Sewer System Master Plan

Final Report

Prepared for: East Valley Water District

December 2019

Stantec

Stantec

2019 Sewer System Master Plan

Final Report

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Prepared for:
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Prepared by:
Stantec

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
ABS	Acrylonitrile-Butadiene-Styrene
ADDF	Average Daily Dry Weather Flowss
ADS	ADS Environmental Services, Inc.
ADWF	Average Dry Weather Flow
Ave.	Avenue
Blvd.	Boulevard
CCTV	Closed Conduit Television
CDPH	California Department of Public Health
CIP	Cast Iron Pipe
COP	Certificates of Participation
CWSRF	Clean Water State Revolving Fund
DI	Ductile Iron
DIP	Ductile Iron Pipe
DWR	Department of Water Resources
EPA	Environmental Protection Agency

ESRI	Environmental Systems Research Institute, Inc.
EVWD	East Valley Water District
FM	Flow Monitor
fps	Feet per Second
GIS	Geographic Information System
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
gpd/acre	Gallons per Day per Acre
ID	Identification
In.	Inch
IRWMP	(Greater Los Angeles) Integrated Regional Water Management Plan
IS	Initial Study
lf.	Linear feet
Ln.	Lane
MG	Million Gallons
MGD	Million Gallons per Day
MH	Manhole
NASSCO	National Association of Sewer Service Companies

PACP	Pipeline Assessment Certification Program
PDWF	Peak Dry Weather Flow
pvc	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
rcp	Reinforced Concrete Pipeline
Rd.	Road
RDII	Rainfall-Derived Infiltration and Inflow
SBMWD	San Bernardino Municipal Water Department
SBVRUWMP	San Bernardino Valley Regional Urban Water Management Plan
SBWRP	San Bernardino Water Reclamation Plant
SCAG	Southern California Association of Governments
SNRC	Sterling Natural Resources Center
SRF	State Revolving Fund
SSMP	Sewer System Master Plan (2013)
SSMP	2019 Sewer System Master Plan
St.	Street
UNK	Unknown

US	United States
USEPA	United States Environmental Protection Agency
WIFIA	Water Infrastructure Finance and Innovation Act
WSMP	Water System Master Plan (2014)
WSMP	2019 Water System Master Plan
WWF	Wet Weather Flow

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EXECUTIVE SUMMARY

INTRODUCTION

East Valley Water District (EVWD) retained Stantec Consulting Services, Inc. (Stantec) to prepare this 2019 Sewer System Master Plan (SSMP) on January 11, 2018. The primary objective of EVWD's SSMP is to update the 2013 Sewer System Master Plan (SSMP) and associated hydraulic model. This SSMP provides a guideline for the orderly planning of EVWD's sewer system and evaluates the sewer system under existing and future (near-term and build-out) conditions. The overall goal of this SSMP is to provide cost-effective and fiscally responsible sewer services that meet the quality and reliability requirements of EVWD's customers. The SSMP also provides a list of recommended improvements and actions in order to meet the existing and future sewer system needs. This list includes recommended facilities, proposed phasing of those facilities, opinions of probable construction cost, and recommended actions for EVWD to take to improve understanding and operation of the system.

EXISTING SEWER COLLECTION SYSTEM

The existing sewer system consists of approximately 213 miles of pipeline, 4,400 sewer manholes, 7 siphons, and 5 diversion structures. The existing sewer system conveys flows into San Bernardino Municipal Water Department's (SBMWD) East Trunk Sewer which outlets to the San Bernardino Water Reclamation Plant (SBWRP). A computer hydraulic model has been developed that represents the existing sewer system including transmission and collection pipeline, siphons, and manholes. This model is used for evaluating existing and future conditions for deficiencies and to identify areas for improvements.

EVWD's sewer pipeline network includes approximately 213 miles of pipeline ranging in size from 4 inches to 24 inches in diameter. The East Trunk Sewer is approximately 9 miles long ranging in size from 8 inches to 54 inches in diameter. EVWD's system includes seven siphons to convey flows in areas where physical constraints prevent gravity flow. Two additional siphons are constructed on the East Trunk Sewer. These are owned and operated by the City of San Bernardino. EVWD has five diversion structures in its sewer collection system. Diversion structures are generally installed in manholes to divert flows along a specific route in case of a blockage in the system or during times of high flow. EVWD's sewer system does not include any lift stations or force mains. All flow is conveyed by gravity to the East Trunk Sewer.

POPULATION, LAND USE AND SEWER FLOWS

Population projections along with existing and future land use were used to analyze existing sewer flows and project future sewer flows. Specific future sewer flows are calculated based on estimated population through year 2040 and EVWD's will-serve list for future developments. The following sources were contacted to develop existing and future land use and population projections:

- Southern California Association of Governments (SCAG)
- United States Census Bureau
- San Bernardino County Transportation Authority
- City of Highland

- California Department of Finance

Final projected future flows as input into the collection system model are summarized in Table ES-1 and represented on Figure ES-1. The "Planning Total" line on Figure ES-1 represents the final projections used for this SSMP.

Table ES-1: Average Dry Weather Flow Projection Comparisons in MGD

	Existing 2018	2020	Near-Term	2030	2035	Build-Out
Land Use	6.34	7.05	8.23	9.42	10.60	11.79
Population Method	7.23	7.41	7.71	8.01	8.3	8.59
Future Developments			2.39			
Population and Future Developments	7.23		10.1			10.98
Flows to Model	**7.23**		**10.1**			**11.79**

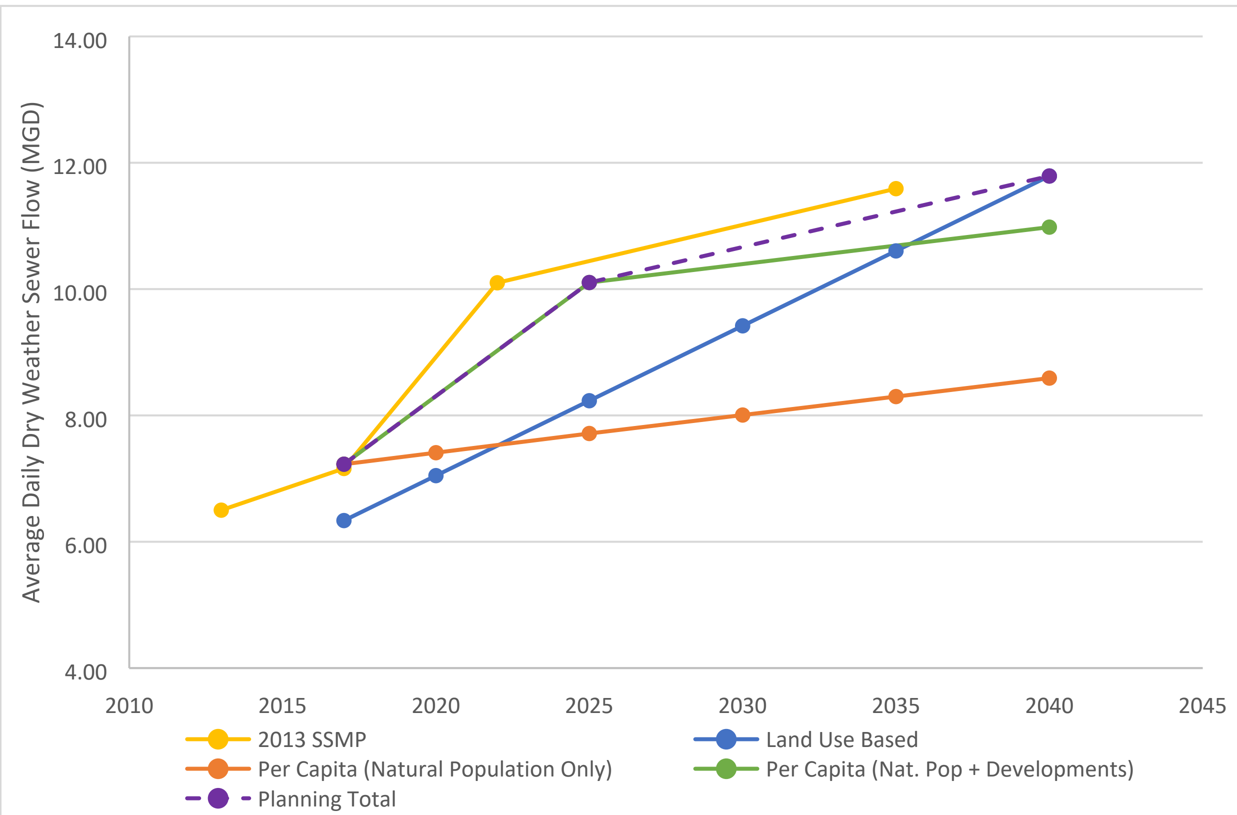


Figure ES-1: Summary of Future Sewer Generation Projections

HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

Model Development

The process of updating the existing sewer system model included data collection, model construction, flow allocation, future projections, and calibration. The model build process begins with reviewing and updating sewer GIS data (manholes, pipes, and siphons), identifying sewer asset nomenclature, inputting data into the sewer model, and performing a quality check of model input data. Once the model is verified for connectivity (pipes connecting to manholes), sewersheds are created in order to subdivide the service area into distinct areas. Sewer flows are calculated and assigned to the sewersheds in the model by identifying a demand node within each sewershed. Once the model flows have been assigned, the model is calibrated against flow data from field monitoring to ensure agreement, and then used to run analyses and identify any sewer capacity issues.

Flow Monitoring

Flow monitors measure flow, depth, and velocity and this data can be used to validate the performance of the model. ADS Environmental Services (ADS) completed three recent flow monitoring studies that were used to calibrate the model. Two studies were performed specifically for this master plan, and a third was performed for the San Manuel Band of Mission Indians. EVWD maintains two permanent flow monitors through ADS at the terminus of their system, capturing most flow generated in their service area before entering the East Trunk Sewer.

Ten temporary flow meters were deployed in conjunction with EVWD's two permanent flow meters. Of the ten temporary meters, three were deployed to determine land-use specific usage patterns. The remaining seven flow monitors were placed at locations to capture flow from similarly sized sewersheds comprising a majority of the EVWD system. A map of the flow meters and their respective meter basins is shown on Figure ES-2.

Flow Allocation

Existing flows were allocated into the model using the flow monitoring data, U.S. census block data, and the existing EVWD sewersheds. Future flows were developed using SCAG population projections, EVWD's will-serve list, specific development projections and reports, the City of Highland General Plan future land use shapefile, and flow monitoring data.

Long term flow monitors at 3rd and 6th Streets have metered wet weather responses since their installation at the end of 2014. These meters were reviewed and evaluated for a wet weather peaking factor to be applied to the system. Stantec evaluated historical rainfall data and compared this with the hourly flow monitoring data provided by EVWD. Based on this analysis, the wet weather peaking factor was approximately 1.7. To conservatively estimate the wet weather flows the system might experience, Stantec and EVWD agreed on applying a peaking factor of 2.0 to the existing dry weather flows.

Total flows allocated to EVWD's sewer model are summarized in Table ES-2. Flows are totaled for both EVWD's service as well as total flows at the SBWRP.

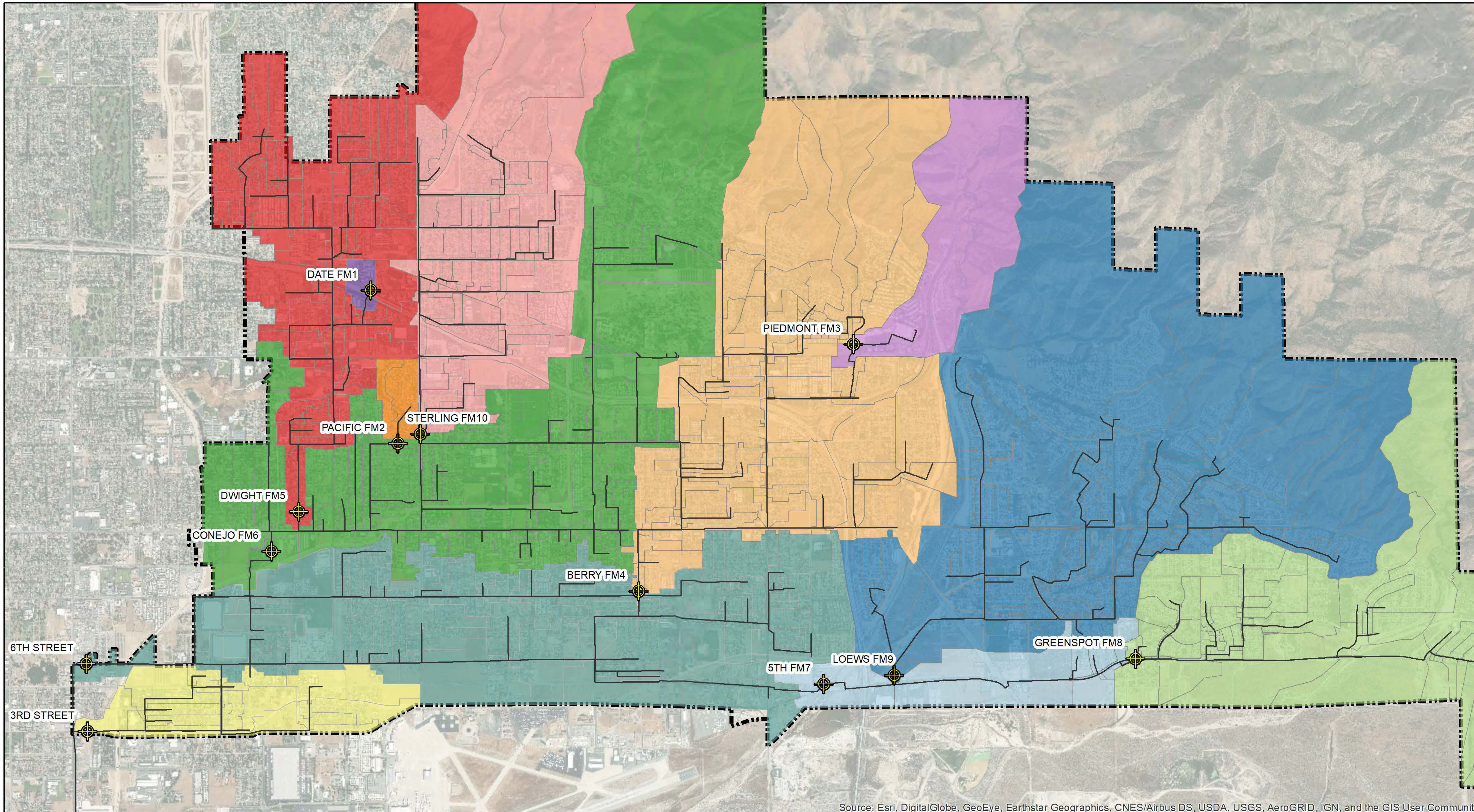
Table ES-2: Summary of Inflow Allocation

Model Scenario	EVWD Service Area Flow (MGD)	Total Flow at SBWRP (MGD)
Calibration	6.0	N/A
Existing DWF	7.2	13.7
Exiting Peak WWF	14.5	27.4
Near-Term Average DWF	10.1	16.6
Near-Term Peak WWF	17.3	31.5
Build-out Avg. DWF	11.8	18.3
Build-out Peak WWF	19.0	33.2

Model Calibration

Dry weather model flows, diurnal patterns, and Manning's coefficients are adjusted to match the flow and depth observed at each flow metering location. The model was only calibrated to dry weather conditions because no wet weather events were captured in the flow monitoring study. The goal of calibration was to have a 10 percent or less difference between the modeled and observed dry weather flows.

The dry weather flow calibration results are summarized in Table ES-3. Most of the results are well within the 10 percent criteria for calibration, with the 3rd Street location being the largest outlier. The cause of this discrepancy is thought to be disagreement in some of the source data for the dimensions of the pipelines and manholes upstream of this location, and low flow at this location. The calibration could not be further refined without decreasing the accuracy of other locations and it is noted that the model is showing higher flows than the flow monitoring which suggests model results are a conservative representation of flow in the pipe. Overall, the model flows agree closely with flow monitoring data and the results relay a high level of confidence in model accuracy. In order to further refine the calibration during future updates, it is recommended that EVWD conduct further flow studies in the system, focusing on areas of low confidence.



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Date: December 11, 2018

Flow Monitoring Locations

Stantec

Figure ES-2

Table ES-3: Calibration Results

	Modeled Flow (MGD)	Observed Average Weekday Flow (MGD)	Percent Difference	Modeled Depth (FT)	Observed Average Weekday Depth (FT)	Percent Difference
	Total Volume			**Average Depth**		
FM 4	0.75	0.78	-3	0.51	0.46	11
FM 5	1.68	1.71	-2	0.45	0.46	-2
FM 6	3.18	3.20	0	0.65	0.59	10
FM 7	0.90	0.97	-7	0.38	0.37	3
FM 8	0.35	0.37	-6	0.30	0.32	-7
FM 9	0.52	0.55	-5	0.30	0.27	14
FM 10	0.71	0.72	0	0.24	0.21	11
3rd Street	0.26	0.32	-18	0.24	0.20	19
6th Street	5.69	5.49	4	1.01	1.11	-9
	Peak Flow			**Maximum Depth**		
FM 4	1.08	1.14	-5	0.63	0.57	11
FM 5	2.36	2.45	-4	0.55	0.56	-1
FM 6	4.47	4.64	-4	0.79	0.75	4
FM 7	1.55	1.66	-7	0.51	0.50	3
FM 8	0.59	0.66	-11	0.40	0.45	-12
FM 9	0.93	1.00	-7	0.42	0.35	20
FM 10	1.02	1.13	-10	0.29	0.29	-2
3rd Street	0.38	0.52	-28	0.29	0.26	13
6th Street	7.95	7.77	2	1.22	1.32	-8

PLANNING CRITERIA

Criteria are established for evaluating the adequacy and condition of EVWD's sewer collection system and designing replacement or new infrastructure in the system and are discussed in detail in Section 5. Peak sewer flow factors for EVWD's system are determined based on a review of flow monitoring data produced by EVWD for the purpose of this SSMP update. The criteria are developed using typical planning criteria of similar wastewater utilities, engineering judgment, and commonly accepted industry standards. The "industry standards" are typically ranges of values that are acceptable for the criterion in question and, therefore, are used more as a check to confirm that the values being developed are reasonable. Deviations from the recommended guidelines may be necessary in defining specific improvement projects for an existing sewer collection system due to the restrictions posed by existing upstream and downstream conditions. In these special circumstances, design criteria will need to be determined on a case-by-case basis.

Table ES-4 shows the recommended design criteria for new sewers and manholes. The criteria presented in this table are discussed in more detail below.

Table ES-4: Gravity Sewer Design Criteria

Design Criteria	Value
Per Capita Flow	
Flow Generation Rate	Based on Population and Land Use
Velocity	
Minimum	2 fps
Maximum	10 fps
d/D Ratio during peak dry weather flow	
For all sewers that are less than 18-inch in diameter	0.5
For all sewers that are greater than or equal to 18-inch in diameter	0.75
d/D Ratio during peak wet weather flow	
All Diameters	d/D = 1.0 (Surcharge)
Siphon Pipelines	
All Diameters	Maximum Velocity < 8 feet per second
Other Criteria	
Manning's n (gravity mains)	Dependent upon material, 0.013 used for all existing pipelines in the system or if material is not known
Average Manhole Losses	0.1 feet
Manhole Losses during peak wet weather flow	0.5 feet

SYSTEM EVALUATION

The System Evaluation is presented in Section 6 and describes the evaluation of both existing and future conditions.

Existing System Evaluation

The updated sewer system model was evaluated under existing conditions for both dry and wet weather for the purpose of identifying capacity constraints. Table ES-5 summarizes the lengths of pipes that were identified in the existing model as being outside the limits of the design criteria.

Table ES-5: Summary of Existing 2018 Model Results

Parameter	Dry Weather		Wet Weather	
	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)
Pipes < 18", 1> d/D > 0.5	626	3,670	-	-
Pipes ≥ 18", 1> d/D > 0.75	0	2,706	-	-
Surcharged Pipe (LF)	0	627	10,973	19,362
Deviation from planning criteria (LF)	**626**	**6,376**	**10,973**	**19,362**

Stantec discussed locations of critical pipes with EVWD. A reliability evaluation was performed for these location that looked at the bypass pumping required to convey flow in these areas due to a pipe failure. Because of the configuration of the current EVWD system, flow diversion at upstream locations is not feasible. The only option should one of these pipes fail would be temporary bypass pumping while the pipe is repaired. For each location, a peak dry weather flow was assessed in the hydraulic model, and the amount of bypass pumping required to convey that flow was calculated.

The results of the reliability evaluation are summarized in Table ES-6.

Table ES-6: Summary of Reliability Analysis

Location	Peak Dry Weather Flow Rate (MGD)	Total Volume, (MG)	Bypass Pumping Required (gpm)
Pacific St. and Del Rosa Dr.	2.81	1.99	279 – 1,951
Sterling Ave and Highland Ave.	1.05	0.74	104 – 729
Greenspot Rd. at City Creek	1.99	1.16	197 – 1,382

Near-Term System Evaluation

Additional sewer flows were applied to the sewer system model based on growth projections in EVWD's service area for the near-term planning horizon. The near-term scenario was developed to evaluate the sewer system under future conditions related to development expected with relative certainty, such as those on EVWD's will-serve list and converted septic customers. Table ES-7 summarizes the lengths of pipes that were identified in the near-term model as being outside the limits of the design criteria.

Table ES-7: Summary of Near-Term Model Results

Parameter	Dry Weather		Wet Weather	
	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)
Pipes < 18", 1 > d/D > 0.5	26,930	3,670	-	-
Pipes ≥ 18", 1> d/D > 0.75	9,527	5,905	-	-
Surcharged Pipe (LF)	11,868	3,844	44,813	20,475
Total length pipeline out of planning criteria based on model results (LF)	36,457	9,575	44,813	20,475

Build-Out System Evaluation

Additional sewer flows were applied to the sewer system model based on projections for future build-out of the EVWD service area. The build-out scenario was developed to evaluate the sewer system under future conditions caused by construction of all expected specific developments as well as development in line with SCAG's General Plan for the service area. All EVWD's will-serve list and current septic customers are assumed to be contributing flow to the future system. The build-out scenario was evaluated under both dry and wet weather to identify capacity constraints. Table ES-8 summarizes the lengths of pipes that were identified in the build-out model as being outside the limits of the design criteria.

Table ES-8: Summary of Build-Out Model Results

Parameter	Dry Weather		Wet Weather	
	EVWD Pipes (LF)	East Trunk Sewer (LF)	EVWD Pipes (LF)	East Trunk Sewer (LF)
Pipes < 18", 1 > d/D > 0.5	36,456	4,604	-	-
Pipes ≥ 18", 1 > d/D > 0.75	12,242	6,077	-	-
Surcharged Pipe (LF)	23,964	3,844	49,296	22,230
Total length pipeline out of planning criteria based on model results (LF)	48,698	10,681	49,296	22,230

Build-Out System East Trunk Sewer Analysis

The Sterling Natural Resources Center is a state-of-the-art water reclamation facility currently under construction at the intersection of Del Rosa Ave. and 6th Street. When complete, the SNRC will provide a sustainable new water supply to EVWD and the region. The SNRC will have a treatment capacity of 10 MGD, and the build-out model scenario was used to determine sources for the future flow.

Through discussion with EVWD, the details of a new SNRC interceptor pipeline were determined and used to evaluate flows at the proposed interception locations. According to the model, 11.7 MGD of flow can be redirected from the East Trunk Sewer to the SNRC through the new Interceptor. This interceptor may also alleviate surcharge pipe conditions in the East Trunk Sewer. It is recommended that recommended projects downstream of the SNRC be monitored to determine if the project is needed immediately or can be postponed until the SNRC is online the pipe can be reassessed.

GIS MANAGEMENT PLAN

Section 7 presents EVWD with best practices for wastewater GIS databases to improve the process of ensuring GIS data is model-ready to facilitate updates in the hydraulic model in the future. EVWD should consider incorporating the following key requirements:

- Maintain a UniqueID across all features. Tools such as Attribute Assistant can be used for this purpose.
- Ensure each pipe maintains a TO_ and FROM_ node (UpManhole, DownManhole) to properly designate direction of flow in the network and establish connectivity.
- Use accurate elevations in GIS, especially considering EVWD's system is a gravity system.
- As needed when adding any facilities, consider representing the facility in detail in GIS to more seamlessly translate to the model.
- Utilize the typical connectivity checks described in Section 7.3, available topology rules, and data reviewer checks to develop a QA/QC process to ensure data quality and integrity.

RECOMMENDATIONS

Once deficiencies in the sewer system were identified using the updated hydraulic model, capital projects were developed to address these deficiencies. Stantec reviewed recommendations from the 2013 SSMP and using current system data, identified cost effective projects that addressed as many deficiencies as possible with the least amount of new, replaced, or rehabilitated pipeline. Pipelines in need of replacement were grouped into projects based on their proximity to other recommendations in order to minimize construction costs, time, and impacts of construction. Some of the pipes upsized as part of a larger project did not show deficiencies themselves but were upsized to avoid constrictions in pipe diameter as flow travels downstream; when making recommendation Stantec avoids recommending a pipe upgrade that would feed into a smaller diameter pipe as this can lead to constriction of flow, blockages, and other operational problems. However, when implementing these improvements, it is recommended that EVWD perform a pre-design of the improvement to determine if a pipe constriction is warranted given updated flow information and the downstream slopes.

Before EVWD decides to design or construct the recommended improvements, the need for the project should be confirmed through field investigation, flow monitoring, and additional detailed analysis.

Capacity Based Improvements

A summary of the recommended capacity improvements is shown in Table ES-9. Recommended capacity projects are shown by project on Figure ES-3, and Figure ES-4 shows projects by their prospective planning horizon, as well as “pipes to monitor.” “Pipes to monitor” are pipes showing capacity deficiency in the future planning horizon during wet weather flow and should be monitored for surcharging to verify the need for replacement and possibly realignment once significant growth has occurred in the service area. Relief lines may also be considered; however, it is important to consider where these lines would connect back to the main system so as not to overload downstream pipes or cause flow constriction and blockages. The deficiencies in the watch areas may be due to pipe slope or hydraulics and are localized enough that a project is not recommended in this SSMP until the deficiency can be field verified in the future.

It is noted that some of the projects identified on Table ES-9 are downstream of planned points of intercept for the SNRC project. Diversion of flow to the SNRC interceptor may alleviate the deficiencies observed during the model analysis for these projects. The model was run without the SNRC interceptor incorporated as final intercept points were not available prior to the analysis. It is important that EVWD conduct flow studies subsequent to the SNRC and the interceptor becoming operational to determine the efficacy of the interceptor and the final flows observed in the interceptor and the contributing sewers. It is recommended that projects downstream of the SNRC interceptor be monitored to assess if conditions require immediate action, or if the pipe can remain in service until the SNRC comes online and the need for improvement can be determined.

Table ES-9: Summary of Capacity Improvements

Planning Horizon	Project Name	Description	Driver	Original Diameter	New Diameter	Length (LF)	Estimated Construction Cost ($)	Contingency (20% of Construction Cost) ($)	Engineering, Legal & Administration (30% of Construction Cost) ($)	Total Project Cost ($)
Existing	**E-1**[1]	Upsize 5,900 LF of 27"-48" pipe with 30"-54" pipe, including a possible siphon upsize. East Trunk Sewer project.	Existing DWF	27	36	1,366	7,873,000	1,574,600	2,361,900	11,809,500
				33	42	2,127				
				39	42	662				
				39	48	1,025				
				48	54	663				
	E-2[1]	Upsize 6,500 LF of 21"-30" pipe with 30"-36" pipe. East Trunk Sewer project.	Existing DWF	21	30	880	7,093,000	1,418,600	2,127,900	10,639,500
				24	30	1,875				
				27	36	2,068				
				30	36	1,650				
	E-3[1]	Upsize 8,500 LF of 15"-24" pipe with 18"-30" pipe. East Trunk Sewer project.	Existing WWF	15	18	326	5,586,000	1,117,200	1,675,800	8,379,000
				15	21	5,176				
				18	21	2,103				
				24	30	835				
	E-4[1]	Upsize 15,000 LF of 21"-24" pipe with 30" pipe. Provides and SNRC sewer relief.	Existing WWF	21	30	9,861	15,273,000	3,054,600	4,581,900	22,909,500
				24	30	5,113				
	E-5	Replace 400 LF of 8" pipe with modified slope in order to address areas of flat slope that cause non-ideal flow conditions	Existing WWF	8	8	383	99,000	19,800	29,700	148,500
	E-6	Upsize 30 LF of 8" pipe to 10" pipe.	Existing WWF	8	10	31	10,000	2,000	3,000	15,000
Subtotal							**35,924,000**	**7,184,800**	**10,777,200**	**53,886,000**
Near-Term	**N-1**	Upsize 6,200 LF of 8"-12" pipe to 15" pipe. Development driven (Casino Expansion).	Near-Term DWF and Casino Expansion	8"	15"	4,565	2,943,000	588,600	882,900	4,414,500
				12"	15"	1,670				
	N-2	Upsize 20,200 LF of 12"-18" pipe to 18"-21" pipe. Development driven (Harmony and Sunland/Mediterra).	Near-Term DWF	12"	18"	13,219	11,648,000	2,329,600	3,494,400	17,472,000
				15"	18"	3,060				
				15"	21"	3,543				
				18"	21"	346				
	N-3	Upsize 4,500 LF of 24" pipe to 30" pipe. Development driven.	Near-Term WWF Dependent upon assumed development	24"	30"	4,542	4,633,000	926,600	1,389,900	6,949,500
Subtotal							**19,224,000**	**3,844,800**	**5,767,200**	**28,836,000**
Build-out	**B-1**	Upsize 2,100 LF of 6"-8" pipe to 10" pipe.	Build-out WWF	6"	10"	1,092	687,000	137,400	206,100	1,030,500
				8"	10"	1,034				
	B-2[2]	Upsize 2,200 LF of 15" pipe with 18" pipe, including a possible siphon upsize.	Build-out WWF	15"	18"	2,077	1,176,000	235,200	352,800	1,764,000
Subtotal							**1,863,000**	**372,600**	**558,900**	**2,794,500**
Pipes to Monitor	**M-1**	Pipe S-SM-I9-1012.	Build-out WWF	10		27	-			
	M-2	Pipe S-SM-J11-1020.	Build-out WWF	8		75	-			
	M-3	Pipe S-SM-J11-1042.	Build-out WWF	10		44	-			
	M-4	Pipe S-SM-J5-1052.	Build-out WWF	21		8	-			
	M-5	Pipe S-SM-K10-1047.	Build-out WWF	18		50	-			
Total Capital Cost							**57,011,000**	**11,402,200**	**17,103,300**	**85,516,500**

[1]: These projects may be relieved by the SNRC interceptor and should be monitored to assess if the deficiencies require immediate attention or can be monitored until the interceptor is operational and flows can be reassessed.

[2]: This project should be reassessed in a future update with the SNRC interceptor final dimensions in order to assess the extant to which the interceptor has relieved flows and if the improvement is still necessary.

