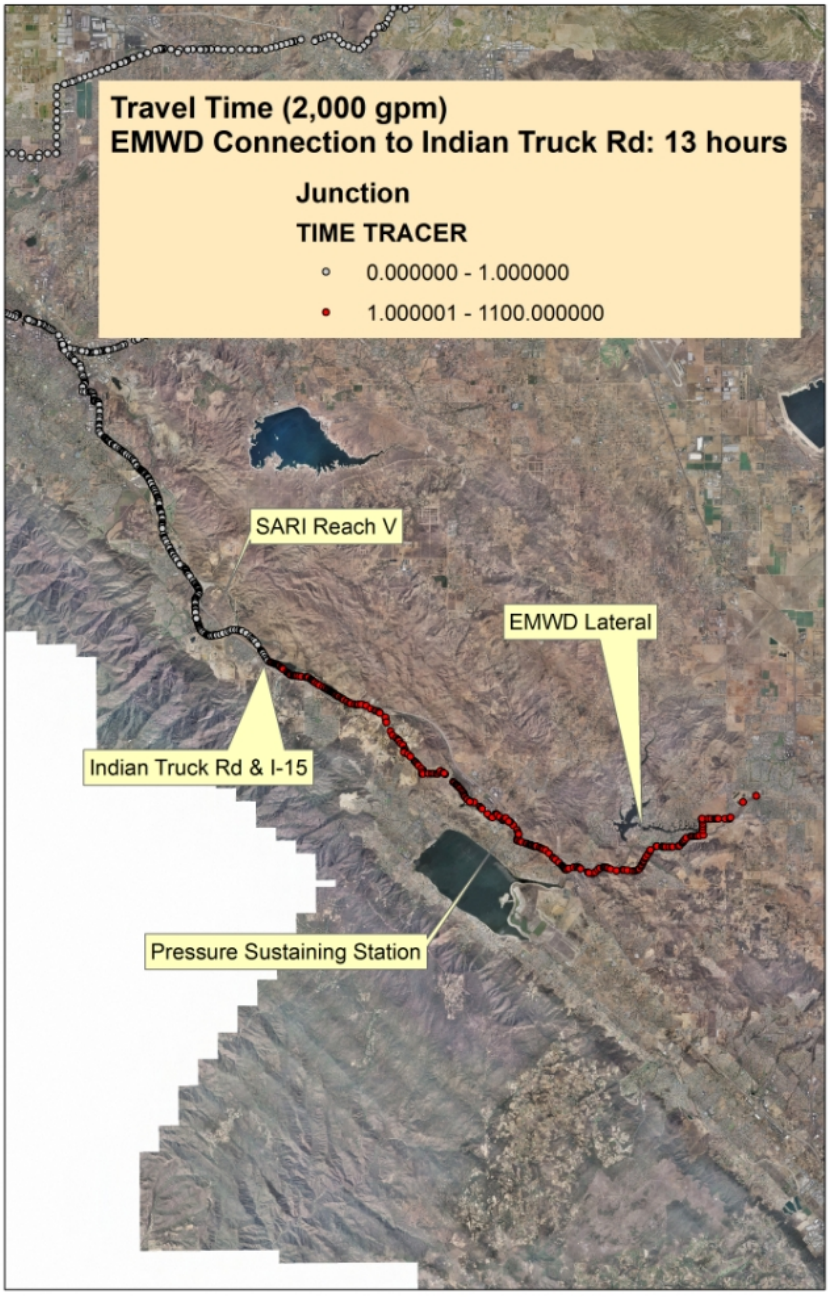


Figure A-11. Travel Time from EMWD to Reach IV-B; 2,000 gpm (19 hours)