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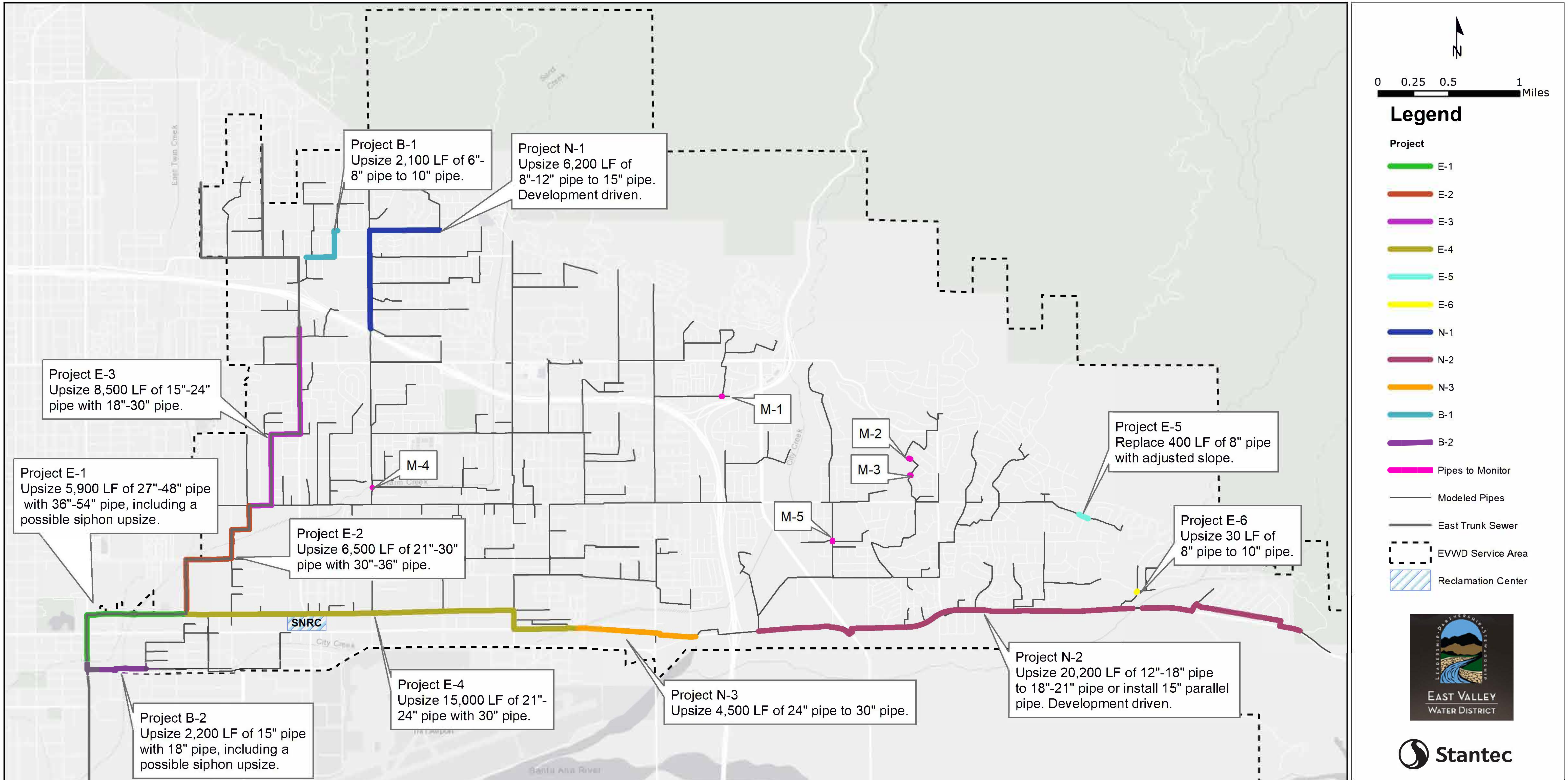
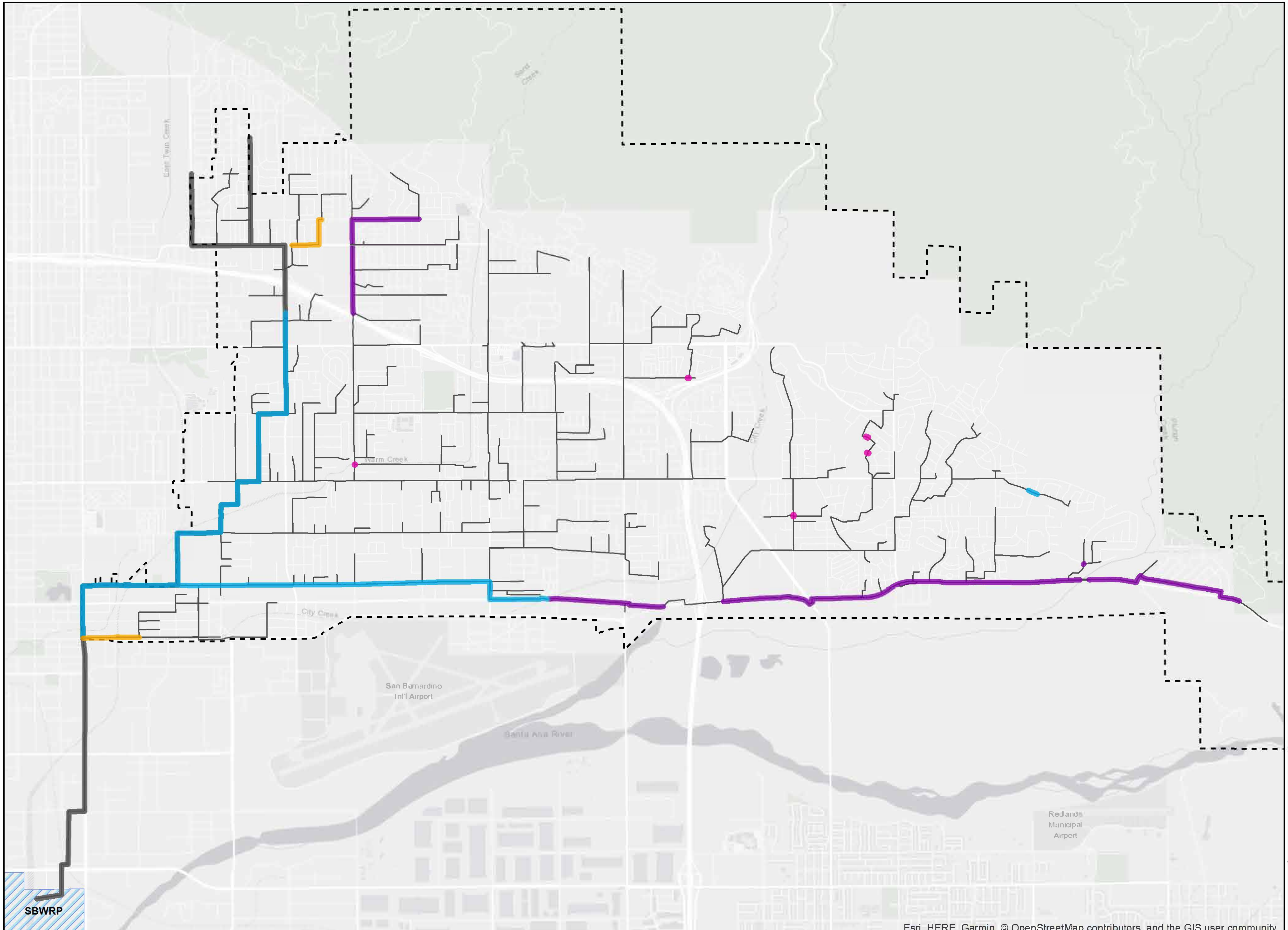


Figure ES-3
Recommended Capacity Projects

Date: 12/20/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet



N

0 0.25 0.5 1 Miles

Legend

Projects

- Existing
- 2025
- 2040
- Areas to Monitor
- Modeled Pipes
- EVWD Service Area
- East Trunk Sewer
- SBWRP

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Figure ES-4
Capacity Recommendations by Planning Horizon

Date: 12/20/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 7-2 Projects by Horizon.mxd

Condition Assessment Recommendations

Stantec analyzed recent CCTV records for EVWD sewer pipes televised since the previous SSMP. Condition scoring was provided for 3,108 unique pipes with a total length of roughly 138.9 miles, or 46 percent of the total pipe length in the EVWD system. Stantec applied the analysis performed in the 2013 SSMP to estimate the capital cost to repair and rehabilitate the pipeline assets.

Stantec used the sewer system hydraulic model to calculate existing peak flows for each pipeline, along with the Quick Ratings for each pipeline to establish a prioritization for rehabilitation. The different categories of pipelines per the matrices are then organized into four levels of prioritization as summarized by cost in Table ES-10.

Table ES-10: Prioritized List of Pipeline Condition Rehabilitation

Priority	Number of Pipelines	Estimated Length (ft.)	Project Cost ($)
Priority 1	43	4,835	1,250,000
Priority 2	43	4,777	1,238,000
Priority 3	228	17,674	4,570,000
Priority 4	132	1,450	377,000
Total	446	28,736	7,435,000

No inspection data or updated information was available for the East Trunk Sewer as part of this master plan update. The condition assessment findings presented in EVWD's 2013 SSMP is a presented. The assessment is limited to an understanding of the pipelines materials, age, hydraulic characteristics, and experience with similar types of gravity sewers. To confirm the estimated remaining life expectancy of approximately 10 years (based on a 70 useful life) and prioritize rehabilitation projects, further inspection data will need to be collected.

GENERAL RECOMMENDATIONS

Section 8 summarizes recommendations made throughout this SSMP. These recommendations have not been costed as part of the final CIP but are offered to improve system operations and aid in future analyses of the system.

Manholes:

- There are some connections in the system that cause non-ideal flow dynamics in localized areas including service laterals and main lines that enter manholes at 90-degree angles. These lines may or may not be modeled depending on the size and function in the system. It is recommended that EVWD consider reforming channels in existing manhole bases or installing new manholes in these areas to correct the problem, and in extreme cases realign the pipelines to avoid 90-degree flow patterns.
- The recommended maximum spacing allowable between manholes is 400 feet unless otherwise approved.

Sewer Flows and Projections:

- Based on the current usage data, the recommended per capita sewer flow is 70 gpcd, which accounts for decreased flows due to conservation while allowing for some increase in per capita use based on drought recovery and the lifting of drought restrictions. EVWD should periodically update this usage number based on new data to further refine the model

Septic Conversion:

- In order to maximize potential flow to the SNRC, EVWD should prioritize projects with a high density of septic customers in the same area for conversion to sewers. The map shown on Figure 4-8 shows the areas recommended for prioritizing.

Pipelines:

- New pipelines should be sized for partially-full conditions at peak dry weather flow (PDWF). Peak dry weather flow be determined using the following criteria:
    - For collector sewers less than 18-inch in diameter, the design PDWF should be equal to 3 times the average dry weather flow.
    - For trunk sewers greater than or equal to 18-inch in diameter, the design PDWF should be equal to 2.5 times the average dry weather flow.
    - These peak dry weather flows for design do not include increases in flow rates due to Rainfall-Derived Infiltration and Inflow (RDII).

System Analysis:

- While improvements are recommended for those pipe segments identified as having insufficient capacity, a d/D threshold of 0.85 is recommended as a “trigger” point to necessitate implementation of a relief project. Any modeled pipes with a d/D ratio over 0.85 at PDWF will be recommended for improvement, either immediately for existing pipes, or at the appropriate planning horizon.

Implementation and Continued Monitoring:

- Before EVWD decides to design or construct any of the recommended improvements, the need for the project should be confirmed through field investigation, flow monitoring, and additional detailed analysis.
- “Pipes to monitor” or watch areas are single pipes showing capacity deficiency in the future planning horizon during wet weather flow and should be monitored to verify the need for replacement and possibly realignment once significant growth has occurred in the service area. The deficiencies in the watch areas may be due to pipe slope or hydraulics and are localized enough that a project in not recommended in this SSMP until the deficiency can be field verified in the future.
- The following inspection and evaluation methods should be considered:

- CCTV allows visual observation of the pipe and is useful for identifying larger defects such as leaking joints, leaking lateral connections, cracks in the pipe wall, and joint alignment. CCTV technology has improved over the years and now includes “panorama” and pan and tilt capabilities.
- Laser scanning is a newer technology that provides accurate measurement of the ovality of the pipe, a measurement of wall loss above the waterline, and any defects in the pipe wall. This is an improvement over the visual CCTV because it provides actual measurements of the pipe interior in addition to visual observations.
- Sonar profiling is another newer, yet proven, technology for inspection of partially full sewer pipes and produces an image below the waterline and can be used to identify build-up of sediment or other material in the pipelines and any major defects. Previously, inspections could not provide information below the water surface. This information is helpful when planning for cleaning of the pipe to provide accurate quantities.

FUNDING

There are several possible funding sources available for the successful implementation of sewer projects, including pay-as- you-go, Clean Water State Revolving Fund Loan Program, general obligation bonds, revenue bonds, Certificates of Participation, commercial paper (short term notes), developer impact or connection fees, and other state grants and loans. These methods are further described in Section 9.

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1.0 INTRODUCTION

EVWD retained Stantec Consulting Services, Inc. (Stantec) to prepare this 2019 Sewer System Master Plan (SSMP) on January 11, 2018. This SSMP updates EVWD's 2013 Sewer Master Plan and associated hydraulic model. A brief narrative of the project background, scope of work, and a description of the report sections is presented below.

1.1 PROJECT BACKGROUND

EVWD provides both water and sewer service to customers within its service area that lies at the foothills of the San Bernardino Mountains, east of the City of San Bernardino and north of the City of Redlands. This SSMP covers the entire service area of EVWD, which includes the City of Highland, portions of the City of San Bernardino, the San Manuel Band of Mission Indians, and portions of unincorporated San Bernardino County. Since completion of the 2013 Sewer System Master Plan (SSMP), there have been significant changes in sewer generation within EVWD's service area. These changes are due to factors such as the economic downturn following the housing market collapse in 2008, the prolonged drought in southern California that severely reduced water demands and subsequent wastewater flows, and changes to anticipated development. These resulted in projected sewage generation estimated in the 2013 SSMP being higher than what was recorded.

Updated information on the proposed Harmony, Highland Hills, and Greenspot Village and Marketplace Developments have affected projected generation and planning for the sewer system. Finally, the proposed Sterling Natural Resources Center (SNRC) water recycling project has also driven a need for changes to the SSMP, such as an increased focus on converting septic systems to the sewer collection system.

The sewer system flows completely by gravity, generally from northeast to southwest. In a 1957 Joint Powers Agreement with the City of San Bernardino, all flows from EVWDs service area are discharged into the East Trunk Sewer and treated at the San Bernardino Water Reclamation Plant (SBWRP), both of which are owned and operated by the City of San Bernardino.

This SSMP update provides a guideline for the orderly planning and expansion of EVWD's sewer system and evaluates EVWD's sewer system under existing and future (near-term and build-out) conditions. EVWD currently serves a population of approximately 100,000 customers, and anticipates additional growth through expansion, infill, and septic system user conversion. Proposed developments and infill within EVWD's service area offer a significant potential for growth, and attendant generation of additional sewage. The planning and sizing of new facilities to serve new developments and customers are an important focus in this SSMP, as is quantifying future sewer flows.

1.2 GOAL AND OBJECTIVES

The primary goal of this SSMP is to provide cost-effective and fiscally responsible sewer services that meet the quality and reliability requirements of EVWD's customers. This SSMP assists EVWD achieve this goal by meeting the following objectives:

- Developing an infrastructure plan that balances sewer service reliability and cost
- Updating and calibrating EVWD's sewer system model
- Evaluating sewer system performance under existing and build-out conditions

- Identifying septic system users and planning for their conversion to the collection system
- Identifying needed capital improvement projects

EVWD's sewer system computer model was updated and calibrated based on recent flow monitoring data. The calibrated sewer model includes all pipes 10 inches in diameter and greater, as well as some smaller diameter pipes where necessary to fully define catchments within the model. Future system elements necessary to meet build-out service conditions are added to analyze the future conditions and system improvements.

Recommended improvements include all system facilities required to meet existing and future sewer system needs. These improvements are identified by analyzing the sewer system under existing and future flow conditions. The recommended improvements includes a list of recommended facilities, proposed phasing of those facilities, and opinions of probable construction cost. The recommended improvements provides EVWD with a sewer system planning road map for the future.

1.3 SCOPE OF WORK

The Scope of Work consists of the following tasks:

- Data collection and review of EVWD documents and records
- Project wastewater flows in the service area
- Update EVWD's existing model
- Analyze the collection system under existing conditions
- Analyze the collection system under future conditions
- Identify collection system improvements
- Identify septic customers and plan for conversion to the collection system
- Perform a trunk line analysis and maximize sewage flows to the SNRC
- Prepare a Capital Improvement Program for the sewer collection system

1.4 DATA SOURCES

In preparing this update, EVWD's staff supplied many reports, maps, and other sources of information. In addition, multiple meetings with EVWD staff were held to obtain a thorough understanding of available data, goals for the service area, operational issues, condition of current infrastructure, and general information on the collection system. Pertinent materials included updated GIS information, flow monitoring data, the previous computer model, data on the SNRC, and a list of septic customers. A full list of references used in this SSMP is presented in Appendix A.

1.5 ACKNOWLEDGEMENTS

Stantec wishes to acknowledge and thank all EVWD's staff for their support and assistance in completing this project. Special thanks go to the following key staff:

CEO/General Manager:	John Mura
Director of Engineering and Operations:	Jeff Noelte
Operations Manager:	Patrick Milroy

Senior Engineering Technician:	Leida Thomas

1.6 PROJECT STAFF

The following Stantec staff members were principally involved in preparing this report:

Principal-in-Charge:	Venu Kolli
Technical Reviewer:	Carl Chan
Project Manager:	Jim Cathcart
Project Engineers:	Oliver Slosser
	Michael Steele
	Areeba Syed
GIS Specialist:	Chisa Whelan

1.7 REPORT OUTLINE

This Sewer System Master Plan is divided into seven sections. Section 2 discusses the existing sewer system, while Section 3 discusses current and projected sewer generation and flow. The sewer system computer model update and calibration effort are described in Section 4. Planning criteria are discussed in Section 5 and the system evaluation is discussed in Section 6. GIS Management analysis and recommendation are presented in Section 7, and the sewer system recommended improvements are developed and discussed in Section 8. Section 9 presents funding recommendations for implementation of projects. A description of the topics discussed within each section can be found in the Table of Contents.

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2.0 EXISTING SEWER COLLECTION SYSTEM

This section describes EVWD's existing sewer system facilities and provides an understanding of the sewer system operations. The existing sewer system consists of approximately 213 miles of pipeline, 4,400 sewer manholes, 7 siphons, and 5 diversion structures. The sewer system flows into San Bernardino's East Trunk Sewer which conveys flows to the San Bernardino Water Reclamation Plant (SBWRP). The sewer system components are summarized in Figure 2-1.

A computer hydraulic model has been developed that represents the existing sewer system. This model is used for evaluating existing and future conditions, as well as to identify areas for improvements. The model creation and calibration are described in Section 4, while the system analyses for the existing and future conditions are described in Section 6.

2.1 GRAVITY SEWER PIPELINES

EVWD's sewer pipeline network includes approximately 213 miles of pipeline ranging in size from 4 inches to 24 inches in diameter. The East Trunk Sewer is approximately 9 miles long ranging in size from 8 inches to 54 inches in diameter. Table 2-1 shows the existing sewer facilities, and Figure 2-2 shows EVWD's sewer pipelines by diameter.

Approximately 75 percent of EVWD's sewer pipes are vitrified clay pipe (VCP). A majority of the rest of the pipes (17 percent of the total) are constructed of Polyvinyl Chloride (PVC). Table 2-2 and Figure 2-3 summarize the various pipe materials in the system. The East Trunk Sewer was installed in 1958 and is comprised of VCP for pipes 36 inches in diameter and smaller and reinforced concrete pipeline (RCP) for diameters 39 inch and larger.

Most pipes in EVWD's sewer collection system were installed prior to 1970. Table 2-3 and Figure 2-4 summarize the age of pipes in EVWD's system.

Stantec conducted a meeting with EVWD staff including system operators, during which flow splits and flow constrictions in the system were discussed. Flow constrictions are any transition from one pipe to another pipe where the downstream pipe has a smaller diameter than the upstream pipe, and a flow split is any manhole where sewage can flow down multiple pipelines. From these discussions, EVWD identified the following areas where a flow split or constriction has significant impact on their operation and maintenance activities:

- There is a flow split at Witlock Ave, where there is a relief line. Normal flow is routed to the main line and high flows overflow to the relief line.
- There are some connections in the system that cause non-ideal flow dynamics in localized areas. They include service laterals and main lines (at Hospital) that enter manholes at 90-degree angles. These lines may or may not be modeled depending on the size pipeline where these flow dynamics occur. It is recommended that EVWD provide new manhole bases, or new manholes in these areas to correct the problem, and in extreme cases realign the pipelines to avoid 90-degree bends.

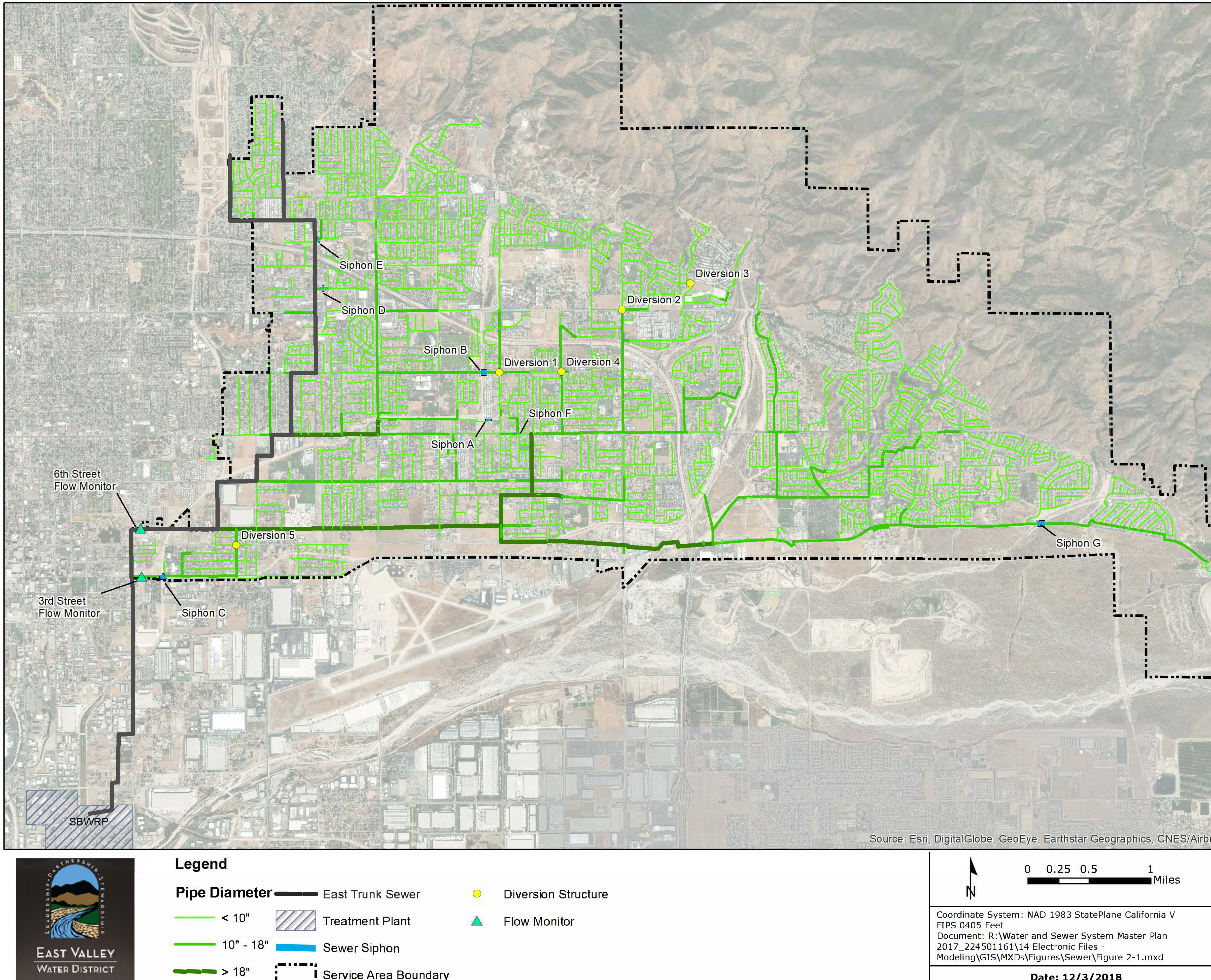
Flow splits and flow geometry were recorded and used to build the EVWD sewer system model.

Table 2-1: Summary of Sewer Mains by Diameter

Diameter (in)	Cumulative Length of Sewer Pipelines in EVWD System (LF)[1]	Cumulative Length of Sewer Pipelines Comprising SBMWD East Trunk Sewer Line (LF)[2]
4	250	0
6	157,610	0
8	789,190	970
10	41,220	2,340
12	50,560	2,290
15	39,200	9,570
16	660	0
18	13,230	2,100
21	17,300	1,200
24	16,100	2,710
27	0	3,050
30	0	2,220
33	0	2,130
39	0	1,690
48	0	4,540
54	0	7,810
Unknown	1,370	0
Total	**1,126,690**	**42,620**

[1] Source: EVWD GIS database

[2] Source: 2013 Wastewater Collection System Master Plan



Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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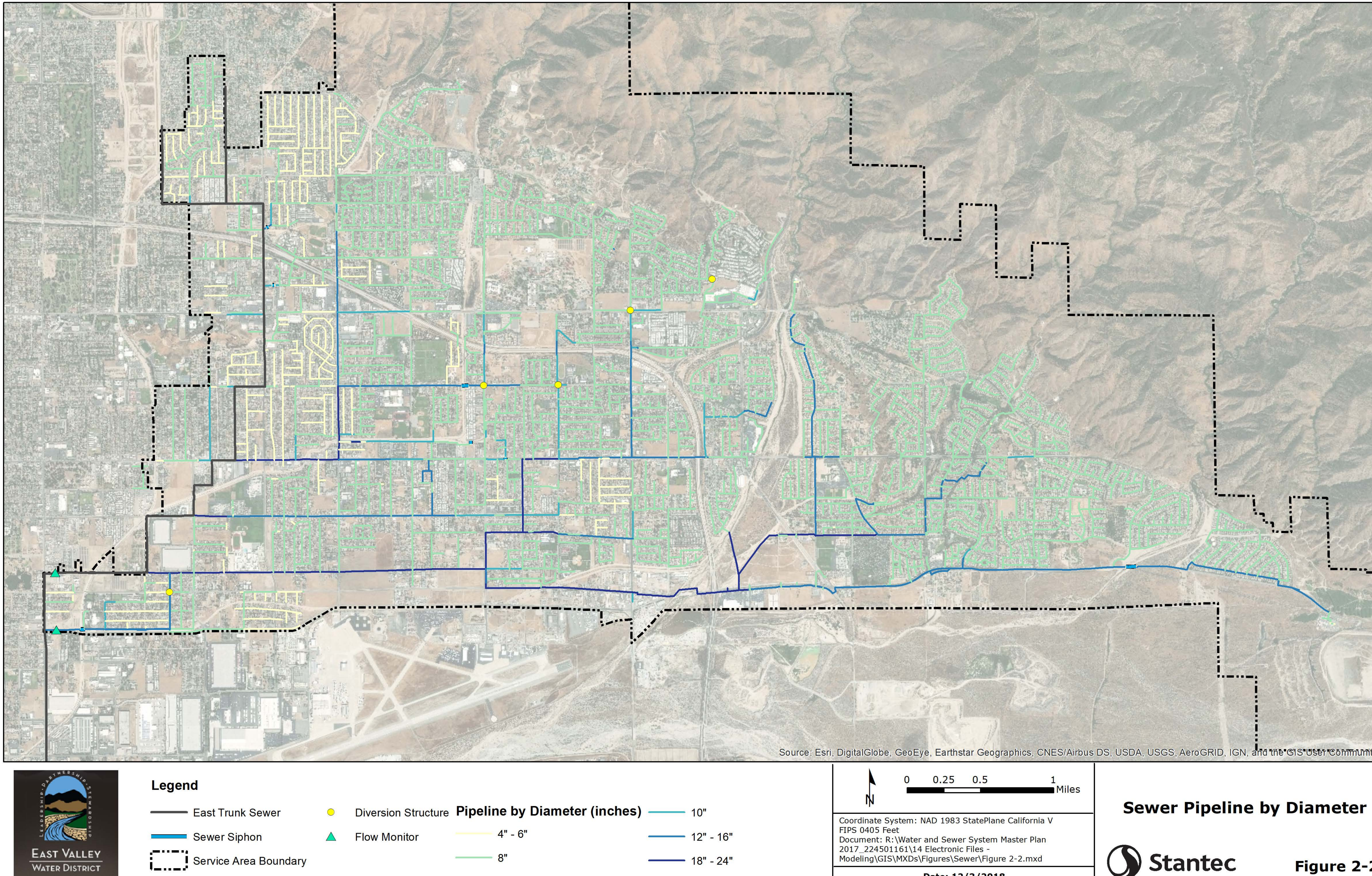
Date: 12/3/2018

East Valley Water District

Existing Sewer Facilities

Stantec

Figure 2-1



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Date: 12/3/2018

Sewer Pipeline by Diameter

Stantec

Figure 2-2

Table 2-2: Summary of Sewer Pipeline by Material

Material	Total Length (feet)	Total Length (miles)	Total Length (percent)
Acrylonitrile-Butadiene-Styrene (ABS)	6,630	1.3	1
Cast Iron (CIP)	4,780	0.9	0
Ductile Iron (DI)	4,980	0.9	0
Polyvinyl Chloride (PVC)	195,140	37.0	17
Steel	30	0.0	0
TRUSS	74,810	14.2	7
Vitrified Clay Pipe (VCP)	840,320	159.2	75
Total	**1,126,690**	**213.4**	**100**

Source: EVWD GIS database
Note: Totals are exclusive of East Trunk Sewer

Table 2-3: Summary of Sewer Pipeline by Installation Period

Installation Period	Total Length (feet)	Total Length (miles)	Total Length (percent)
1957-1959	293,540	55.6	26
1960-1969	251,270	47.6	22
1970-1979	118,660	22.5	11
1980-1989	183,260	34.7	16
1990-1999	134,410	25.5	12
2000-2009	75,370	14.3	7
2010-2016	13,210	2.5	1
Unknown	56,970	10.8	5
Total	**1,126,690**	**213.4**	**100**

Source: EVWD GIS database
Note: Totals are exclusive of East Trunk Sewer

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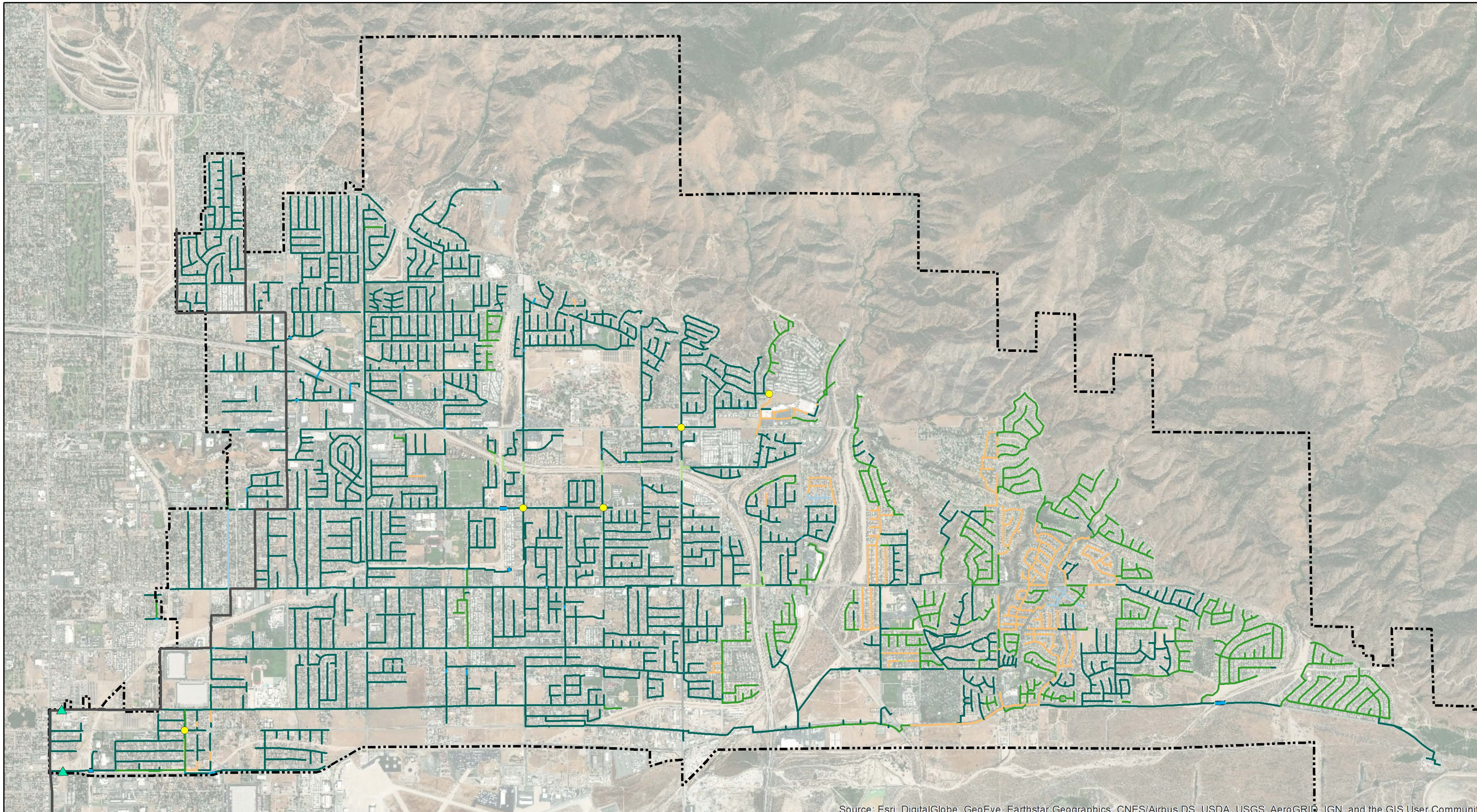

EAST VALLEY WATER DISTRICT

Legend

- East Trunk Sewer
- Sewer Siphon
- Service Area Boundary
- Diversion Structure
- Flow Monitor

Material

- Acrylonitrile Butadiene Styrene
- Cast Iron Pipe
- Ductile Iron Pipe
- Polyvinyl Chloride
- Steel
- Truss Pipe
- Vitrified Clay Pipe

N

0 0.25 0.5 1 Miles

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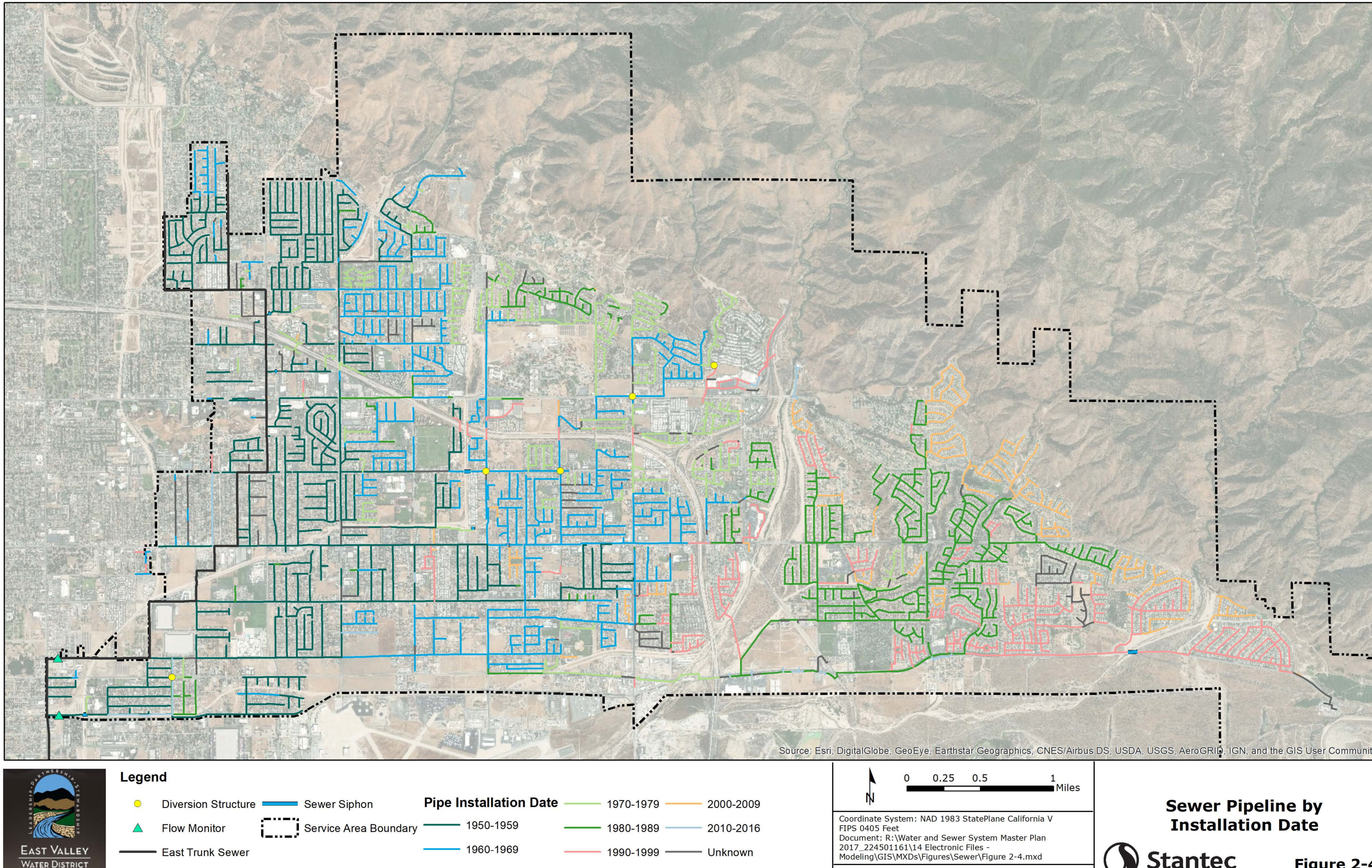
Date: 12/3/2018

Sewer Pipeline by Material

Stantec

Figure 2-3



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Date: 12/3/2018

Sewer Pipeline by Installation Date

Stantec

Figure 2-4

2.2 SIPHONS

EVWD's system includes seven siphons to convey flows in areas where physical constraints prevent gravity flow. Two additional siphons are constructed on the East Trunk Sewer. These are owned and operated by the City of San Bernardino. Table 2-4 summarize the siphons in the EVWD system.

Siphons are visually inspected weekly and cleaned monthly, cameras cannot be fed through the siphons for visual inspection. Siphons 2 and 5 are frequently impacted by grease and require regular maintenance. Siphon 3 has regular maintenance issues due to the state hospital that discharges to the siphon. Rags, bedsheets, and other items have been found in Siphon 3. EVWD has discussed the potential of cost sharing with the hospital for an onsite macerator or other solution to intercept the items before they enter the collection system. Stantec suggests that EVWD also consider requiring the hospital to install an upstream trash rack or traveling bar screen as the macerator may not be effective in dealing with fibrous material in large quantities. Maintenance and cleaning of this infrastructure would need to be determined with Hospital staff prior to a solution being implemented.

Table 2-4: EVWD Siphons

Siphon Number	Location	Number of Barrels	Diameter (in)	Length (feet)	Material	Year Installed
EVWD Siphons						
1	Between Elmwood Rd/Holly Vista Blvd intersection and Del Rosa Ave	2	6	64	CIP	1958
2	Pumalo St between Taylor Rd and Del Rosa Ave	2	6	103	CIP	1958
3	Pacific St between Victoria Ave and Valaria	3	8	235	CIP	1970
4	North of E Third St between Palm Lane and Waterman Ave	2	8	102	CIP	1957
5	San Francisco St just north of Base Line St	3	6	66	DIP	1999
6	Plunge Creek along Greenspot Rd	3	6	326	DIP	1993
7	Warm Creek Siphon	2	4	90	CIP	1971
East Trunk Sewer Siphons (Operated and Maintained by City of San Bernardino)						
8	E Sixth St between Cooley St and Pedley Rd	2	15 & 21	130	RCP	1958
9	S Waterman Ave between E Valley St and E Mill St	2	21 & 30	191	RCP	1958

2.3 DIVERSION STRUCTURES

EVWD has five diversion structures in its sewer collection system. Diversion structures are generally installed in manholes to divert flows along an alternative route in case of a blockage in the system or during times of high flow. Table 2-5 lists the diversion manholes located within EVWD's wastewater collection system.

Table 2-5: Diversion Structures

Diversion Number	Manhole Number	Intersection	Primary Flow Direction	Secondary Flow Direction
1	I6-142	Pacific Street & Victoria Avenue	West	South
2	H8-118	Highland Avenue & Palm Avenue	South	West
3	G9-161	Piedmont Drive & Diablo Drive	South	West
4	I7-126	Central Avenue & Pacific Street	South	West
5	M3-118	5th Street & Whitlock Avenue	South	West

2.4 LIFT STATIONS AND FORCE MAINS

EVWD's sewer system does not include any lift stations or force mains. All flow is conveyed by gravity to the East Trunk Sewer.

2.5 OTHER FACILITIES AND ASSETS

2.5.1 Geographic Information System (GIS)

EVWD maintains geographic information system (GIS) data of its existing facilities. Data are stored as feature classes within a geodatabase, with separate feature classes for facility types. GIS data include laterals, mains, manholes, service area boundaries, and sewersheds. Data for facilities include installation year, material, diameter,as appropriate. Data are updated as old facilities are repaired or replaced and as new facilities are installed. GIS data were used to compile most of the information presented in this section.

2.5.1.1 Septic Customers

EVWD maintains a GIS layer of septic customers, which was provided to Stantec for use in this SSMP. This information is collected by identifying customers with a water service account but no sewer account in the EVWD billing system. This septic customer GIS layer was cross referenced with billing data provided by EVWD and used to estimate future wastewater flow contributions from septic customers in the planning horizons. Septic customers are discussed in more detail in Section 4.3.2.2.

3.0 POPULATION, LAND USE, AND SEWER FLOWS

Population projections along with existing and future land use were used to analyze existing sewer flows and project future sewer flows. Specific future sewer flows are calculated based on estimated population through build-out and EVWD's will-serve list for future developments. The following sources were contacted to develop existing and future land use and population projections:

- Southern California Association of Governments (SCAG)
- United States Census Bureau
- San Bernardino County Transportation Authority
- City of Highland
- California Department of Finance

Additional details regarding existing and future population for EVWD's service area are presented in this section.

3.1 POPULATION

Population estimates were developed as described in Section 3 of EVWD's 2018 2019 Water System Master Plan (WSMP) and are summarized in the following section.

3.1.1 Existing Population

EVWD's service area population from 2017 is representative of the baseline population used for this SSMP. The 2017 population serves as the basis for future sewer flow projections and for evaluating the existing system. Population within the service area was estimated by analyzing the baseline population established in the 2014 Water System Master Plan (2014 WSMP) and applying estimated growth rates for 2010 to 2017 from California Department of Finance. Population estimates were calculated for each census block located within the service area. For census blocks partially located within the service area, the estimated population was adjusted based on the areal percentage of the census block area located within the service area. Census blocks were also visually inspected against aerial imagery to validate the adjustments made for blocks that are partially located within the service area. The 2017 population estimate within the service area is 103,249. This is a 6.4% increase from the estimated 2010 service area population of 97,001.

3.1.2 Future Population Projections

Population forecasts developed by SCAG form the basis of the projections developed by Stantec for EVWD's service area. Stantec developed population projections for the following four scenarios as discussed with EVWD staff:

- Scenario 1: Based on SCAG Projections through year 2040 using current population numbers for 2018 and applying projections thereafter.
- Scenario 2: SCAG Projections from 2021 through 2040. No growth in the service area until 2020. This scenario assumes longer recovery from current population levels to those assumed in the SCAG projections but with the same rate of increase.
- Scenario 3: SCAG Projections through year 2040. All major developments are constructed between year 2018 and year 2025. This scenario assumes a greater rate of population increase in the near-term based on

the assumption that will serve development will occur within seven years, and subsequent growth will occur at the rate assumed in the SCAG projections

- Scenario 4: SCAG Projections through year 2040. All major developments are constructed between year 2025 and year 2040. This assumes that the growth from known developments occur between 2025 and 2040, and the rate of growth until 2025 occurs at the rate assumed in the SCAG projections

Scenarios 3 and 4 assume that growth associated with the major developments are not included in the SCAG projections. Figure 3-1 shows the population projections for these scenarios.

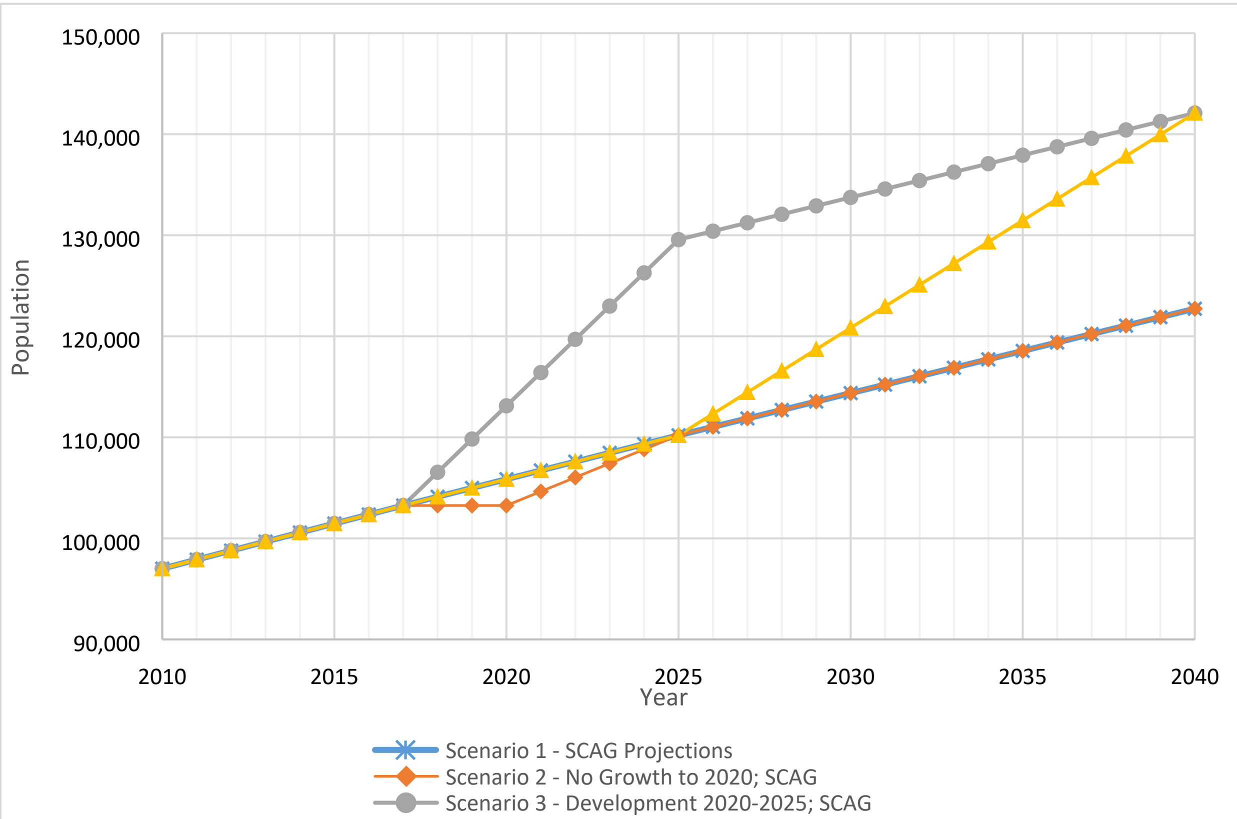

Figure 3-1: Population Projections for EVWD's Service Area

The projections range from approximately 123,000 people by 2040 in Scenarios 1 and 2 to approximately 142,000 people by 2040 in Scenarios 3 and 4. Scenarios 1 and 2 represent a 19 percent increase in population from 2017. Scenarios 3 and 4 represent a 37 percent increase from 2017. Populations for Scenarios 3 and 4 are different from Scenarios 1 and 2 as they include the proposed developments summarized in Table 3-1. As a conservative estimate, Scenario 3 was used for this SSMP.

Major future developments that were included in the population projections and their estimated future populations are summarized in Table 3-1.

Table 3-1: Major Future Developments

Name	Type	Units	Population	Percent of Total (%)
San Manual Casino Expansion and Hotel[1]	Commercial	504 Rooms	-	
Harmony	Single-Family Residential	3,600	12,600	63.7
Greenspot Village	Commercial/Multi-Family	Unknown	2,800	14.2
Highland Hills Ranch	Single-Family Residential	650	2,275	11.5
Sunland Communities	Single-Family Residential	600	2,100	10.6
Total			19,775	100

[1]: Because a casino and hotel expansion would not add any permanent population to the EVWD service area, no population numbers are accounted for in this analysis. However, the flow generation from this development is accounted for as a future projected flow in the model.

Population estimates were compared to the San Bernardino Valley Regional Urban Water Management Plan (SBVRUWMP) and are summarized in Table 3-2.

Table 3-2: Population Estimate Comparisons

	2020	2025	2030	2035	2040
Stantec Estimate – Scenario 3	113,312	130,085	134,261	138,436	142,612
2015 SBVRUWMP Estimate	124,062	130,391	135,690	141,205	146,945

3.1.3 Historical Sewer Flow Generation

Permanent flow monitors were installed in 2014 at the 3rd Street and 6th Street connections with the East Trunk Sewer, which captures much of the sewer flow generated in EVWD's service area. The average flow recorded at those meters were compared with the estimated service area population to determine an overall per capita generation factor, as summarized in Table 3-3. As shown on the table, the flow and per capita usage has trended downward since 2013 due to conservation. These trends were accounted for in the future projections used in the model.

Table 3-3: Historical Per Capita Sewer Flows

Dates	Average Monthly Flow (MGD)	Estimated Population	GPCD
2013 Sewer Master Plan Flows & 2014 Water Master Plan Estimated Population			
2010	6.5	97,001	67
Permanent Flow Monitors on 3rd and 6th Street with Estimated Populations within tributary areas[1]			
2015	6.0	91,310	66
2016	6.0	92,120	65
2017	5.9	92,930	63
Weighted average of FM 4, 6, & 7 during 2018 flow monitoring and estimated populations within tributary areas[2]			
2018 (May – June)	5.0	84,400	59

[1]Assumes 10 percent of population live outside of 3rd and 6th street flow meter sheds

[2]These three flow monitors were selected as they represent the largest area of the system without overlap from the monitors used in the flow monitoring study.

3.2 LAND USE

In addition to population, existing and future sewer flows for EVWD's service area are estimated based on development projections, land use classifications, and sewer flow duty factors. A sewer flow duty factor is the average sewer flow of a given land use type (in gallons per acre per day). Establishing sewer flow duty factors for EVWD's service area was based on the established water duty factors, water-to-wastewater factors, flow monitoring data and locations, and existing and future land use designations. The development of sewer flow duty factors using GIS (Geographic Information System) software is presented in the following paragraphs.

3.2.1 Assigning Average Flow and Land Use Types

Water consumption data and the spatial location of water meters in the system were used to establish existing water duty factors, as described in Section 3 of EVWD's 2018 WSMP. By analyzing EVWD's geocoded GIS water meter information, a link between the spatial location of the meters and the water consumption billing data was established. Several thousand additional water meters for which billing data exists were located by matching the billing addresses to existing geo-located meters. Finally, the largest remaining consumptive meters were manually located. A three-year average (2015-2017) flow was developed for these meters, and any meter that was inactive for November and December of 2017 was assumed to be inactive.

Existing land use and general plan land use shapefiles were obtained from the SCAG website. Based on their spatial locations within the service area, a land use type was assigned for each meter and current land use designations were assigned to all parcels within EVWD's service area. The resulting current land use is shown on Figure 3-2. The 2006 City of Highland General Plan land use and subsequent 2012 General Plan Implementation Report was used to establish a future land use designation for all parcels, as shown on Figure 3-3. Table 3-4 tabulates the land use classifications within the service area and summarizes the vacant and occupied acreage for each land use within the system under existing conditions.

Table 3-4: Land Use Classifications and Acreage

Land Use	Current Area (Acres)	Percent of Total	Future Planned Area (Acres)	Percent of Total
Agricultural	536	3		0
Commercial	481	3	990	6
Industrial	154	1	163	1
Multi-Family Residential	618	4	1,543	9
Open Land	1,558	9	1,031	6
Parks	212	1	173	1
Public	825	5	749	4
Single-Family Residential	5,004	30	8,136	48
Vacant	7,490	44	4,093	24
Total	16,878	100	16,878	100

3.2.2 Sewer Duty Factors

Sewer flow generation duty factors were developed for each land use type using the water duty factors developed for the water master plan, the results from the land-use specific flow monitoring study, and review of typical values. A water duty factor for each land use type was calculated by dividing the three-year average flow for each meter overlying a parcel (from 2015 to 2017) in gallons per day (gpd) by the area (in acres) of the parcel it serves. These values were then averaged for every meter in the system by land use type. Because sewer flows are not metered at every customer connection, a water-to-wastewater ratio was estimated based on typical flows that each land use type contributes to sewer flow. Multiplying the water duty factors by the water-to-wastewater ratio results in the sewer flow duty factors. Table 3-5 contains the initial sewer flow duty factors for the different land use types.

Table 3-5: Calculated Sewer Duty Factors

Land Use	Water Duty Factor (GPD/acre)	Water to Wastewater Ratio (Wastewater/Water)	Sewer Flow Duty Factor (GPD/acre)
Agricultural	1,000	0	0
Commercial	2,000	0.25	500
Industrial	800	0.38	300
Multi-Family Residential	3,500	0.60	2,100
Open Land	1,000	0	0
Parks	3,000	0	0
Public	3,000	0.10	300
Single-Family Residential	2,000	0.45	900
Vacant	0	0	0

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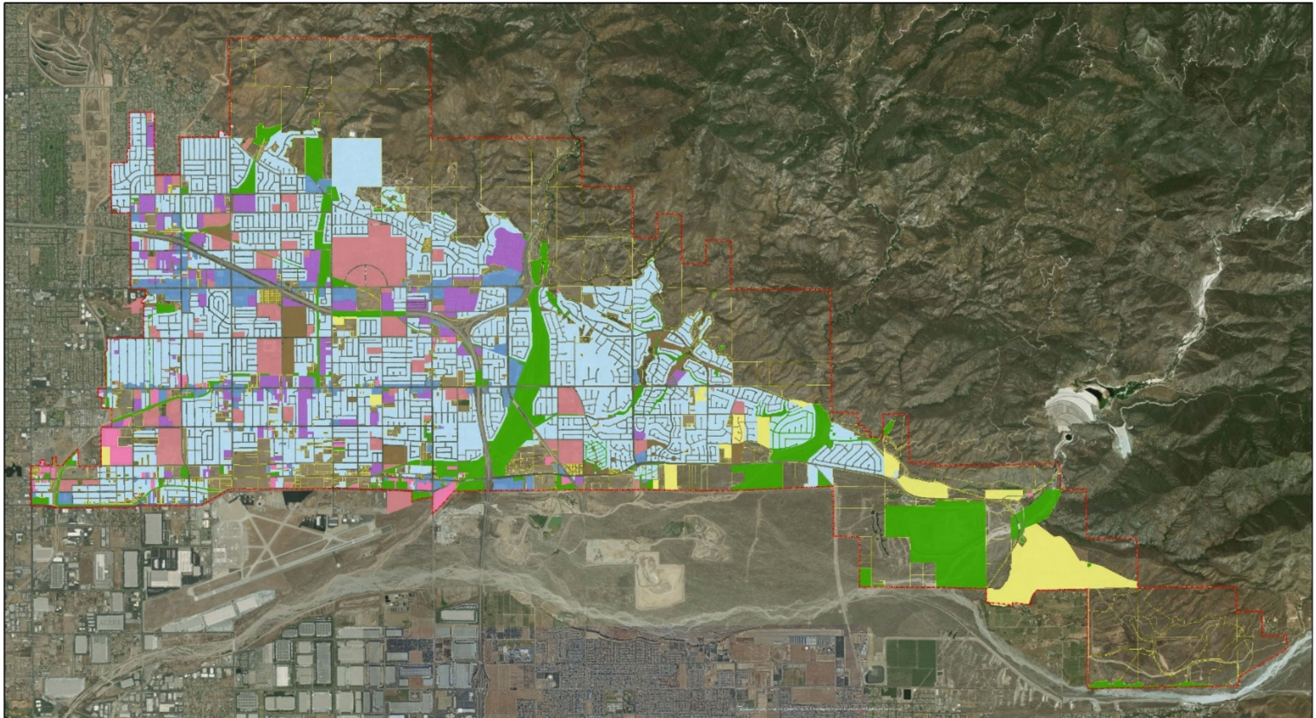
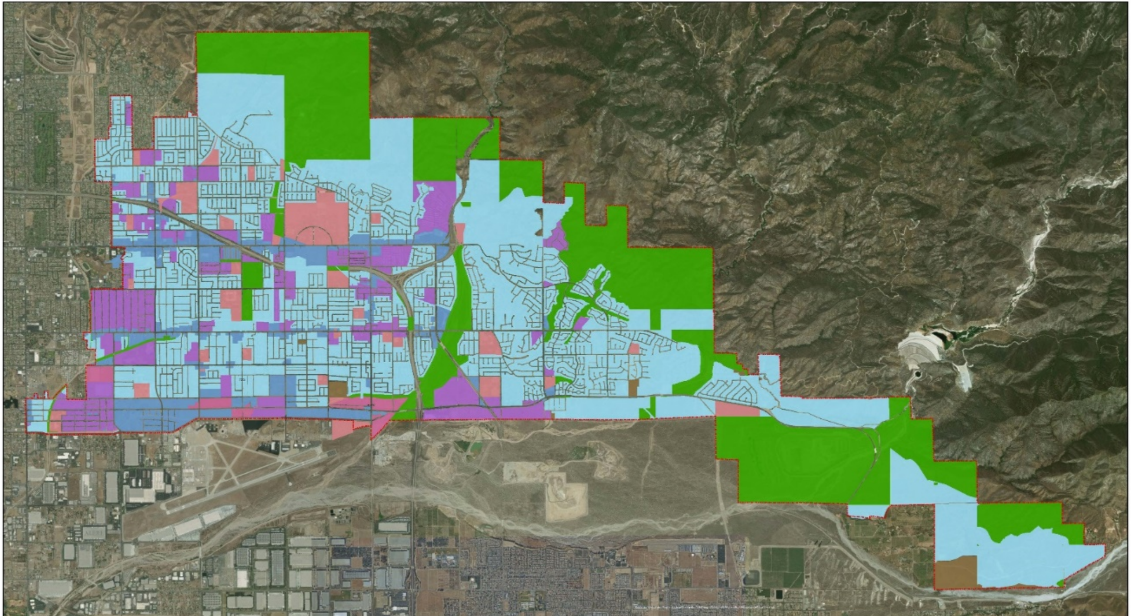


Existing Land Use

Figure 3-4



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Date: April 27, 2018

Future/Buildout Land Use

Stantec

Figure 3-5

Three land-use-specific wastewater flow meters were deployed to help determine the volume and diurnal pattern of flow generated from an area with a single land use. The results are summarized in Table 3-6.

Table 3-6: Land Use Sewer Generation Study Results

Location	Pacific St. and Elm Ave.	Date St. and Chiquita Ln.	Piedmont (4010 Highland Ave.)
Type	Single-Family Residential	Multi-Family Residential	Commercial
Acres	50.9	11.3	33.7
Metered Average DWF (MGD)	0.055	0.065	0.015
Duty Factor (GPD/Acre)	1,075	5,740	440
Dwelling Units	269	163	0
Per Dwelling Unit (GPD)	204	397	-
Per Person (3.5/unit)	58	113	-

Sewer duty factors were input into the collection system model and were calibrated against measured flow at the 3rd and 6th street flow monitors, as well as the 10 temporary flow monitoring locations as discussed in Section 4.2. This process uses the initial duty factors presented in Table 3-5, and then adjusts them as necessary to match measured values from the flow monitors. Table 3-7 show the final calibrated sewer generation duty factors, and the total flows by land use tributary to the 3rd and 6th street flow monitors.

Table 3-7: Final Sewer Generation Duty Factors

Land Use	Sewer Flow Generation Duty Factor (GPD/Acre)	Acreage in 3rd and 6th Street Flow Meter Shed	Duty Factor Calculated Flow (MGD)*
Agriculture	0	34	0
Commercial	500	432	0.22
Industrial	500	109	0.05
Multi-Family Residential	2,100	571	1.20
Open	0	75	0
Park	0	125	0
Public	600	760	0.46
Single-Family Residential	925	4,382	4.05
Vacant	0	209	0
Total		6,697	**5.98**
Avg. 2015-2017 dry weather flow at 3rd and 6th Street flow monitors			**5.97**

* Total DWF for all areas tributary to the 3rd and 6th street flow monitors.

3.2.3 Build-Out Sewer Flow Projections – Land Use Methodology

Using the sewer flow duty factors described previously in this section, build-out sewer flow projections were estimated based on general plan land use designations obtained from SCAG. Build-out flows for parcels were estimated using the sewer flow duty factors estimated for the land use types. The projected build-out sewer flow is approximately 11.8 MGD. The estimated flow generated by land type is summarized in Table 3-8.

Table 3-8: Existing and Build-out Land-Use-Based Sewer Generation

Land Use	Existing Land Use (Acres)	Existing Calculated Avg. DWF (MGD)*	Future/Build-out Land Use (Acres)	Build-out Calculated Avg. DWF (MGD)
Agriculture	536	0		0
Commercial	481	0.24	990	0.50
Industrial	154	0.08	163	0.08
Multi-Family Residential	618	1.30	1,543	3.24
Open	1,558	0	1,031	0
Park	212	0	173	0
Public	825	0.50	749	0.45
Single-Family Residential	5,004	4.63	8,136	7.53
Vacant	7,490	0	4,093	0
Total	**16,878**	**6.74**	**16,878**	**11.79**

* DWF totals for all areas in the EVWD service area

The build-out capacity of the SNRC facility is 10 MGD, which is less than the projected wastewater generation for the EVWD service area at build-out. However, due to the location of the SNRC, not all wastewater generated in the system can be conveyed to the facility cost efficiently and therefore the SNRC will likely be capable of treating any wastewater tributary it.

3.2.4 Future Sewer Flow Projections – Population Methodology

A per capita sewer flow generation factor must be established to estimate future flows by population growth. The future population includes all customers estimated to live in the service are, including septic customers. When compared to historical trends, the 2018 flow monitoring period had lower than average flows. This is due to water conservation and drought restrictions since the previous SSMP. Based on the current usage data, the recommended per capita sewer flow is 70 gpd per capita, which accounts for the impact of conservation while allowing for some increases in per capita use based on drought recovery and lifting of some conservation requirements.

Additional conservation was not assumed for the future scenarios as the current per capita usage rate is historically low and may represent a minimum for possible conservation in the service area. Recent water usage was below the 2020 compliance target of 175 gpcd and is expected to stay below this number. Assuming 70 gpcd, the projected increase in flow due to population growth (not associated with specific developments) is shown in Table 3-9. Infill growth is defined as densification within the service area and accounts for changes in land use and occupancy of vacant areas throughout the system.

Table 3-9: Increase in Flow due to Infill Population Growth

	2018	2020	2025	2030	2035	2040
Population	103,249	105,418	110,430	115,690	121,210	122,802
Flow (MGD)	7.23	7.38	7.73	8.10	8.48	8.60
Increased in Flow (MGD)		0.15	0.50	0.87	1.26	1.37

Note: Assuming 70 gpd per capita

Future major developments not included in the population growth were also analyzed. Using specific development information and EVWD's will-serve list, populations and sewer flow were projected for the future scenarios. Future planned developments with population greater than 500 are included. When detailed information on projected population for these developments were not available, 3.5 people per dwelling unit were assumed (from City of Highland 2012-2016 Census data) and a per capita sewage generation of 70 gpd were assumed, for a total sewer flow of approximately 245 gpd per dwelling unit. In the absence of dwelling units, the expected flow generation for the development was based on the population and the 70 gpcd generation rate. These projections are summarized in Table 3-10.

Table 3-10: Increase in Flow due to Specific Major Developments

Development	Population Estimate	Sewer Generation (MGD)
Harmony	12,712	0.88
San Manual Casino Expansion		1.01
Greenspot Village	2,800	0.20
Highland Hills Ranch	2,275	0.16
Sunland Communities	2,100	0.15
Total	**19,887**	**2.39**

3.2.5 Summary of Future Flow Projections

The projected future flows from these various projection methods were compared with each other, historical data, and previous projections, and discussed with EVWD staff. The following projection methodology was used for each of the three planning horizons.

The flows assigned to the existing model scenario are equal to the estimated service area population multiplied by the established per-capita generation factor. Flows assigned to the model for the near-term scenario are equal to all specific future developments being built in addition to the infill population growth from 2017 to 2025. While 2025 was selected for the infill growth, the near-term scenario is not specific to any year and is predicated upon will serve development timing. The flows assigned to the model for the build-out scenario are equal to the totals based on the land-use duty factors and build-out land use. Specific flows for major developments are retained in the build-out scenario; if an inflow was identified for the near-term scenario it was not decreased in the build-out scenario in order to match build-out land use estimates.

These totals provide a conservative estimate of the flows that EVWD could experience in the system at each planning horizon. Overall, the projected flows are similar in volume to the 2013 SSMP at each planning horizon, however the year in which these flows are projected are roughly five years later than what was projected in the previous master plan, likely due to slower growth in the service area. Final projected future flows as input into the collection system model are summarized in Table 3-11 and represented on Figure 3-4. The “Planning Total” line on Figure 3-4 represents the final projections used for this SSMP.