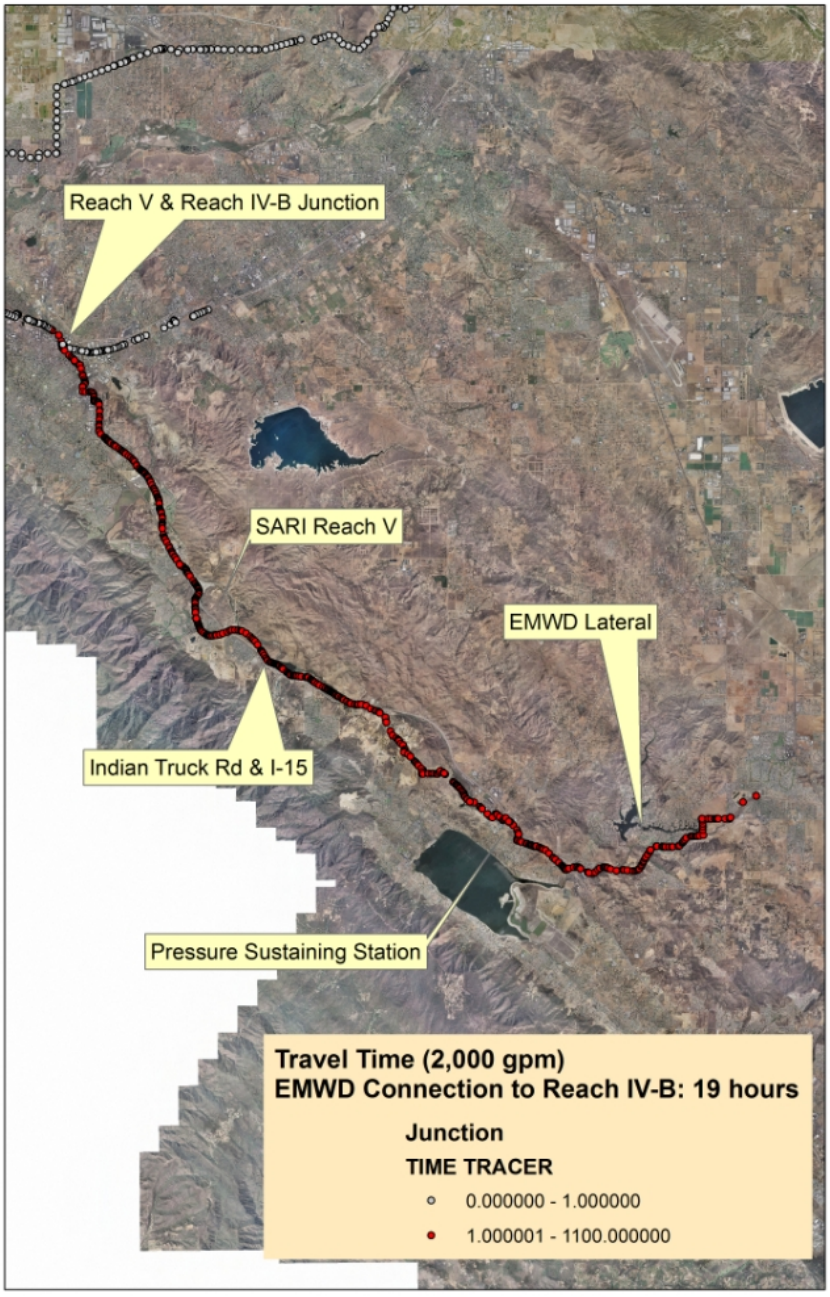


Figure A-12. Travel Time EMWD to PSS; 4,000 gpm (5 hours)