Table 3-11: Average Dry Weather Flow Projection Comparisons in MGD

	Existing 2018	2020	Near-Term	2030	2035	Build-Out
Land Use	6.34	7.05	8.23	9.42	10.60	11.79
Population Method	7.23	7.41	7.71	8.01	8.3	8.59
Future Developments			2.39			
Population and Future Developments	7.23		10.1			10.98
Flows to Model	**7.23**		**10.1**			**11.79**

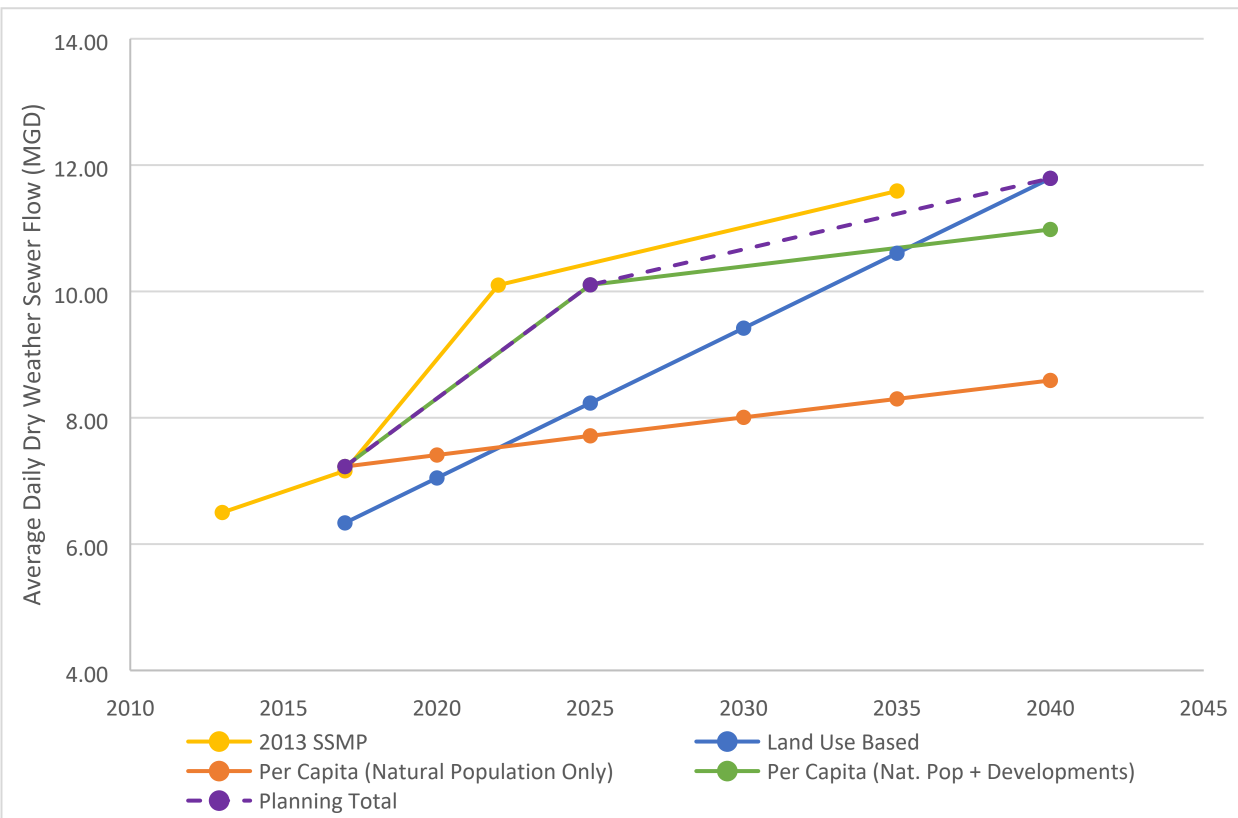


Figure 3-4: Summary of Future Sewer Generation Projections

4.0 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

The process of updating the existing sewer system model included data collection, model construction, flow allocation, future projections, and calibration. The discussion of data collection in this section includes information on how data were prioritized and incorporated into the model, and the assumptions and methods used for addressing incomplete data. Assets constructed since the previous SSMP were also added to the updated model. A discussion is included on the methodology used to allocate existing and future dry and wet weather flows into the model scenarios. Finally, a discussion on calibration of the model is presented.

4.1 MODEL DEVELOPMENT

EVWD's existing sewer model was created using Innovyze InfoSewer, which is run in the ESRI ArcGIS, Version 10 environment, allowing for a modeling system that is fully integrated with GIS software and permits all the advanced ArcGIS functions to be used. With EVWD's most recent GIS data, the previous model was updated to reflect physical changes in the sewer collection system that have occurred since the previous model build.

This model build process begins with reviewing and updating sewer GIS data (manholes, pipes, and siphons), identifying sewer asset nomenclature, inputting data into the sewer model, and performing a quality check of model input datadata. Once the model is verified for connectivity (pipes connecting to manholes) and it is confirmed that the model runs properly, sewersheds are created in order to subdivide the service area into distinct areas. Sewer flows are calculated and assigned to the sewersheds in the model by identifying a demand node within each sewershed. Once the model flows have been assigned, the model is calibrated against flow data from field monitoring, to ensure agreement, and then used to run analyses and identify any sewer capacity issues.

4.1.1 Data Collection

Data were provided by EVWD for developing the model update. Key data sources used for the model update include:

- Previous EVWD Sewer Model
- 2013 Sewer Master Plan
- GIS file of sewer mains
- GIS file of sewer manholes
- GIS file of 1-foot contours
- As built drawings of new infrastructure
- Atlas maps

4.1.2 Data Update

The first step in the model update process is to review available data and identify any data gaps. The sewer network is built using GIS files of the sewer pipes and manholes in GIS shapefile format (.shp). These shapefiles are projected in the State Plane Coordinate System North American Datum of 1983 (NAD83), California Zone V. The attribute information from shapefiles are organized into categories known as fields, which contain information such as identification (ID) numbers, installation year, material, lengths or depths, invert elevations, and other attributes of a pipe or manhole.

New pipes and manholes that need to be input into the model are identified and the data attributes reviewed. During Stantec's review, most of the missing data identified were ground and invert elevation data as well as missing ID numbers. Missing ID numbers were resolved by evaluating other attribute values for the GIS record in question, discussion with EVWD staff, and referencing as built drawings and atlas maps to identify the ID for the specific record. Missing elevations and depths were determined by evaluating attribute values for the record in question, discussion with EVWD staff, and referencing other sources of data such as atlas maps. When an elevation or depth could not be determined from the supporting data, adjacent pipes, manholes, or contours were used to estimate the missing information. All missing data and resolutions were catalogued before being resolved. A full list of missing data and the respective resolution is detailed in Table 4-1 below.

Table 4-1: Missing Data

Facility ID	Missing Attribute Field	Solution	Value
S-SM-N2-1021	Facility ID	Determined from adjacent pipes.	S-SM-N2-1021
S-MH-H10-134	ManHoleNumber	Determined from Facility ID.	H10-134
S-SM-M16-1027	UpManhole, DownManhole	Determined from connecting manhole numbers.	M16-126, M16-125
S-SM-M16-1028			M17-100, M16-126
S-SM-M17-1000			M17-102, M17-100
S-SM-M17-1001			M17-103, M17-102
S-SM-M16-1026	InElevation, OutElevation (pipe slope reversed)	Switched two attributes to achieve correct slope based on Slope and PipeLength values and adjacent pipes.	1639, 1626.37
S-MH-J6-134	RimElevation	InvertElevation – ManholeDepth.	1130.03
S-MH-J6-137			1131.4
S-MH-M3-138	RimElevation	Estimated from nearest 1-foot contours.	1064
S-MH-M3-137			1063
S-MH-M3-136			1063
S-MH-M3-135			1061
S-MH-M3-134			1060
S-MH-N3-119			1059.5
S-MH-N3-118			1057
S-MH-N3-117			1055
S-MH-N3-116			1054
S-MH-N2-121			1053
S-MH-N2-120			1050
S-MH-N2-119			1050
S-MH-N2-118			1048
S-MH-N2-117			1045
S-MH-N2-116			1042.5
S-MH-M12-137			1333

Facility ID	Missing Attribute Field	Solution	Value
S-MH-K8-153			1203.5
S-SM-L8-1002	OutElevation & InElevation	Estimated from downstream manhole invert and minimum flow.	1194.22, 1196.6
S-SM-H7-1107 S-SM-H7-1084 S-SM-H7-1121 S-SM-H7-1091 S-SM-H7-1108 S-SM-H7-1109 S-SM-H7-1110 S-SM-H7-1115 S-SM-H7-1114 S-SM-H7-1091 S-SM-H7-1004 S-MH-H7-177 S-MH-H7-176 S-MH-H7-150 S-MH-H7-152 S-MH-H7-156 S-MH-H7-155 S-MH-H7-200 S-MH-H7-201 S-MH-H7-202	InvertElevation	Owned by Patton State Hospital. Not added to model.	

4.1.3 Nomenclature

Easy identification of model elements (i.e. links and nodes) is important as it provides for better understanding and use of the model. The model requires a unique identification value for each element. Identification for the manholes in the model is based on EVWD's manhole number. Identification for the pipes in the model is based on EVWD's Facility ID number.

In the model, pipes are represented as links and manholes are represented as nodes. Not every node in the model will represent a manhole. Additional nodes may be needed along a pipe to model changing invert elevations or offsets that do not occur at a manhole. An example of this is a siphon where the pipe slope changes throughout the siphon with no manhole. These pipe slope changes are represented in the model with multiple links and require a node to be added between the links. New nodes in the model that are not associated to EVWD manholes are labeled as a 2- or 3-digit numerical ID code designated by the InfoSewer software. Nodes associated with East Trunk Sewer manholes are labeled with a 7-digit numerical ID code. Links in the model associated with East Trunk Sewer pipes are named with a 14-digit numerical ID code, or as BV followed by a 2-digit numerical code (BV##). This nomenclature system is carried through from the previous master plan to keep the update consistent with the previous model.

4.1.4 Model Update

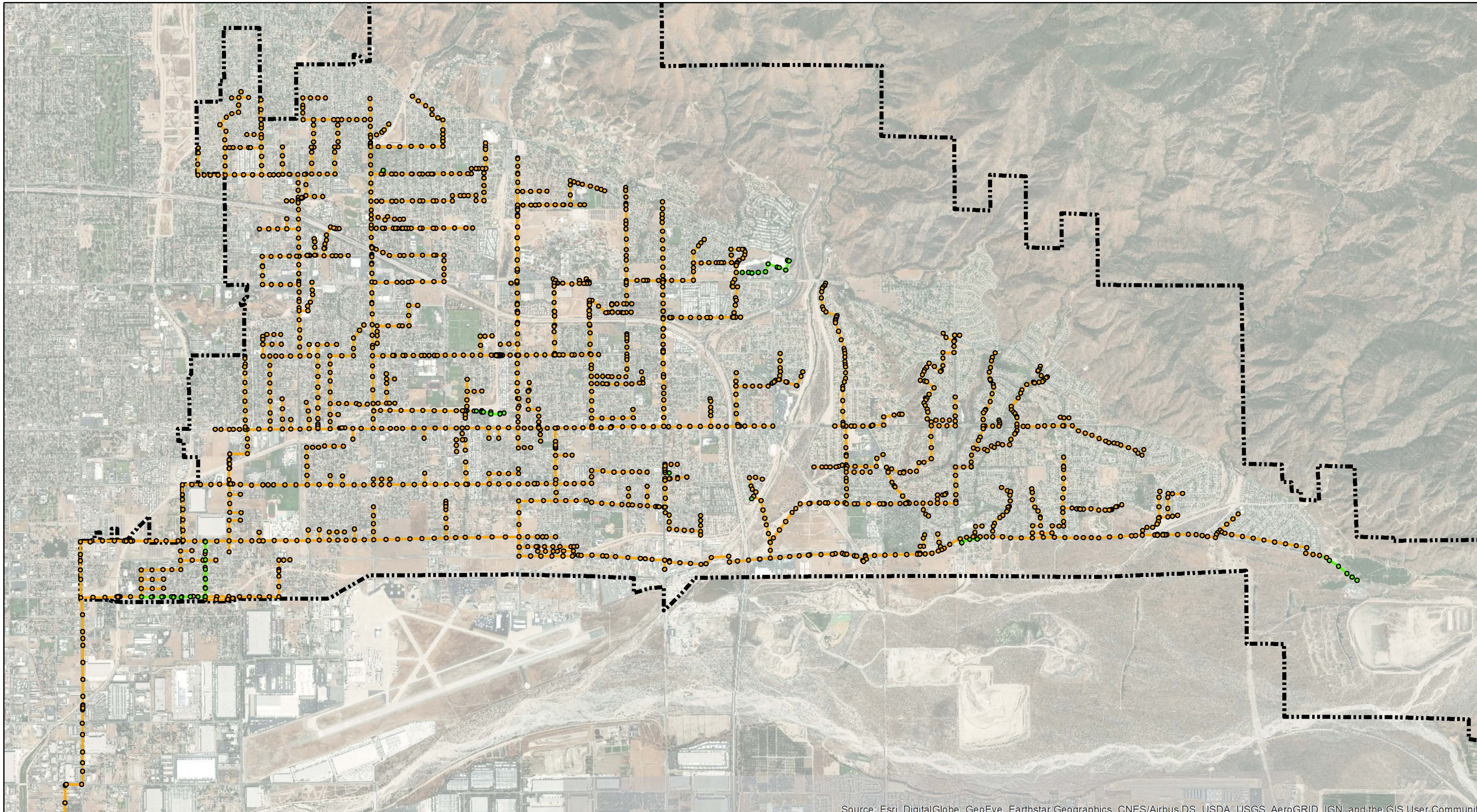
After missing data were identified, resolved, and input into the GIS database, the model was updated with infrastructure changes that occurred since the previous model version. The criteria used to identify new pipes and manholes added to the model were determined by the following:

- Mains greater than or equal to 10" diameter and associated manholes
- All manholes where sanitary sewer overflows (SSOs) have occurred
- Any mains and associated manholes needed to connect features to the sewer model

A list of the Facility ID numbers of the pipes and manholes that were added to the model are listed in Table 4-2 and shown on Figure 4-1.

Table 4-2: New Model Assets

Pipes Added			
S-SM-M16-1026	S-SM-H9-1035	S-SM-M12-1038	S-SM-M3-1043
S-SM-F5-1049	S-SM-J6-1049	S-SM-M12-1039	S-SM-N2-1020
S-SM-H10-1004	S-SM-J6-1050	S-SM-M12-1042	S-SM-N2-1021
S-SM-H10-1031	S-SM-J6-1051	S-SM-M16-1026	S-SM-N2-1022
S-SM-H10-1032	S-SM-J6-1054	S-SM-M16-1027	S-SM-N2-1023
S-SM-H10-1033	S-SM-J6-1055	S-SM-M16-1028	S-SM-N2-1024
S-SM-H10-1035	S-SM-J6-1056	S-SM-M17-1000	S-SM-N2-1025
S-SM-H9-1022	S-SM-J6-1059	S-SM-M17-1001	S-SM-N2-1026
S-SM-H9-1030	S-SM-J6-1060	S-SM-M3-1039	S-SM-N3-1020
S-SM-H9-1031	S-SM-J6-1061	S-SM-M3-1040	S-SM-N3-1021
S-SM-H9-1033	S-SM-L9-1028	S-SM-M3-1041	S-SM-N3-1022
S-SM-H9-1034	S-SM-M12-1037	S-SM-M3-1042	S-SM-N3-1023
S-SM-L8-1002			
Manholes Added			
F5-150	J6-133	M12-136	N2-116
H10-102	J6-134	M12-137	N2-117
H10-104	J6-136	M16-125	N2-118
H10-130	J6-137	M16-126	N2-119
H10-131	J6-138	M17-100	N2-120
H10-133	J6-139	M17-102	N2-121
H10-134	J6-140	M17-103	N3-116
H9-125	J6-141	M3-134	N3-117
H9-126	J6-142	M3-135	N3-118
H9-128	K8-153	M3-136	N3-119
H9-129	L9-126	M3-137	
H9-130	M12-135	M3-138	



EAST VALLEY WATER DISTRICT

Legend

- Service Area Boundary
- New Pipes
- New Manholes
- Pipes
- Manholes

N

0 0.275 0.55 1.1 Miles

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Date: December 11, 2018

New Sewer Model Assets

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Figure 4-1

4.1.4.1 Field Mapping

The GIS Gateway tool was used to import shapefiles into the model, and link data from the shapefile fields to the appropriate InfoSewer model attributes. The names of the shapefiles used to create the model and the field mapping to the model are shown in Table 4-3.

Table 4-3: GIS Shapefile Field Mapping to Sewer Model

EVWD Shapefile Name	Shapefile Description	Field Title	Description	InfoSewer Attribute
sManhole.shp	EVWD Manholes	RimElevati	Manhole Rim Elevation	MHHYD->RIM_ELEV
		FacilityID	Facility ID Number	MANHOLE->2018FACID
		GIS X[1]	X position	NODE->X
		GIS Y[1]	Y position	NODE->Y
sMain.shp	EVWD Pipes	UpManhole	Upstream manhole name	LINK->FROM
		DownManhol	Downstream manhole name	LINK->TO
		MainSize	Pipe diameter	PIPEHYD->DIAMETER
		Material	Pipe material	PIPE->MATERIAL
		InElevatio	Upstream invert elevation	PIPEHYD->FROM_INV
		OutElevati	Downstream invert elevation	PIPEHYD->TO_INV
		FacilityID	Facility ID Number	PIPE->2018FACID
		GIS Length[1]	Pipe length	PIPEHYD->LENGTH

Note: [1] Calculated GIS values

4.1.4.2 Pipe Roughness Coefficients and Manhole Diameters

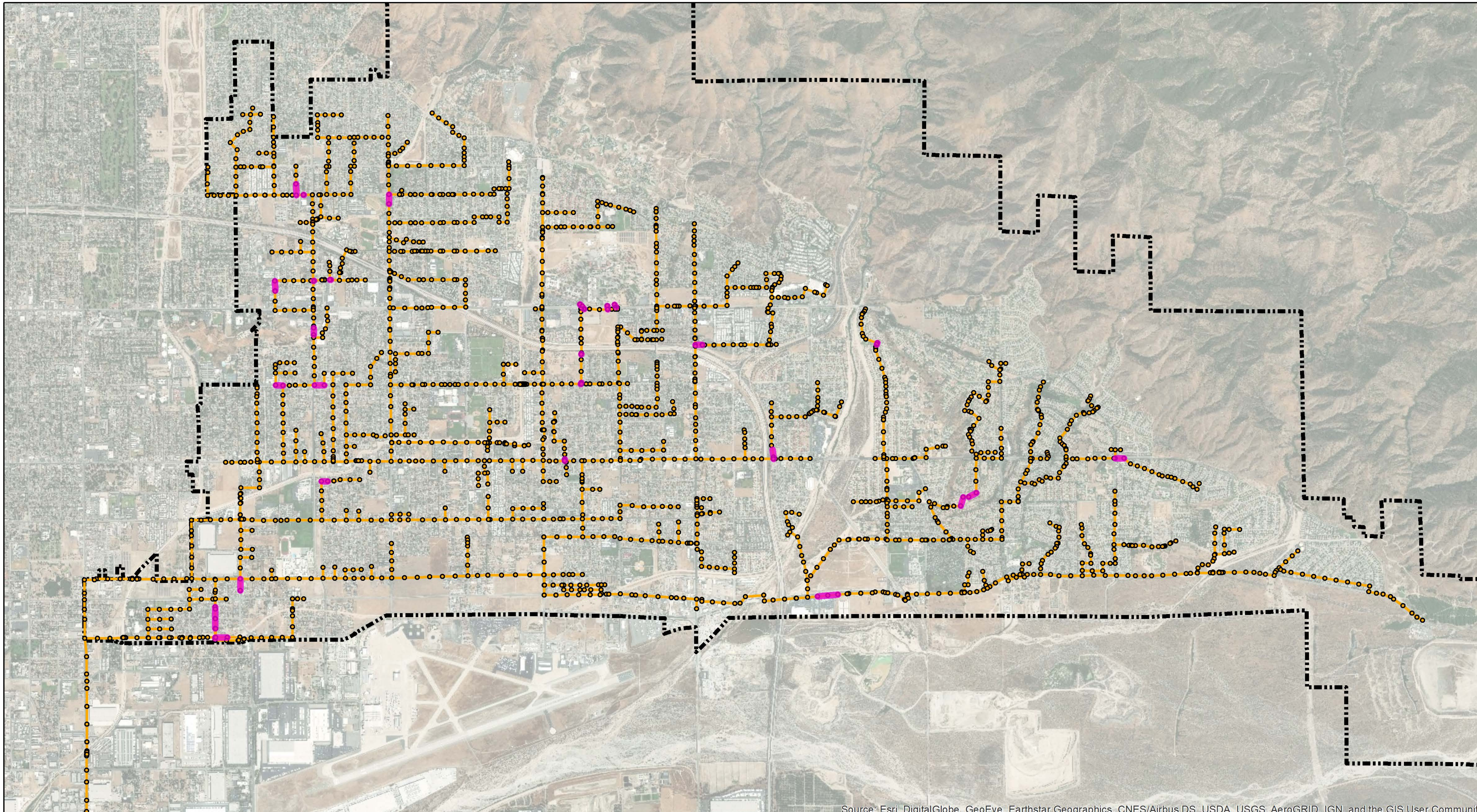
In addition to the GIS data provided in the shapefiles, certain element attributes are needed in order to run the model. These attributes include pipe roughness coefficients used to calculate friction losses as the wastewater flows through the sewers and manhole diameters, which are not always contained in the provided GIS. Pipe roughness coefficients were manually assigned to all pipes added to the model and assumed to be a Manning's $n = 0.013$. This assumption is based on the previous model and industry standards for pipes that have been in service for many years. This initial assumption was further refined during model calibration. Diameters for manholes that were added to the model were assumed to be 5 feet. The diameters of the manholes do not have a significant modeling effect on the hydraulics of the underlying flow but do define a volume for the manhole and amount of sewage needed to cause an overflow. Since pipes in the system showing full flow are identified for monitoring or improvement, the volume for overflow is not a significant factor in model analysis. Both assumptions were made for consistency with the previous version of the model.

4.1.4.3 Model Verification

Once new infrastructure was identified and added to the model, a comparison of the previous model to EVWD's current GIS database was performed in ArcMAP and in Excel to find existing model assets whose attributes changed since the previous model update. Pipes with different diameters, materials, or that had been abandoned were changed in the model to match EVWD’s current GIS information. Table 4-4 lists the pipes that were updated in the model and the respective changes and are shown on Figure 4-2.

Table 4-4: Modeled Pipe Updates

Change Type	Facility ID #	Changed From	Changed To
Diameter	S-SM-F5-1051	8”	10"
	S-SM-H4-1003	8"	10"
	S-SM-H4-1015	10"	12"
	S-SM-H4-1061	15"	18"
	S-SM-H7-1000	12"	10"
	S-SM-H7-1001	12"	8"
	S-SM-H7-1005	12"	10"
	S-SM-I10-1004	12"	8"
	S-SM-I3-1010	6"	10"
	S-SM-I4-1069	6"	8"
	S-SM-I7-1031	12"	8"
	S-SM-I7-1073	12"	8"
	S-SM-I8-1020	12"	10"
	S-SM-J9-1060	10"	8"
	S-SM-K4-1031	8"	6"
	S-SM-K9-1006	10"	8"
	S-SM-N3-1007	8"	15"
Material	S-SM-K7-1011	Vitrified Clay Pipe	Ductile Iron Pipe
	S-SM-K7-1013	Vitrified Clay Pipe	Ductile Iron Pipe
	S-SM-K11-1057	Vitrified Clay Pipe	PVC
	S-SM-K11-1062	Vitrified Clay Pipe	PVC
	S-SM-N3-1007	Vitrified Clay Pipe	PVC
	S-SM-M3-1009	Vitrified Clay Pipe	Truss
	S-SM-M3-1028	Vitrified Clay Pipe	Truss
	S-SM-M3-1036	Vitrified Clay Pipe	Truss
	S-SM-N3-1008	Vitrified Clay Pipe	Truss
	S-SM-F4-1034	UNK	Vitrified Clay Pipe
	S-SM-F4-1047	UNK	Vitrified Clay Pipe
	S-SM-H3-1003	UNK	Vitrified Clay Pipe
	S-SM-M10-1015	PVC	Vitrified Clay Pipe
	S-SM-M10-1016	PVC	Vitrified Clay Pipe
	S-SM-K13-1004	PVC	Vitrified Clay Pipe
Abandoned	S-SM-H7-1002	Active	Removed
	S-SM-H7-1003	Active	Removed
	S-MH-H7-102	Active	Removed
	S-MH-H7-103	Active	Removed



East Valley Water District

Legend

- Updated in Model
- Modeled Manholes
- Modeled Pipes
- Service Area Boundary

N

0 0.25 0.5 1 Miles

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Date: December 11, 2018

Sewer Model Asset Updates

Stantec

Figure 4-2

4.1.5 Model Correction and QA/QC

Once GIS information was input into the model using the GIS Gateway, a thorough quality assurance and quality control (QA/QC) analysis of the system was conducted for pipeline and manhole data. To execute this QA/QC process, several tools within the InfoSewer model were employed. In addition to the proprietary functions of the InfoSewer software, manual checks of data were performed to ensure accuracy, with emphasis placed on new or changed elements in the model as described above. Because this project entails the update of an existing model as opposed to the creation of a new one, many typical errors that would need to be resolved had previously been addressed. Because extensive evaluation was done of the data prior to model update, many potential errors with the updated model assets were identified early in the process. The following QA/QC checks were performed of the updated model:

- Review pipes not connected to a manhole
- Delete abandoned and orphaned manholes
- Verify pipe lengths against GIS
- Verify manhole rim elevations against GIS
- Verify pipe information (e.g., upstream and downstream invert elevations, pipelines with missing diameter, etc.)
- Profile check of new pipes in the model. Profile checks involve visualizing the hydraulic profile of the pipes in the InfoSewer software and verifying connectivity and a negative slope.

Discrepancies between the GIS data and the InfoSewer model included the following:

- Pipes (1884 total pipes)
  - 63 pipes did not have a pipe length in the GIS database.
  - 23 pipes had greater than a one-foot difference between their modeled and GIS lengths.
  - 102 pipes had no associated upstream invert elevations
  - 99 pipes had no downstream invert elevations in the GIS database.
  - 54 pipes were identified with a difference in elevation of greater than 1 foot between the modeled and GIS elevations.
- Manholes (1865 total manholes)
  - 107 had no GIS rim elevations
  - 35 manholes were identified with a difference in elevation of greater than 1 foot between the modeled and GIS elevations.

Discrepancies with new manholes and pipes added to the model were resolved by reviewing adjacent network features and attributes, discussions with EVWD staff, and referencing supporting data as discussed in Section 4.1.2.

4.1.6 Adequacy of Sewershed Areas

When developing a sewer system model, the geographical area that the model covers must be divided up into sub-areas, or sewersheds. These geographical areas represent all the pipes and manholes in a similar area, such as a neighborhood block, that are contributing flow to a single node in the model. By dividing the service area into these sewersheds, sewer flows can be easily summed up and assigned to nodes within the model. Creation of these sewersheds requires balancing the ease of which the modeler can assign flows to nodes in the model, while not being so large that they do not represent flow in individual pipes accurately, and thus do not accurately represent the creation of flow throughout the system. It is important that each sewershed has a single outlet for flow (i.e. one exiting pipeline); otherwise flows might be misappropriated in the model and sent down the wrong pipeline.

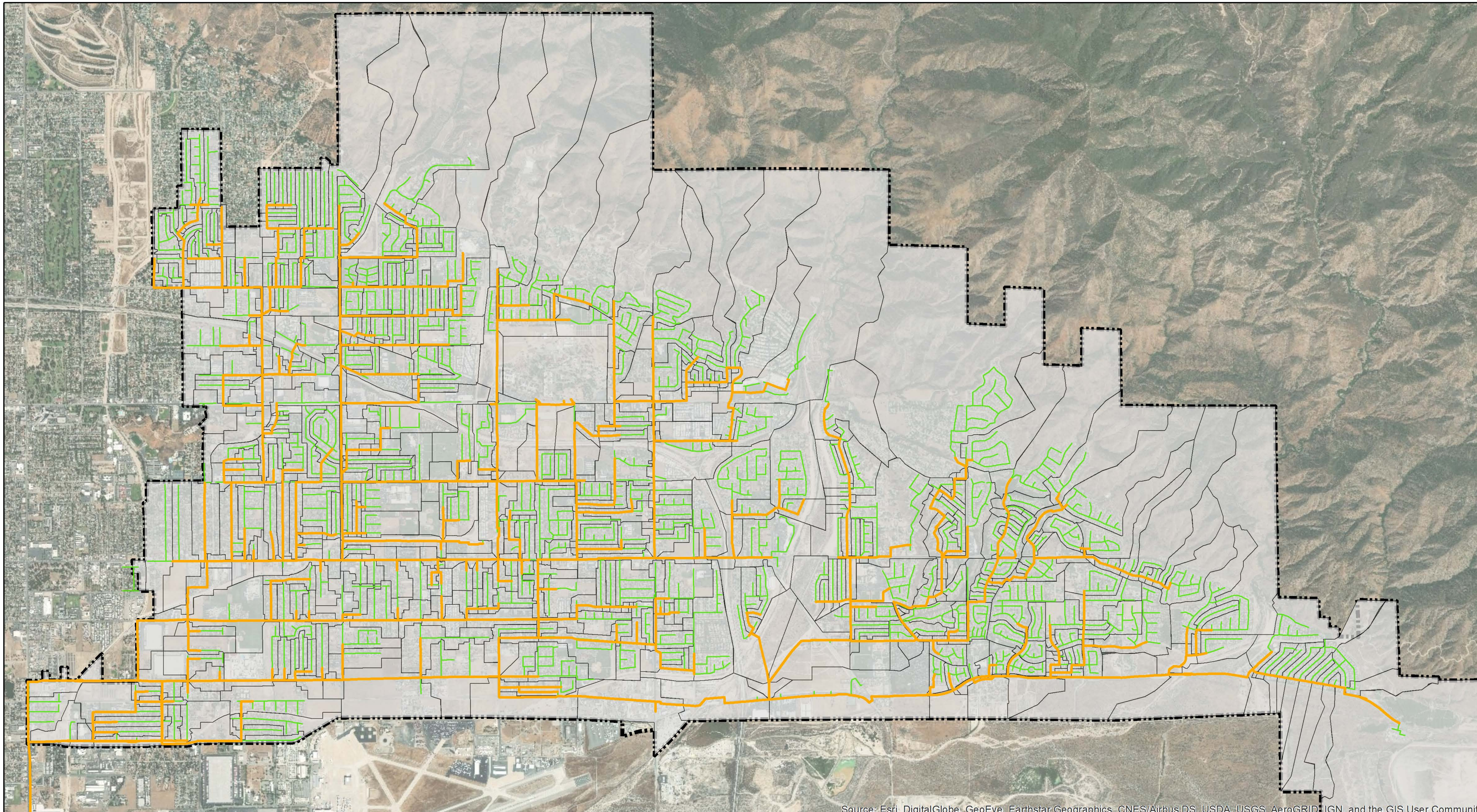
Furthermore, an inflow node should be chosen within each sewershed such that flow is being represented in as many of the pipes as possible. When evaluating the adequacy of the sewersheds provided by EVWD, the number of pipelines exiting the sewershed, the inflow nodes, the size and shape of the sewershed, and its relationship to neighboring sewersheds are all considered in the analysis. Stantec evaluated the previously-developed sewershed areas to assess their accuracy for this model update. A map of the sewersheds is shown on Figure 4-3.

In total, the EVWD Sewer System Model is represented by 547 sewershed areas. These 547 sewersheds average approximately 35 acres and comprise 19,320 acres in total, which is approximately 60 acres greater than the total acreage of EVWD's service area. This is because not all sewersheds are "snapped" to the edges of the service area boundary and the boundaries of neighboring sewersheds which may mean that some sewersheds overlap and some areas of the service area are not contained within a sewershed. EVWD could pursue rectifying this in future updates, however this is typically a time-consuming process and given the degree of overlap, would likely have a negligible effect on the overall usefulness of the sewershed layer. In general, no further changes are needed to use the sewersheds for future updates barring significant changes to the pipe network and flow directions. Also, three sewersheds do not contribute flow to the model because flows are conveyed directly into the City of San Bernardino's collection system.

The size of the sewersheds are relatively small and offer a strong level of granularity to allocation of inflows in the model. All sewersheds had a single point of outlet, or if multiple outlet points were present, the hydraulics of any split were well defined (such as the case of an overflow pipeline). The size of the sewersheds do require a higher than average amount of inflow calculation, but not prohibitively so.

4.1.7 Summary of Model Update

A total of 49 pipes and 46 manholes extending over 2.1 miles were added to the existing sewer network. The entire updated model network now contains approximately 1,900 manholes, 1,900 pipe segments, and extends over 83 miles within the EVWD service area, or approximately 32 percent of the entire network. The analyzed database includes all collection system pipelines 10-inches in diameter and larger. Additional pipes with diameters smaller than 10-inches were added in order to capture flow from a larger network of small pipes. All information imported from the EVWD GIS information described above, and any additional information taken from atlas maps or through discussion with EVWD staff, is included in the InfoSewer database. The EVWD sewer system as modeled in InfoSewer is shown on Figure 4-4.



EAST VALLEY WATER DISTRICT

Legend

- ModelPipes
- Sewer Main
- Sewershed
- Service Area Boundary

N

0 0.25 0.5 1 Miles

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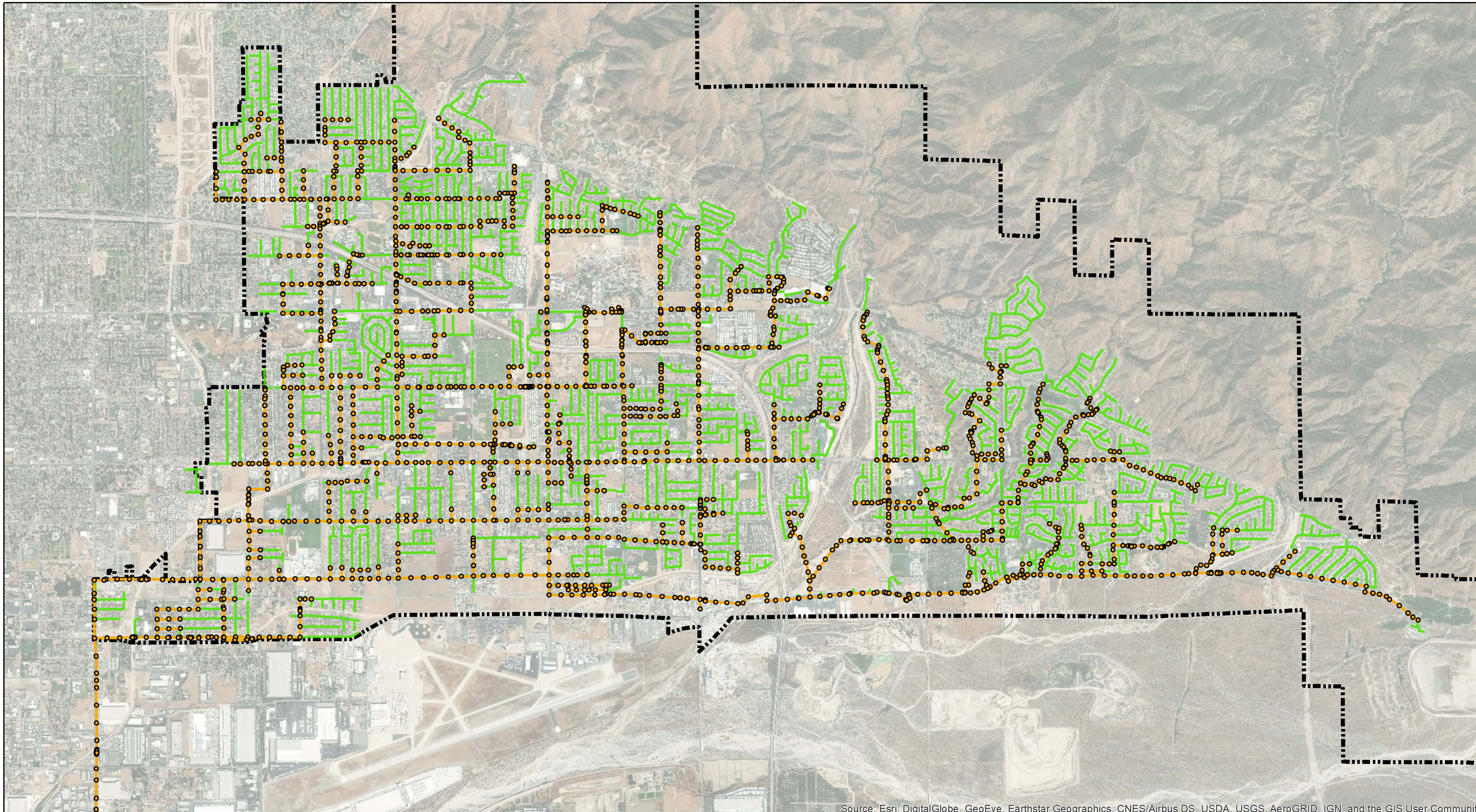
Date: December 11, 2018

Sewersheds

Stantec

Figure 4-3



EAST VALLEY WATER DISTRICT

Legend

- Modeled Pipes
- Modeled Manholes
- Sewer Main
- Service Area Boundary

N

0 0.25 0.5 1 Miles

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Date: December 11, 2018

Modeled Sewer System

Stantec

Figure 4-4

4.2 FLOW MONITORING

Flow monitoring is essential for developing and calibrating a sewer system model. Flow monitoring data measure flow, depth, and velocity to validate assumptions made while developing the model. By adjusting the model to match actual data collected in the field, there is greater confidence in the model and resulting analysis and recommendations. For development of a sewer model, the flow metering points are the only points in the system that you can confirm existing flow conditions; therefore, there is a direct correlation between the amount of flow monitoring data available and model accuracy.

4.2.1 Flow Monitoring Studies

ADS Environmental Services (ADS) completed three recent flow monitoring studies that were used to calibrate the model. Two studies were performed specifically for this master plan, and a third was performed for the San Manuel Band of Mission Indians. No wet weather events were captured in these studies so wet weather flows were based on previous studies. Details of the three flow monitoring studies are summarized below in Table 4-5.

Table 4-5: Flow Monitoring Studies

Name of Study	Dates of Study	Metered Locations
EVWD Sewer Flow Verification Report	May 17, 2018 – June 15, 2018	7
EVWD Land Use Sewer Generation Report	May 8, 2018 – June 6, 2018	3
Casino Sewer Flow Study	May 26, 2018 – June 8, 2018	1

In addition to these studies, EVWD maintains two permanent flow monitors through ADS at the terminus of their system, capturing most flow generated in their service area before entering the East Trunk Sewer. These permanent monitoring locations were also used for model calibration, as well as for developing long-term flow trends and peaking factors.

4.2.2 Flow Metering Locations

EVWD performed the sewer flow verification and land use factor generation study to establish current flows in the collection system. The results of this study were used to allocate sewer flow and calibrate the model. Ten temporary flow meters were deployed in conjunction with EVWD's two permanent flow meters. Of the ten temporary meters, three were deployed to determine land-use specific usage patterns; these meters were located to record the pattern of flows contributed from EVWD three most common single land use types (single family residential, multi-family residential, and commercial). The remaining seven flow monitors were placed at locations to capture flow from similarly sized sewersheds comprising a majority of the EVWD system. These seven monitors were used to calibrate flow for these discrete areas and identify any anomalous flow generation in areas of the system. Additionally, data from a temporary flow meter installed at the San Manuel Casino as part of a different project was analyzed to help predict future flows resulting from an anticipated casino expansion (one of the larger anticipated developments for the EVWD system). A schematic of the flow meters and their relation to each other is shown on Figure 4-5; blue boxes were part of the flow monitoring study initiated for this master plan to determine land use factors and for calibration, while yellow boxes represent permanent flow monitors, and the gray box represents the Casino flow which was studies seperately.

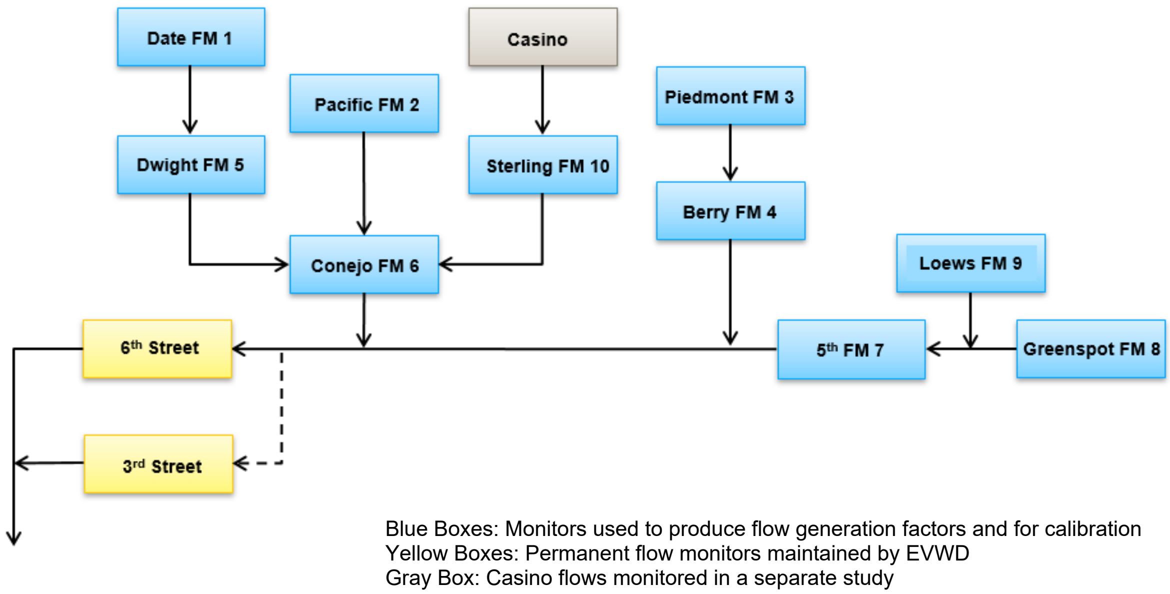
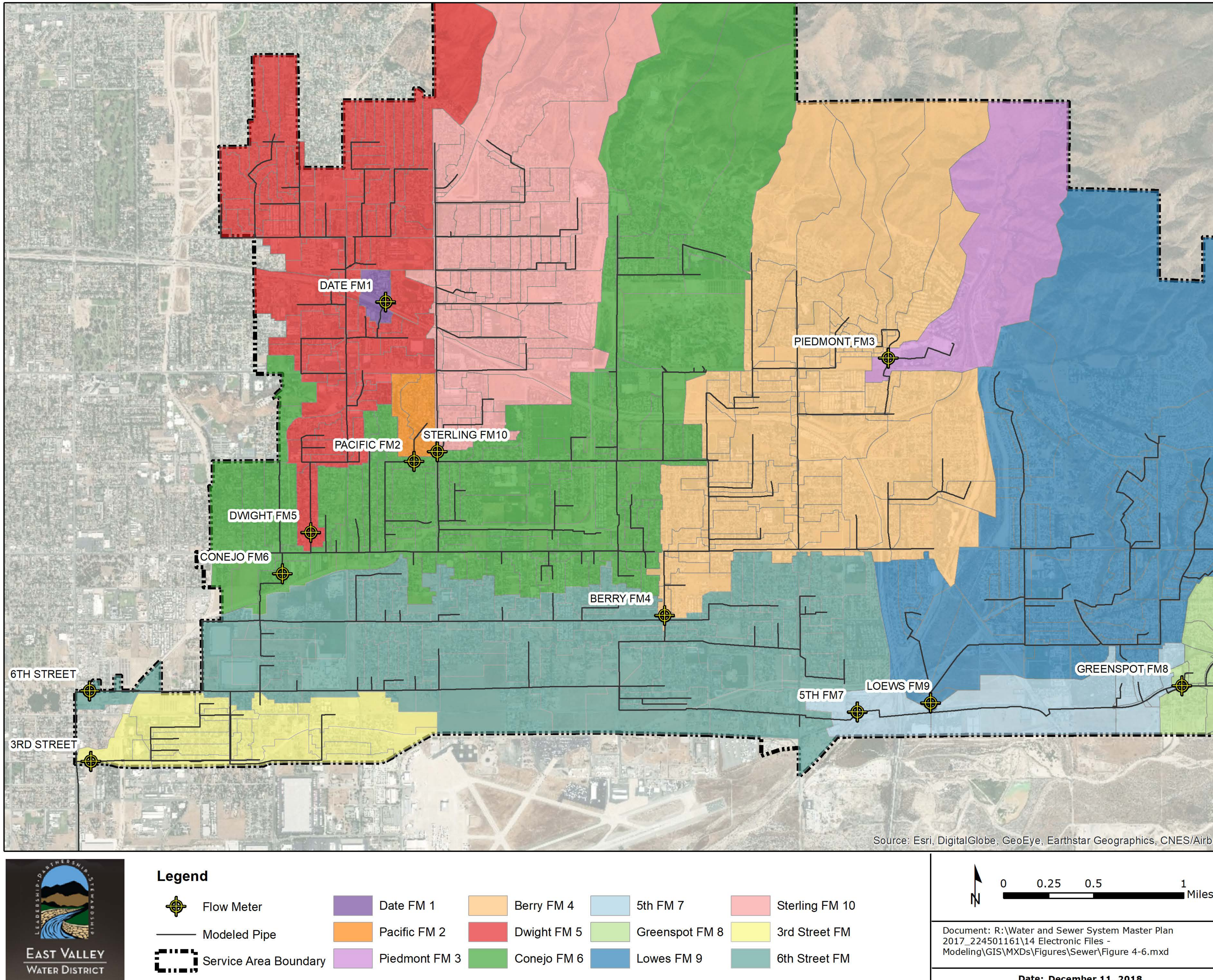


Figure 4-5: Flow Meter Schematic

For each meter, a meter sewershed or basin was developed that encompassed the tributary area and population contributing flow to that meter. Each meter basin includes the sewersheds upstream of the meter, up to the next upstream meter or the end of the sewer main. A map of the flow meters and their respective meter basins is shown on Figure 4-6.



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Date: December 11, 2018

Flow Monitoring Locations

Stantec

Figure 4-6

4.3 INFLOW ALLOCATION

Existing inflows were allocated into the model using the flow monitoring data, U.S. census block data, and the existing EVWD sewersheds. Future flows were developed using SCAG population projections, EVWD's will-serve list, specific development projections and reports, the City of Highland General Plan future land use shapefile, and flow monitoring data. Flow allocation methods are described herein.

4.3.1 Existing Dry Weather Flow

Flow monitor basins were evaluated by determining every pipe upstream of a flow meter that conveys flow only to that specific meter. Data from the flow monitor studies were used to develop average weekday (Monday-Thursday) and weekend flows. Weekday diurnal flows typically had larger peaks and were therefore used to allocate flow in the model. By comparing Average Daily Dry Weather Flows (ADDF) at each meter with the estimated population living within that basin, an average flow generation factor was determined. This factor was then adjusted to account for residents that use septic systems instead of the centralized collection system, as well as for flows that are generated from areas outside of EVWD's service area.

Each flow monitor basin is comprised of many sewersheds, and each sewershed has a single manhole to which flows are assigned in the model. This is known as the demand node for the sewershed. The flow generated at each manhole is estimated by multiplying the number of people calculated to live in the sewershed by the flow generation factor for that basin.

EVWD's two permanent flow meters are located near the intersection of 3rd Street with Waterman Ave. and 6th Street with Waterman Ave. These meters are not used for flow allocation due to a higher propensity for data errors resulting from their permanent installation. However, they are used for model calibration, as discussed in Section 4.4. The results of the sewer flow verification study and basin flow generation factors are summarized in Table 4-6.

Table 4-6: Sewer Flow Verification Study Results

Flow Meter Basin	Metered Weekday Avg. (MGD)	Estimated 2017 Population	Revised GPCD[1]
4	0.78	14,098	59
5	1.72	17,093	87
6	3.21	50,716	60
7	0.98	19,591	59
8	0.37	6,238	66
9	0.55	13,571	50
10	0.73	10,233	71
Most Downstream Meters (4, 6, & 7)	4.97	84,405	60[2]

[1] Revised based on assumptions including septic population and flow from outside of EVWD service area

[2] Weighted average

Weekday diurnal curves were identified for each basin and applied to the inflow generated at each manhole within that basin to simulate the flow variation that occurs throughout an average day. Both weekday and weekend diurnal curves were evaluated, and weekday curves were applied to the model due to the higher peaking observed at Flow Meter 6 – Conejo, which had the greatest average and peak flow in the study. Diurnal patterns also vary based on the land use types within the basin. EVWD's service area typically generates two peaks in flow, a morning peak and an evening peak, which is typical for a largely residential service area. Most meters recorded a larger peak in the evening compared to the morning for an average weekday, but a larger late-morning peak compared to the evening for a typical weekend. A sample plot for flow meter 6 – Conejo is shown on Figure 4-7. Plots of the average weekday and weekend diurnal curves for each flow meter are included in Appendix B.

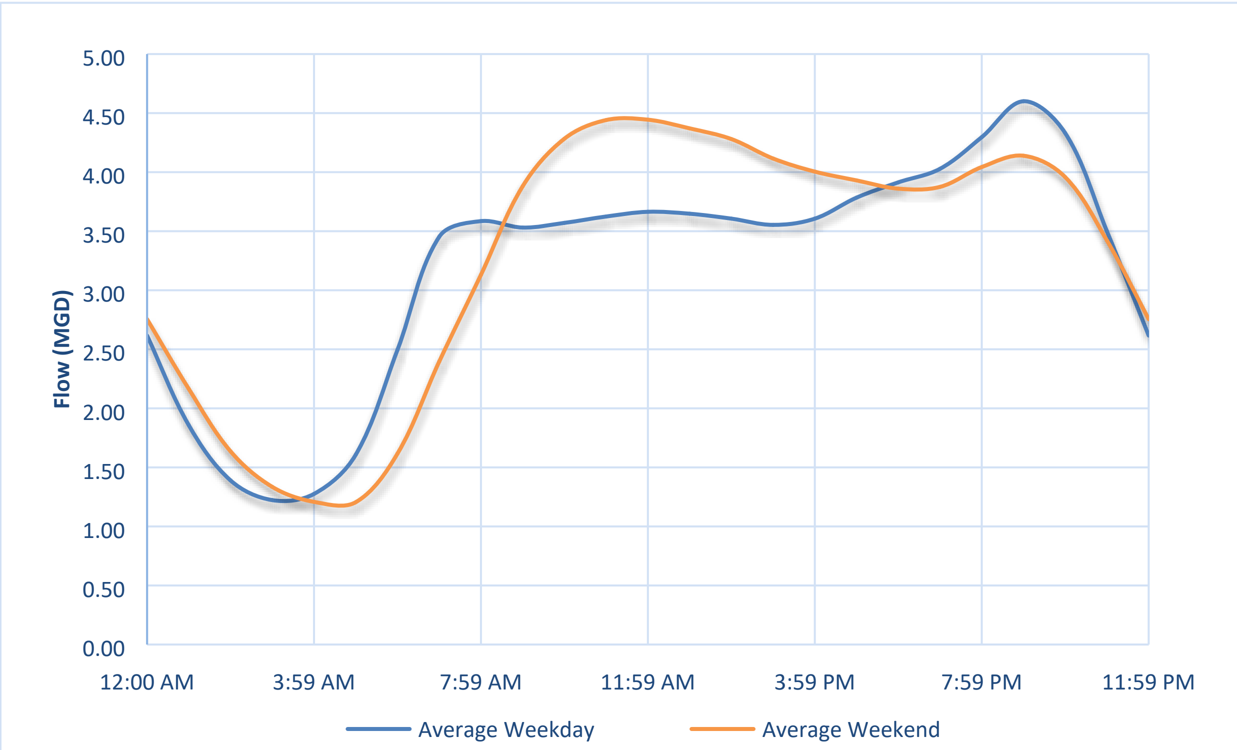


Figure 4-7: Average Diurnal for Flow Meter 6 - Conejo

After model calibration (discussed in Section 4.4), an existing scenario is created for analysis by scaling up the calibrated flows. Because flows vary month to month and year to year, this is done to adjust for any seasonal variability between the flow monitoring period and other times of the year. This scaling is also a conservative estimate to keep from evaluating the sewer system in a year in which EVWD might be experiencing lower than normal flows, such as might occur in a dry weather year. This assumption was validated by comparing historical flows, as discussed in Section 3. To create the existing scenario, the inflows were increased by approximately 28 percent.

4.3.1.1 East Trunk Sewer and City of San Bernardino Flows

Flows in the East Trunk Sewer consist of flow generated both in EVWD's service area as well as the City of San Bernardino. It is important to include these flows to accurately model the actual flows observed in the East Trunk Sewer pipes. Because data from the City of San Bernardino was limited, several assumptions were carried through from previous reports. EVWD's Solids Separation Study estimated that 1218 parcels outside of EVWD's service area to the north contribute approximately 0.342 MGD of flow into the East Trunk Sewer. These flows are distributed between two connection points at Harrison St. and Marshall Blvd. and Mountain Ave. and Eureka St. The distribution of flows between these two locations is based on the percentage between inflows at these two manholes in the 2013 Master Plan.

Another major connection point where San Bernardino flows enter the East Trunk Sewer is at the intersection of Waterman Ave. and 6th St., downstream of EVWD's permanent 6th Street flow monitor. The 2013 Master Plan estimated the average daily dry weather flow (ADDF) at this location to be 6.135 MGD. The land area and flows in this area are largely built-out and not expected to change dramatically. This assumption was carried forward for this master plan. The existing average daily dry weather flows generated from San Bernardino and used in the East Trunk Sewer System Model are summarized in Table 4-7.

Table 4-7: San Bernardino Flow in the East Trunk Sewer

Intersection	Estimated ADDF	Model Node
Harrison Street and Marshall Boulevard	.161	F3-108
Mountain Avenue and Eureka Street	.181	E3-126
Waterman Avenue and 6th Street	6.135	0670079

4.3.2 Future Dry Weather Flow

The existing scenario flows form the basis for flows in future scenarios. To project future growth and future flows, Stantec analyzed multiple sources of information including EVWD's will-serve list, EVWD's GIS database, current and future land use, and population projections.

Whenever possible, specific information is used to develop flow projections. EVWD's will-serve list includes potential future developments and information on these developments. If future flows had not previously been developed, Stantec used the assumption developed in Section 3 of 70 gpd per person. Using EVWD's GIS database, Stantec developed targeted septic parcels for conversion into the sewer system. When other more specific development information was not available, current and future land use from the general plan was used in conjunction with land use duty factors to estimate flow.

4.3.2.1 Major Developments

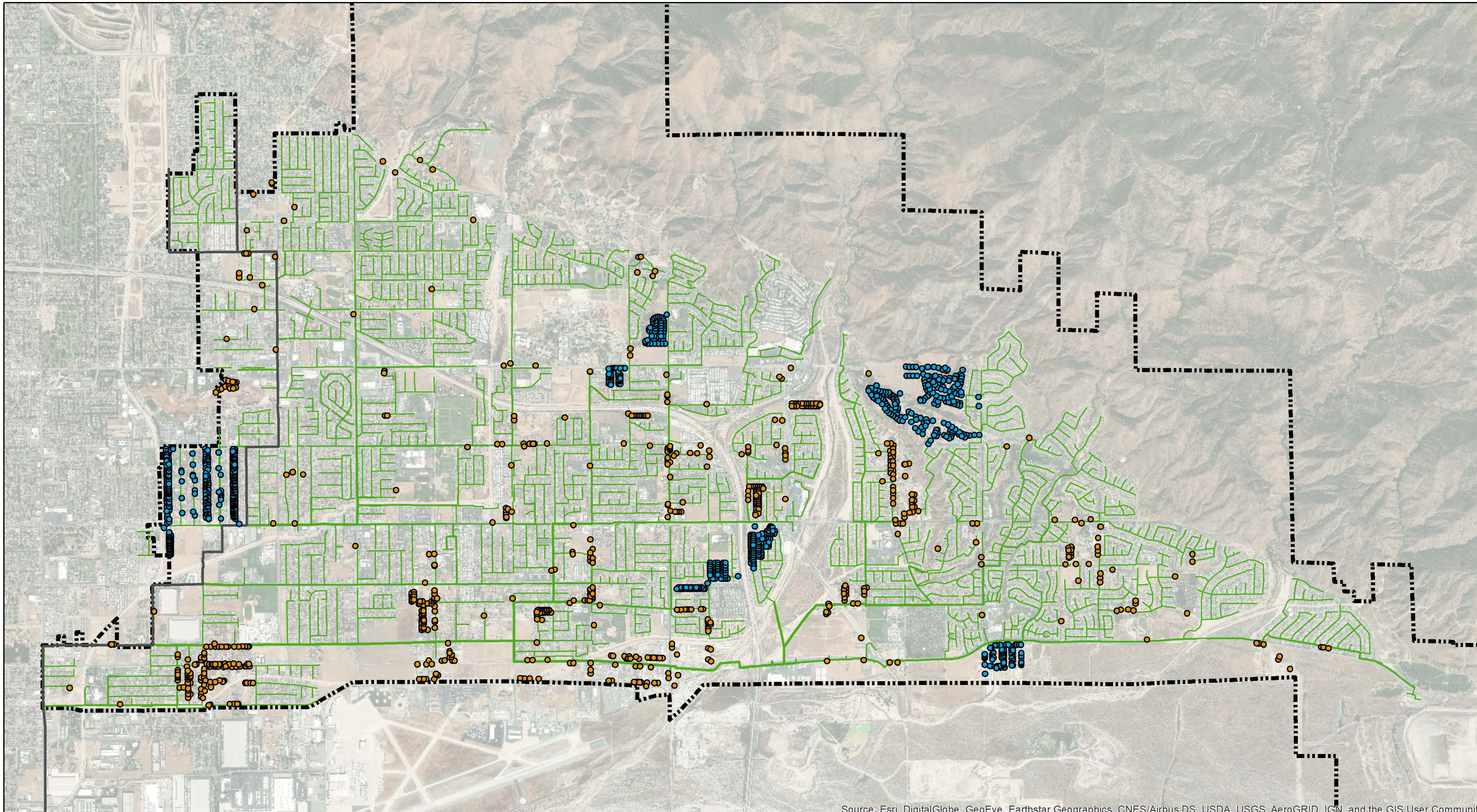
A will-serve list contains information on proposed developments for which the developer and EVWD have entered into an agreement to provide future sewer access. This is typically one of the best sources of specific information about future flow generation from an undeveloped parcel. Population projected to inhabit these developments were determined from the will-serve list as well as publicly-available information. When projected sewer flow generation was not available, 70 gallons per day per person was estimated. If specific populations were not projected, then 3.5 residents per dwelling unit were assumed based on the City of Highland's average household size. Whenever available, Stantec used these specific estimates instead of flows estimated from the General Plan and Land-Use-Based generation factors. The inflows were applied as point flows to the parcel on which they will be constructed, or at the nearest parcel to an existing sewer for multi-parcel developments. Projected flows and the assumed locations in the model for major developments with populations greater than 500 people as well as the major casino expansion are summarized in Table 4-8.

Table 4-8: Future Major Developments

Development	Population	Projected Sewer Flow Generation (MGD)	Inflow Manhole
Harmony	12,712	0.882	M16-124
San Manual Casino Expansion	-	1.008	F6-135
Greenspot Village	2,800	0.196	M11-115
Highland Hills Ranch	2,275	0.159	H10-111
Sunland Communities	2,100	0.147	M16-124

4.3.2.2 Septic Conversions

Stantec evaluated the current residents within EVWD's service area that use septic systems to treat wastewater instead of contributing flows to the centralized sewer collection system. According to EVWD's GIS data, there are 1,495 customers that are billed for water but not sewer. These correspond to 1,400 unique parcels totaling 745 acres. Approximately 90 percent of parcels' current land use is single-family residential. Using the sewer generation duty factors, the estimated total amount of flow to be added to the system if all parcels were converted to sewers is approximately 0.75 MGD. To maximize potential flow to the SNRC, Stantec proposes prioritizing projects with a high density of septic customers in the same area for conversion. The map shown on Figure 4-8 shows the areas that Stantec recommends prioritizing. Blue dots account for 810 of the 1,495 (54 percent) septic nodes and were included in the near-term planning horizon flow projections. All remaining septic nodes are assumed to be converted for the build-out scenario.



East Valley Water District

Legend

Sewer Main

- <10"
- 10" to 16"
- 18" and greater

Septic Conversion Year

- 2025
- 2040/Buildout

- Service Area Boundary
- East Trunk Sewer

N

0 0.25 0.5 1 Miles

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Date: December 11, 2018

Septic Conversion

Stantec

Figure 4-8

4.3.2.3 Summary of Future Flow Projections

When more detailed information is not available, future flow projections are estimated by comparing the existing land use to future land use from the general plan. By using the acreage of a parcel and the land use generation factors, a future flow can be estimated. When allocating flows into the model, preference was given to results from the specific analysis performed for the major developments and septic conversion. When using general plan estimates, flow was allocated first to parcels that are currently vacant but are planned to be developed in the future. Additionally, if a future projection for a model node was less than the existing flow, the larger existing inflow was used.

4.3.3 Wet Weather Flow

A wet weather event was not captured during the 2018 flow monitoring studies. However, long term flow monitors at 3rd and 6th Streets have metered wet weather responses since their installation at the end of 2014. These meters were reviewed and evaluated for a wet weather peaking factor to be applied to the system. Stantec evaluated historical rainfall data and compared this with the hourly flow monitoring data provided by EVWD. Based on this analysis, the wet weather peaking factor was approximately 1.7. This is consistent with an equivalent wet weather peaking factor in the previous model scenarios, which was 1.84 times the peak dry weather flow just downstream of the 6th Street meter. Wet weather flow calibration for the previous model included a 5-year, 24-hour storm and a 10-year, 24-hour storm. To conservatively estimate the wet weather flows the system might experience, Stantec and EVWD agreed on applying a peaking factor of 2.0 to the existing dry weather flows.

4.3.4 Summary of Flow Allocation

Total flows allocated to EVWD's sewer model are summarized in Table 4-9. Flows are totaled for both EVWD's service as well as total flows at the SBWRP.

Table 4-9: Summary of Flow Allocation

Model Scenario	EVWD Service Area Flow (MGD)	Total Flow at SBWRP (MGD)
Calibration	6.0	N/A
Existing DWF	7.2	13.7
Exiting Peak WWF	14.5	27.4
Near-Term Average DWF	10.1	16.6
Near-Term Peak WWF	17.3	31.5
Build-out Avg. DWF	11.8	18.3
Build-out Peak WWF	19.0	33.2

4.4 MODEL CALIBRATION

Dry weather model flows, diurnal patterns, and Manning's coefficients are adjusted to match the flow and depth observed at each flow metering location. The model was only calibrated to dry weather conditions because no wet weather event was captured in the flow monitoring study. The flow calibration curve for Flow Meter 6 – Conejo is shown on Figure 4-9. Calibration graphs for all meters are included in Appendix C.

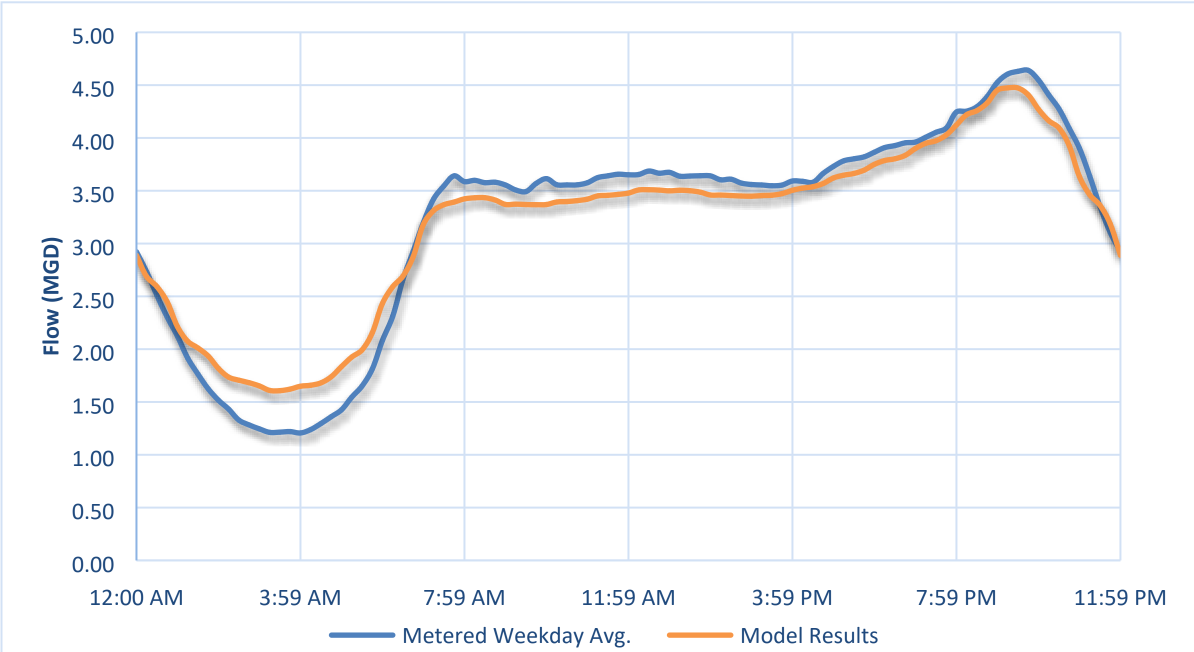

Figure 4-9: Flow Calibration Curve for Flow Meter 6 - Conejo

The goal of calibration was to have a 10 percent or less difference between the modeled and observed dry weather flows. Model results and flow monitoring data are compared both on a total volumetric basis, as well as the peak flow, average, and maximum depth. Some variation from these criteria are expected for any calibration and best judgement must be used to identify the cause of the discrepancies, make adjustments to the model, and decide when the calibration cannot be further improved with the data available.