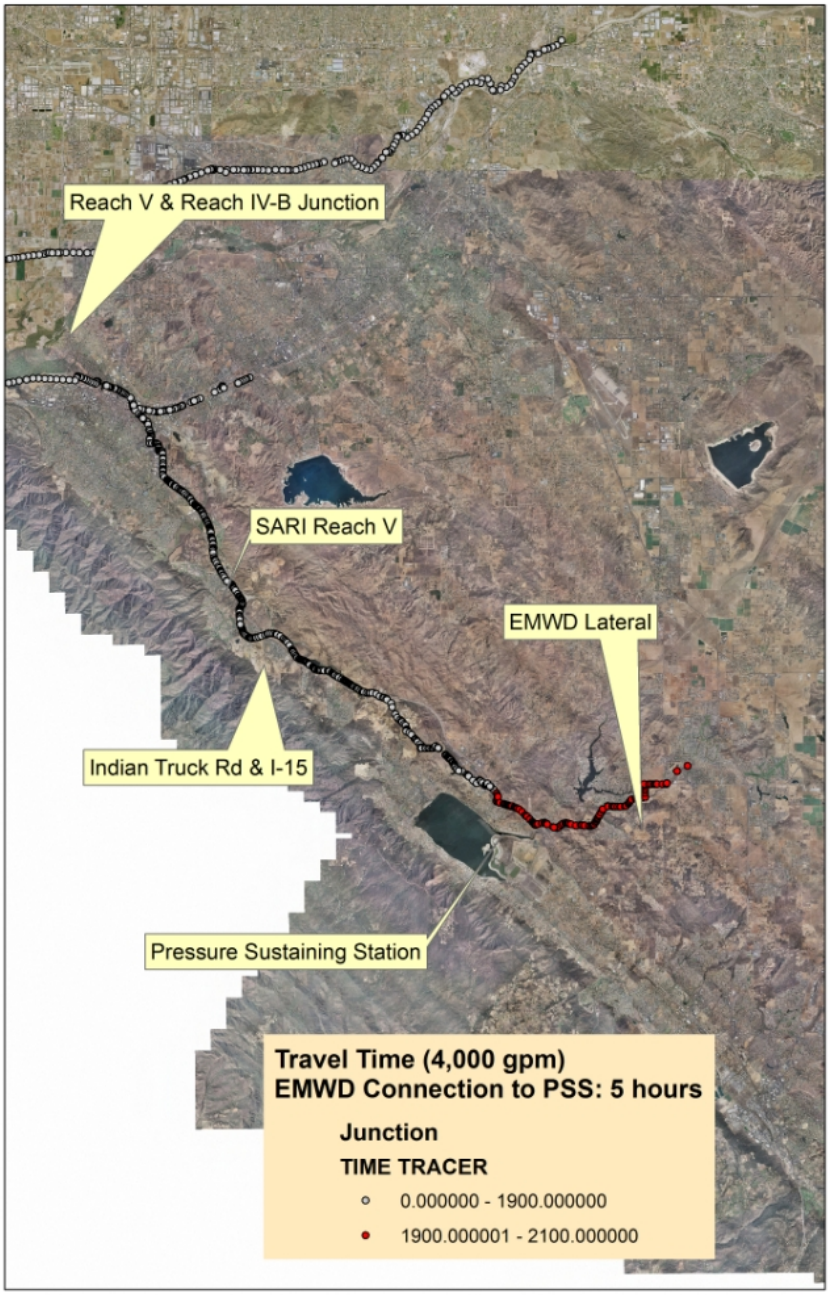


Figure A-13. Travel Time EMWD to Indian Truck Rd.; 4,000 gpm (9 hours)