The dry weather flow calibration results are summarized in Table 4-10. Most of the results are well within the 10 percent criteria for calibration, with the 3rd Street location being the largest outlier. This location was discussed with EVWD staff and the cause of this discrepancy is thought to be disagreement in some of the source data for the dimensions of the pipelines and manholes around this location, and the low flow at this location. The calibration could not be further refined without decreasing the accuracy of other locations and it is noted that the model is showing higher flows than the flow monitoring which suggests model results are a conservative representation. Overall, the model flows agree closely with flow monitoring data and the results relay a high level of confidence in model results. In order to further refine the calibration in future updates, it is recommended that EVWD conduct further flow studies in the system.

Table 4-10: Calibration Results

	Modeled Flow (MGD)	Observed Average Weekday Flow (MGD)	Percent Difference	Modeled Depth (FT)	Observed Average Weekday Depth (FT)	Percent Difference
	Total Volume			Average Depth		
FM 4	0.75	0.78	-3	0.51	0.46	11
FM 5	1.68	1.71	-2	0.45	0.46	-2
FM 6	3.18	3.20	0	0.65	0.59	10
FM 7	0.90	0.97	-7	0.38	0.37	3
FM 8	0.35	0.37	-6	0.30	0.32	-7
FM 9	0.52	0.55	-5	0.30	0.27	14
FM 10	0.71	0.72	0	0.24	0.21	11
3rd Street	0.26	0.32	-18	0.24	0.20	19
6th Street	5.69	5.49	4	1.01	1.11	-9
	Peak Flow			Maximum Depth		
FM 4	1.08	1.14	-5	0.63	0.57	11
FM 5	2.36	2.45	-4	0.55	0.56	-1
FM 6	4.47	4.64	-4	0.79	0.75	4
FM 7	1.55	1.66	-7	0.51	0.50	3
FM 8	0.59	0.66	-11	0.40	0.45	-12
FM 9	0.93	1.00	-7	0.42	0.35	20
FM 10	1.02	1.13	-10	0.29	0.29	-2
3rd Street	0.38	0.52	-28	0.29	0.26	13
6th Street	7.95	7.77	2	1.22	1.32	-8

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5.0 PLANNING CRITERIA

This section presents the design criteria and methodologies for analysis used to evaluate the existing distribution system and its facilities and to size future improvements.

5.1 INTRODUCTION

Criteria are established for evaluating the adequacy and condition of EVWD's sewer collection system and designing replacement or new infrastructure in the system. Peak sewer flow factors for EVWD's system are determined based on a review of flow monitoring data produced by EVWD for the purpose of this SSMP. The criteria are developed using typical planning criteria of similar wastewater utilities, engineering judgment, and commonly accepted industry standards. The "industry standards" are typically ranges of values that are acceptable for the criterion in question and, therefore, are used more as a check to confirm that the values being developed are reasonable. Deviations from the recommended guidelines may be necessary in defining specific improvement projects for an existing sewer collection system due to the restrictions posed by existing upstream and downstream conditions. In these special circumstances, design criteria will need to be determined on a case-by-case basis.

5.2 RECOMMENDED DESIGN CRITERIA FOR GRAVITY SEWERS

This section provides recommended design criteria for sewer mains in the EVWD system. Table 5-1 shows the recommended design criteria for new sewers and manholes. The criteria presented in this table are discussed in more detail below.

Table 5-1: Gravity Sewer Design Criteria

Design Criteria	Value
Per Capita Flow	
Flow Generation Rate	Based on Population and Land Use
Velocity	
Minimum	2 fps
Maximum	10 fps
d/D Ratio during peak dry weather flow	
For all sewers that are less than 18-inch in diameter	0.5
For all sewers that are greater than or equal to 18-inch in diameter	0.75
d/D Ratio during peak wet weather flow	
All Diameters	d/D = 1.0 (Surcharge)
Siphon Pipelines	
All Diameters	Maximum Velocity < 8 feet per second
Other Criteria	
Manning's n (gravity mains)	Dependent upon material, 0.013 used for all existing pipelines in the system or if material is not known
Average Manhole Losses	0.1 feet
Manhole Losses during peak wet weather flow	0.5 feet

5.2.1 Recommended Design Criteria for Special Projects

In addition to the recommended design criteria for gravity sewers, the recommended design criteria for non-gravity sewer improvement projects are discussed in this section. Special projects are defined as projects other than gravity mains, and include such facilities as lift stations, force mains, weirs, etc. Recommended design criteria for special projects are summarized in Table 5-2.

Table 5-2: Design Criteria for Special Projects

Item		Recommended Values
Special Projects	Lift Stations and Force Mains	• Lift Stations and force mains will be avoided whenever possible. • Hazen-William's "C" factor of 120 will be used to analyze hydraulic conditions for all force mains in the system • Force mains shall be sized to provide a design velocity no less than 4 ft. per second with all pumps running and 2.5 ft. per second during normal operations. • Maximum velocity shall be 7 fps.
	Diversion Structures	• New diversion structures will be avoided whenever possible • Maintain existing diversion structures unrestricted with no flow control whenever possible • If a gate/stop-log setting is required for a diversion structure, maintain a fixed setting for all flow conditions whenever possible

5.2.2 Peak Design Flow

Considering the limited precipitation events in southern California and potential for corrosive gasses to form in sewers with very low flow depths, it is recommended that new pipelines for the EVWD sewer system be sized for partially-full conditions at peak dry weather flow (PDWF). Based on master planning activities completed in conveyance systems similar to the EVWD, Stantec recommends the peak dry weather flow be determined using the following criteria:

- For collector sewers less than 18-inch in diameter, the design PDWF should be equal to 3 times the average dry weather flow.
- For trunk sewers greater than or equal to 18-inch in diameter, the design PDWF should be equal to 2.5 times the average dry weather flow.
- These peak dry weather flows for design do not include increases in flow rates due to Rainfall-Derived Infiltration and Inflow (RDII).

These criteria should be used to estimate PDWF in the absence of real flow data.

5.2.3 Peaking Factors

A typical flow pattern from field monitoring data is presented on Figure 5-1. These curves represent the variation in sewer flows over a 24-hour period and were generated from the flow monitoring discussed in Section 3. The y-axis shows peaking factors (i.e. normalized flows as a factor of the average flow for the 24 hours). The peaking factors shown are based on dry weather flow data.

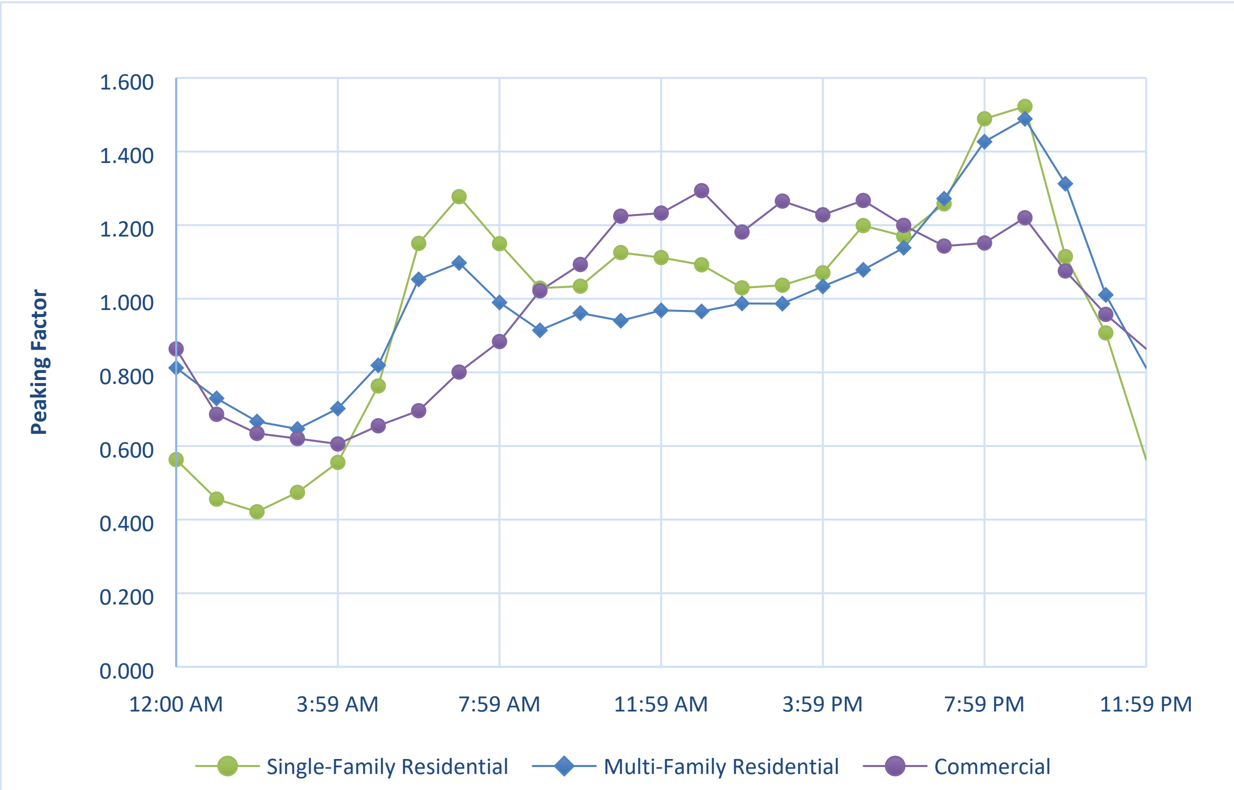

Figure 5-1: Typical Diurnal Flow Patterns

Peaking factors are generated by taking the peak dry weather flow (PDWF) for the system and dividing it by the average dry weather flow (ADWF). These peaking factors are only for dry-weather contributions and are exclusive of RDII contributions. Peaking factor determination specific to the EVWD system is discussed in detail in Section 3.

5.2.4 Coefficients of Pipe Friction

A Manning's 'n' value of 0.013 is used to analyze hydraulic conditions in gravity sewers for all pipe materials in the EVWD system. This value is typical for sanitary sewer systems as a base assumption. Though Manning's "n" values can vary depending on pipe material and size, the deposition of film and material along the walls of pipes leads to a similar roughness for most pipes. If instances of obstructions or other impeding factors are known, or the internal conditions of certain pipes due to material, size, or geography, can be determined to be different from this base assumption from available data (i.e. CCTV, condition assessment, operations and maintenance records, etc.), a higher value will be used to represent those conditions.

5.2.5 Minimum Collection Sewer Size

No sewer shall be less than 8-inches in diameter except at locations authorized by EVWD.

5.2.6 Flow Depth Ratio (d/D)

Typically, sewer systems in climates that do not experience significant rainfall are designed to have a maximum flow depth (d) to pipe diameter (D) ratio (d/D ratio) at PDWF conditions. Under this design scenario, increased flows from usage spikes or RDII during infrequent wet-weather conditions can be conveyed without surcharging the sewer pipe. Based on experience with similar systems in southern California, the d/D ratios recommended for the sewer conveyance system are:

- Maximum d/D ratio for all sewers that are less than 18-inch in diameter shall be 0.50 during PDWF; and
- Maximum d/D ratio for all sewers that are greater than or equal to 18-inch in diameter shall be 0.75 during PDWF.

The above criteria will be used for all new pipes in the system. The criteria will also be used to assess whether existing pipes have sufficient hydraulic capacity or are in need of relief. Any pipes identified as over these thresholds will be documented in this Master Plan.

While improvements are recommended for those pipe segments identified as having insufficient capacity, a d/D threshold of 0.85 is recommended as a “trigger” point to necessitate implementation of a relief project. A d/D of 0.85 at any time during a day indicates essentially full pipe conditions and can result in upstream pipe segments becoming surcharged by creating a backwater condition, or insufficient capacity for accommodating wet weather flows. Initiating a project at this “trigger” point allows the relief project to be designed and installed prior to the pipeline experiencing frequent surcharge conditions. Any modeled pipes with a d/D ratio over 0.85 at PDWF will be recommended for improvement, either immediately for existing pipes, or at the appropriate planning horizon.

5.2.7 Slopes and Velocity

To minimize potential for grit and debris accumulation in the conveyance system, all trunk and collector sewers shall be designed with hydraulic slopes sufficient to result in mean velocities at the ADWF of not less than 2 feet per second (fps). To minimize potential for scouring and pipe erosion, the maximum allowable velocity in the sewer shall not be greater than 10 fps. Table 5-3 summarizes the recommended minimum slope based on pipe.

Table 5-3: Minimum Pipe Slope

Sewer Size (in)	8	10	12	15	18	21	24	27
Minimum Pipe Slope (ft. /ft.)	0.004	0.0032	0.0024	0.0015	0.0012	0.0009	0.0008	0.0006

5.2.8 Manholes

Manholes shall be installed on sewers at all changes in slope, size of pipe, changes in vertical or horizontal alignment and at all intersections of main line sewers. The recommended maximum spacing allowable between manholes is 400 feet unless otherwise approved. The average friction loss through manholes should be 0.1 feet of head, while the peak loss through a manhole should not exceed 0.5 feet of head as listed in Table 5-1. The friction loss is causes by interactions between the surface of the pipe or manhole and the flow of water causing added turbulence and loss of energy.

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6.0 SYSTEM EVALUATION

This section describes the evaluation of the sewer collection system under existing and future conditions, i.e. the planning horizons for near-term and build-out. Capacity and condition deficiencies based on the evaluations are identified and infrastructure improvements are recommended to address the deficiencies. The following information is presented in this section for existing, near-term, and build-out flow conditions:

- A description of the criteria used for the collection system evaluation.
- An evaluation of the collection system for capacity constraints (i.e. undersized pipes) under different flow conditions. This involves applying d/D criteria to ensure pipes can covey flow during peak flow conditions with adequate capacity in the pipes.
- Reliability analyses.

The design criteria and analytical methodologies used to conduct this evaluation are presented in detail in Section 5. Recommendations are made for each of these evaluations, which are combined in a summary of recommendations and proposed improvements at the end of this section.

6.1 EXISTING SYSTEM CAPACITY EVALUATION

The updated sewer system model was evaluated under existing conditions for both dry and wet weather for the purpose of identifying capacity constraints. Table 6-1 summarizes the lengths of pipes that were identified in the existing model as being outside the limits of the design criteria.

Table 6-1: Summary of Existing 2018 Model Results

Parameter	Dry Weather		Wet Weather		Total Pipes	
	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)
Pipes < 18”, 1> d/D > 0.5	626	3,670	-	-	1,080,060	15,170
Pipes ≥ 18”, 1> d/D > 0.75	0	2,706	-	-	46,630	27,450
Surcharged Pipe (d/D > 1.0)	0	627	10,973	19,362		
Total	**626**	**6,376**	**10,973**	**19,362**	**1,126,690**	**42,620**
Percent of Total Pipes	0%	15%	1%	45%		

6.1.1 Dry Weather – Existing System

The existing system model was run under dry weather conditions and the maximum d/D ratios were evaluated to determine the capacity constraints in the system. The results of the model run are shown on Figure 6-1.

6.1.1.1 EVWD Service Area

The model showed 626 feet of pipe in EVWD's service area to be outside the limits of the design criteria. However, none are shown to have a d/D ratio greater than 0.85 which would trigger a replacement project. Siphons were excluded from this analysis as they are expected to function at a d/D of 1.

6.1.1.2 East Trunk Sewer

The model showed 6,376 feet of the East Trunk Sewer to be outside the limits of the design criteria. Pipes in the East Trunk Sewer in the existing 2018 dry weather model run that were identified as overcapacity (d/D > 0.85) include the following:

- A 400 ft section of 27-inch pipe along 6th Street near Palm Park is shown as surcharged in the model run. This section of pipe serves as the basis for the existing dry-weather flow recommendation of Project E-1, as discussed in Section 8. However, because of anticipated relief of this sewer from the SNRC diversion, it is recommended that EVWD perform monitoring of this area to determine when an improvement is justified by flow data.
- A 225 ft section of 24-inch pipe along N. Tippecanoe Ave. is shown as surcharged in the model run. This part of the East Trunk Sewer crosses under Warm Creek and appears to have been constructed to be surcharged. For this reason, a replacement project is not suggested. It is also suggested that EVWD reassess the line after flow has been diverted for the SNRC

6.1.1.3 Low Flow in Dry Weather

The existing model scenario was also evaluated for minimum flow velocities in low flow conditions. The system was evaluated during the early morning, when mimimal flow is typically observed. The pipes in which the modeled velocities are outside of design criteria are shown on Figure 6-2.

There are a significant number of pipes that the model shows are outside of design criteria. It is important to note that the sewer system model was not calibrated to velocity. Common practice is to calibrate the model to measured flow and the depth of flow in pipes. Even though the model was not calibrated to velocity, the model results were compared to the velocities recorded in the flow monitoring studies. Comparison of these results varied, but there were instances in which modeled vs. measured velocities at the flow meter locations varied by up to 1.5 feet per second. This variation can occur due to differences in pipe invert elevations or slope in the model as compared to the actual condition.

Two feet per second is a typical minimum velocity for sewer design criteria as an estimate of the minimum scouring velocity of the pipe. When velocities are less than the scouring velocity for an extended time, it is possible for solids to settle out and deposit in the pipe. Over time this can result in reduced pipe capacity as well as give rise to odor emanating from the pipes. However, periodic (high diurnal) flows sufficient to flush lines can mitigate these issues. As part of ongoing system maintenance, EVWD should perform periodic CCTV of low velocity lines and record any reoccurring customer odor complaints to determine if specific sewer lines are problematic.

Because the model was evaluated during early morning hours, pipes exhibiting low flows outside of minimum criteria is expected and the results presented in Figure 6-2 should be used to inform EVWD's future monitoring and cleaning efforts.

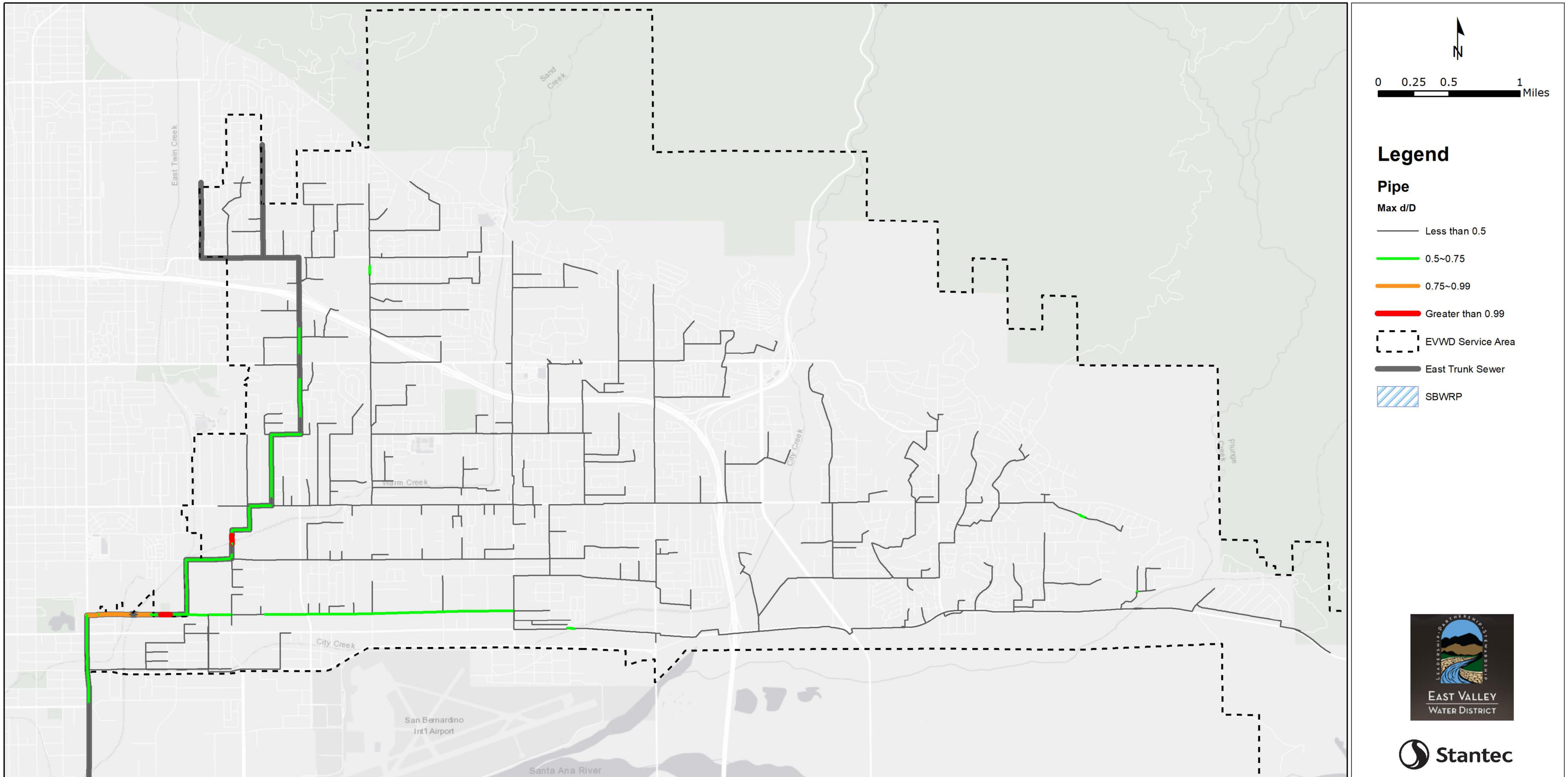


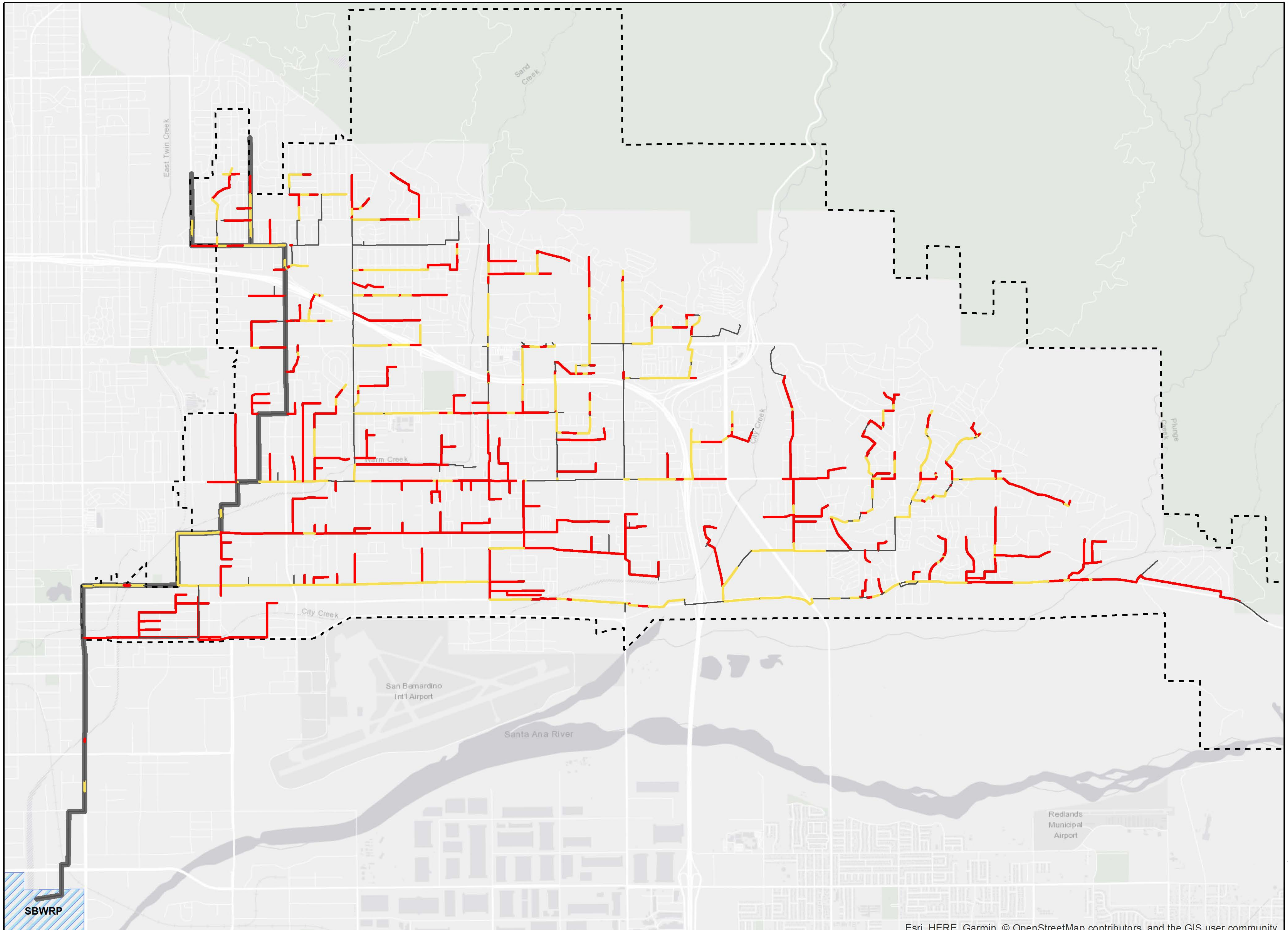
Figure 6-1

Existing 2018 System Dry Weather Capacity Evaluation

Date: 12/12/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-1 Existing_DWF.mxd



N

0 0.25 0.5 1 Miles

Legend

Pipe

Minimum Velocity (fps)

- 0
- 0~2
- 2~3
- Greater than 3
- EVWD Service Area
- East Trunk Sewer
- SBWRP

EAST VALLEY WATER DISTRICT

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Figure 6-2

Existing 2018 System Dry Weather Minimum Velocity Evaluation

Date: 12/13/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-2 Existing_DWF_velocity.mxd

6.1.2 Wet Weather – Existing System

The existing system model was run under wet weather conditions and the maximum d/D ratios were evaluated to determine the capacity constraints in the system. The results of the model run are shown on Figure 6-3.

6.1.2.1 EVWD Service Area

The model showed 10,973 feet of pipe in EVWD's service area to be outside the limits of the design criteria. Because these areas are surcharged during modeled wet weather conditions, it is recommended that EVWD verify flow in these areas during wet weather events to confirm model results and determine the true extent of the surcharging. Projects have been recommended in Section 8 based on modeled results but should be initiated based on field confirmation. Pipes in the existing 2018 wet weather model run identified as surcharged (d/D = 1.0) include the following:

- The model shows approximately 10,000 feet of 21 and 24-inch pipe along 6th Street between Victoria Ave. and Whitlock Ave. as surcharged in wet weather. This serves as the basis for project E-4 discussed in Section 8. This area may be relieved by the SNRC interceptor and should be monitored until such time that it is determined that project E-4 is needed, or the interceptor has adequately relieved capacity deficiency in the pipelines.
- The model shows a 250-foot section of 24-inch pipe along 5th Street as surcharged. Upon discussion with EVWD, this section of pipe was improved in 2015 by the 5th St. Storm Drain Improvement Project and no project is recommended.
- The model shows 265 feet of 8-inch pipe on Southwood Ln. as surcharged. This serves as the basis for project E-5 discussed in Section 8. E-5 call for modification of slope in order to address flat areas that are causing surcharge during wet weather conditions. Upon discussion with EVWD, no surcharging has been observed in this area. It is recommended that EVWD continue to monitor this area and determine if project E-5 is warranted based on field data and observation.
- The model shows 30 feet of 8-inch pipe at the intersection of Santa Ana Canyon Rd. and Alta Vista Rd. as surcharged. This serves as the basis for project E-6 discussed in Section 8. Upon discussion with EVWD, no surcharging has been observed in this area. It is recommended that EVWD continue to monitor this area and determine if project E-5 is warranted based on field data and observation.
- The model shows 330 feet of 8-inch pipe on Sterling Ave. south of Lynwood Dr. as surcharged. This area is part of the sewer affected by the casino expansion currently under construction and is addressed in project N-1.

6.1.2.2 East Trunk Sewer

The model showed 19,362 feet of pipe in the East Trunk Sewer to be outside the limits of the design criteria. Pipes in the 2018 wet weather model run that were identified as surcharged (d/D = 1.0) include the following:

- The model shows approximately 12,650 feet of pipe as surcharged between the downstream limit of Pedley Rd. an 6th Street and the upstream limit of Del Rosa Ave. just North of Pumalo St. Projects E-2 and E-3 address these surcharging issues. This area may be relieved by the SNRC interceptor and should be monitored until such time that it is determined that project E-2 and E-3 is needed, or the interceptor has adequately relieved capacity deficiency in the pipelines.

- The model shows approximately 6,720 feet of pipe along 6th Street and Waterman Ave. with diameters ranging from 27-inch to 54-inch as surcharged. This is addressed by project E-1. No projects are suggested downstream of the intersection of Waterman Ave. and 3rd Street, the boundary of EVWD's service area. This area may be relieved by the SNRC interceptor and should be monitored until such time that it is determined that project E-1 is needed, or the interceptor has adequately relieved capacity deficiency in the pipelines.

6.2 EXISTING 2018 SYSTEM RELIABILITY EVALUATION

Stantec discussed locations of critical pipes with EVWD. A reliability evaluation was performed for these location that looked at the bypass pumping required to convey flow in these areas due to a pipe failure. Because of the configuration of the current EVWD system, flow diversion at upstream locations is not feasible. The only option should one of these pipes fail would be temporary bypass pumping while the pipe is repaired. For each location, a peak dry weather flow was assessed in the hydraulic model, and the amount of bypass pumping required to convey that flow was calculated. The three locations selected by EVWD are:

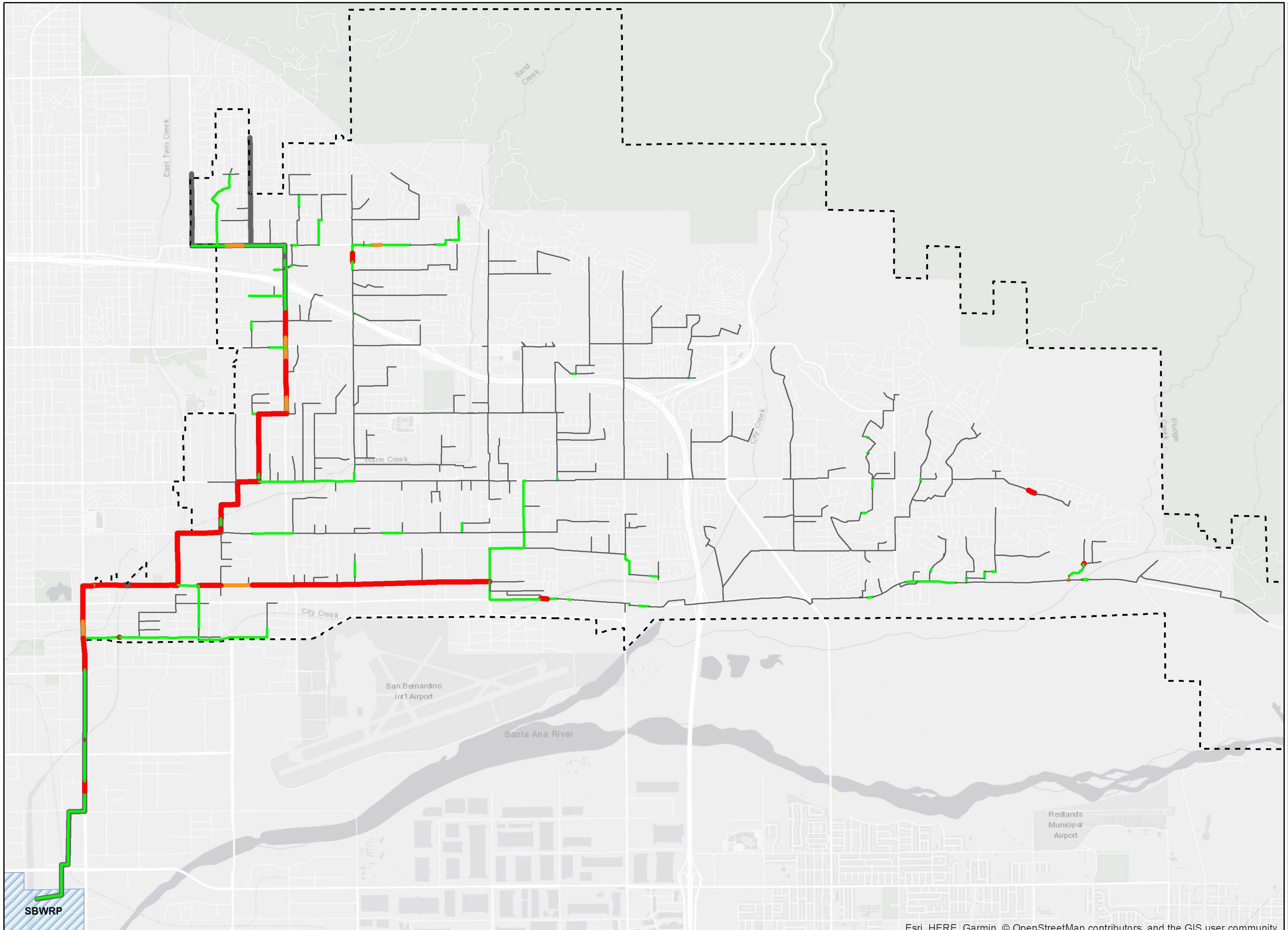
- Pacific St. and Del Rosa Dr.
- Sterling Ave. and Highland Ave.
- Greenspot Rd. at City Creek

The results of the reliability evaluation are summarized in Table 6-2 and are mapped on Figure 6-4.