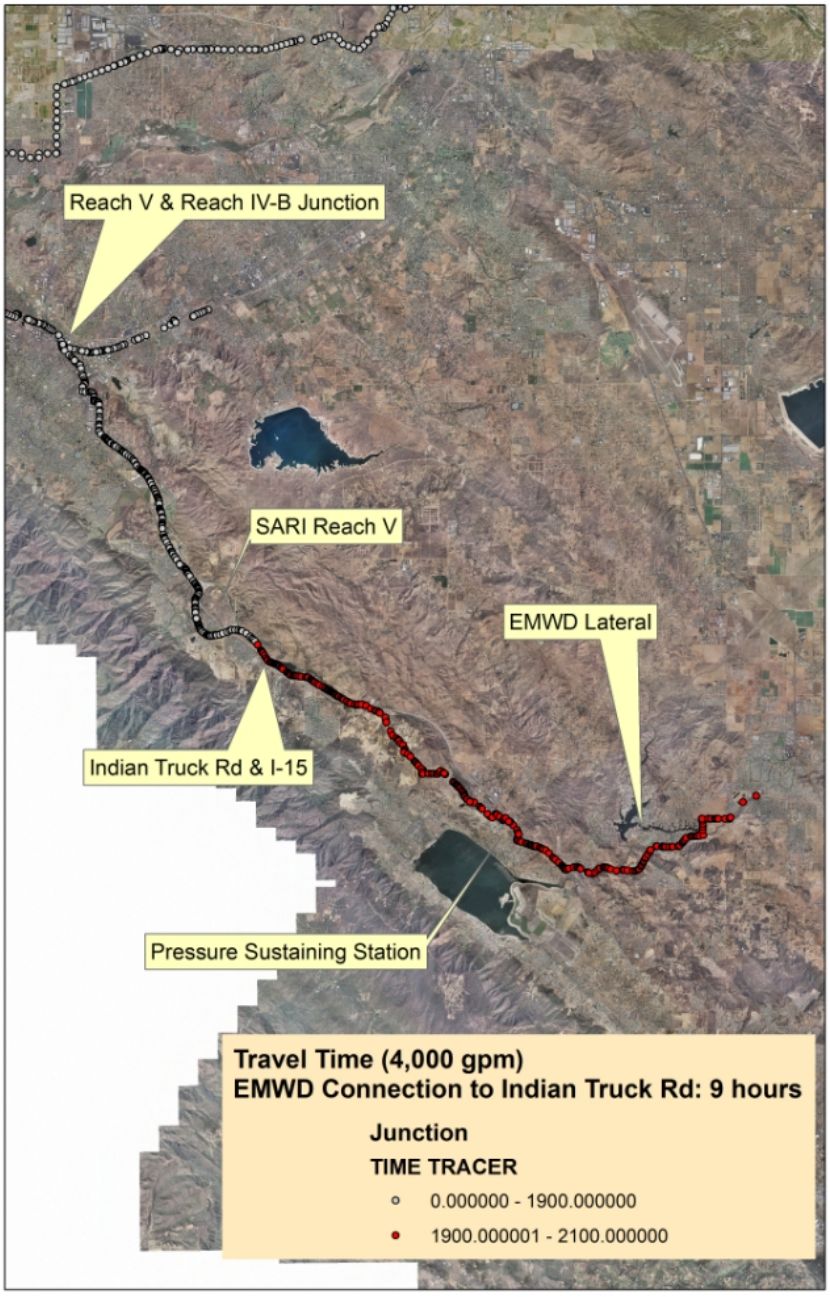


Figure A-14. Travel Time EMWD to Reach IV-B; 4,000 gpm (14 hours)

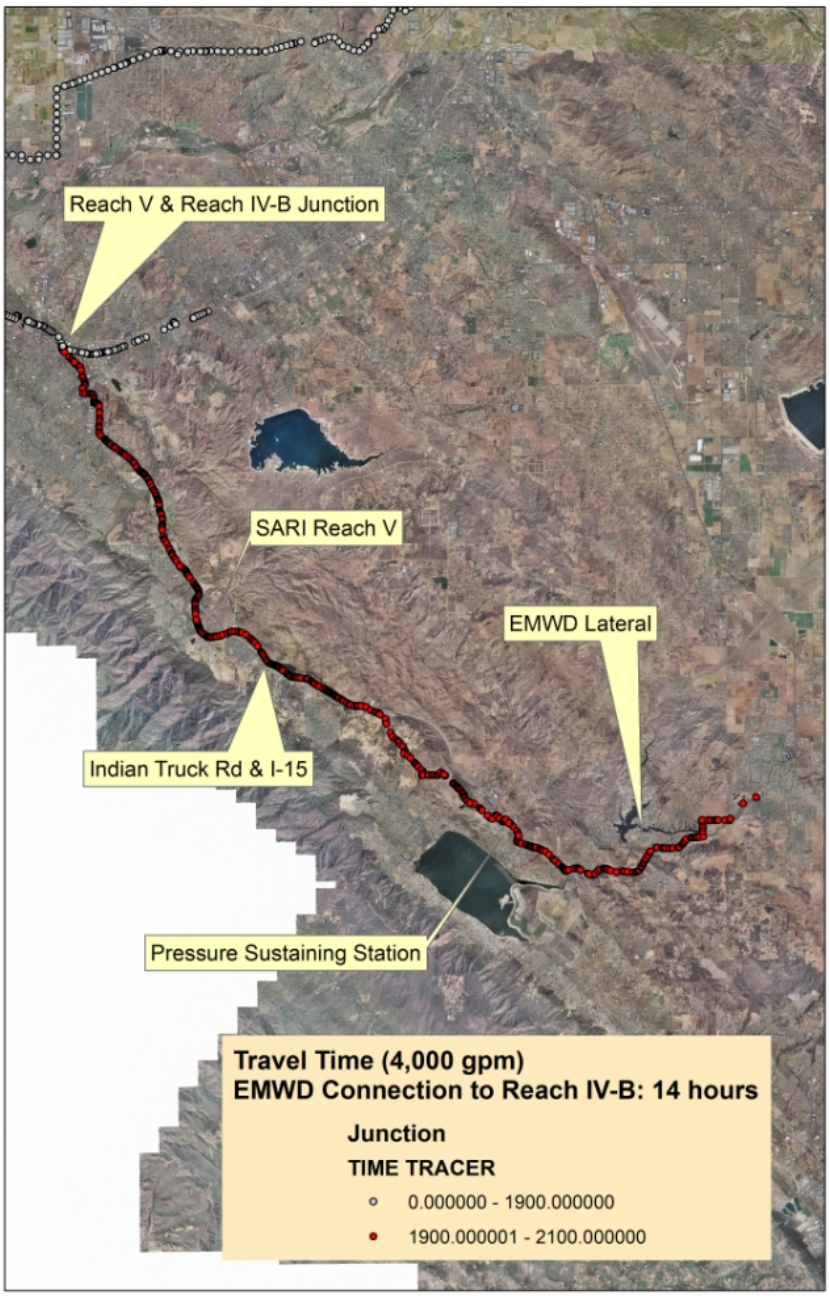


Figure A-15. Travel Time EMWD to PSS; 5,500 gpm (3.75 hours)

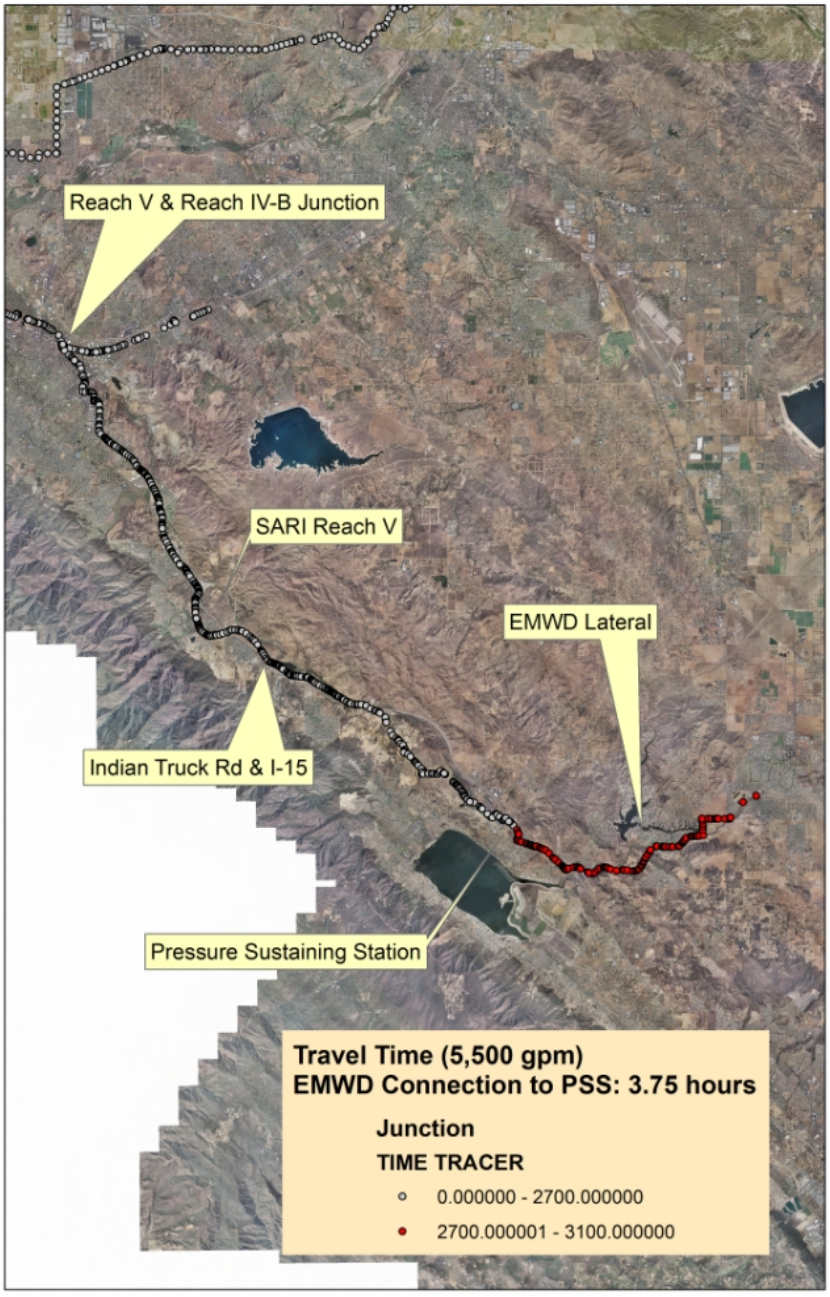


Figure A-16. Travel Time EMWD to Indian Truck Rd.; 5,500 gpm (6.75 hours)