Table 6-2: Summary of Reliability Analysis

Location	Peak Dry Weather Flow Rate (MGD)	Total Volume, (MG)	Bypass Pumping Required (gpm)
Pacific St. and Del Rosa Dr.	2.81	1.99	279 – 1,951
Sterling Ave and Highland Ave.	1.05	0.74	104 – 729
Greenspot Rd. at City Creek	1.99	1.16	197 – 1,382

Bypass pumping should cover a range of flow rates to meet flows from low to peak dry weather conditions. Line breaks should be repaired as quickly as possible in order to limit the amount of bypass pumping required.



0 0.25 0.5 1 Miles

Legend

Pipe

Max d/D

- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99
- EVWD Service Area
- East Trunk Sewer
- SBWRP

East Valley Water District

Stantec

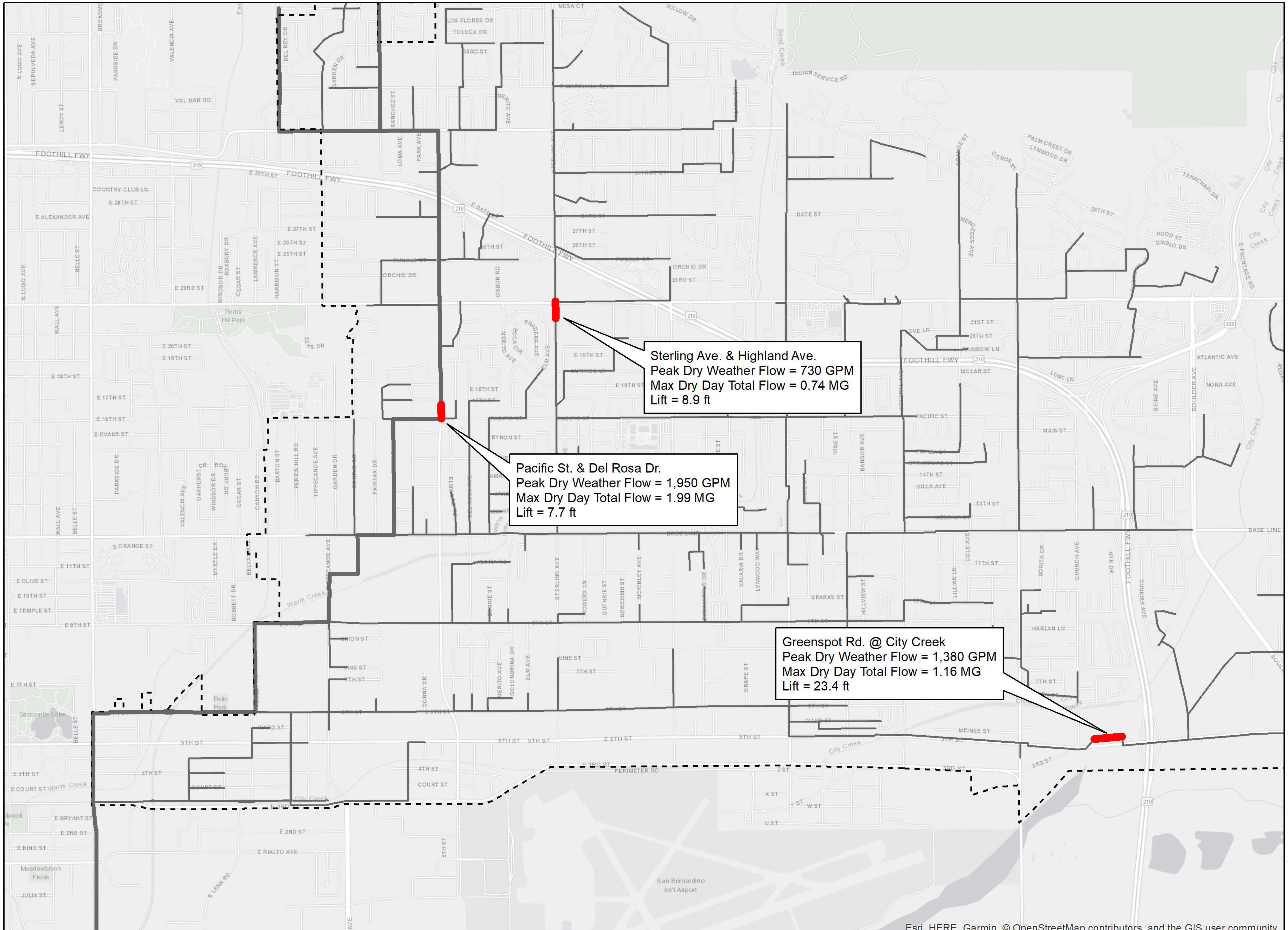
Figure 6-3

Existing 2018 System Wet Weather Capacity Evaluation

Date: 12/12/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_2245011611\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-3 Existing_WWF.mxd



N

0 0.125 0.25 0.5 Miles

Legend

- Critical Pipes
- Modeled Pipe
- EVWD Service Area
- East Trunk Sewer
- SBWRP

EAST VALLEY WATER DISTRICT

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Figure 6-4

Existing 2018 System Reliability Analysis

Date: 12/18/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-4 Reliability Analysis.mxd

6.3 NEAR-TERM SYSTEM CAPACITY EVALUATION

Additional sewer flows were applied to the sewer system model based on growth projections in EVWD's service area for the near-term planning horizon. The near-term scenario was developed to evaluate the sewer system under future conditions related to development expected with relative certainty, such as those on EVWD's will-serve list and converted septic customers. The near-term scenario was evaluated under both dry and wet weather to identify capacity constraints. Table 6-3 summarizes the lengths of pipes that were identified in the near-term model as being outside the limits of the design criteria.

Table 6-3: Summary of Near-Term Model Results

Parameter	Dry Weather		Wet Weather		Total Pipes	
	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)
Pipes < 18", 1 > d/D > 0.5	26,930	3,670	-	-	1,080,060	15,170
Pipes ≥ 18", 1> d/D > 0.75	9,527	5,905	-	-	46,630	27,450
Surcharged Pipe	11,868	3,844	44,813	20,475		
Total	**36,457**	**9,575**	**44,813**	**20,475**	**1,126,690**	**42,620**
Percent of Total Pipes	3%	22%	4%	48%		

6.3.1 Dry Weather – Near-Term System

The near-term system model was run under dry weather conditions and the maximum d/D ratios were evaluated to determine system capacity constraints . Model results are shown on Figure 6-5. The location of the SNRC, construction of which started in late 2018, is also shown on the figure. Resulting from discussion with EVWD, a proposed sewer line is plotted from the site of the San Manuel Casino expansion to the proposed tie-in point with the existing sewer system at the intersection of Arden Ave. and Marshall Blvd. Surcharge in the near-term scenario was often adjacent to surcharged areas in the existing scenario. The ultimate extant of the surcharge were considered when proposing recommendations shown in Section 8.

Because development in the eastern portion of EVWD's service area drive many of the near-term capacity issues, an additional model run was evaluated. This additional scenario is the same as the near-term model run except it assumes the Harmony development has not been built. Significantly fewer pipes surcharge without the Harmony development, as is shown on Figure 6-6. The Harmony development creates capacity issues and a relief sewer would be required when that development occurs in order to mitigate impacts from the increased flow coming from the east of the service area.

6.3.1.1 EVWD Service Area

The model showed 36,457 feet of pipe in EVWD's service area to be outside the limits of the design criteria. In addition to the expansion of previously identified surcharged pipe areas, pipes in EVWD's service area in the near-term dry weather model run that were identified as overcapacity (d/D > 0.85) and needing replacement include the following:

- The model shows approximately 3,320 feet of 8-inch diameter pipe along Marshall Blvd. and Sterling Ave. as surcharged. This serves as the basis for project N-1 discussed in Section 8.
- The model shows approximately 5,520 feet of 12 and 15-inch diameter pipe along Santa Paula St., Mission St., Calle del Rio St., and Greenspot Rd as surcharged. This serves as the basis for project N-2 discussed in Section 8.

6.3.1.2 East Trunk Sewer

The model showed 9,575 feet of pipe in EVWD's service area to be outside the limits of the design criteria. Other than the expansion of previously identified surcharged pipe areas, no additional pipes in the East Trunk Sewer in the near-term dry weather model run necessitated the development of a new replacement project.

6.3.2 Wet Weather – Near-Term System

The near-term system model was run under wet weather conditions and the maximum d/D ratios were evaluated to determine the capacity constraints in the system. The results of the model run are shown on Figure 6-7. The location of SNRC, construction of which started in late 2018, is shown on the figure. Resulting from discussion with EVWD, a proposed sewer line is plotted from the site of the San Manuel Casino expansion to the proposed tie-in point with the existing sewer system at the intersection of Arden Ave. and Marshall Blvd.

Development in EVWD's eastern service area drive many of the recommendations resulting from the near-term model, and additional wet weather model run was evaluated. This additional scenario is the same as the near-term model run except that it assumes the Harmony Development has not been built. As with the dry weather analysis, significantly fewer pipes surcharge without the construction of the Harmony Development, as is shown on Figure 6-8.

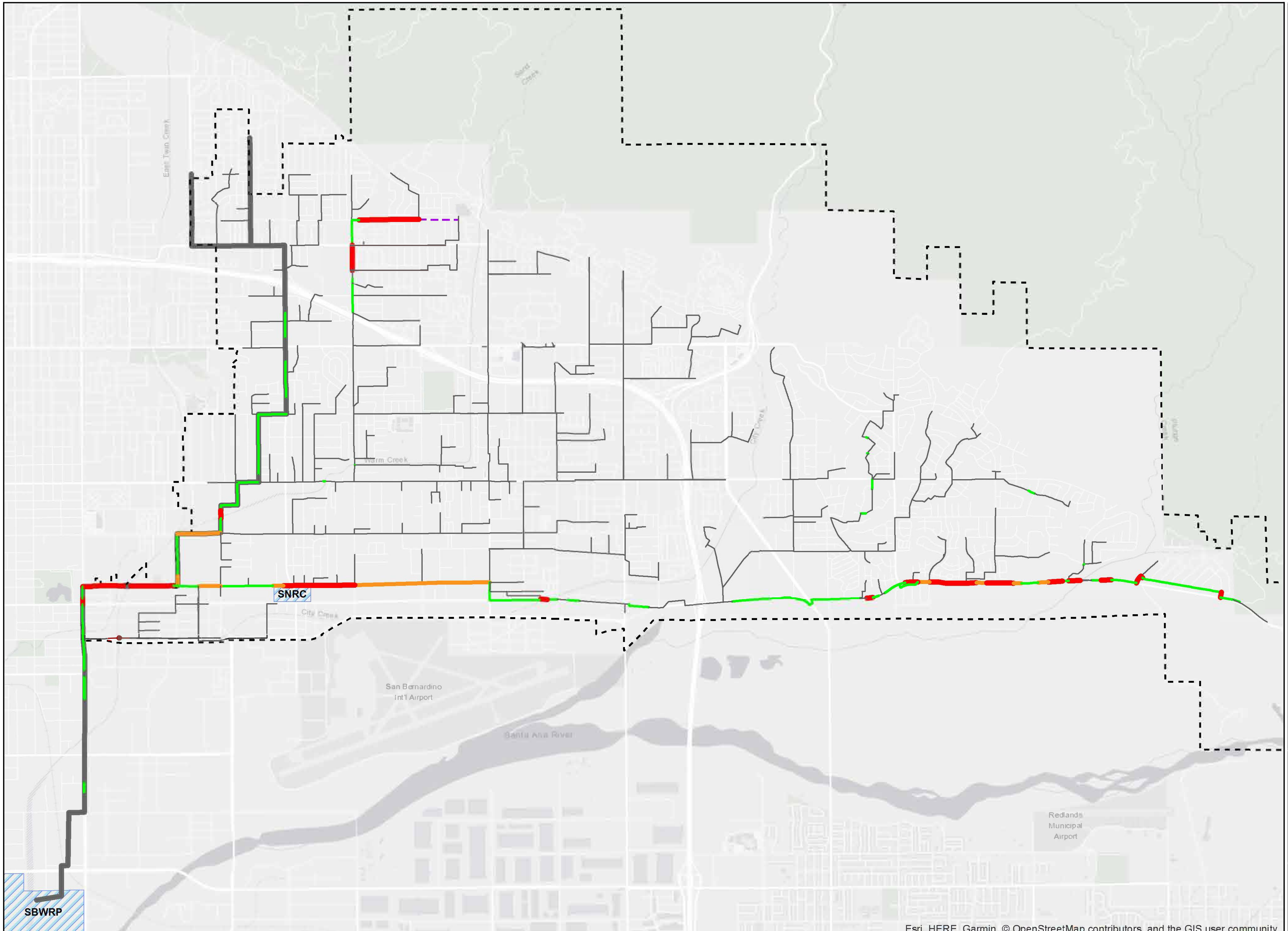
6.3.2.1 EVWD Service Area

The model showed 44,813 feet of pipe in EVWD's service area to be outside the limits of the design criteria. Because these areas are surcharged during modeled wet weather conditions, it is recommended that EVWD verify flow in these areas during wet weather events to confirm model results and determine the true extent of the surcharging. Projects have been recommended in Section 8 based on modeled results but should be initiated based on field confirmation. Pipes in in the near-term wet weather model run that were identified as surcharged (d/D = 1.0) include the following:

- The model shows approximately 940 feet of 24-inch diameter pipe along 5th Street as surcharged in wet weather. This serves as the basis for project N-3 discussed in Section 8. It is noted that the length of the replacement shown for project N-3 exceeds the length of pipe showing as surcharged in the model in order to upsize the pipeline without creating a flow constriction. This involves upsizing the pipe downstream from the surcharged area until it connects to a similar or larger sized sewer pipe.

6.3.2.2 East Trunk Sewer

The model showed 20,475 feet of pipe in the East Trunk Sewer to be outside the limits of the design criteria. Recommended improvements for the East Trunk Sewer in the existing scenario address these deficiencies and no further recommendations were made based on this analysis.



N

0 0.25 0.5 1 Miles

Legend

Pipe

Max d/D

- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99
- EVWD Service Area
- East Trunk Sewer
- Proposed Casino Pipe
- Reclamation Plant

East Valley Water District

Stantec

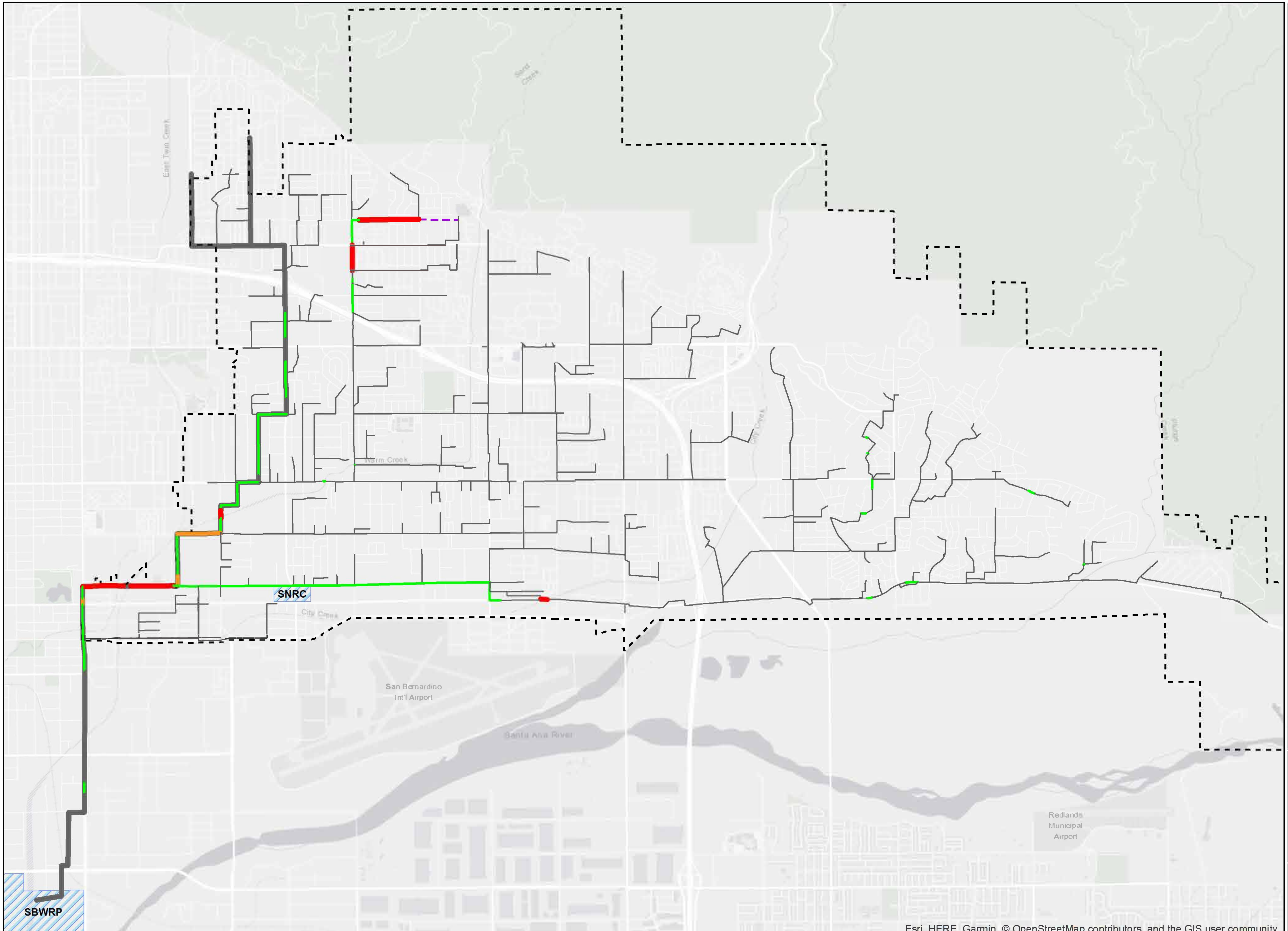
Figure 6-5

Near-Term System Dry Weather Capacity Evaluation

Date: 12/13/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_2245011611\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-5 2025_DWF.mxd



N

0 0.25 0.5 1 Miles

Legend

Pipe

Max d/D

- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99
- EVWD Service Area
- East Trunk Sewer
- Proposed Casino Pipe
- Reclamation Plant

East Valley Water District

Stantec

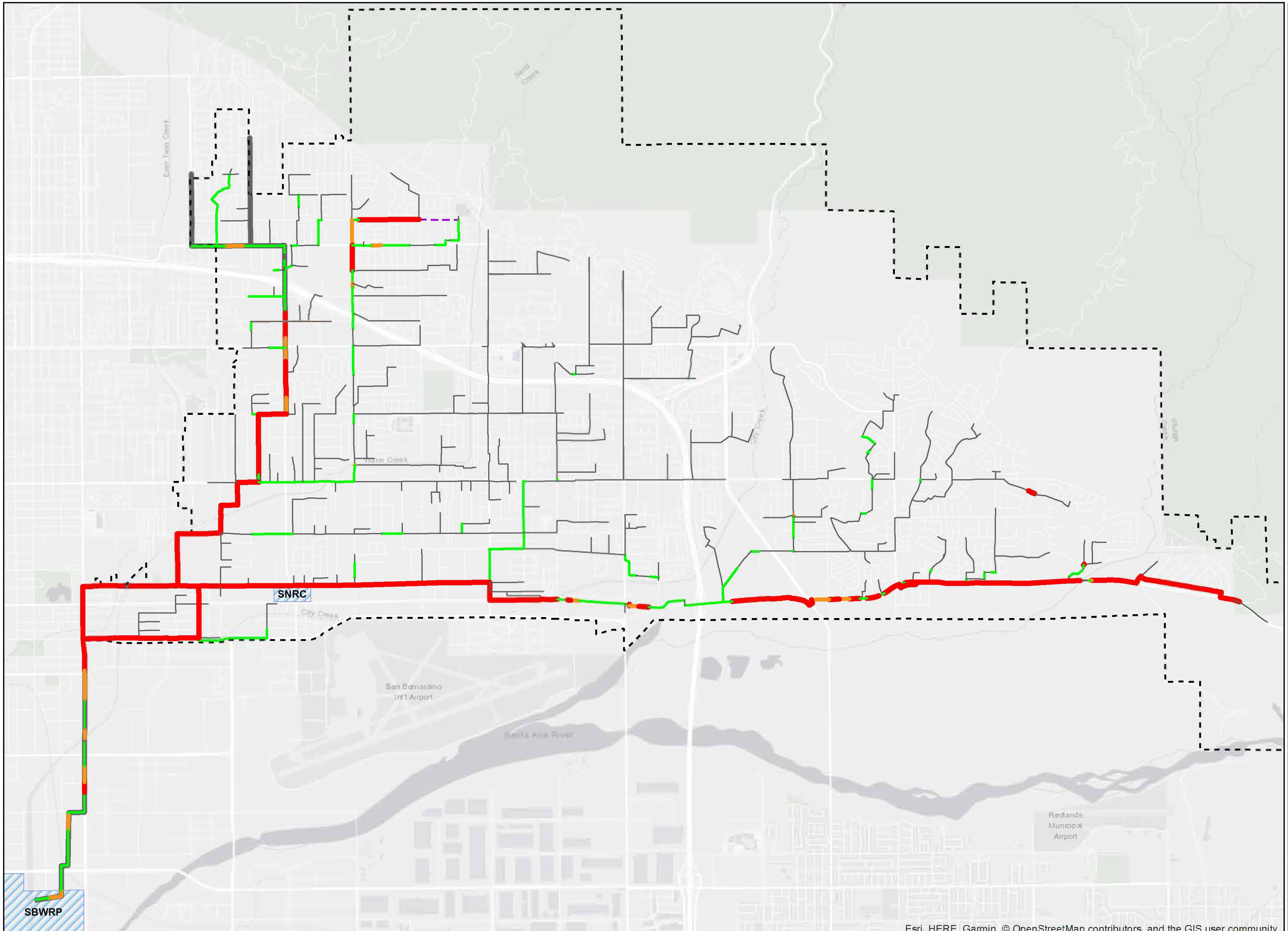
Figure 6-6

Near-Term System (Without Harmony Development) Dry Weather Capacity Evaluation

Date: 12/13/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-6 2025_DWF_No_Harmony.mxd



N

0 0.25 0.5 1 Miles

Legend

Pipe

Max d/D

- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99
- EVWD Service Area
- Proposed Casino Pipe
- East Trunk Sewer
- Reclamation Centers

East Valley Water District

Stantec

Figure 6-7

Near-Term System Wet Weather Capacity Evaluation

Date: 12/13/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-7 2025_WWF.mxd

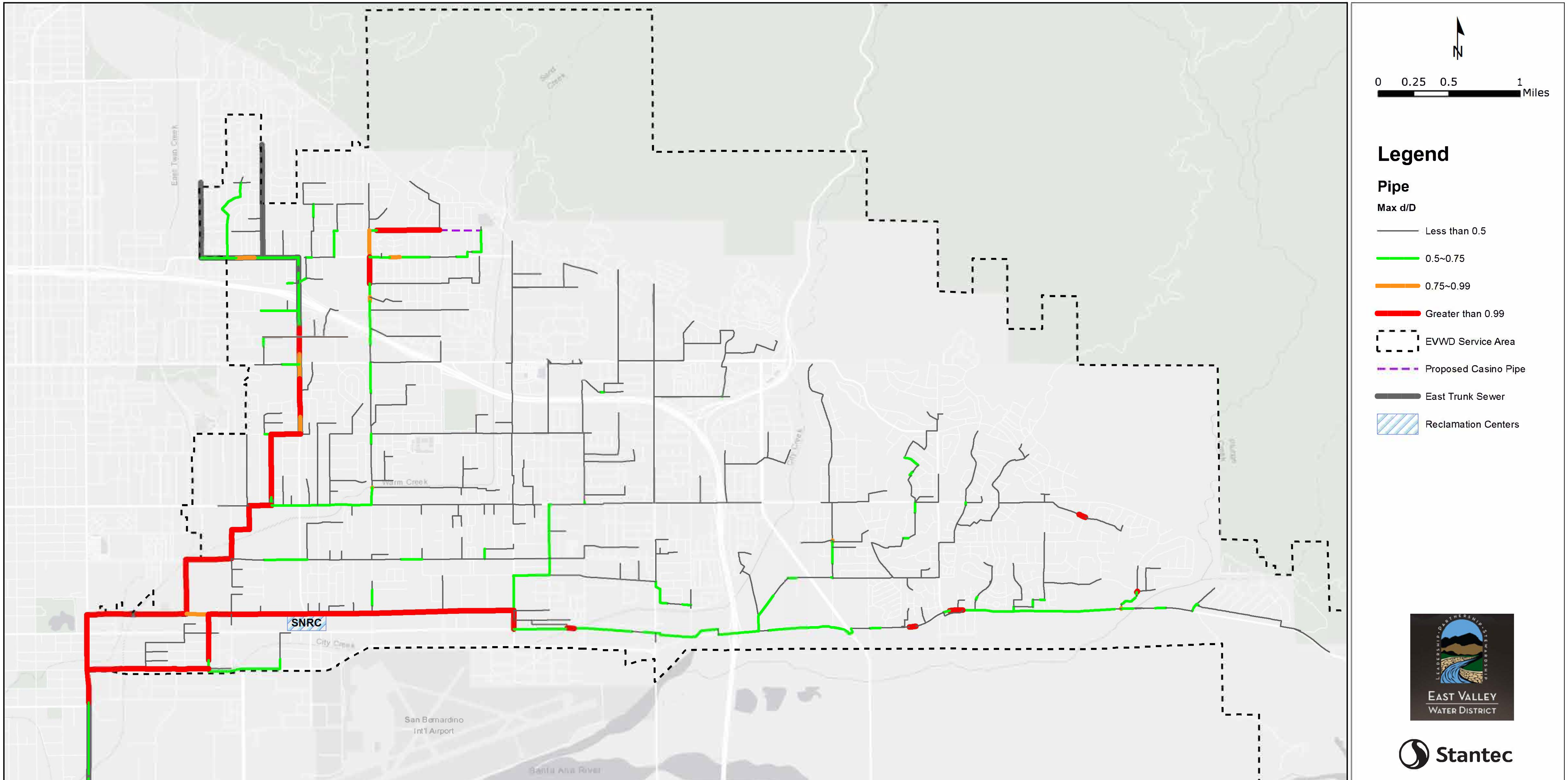


Figure 6-8

Near-Term System (Without Harmony Development) Wet Weather Capacity Evaluation

Date: 12/13/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-8 2025_WWF_No_Harmony.mxd

6.4 BUILD-OUT SYSTEM CAPACITY EVALUATION

Additional sewer flows were applied to the sewer system model based on projections for future build-out of the EVWD service area. The build-out scenario was developed to evaluate the sewer system under future conditions caused by construction of all expected specific developments as well as development in line with SCAG's General Plan for the service area. All EVWD's will-serve list and current septic customers are assumed to be contributing flow to the future system. The build-out scenario was evaluated under both dry and wet weather to identify capacity constraints. Table 6-4 summarizes the lengths of pipes that were identified in the build-out model as being outside the limits of the design criteria.

Table 6-4: Summary of Build-Out Model Results

Parameter	Dry Weather		Wet Weather		Total Pipes	
	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)	EVWD (LF)	East Trunk Sewer (LF)
Pipes < 18", 1> d/D > 0.5	36,456	4,604	-	-	1,080,060	15,170
Pipes ≥ 18", 1> d/D > 0.75	12,242	6,077	-	-	46,630	27,450
Surcharged Pipe (d/D > 1.0)	23,964	3,844	49,296	22,230		
Total	**48,698**	**10,681**	**49,296**	**22,230**	**1,126,690**	**42,620**
Percent of Total Pipes	4%	25%	4%	52%		

6.4.1 Dry Weather – Build-out System

The model was run under build-out, dry weather conditions and the maximum d/D ratios were evaluated to determine the capacity constraints in the system. The results of the model run are shown on Figure 6-9. The location of the SNRC, construction of which started in late 2018, is shown in the figure. A proposed sewer line has been added to the model from the site of the San Manuel Casino expansion to the proposed tie-in point with the existing sewer system at the intersection of Arden Ave. and Marshall Blvd for this analysis.

Several areas that were surcharged in the model in previous planning horizons had additional surcharged pipes in the build-out scenario. The proposed recommendations for these areas were expanded in order to address the increased deficiencies and is discussed in Section 8.

6.4.1.1 EVWD Service Area

The model showed 48,698 feet of pipe in EVWD's service area to be outside the limits of the design criteria. Other than the expansion of previously identified surcharged pipe areas, no additional pipes in EVWD's service area in the build-out dry weather model run necessitated improvements.

6.4.1.2 East Trunk Sewer

The model showed 10,681 feet of pipe in the East Trunk Sewer to be outside the limits of the design criteria. Other than the expansion of previously identified surcharged pipe areas, no additional pipes in the East Trunk Sewer in the build-out dry weather model run necessitated improvements.

6.4.2 Wet Weather – Build-out System

The build-out system model was run under wet weather conditions and the maximum d/D ratios were evaluated to determine the capacity constraints in the system. The results of the model run are shown on Figure 6-10.

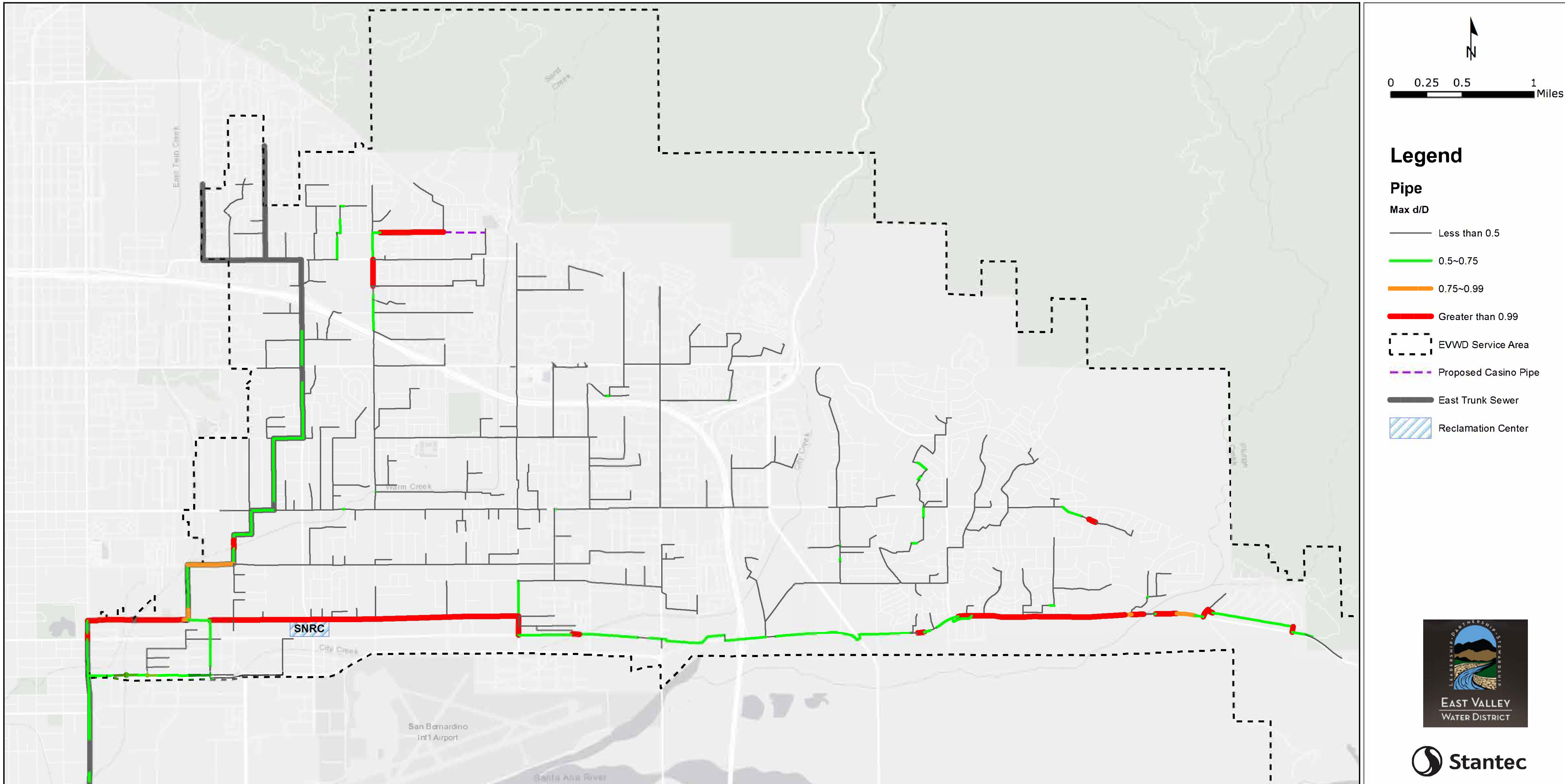
6.4.2.1 EVWD Service Area

The model showed 49,296 feet of pipe in EVWD's service area to be outside the limits of the design criteria. Because these areas are surcharged during modeled wet weather conditions, it is recommended that EVWD verify flow in these areas during wet weather events to confirm model results and determine the true extent of the surcharging. Projects have been recommended in Section 8 based on modeled results but should be initiated based on field confirmation. Pipes in the East Trunk Sewer in the build-out wet weather model run that were identified as surcharged (d/D = 1.0) include the following:

- The model shows approximately 790 feet of 6-inch diameter pipe along Osbun Rd. as surcharged in wet weather. This serves as the basis for project B-1 discussed in Section 8. It is noted that the length of the replacement shown for project N-3 exceeds the length of pipe showing as surcharged in the model in order to upsize the pipeline without creating a flow constriction. This involves upsizing the pipe downstream from the surcharged area until it connects to a similar or larger sized sewer pipe.
- The model shows approximately 1,300 feet of 15-inch diameter pipe along 3rd Street as surcharged in wet weather. This serves as the basis for project B-2 discussed in Section 8.
- The model shows a 30-foot, 8-inch diameter pipe at the intersection of Atlantic Ave. and La Praix Street as surcharged in wet weather. This serves as the basis for a watch area discussed in Section 8.
- The model shows a 75-foot, 8-inch diameter pipe between Ridge Dr. and Leedom Dr. as surcharged in wet weather. This serves as the basis for a watch area discussed in Section 8.
- The model shows a 50-foot, 15-inch diameter pipe along Webster St. as surcharged in wet weather. This serves as the basis for a watch area discussed in Section 8.