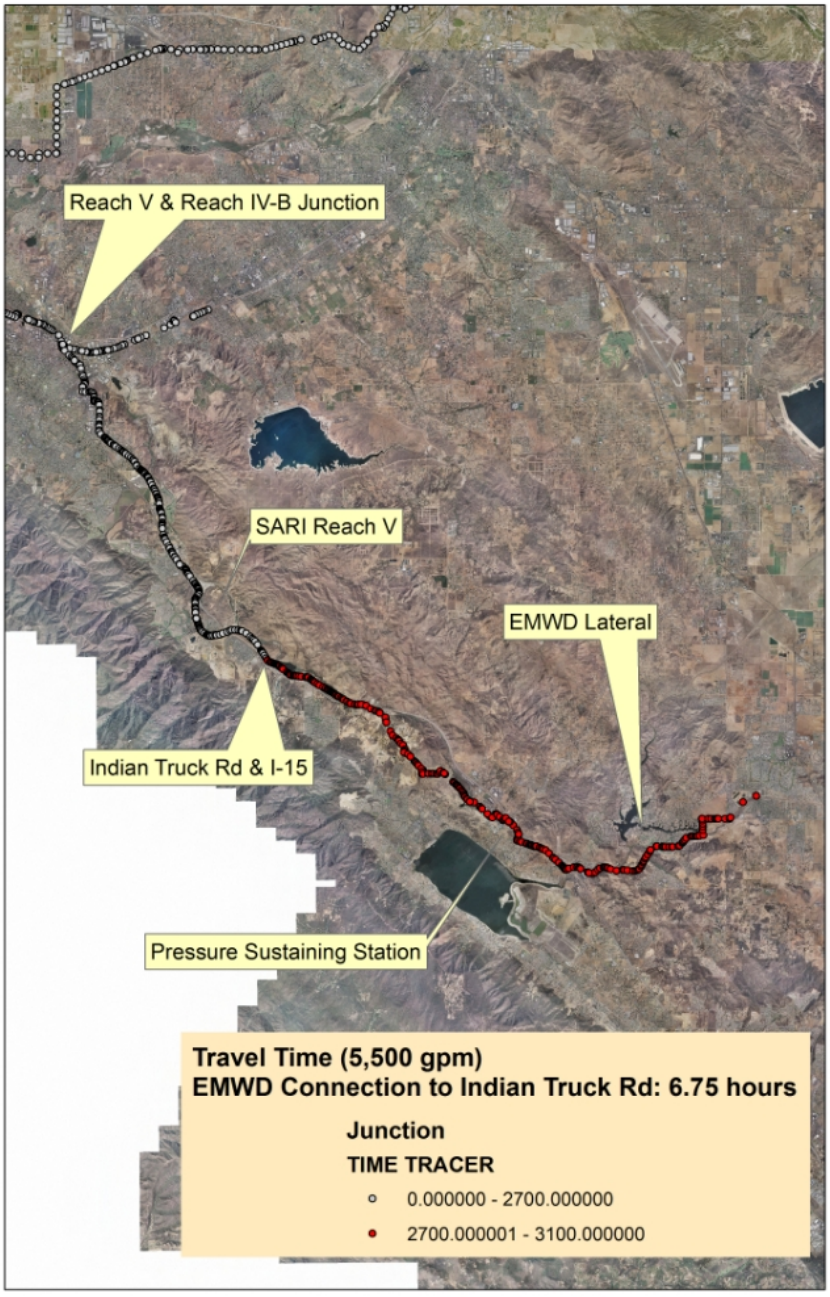


Figure A-17. Travel Time EMWD to Reach IV-B; 5,500 gpm (10 hours)