6.4.2.2 East Trunk Sewer

The model showed 22,230 feet of pipe in the East Trunk Sewer to be outside the limits of the design criteria. Other than the expansion of previously identified surcharged pipe areas, no additional improvements are needed.



East Valley Water District

Stantec

Figure 6-9

Build-Out System Dry Weather Capacity Evaluation

Date: 12/13/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 6-9 2040_DWF.mxd

6.5 STERLING NATURAL RESOURCES CENTER TRUNK LINE ANALYSIS

The Sterling Natural Resources Center is a state-of-the-art water reclamation facility currently under construction at the intersection of Del Rosa Ave. and 6th Street. When complete, the SNRC will provide a sustainable new water supply to EVWD and the region. The SNRC will have a treatment capacity of 10 MGD, and the build-out model scenario was used to determine sources for the future flow.

Through discussion with EVWD, the details of a new SNRC interceptor pipeline were determined and used to evaluate flows at the proposed interception locations. According to the model, 11.7 MGD of flow can be redirected from the East Trunk Sewer to the SNRC through the new interceptor. The location of the SNRC, the proposed interceptor, and a breakdown of the build-out max day dry weather flows at each interception point are shown on Figure 6-11.

Final locations of diversions to the SNRC interceptor were only made available after the analysis of the EVWD system had been completed. However, based on the locations shown on Figure 6-11, the following projects discussed in Section 8 were identified as being downstream of the interceptor and may be relieved, partially or completely, by installation of the interceptor:

- Project E-1
- Project E-2
- Project E-3
- Project E-4
- Project B-2

For these projects, it is recommended that EVWD monitor these locations through observation by operations staff and flow monitoring in order to determine if the projects are warranted immediately, or if the lines can continue to be monitored until the interceptor is operational. Once the interceptor is operational, additional flow monitoring and update of the model should be performed to confirm final flows in the downstream pipes and reassess which projects are still necessary.

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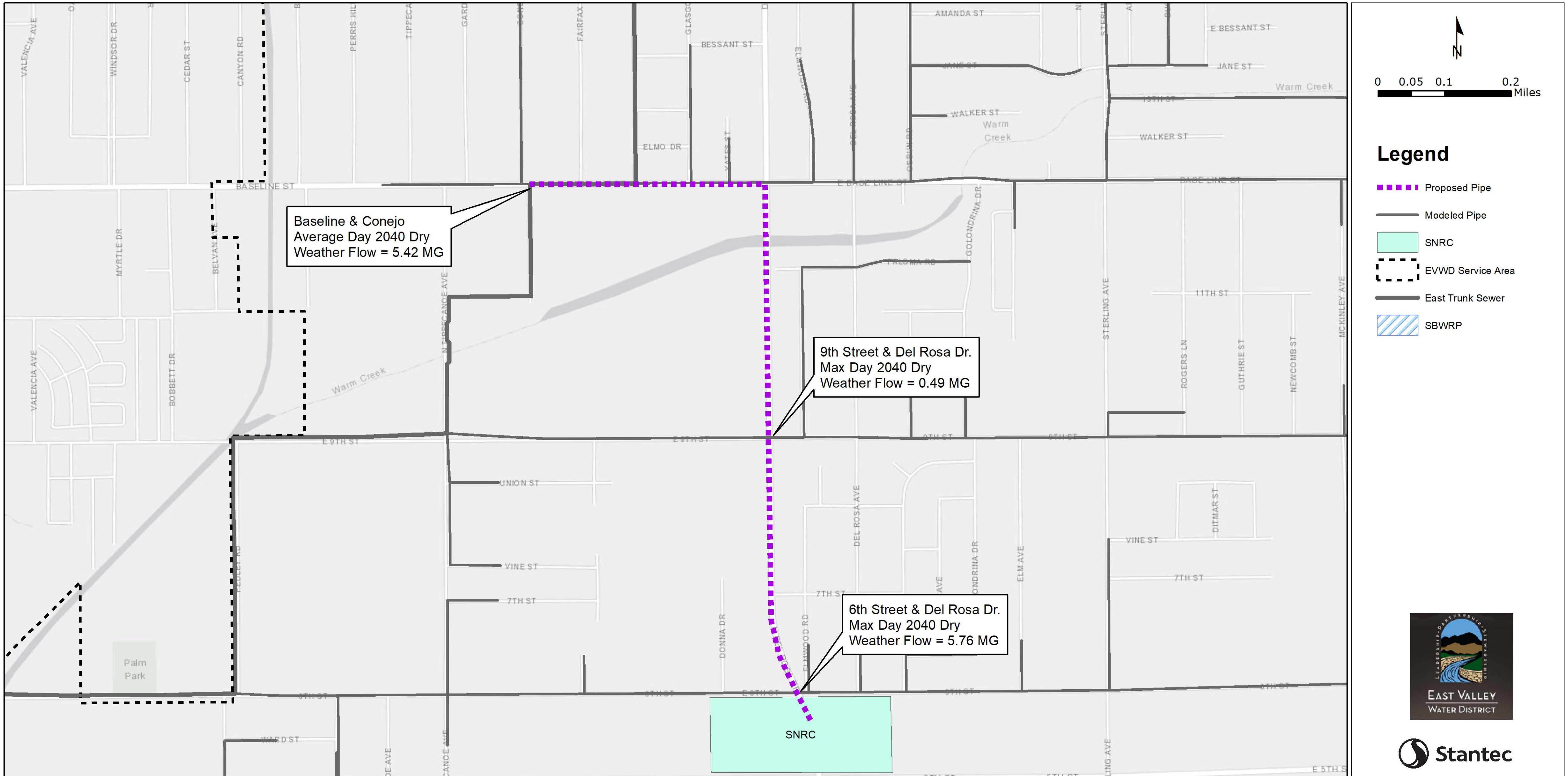


Figure 6-11
Buildout 2040 System
Trunk Line Analysis

Date: 12/19/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure XX Trunk Line Analysis.mxd

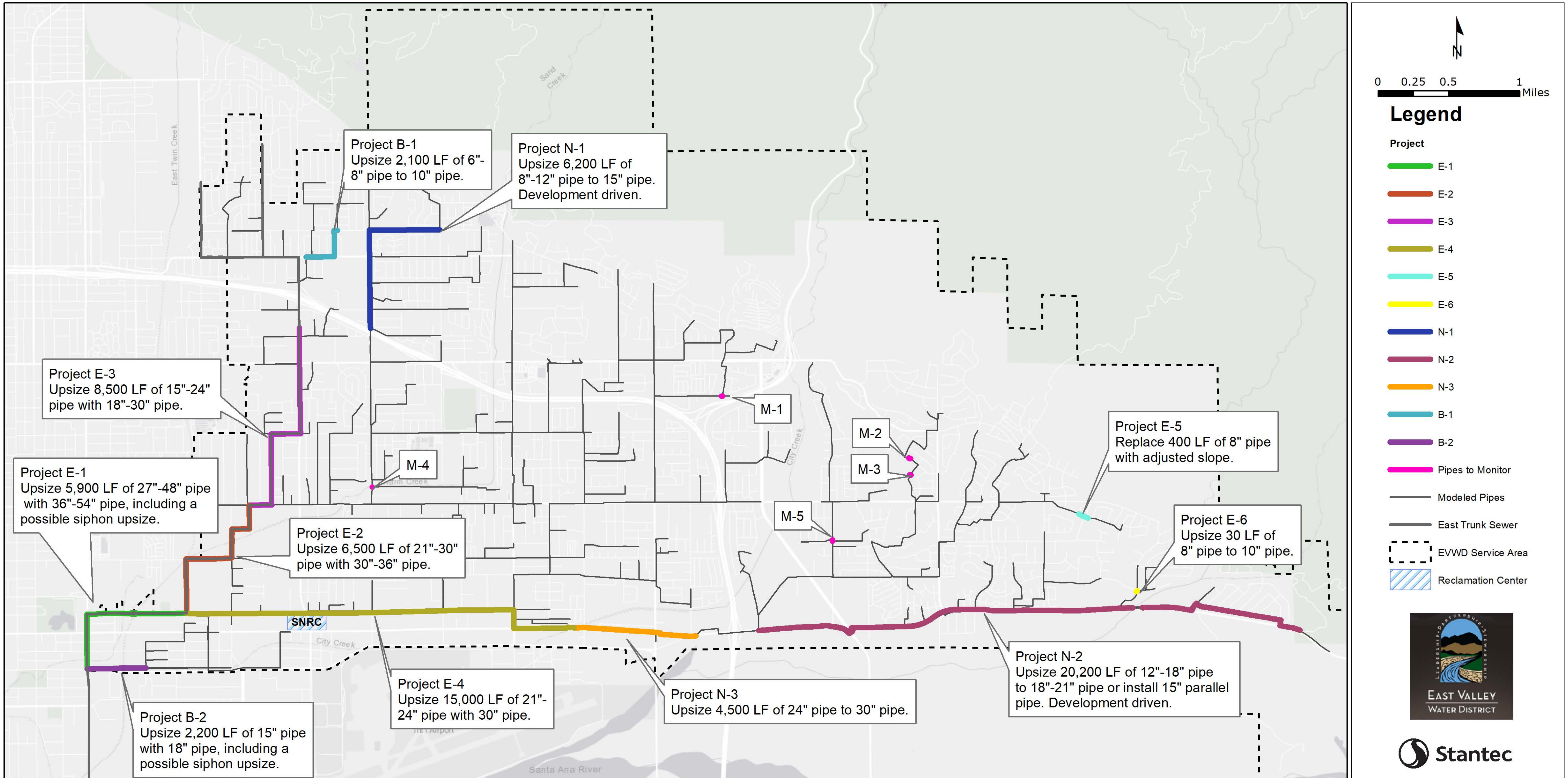


Figure 7-1
Recommended Capacity Projects

Date: 12/20/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

7.0 GIS MANAGEMENT PLAN

7.1 INTRODUCTION

The integration of GIS with the hydraulic modeling is a process by which all sources (GIS database, operation/control data, and model) can be updated (synchronized) to reflect new, updated, or abandoned elements, and the most recent operation/control strategy.

A GIS group within an agency usually supports multiple functions within the utility that demand accurate and current system information. As a result, the GIS database is likely to be updated on a regular basis, whereas the utility's hydraulic model may only be updated periodically.

Traditionally, hydraulic models were only developed or updated to be used for master-planning or for evaluating specific system improvement. The GIS data available at the time will be used, and the model won't be updated until another need arises.

When an approach to integrate the GIS database and the hydraulic model is established, the process to update the hydraulic model becomes streamlined and efficient, allowing for the model to be updated more frequently. This results in an up-to-date hydraulic model based on the current GIS that is more reliable and can be used to meet the needs of the utility. The model can be used to evaluate the impact on the existing system when adding potential customers, simulating operation scenarios, and identifying system deficiencies.

A hydraulic model can be developed to include all pipes, or it can be skeletonized to only include large diameter pipes and main facilities (i.e. pumping stations and diversion structures). All-pipe models take more time to setup and run, compared to skeletonized model due to an increased number of model elements. The level of detail included in the model is usually driven by several factors that include available budget, available data, and application (e.g. master planning, evaluation of localized overflows, or operation). Utilities with large systems could maintain a system-wide skeletal model, and multiple regional all-pipe models.

The sections below focus on presenting EVWD with best practices for wastewater GIS databases to improve the process of ensuring the GIS data is model-ready to facilitate updates in the hydraulic model in the future.

7.2 GIS FEATURE CLASS REVIEW

As with a GIS water network, GIS layers representing a wastewater system are comprehensive and not all are needed to develop a hydraulic model. Conversely, there is information that is essential for modeling, but are unnecessary when building GIS layers. Given this, there are changes to the current GIS and data management practices that may be needed to better integrate GIS with the selected modeling software.

While the geodatabase provided by EVWD contained layers representing its wastewater collection system, only layers relevant to model development were reviewed and are referred to as primary layers. The primary layers, which include sMain, sManhole, sCleanout, and sFitting have comprehensive accounting of system features needed for model development.

The primary layers can be imported into the model using InfoSewer's GIS Gateway tool. The GIS Gateway should to be setup to only import features that meet an established feature attribute filter criteria that meets model requirements. Table 7-1 shows the feature classes relevant to the sewer model development.

Table 7-1: Feature Classes Relevant to Sewer Model Development

GIS Feature Class	Data Type	Model Layer	Comments
sManhole	Point	Manholes	Import Active Elements
sCleanout[1]	Point	Manholes	Import Active Elements
sFitting[1]	Point	Manholes	Filter for FittingType = 3 (Indicates a Pipe Change)
sMain	Line	Pipes	Import Active Elements

Note: sCleanout and sFitting can be represented as manholes in the model for connectivity purposes and "tagged" to be differentiated from actual manholes.

7.3 TYPICAL CONNECTIVITY CHECKS

The typical connectivity checks performed in the model can be considered and incorporated in the GIS edit templates and topology rules to help prepare the wastewater GIS network for model import. The InfoSewer built-in Network Review/Fix and Connectivity tools that can be used to review network connectivity and identify connectivity issues are described as follows:

- **Trace (Upstream and Downstream) Network Disconnect (TND)**– Identifies nodes or pipes that are not connected to the system as a result of snapping tolerance. Disconnected elements in a hydraulic model will prevent the model from running, as they have no connection to an outlet and flow cannot travel.

- **Orphan Nodes/Pipes (Orphan)** – Identifies orphan nodes that are not connected to a model pipe. An Orphan pipe is missing either a "To" node or a "From" node, or both. Most Orphan nodes will also be identified in the Trace Network command as Disconnected (TND).

- **Nodes in Close Proximity (NICP)** – Identifies nodes that overlap or are duplicated. The NICP search tolerance is a critical parameter and can be defined as a percentage of the shortest pipe length or set to a specific value.

- **Pipe Split Candidates (PSC)** – Identifies nodes that lie on top of a pipe but do not split the pipe. These may have a significant impact on connectivity required by the modeling software. The PSC search tolerance is a critical parameter and can be defined as a percentage of the shortest pipe length.

- **Crossing/Intersecting Pipes (CP)** – Identifies pipes that are crossing or intersecting with another pipe but do not split each other with a junction.

- **Parallel Pipes (PP)** – Identifies pipes that have the same START and END nodes but have different alignment.

- **Duplicate Pipes (DP)** – Identifies pipes that have the same START and END nodes and have the same alignment.

- **Invert Comparison (INVC)** – Identifies flat slope and adverse/negative slope pipes.
- **Manhole Depth (MD)** – Checks manhole depth, and whether what's in the database meets guidelines. Also checks that manhole invert is at or below incoming/outgoing pipe invert.

7.4 CONCLUSIONS AND RECOMMENDATIONS

Based on the GIS feature class review and general best practices for wastewater networks, the following sections outline the conclusions and recommendations for EVWD to consider incorporating in their overall GIS workflow.

7.4.1 Recommended Feature Attributes

To build or update the collection system hydraulic model, there are mandatory attributes that are required for the model to be valid, while other fields are needed for informational purposes. Table 7-2**Error! Reference source not found.** shows a list of existing EVWD GIS attributes and recommended additional fields.

Table 7-2: Layer Attributes-Required, Informational, and Proposed

GIS Feature Class	Type	Existing Fields Required	Existing Fields Informational	Proposed Fields
sManhole	Point	FacilityID, RimElevation, InvertElevation, ManholeDepth	OperatingStatus, InstallData, ManholeType	inModel, ElevationDatum
sCleanout	Point	FacilityID, RimElevation	OperatingStatus, InstallData, CleanOutSize	inModel, ElevationDatum
sFitting[1]	Point	FacilityID	OperatingStatus, InstallData, ValveType	inModel
sMain	Line	FacilityID, UpManhole, DownManhole, MainSize, InElevation, OutElevation, Slope, PipeLength	OperatingStatus, InstallData, Material, Siphon	inModel
Pumps	Line	N/A	N/A	FacilityID*, UpManhole*, DownManhole*, Type*, Design Head*, Design Flow*, OperatingStatus, InstallData, inModel
Force mains	Line	N/A	N/A	FacilityID*, UpManhole*, DownManhole*, MainSize*, InElevation*, OutElevation*, PipeLength*, OperatingStatus, InstallData, inModel
Wet wells	Point	N/A	N/A	FacilityID*, Diameter*, BottomElevation*, MinElevation*, MaxElevation*, OperatingStatus, InstallData, inModel

1: Only consider including Fittings at sMain endpoints
*Data required to run a valid model.

Below is a description of some of the key fields in the GIS database, or recommended to be added:

- **FacilityID:** Relationship between different model elements is maintained through connectivity and a unique ID. A unique ID, which is mapped to the FacilityID attribute in GIS, should be unique not only in individual layers, but amongst all layers associated with the model. In the case of abandoning features, IDs should not be reused.

- **ElevationDatum:** Often as-builts can reference different datums. This can have an impact elevation data integrity and consistency in the model. It's important to know which datum elevation data references to apply adjustments as necessary.

- **InModel:** A Boolean field used to identify GIS features to be included in a hydraulic model. For example, a service line would be marked with a value of NO while an active sewer pipe would be marked with a value of YES.

The sFitting layer represents elements associated with sewer pipes, such as pipe material change sleeves, service connections, and bends, along with other. These elements are buried, and not exposed to the ground. Only Fittings where pipes are split (e.g. at Pipe Material Change or terminating (e.g. at caps and terminating points) should be imported in the model. Similarly, the sCleanout layer can be either imported in the model or discarded, and if discarded then the connecting pipes should be excluded from model as well.

EVWD's sewer system is a gravity system and does not have any pumping stations, so the unused layers proposed in Table 7-2 are listed for informational purposes and in the case where these facilities are later added to the system. The operation of a gravity only system does not require active operation or control logic. Also, a collection system model should have at least one outlet, which represents a treatment plant or a discharge point into a large interceptor where downstream water level does not impact the upstream system. For the EVWD model, two outlets will be present, one for the East Trunk sewer where flow is conveyed to SBMWD, and the SNRC where flows are diverted for recycling.

7.4.2 Key Considerations

In addition to adding the proposed GIS attribute data listed in Table 7-2**Error! Reference source not found.**, EVWD should consider incorporating the following key requirements:

- Maintain a UniqueID across all features. Tools such as Attribute Assistant can be used for this purpose.

- Ensure each pipe maintains a TO_ and FROM_ node (UpManhole, DownManhole) to properly designate direction of flow in the network and establish connectivity.

- Use accurate elevations in GIS, especially considering EVWD's system is a gravity system.

- As needed when adding any facilities, consider representing the facility in detail in GIS to more seamlessly translate to the model.

- Utilize the typical connectivity checks described in Section 7.3, available topology rules, and data reviewer checks to develop a QA/QC process to ensure data quality and integrity.

8.0 RECOMMENDED IMPROVEMENTS

This section presents a summary of EVWD's recommended improvement plan and planning level cost estimates for the recommended projects.

8.1 UNIT COSTS

The recommended improvements cost estimates in this section are planning level costs and may not be an actual representation of design to construction activities and costs. This estimate was developed as an Association for the Advancement of Cost Engineering (AACE) – International Class 5 cost estimate which has an expected accuracy range of -20 to -50 percent on the low end, and +30 to +100 percent on the high end. This range depends on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Accuracy could exceed this range in unusual circumstances. The estimate was prepared using a combination of parametric estimating factors and local experience in delivering similar projects.

Table 8-1 shows a summary of the unit costs for gravity mains used for this cost estimate. All improvements are assumed to take place under asphalt road, and operations and maintenance costs are not included in this estimate. A summary of costs for all estimates for this project can be found at the end of this section.

Due to fluctuations in market conditions, local construction activity and other factors, a more rigorous estimate should be prepared during preliminary design of recommended improvements. For these projects, it was assumed that manholes would not need replacement; if new manholes need to be installed costs for the new manholes will need to be costed separately.

Table 8-1: Summary of Gravity Main Unit Costs

Diameter (in)	VCP Cost ($/lf)	VCP Cost ($/in-dia./lf)	PVC Cost ($/lf)	PVC Cost ($/in-dia./lf)
8	304	38.0	258	32.3
10	380	38.0	323	32.3
12	444	37.0	377	31.5
15	555	37.0	472	31.5
18	666	37.0	566	31.5
21	735	35.0	625	29.8
24	840	35.0	714	29.8
27	918	34.0	-	-
30	1,020	34.0	-	-
36	1,152	32.0	-	-
42	1,344	32.0	-	-
48	1,440	30.0	-	-

1) Costs assume using PVC pipes for pipes 24 inches in diameter and less, and VCP for pipes greater than 24” in diameter.
2) Costs assume installation under asphalt road with 10 feet or less of cover.
3) Costs are including of valves and vaults, but do not include manhole costs.

8.2 CAPACITY BASED IMPROVEMENTS AND COSTS

Once deficiencies in the sewer system were identified using the updated hydraulic model, capital projects were developed to address these deficiencies. Stantec reviewed recommendations from the 2013 SSMP and using current system data, identified cost effective projects that addressed as many deficiencies as possible with the least amount of new, replaced, or rehabilitated pipeline. Pipelines in need of replacement were grouped into projects based on their proximity to other recommendations in order to minimize construction costs, time, and impacts of construction. Some of the pipes upsized as part of a larger project did not show deficiencies themselves but were upsized to avoid constrictions in pipe diameter as flow travels downstream; when making recommendation Stantec avoids recommending a pipe upgrade that would feed into a smaller diameter pipe as this can lead to constriction of flow, blockages, and other operational problems. However, when implementing these improvements, it is recommended that EVWD perform a pre-design of the improvement to determine if a pipe constriction is warranted given updated flow information and the downstream slopes.

Before EVWD decides to design or construct the recommended improvements, the need for the project should be confirmed through field investigation, flow monitoring, and additional detailed analysis.

Figure 8-1 shows the improvements grouped into projects, while Figure 8-2 shows the projects color coded by their respective planning horizon, as well as “pipes to monitor.” “Pipes to monitor” are pipes showing capacity deficiency in the future planning horizon during wet weather flow and should be monitored for surcharging to verify the need for replacement and possibly realignment once significant growth has occurred in the service area. Relief lines may also be considered; however, it is important to consider where these lines would connect back to the main system so as not to overload downstream pipes or cause flow constriction and blockages. The deficiencies in the watch areas may be due to pipe slope or hydraulics and are localized enough that a project is not recommended in this SSMP until the deficiency can be field verified in the future.

8.2.1 EVWD Service Area

The improvements identified are summarized in Table 8-2. For each project, a total length of pipeline replaced, original pipeline diameter, and new pipeline diameter are identified, as well as a description of the project, and which model scenario deficiency is addressed by each project. These projects are listed in a prioritized order, addressing the dry weather capacity deficiencies in each planning horizon first. Costs for each project are calculated by taking the unit costs previously submitted to EVWD multiplied by the pipe diameter, length, and maximum pipeline depth as calculated from the EVWD GIS information. The unit cost table provides different costs for pipes depending on how deep the pipeline is buried. Stantec calculates the upstream and downstream manhole depths from the GIS and uses the largest value to determine which unit cost to apply to each replacement.

Table 8-2: EVWD Capacity Improvement Project Cost Estimates

Project Name	Description	Estimated Construction Cost ($)	Contingency (20% of Construction Cost) ($)	Engineering, Legal & Admin. (30% of Construction Cost) ($)	Total Project Cost ($)
E-4[1]	Upsize 15,000 LF of 21"-24" pipe with 30" pipe.	15,273,000	3,054,600	4,581,900	22,909,500
E-5	Replace 400 LF of 8" pipe with modified slope.	99,000	19,800	29,700	148,500
E-6	Upsize 30 LF of 8" pipe to 10" pipe.	10,000	2,000	3,000	15,000
Existing Subtotal		15,382,000	3,076,400	4,614,600	23,073,000
N-1	Upsize 6,200 LF of 8"-12" pipe to 15" pipe. Development driven (Casino Expansion).	2,943,000	588,600	882,900	4,414,500
N-2	Upsize 20,200 LF of 12"-18" pipe to 18"-21" pipe. Development driven (Harmony and Sunland/Mediterra).	11,648,000	2,329,600	3,494,400	17,472,000
N-3	Upsize 4,500 LF of 24" pipe to 30" pipe. Development driven.	4,633,000	926,600	1,389,900	6,949,500
Near-term Subtotal		19,224,000	3,844,800	5,767,200	28,836,000
B-1	Upsize 2,100 LF of 6"-8" pipe to 10" pipe.	687,000	137,400	206,100	1,030,500
B-2[2]	Upsize 2,200 LF of 15" pipe with 18" pipe, including a possible siphon upsize.	1,176,000	235,200	352,800	1,764,000
Build-out Subtotal		1,863,000	372,600	558,900	2,794,500
Total		**36,469,000**	**7,293,800**	**10,940,700**	**54,703,500**

[1]: This project may be relieved by the SNRC interceptor and should be monitored to assess if the deficiencies require immediate attention or can be monitored until the interceptor is operational and flows can be reassessed.

[2]: This project should be reassessed in a future update with the SNRC interceptor final dimensions in order to assess the extant to which the interceptor has relieved flows and if the improvement is still necessary.

8.2.2 East Trunk Sewer

Capacity deficiencies in the East Trunk Sewer were also determined, and the estimated costs for these projects are summarized in Table 8-3**Error! Reference source not found.**.

Table 8-3: East Trunk Sewer Capacity Improvement Project Cost Estimates

Project Name	Description	Estimated Construction Cost ($)	Contingency (20% of Construction Cost) ($)	Engineering, Legal & Admin. (30% of Construction Cost) ($)	Total Project Cost ($)
E-1[1]	Upsize 5,900 LF of 27"-48" pipe with 30"-54" pipe, including a possible siphon upsize.	7,873,000	1,574,600	2,361,900	11,809,500
E-2[1]	Upsize 6,500 LF of 21"-30" pipe with 30"-36" pipe.	7,093,000	1,418,600	2,127,900	10,639,500
E-3[1]	Upsize 8,500 LF of 15"-24" pipe with 18"-30" pipe.	5,586,000	1,117,200	1,675,800	8,379,000
Total		**20,552,000**	**4,110,400**	**6,165,600**	**30,828,000**

[1]: These projects may be relieved by the SNRC interceptor and should be monitored to assess if the deficiencies require immediate attention or can be monitored until the interceptor is operational and flows can be reassessed.

8.2.3 Pipes to Monitor

Several areas that were determined from the model capacity evaluation to be surcharged in the build-out scenario is recommended as “pipes to monitor” as shown on Figure 8-1.

8.2.4 Summary of Capacity Improvements

A summary of the recommended capacity improvements is shown in Table 8-4.

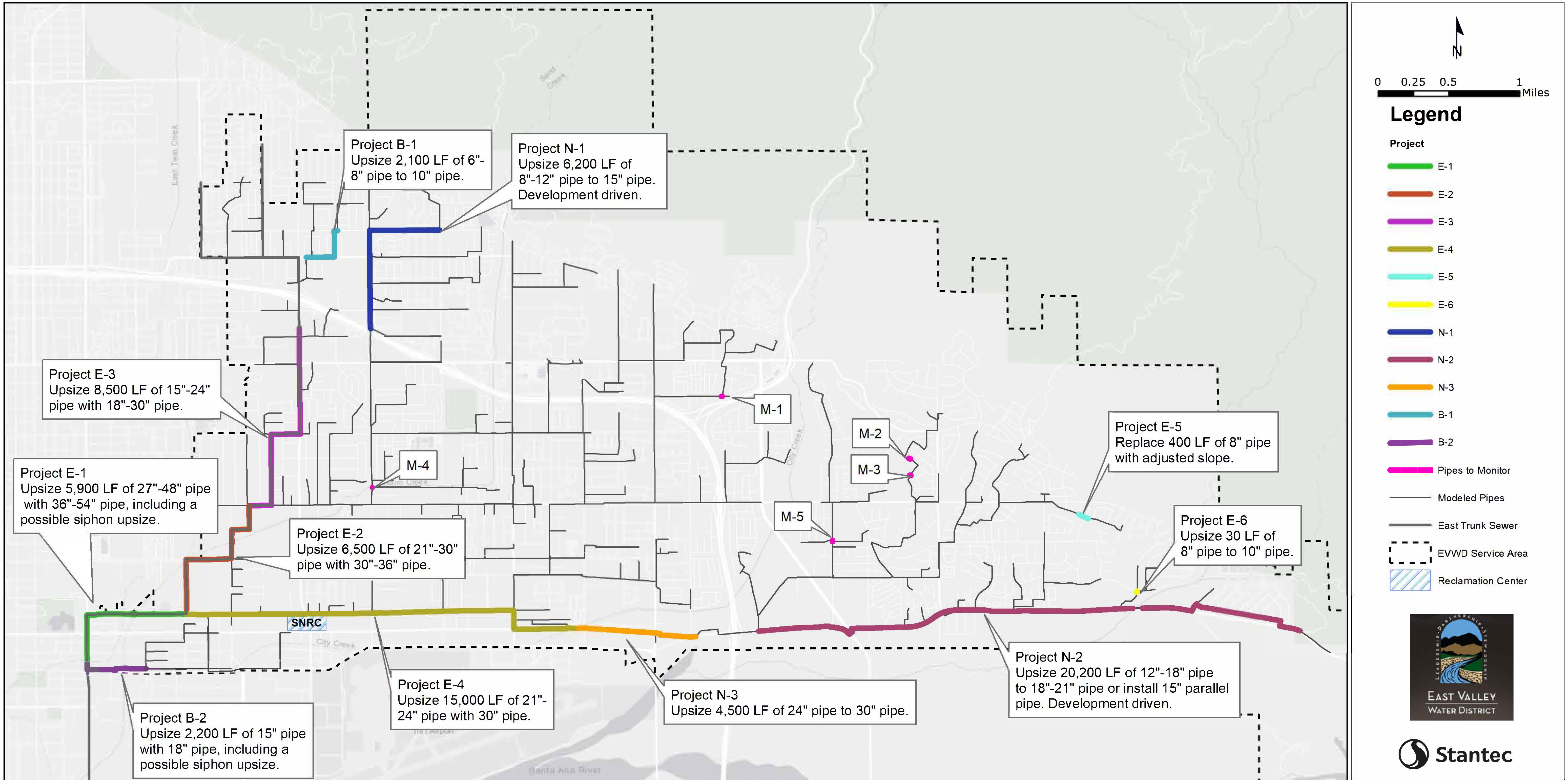
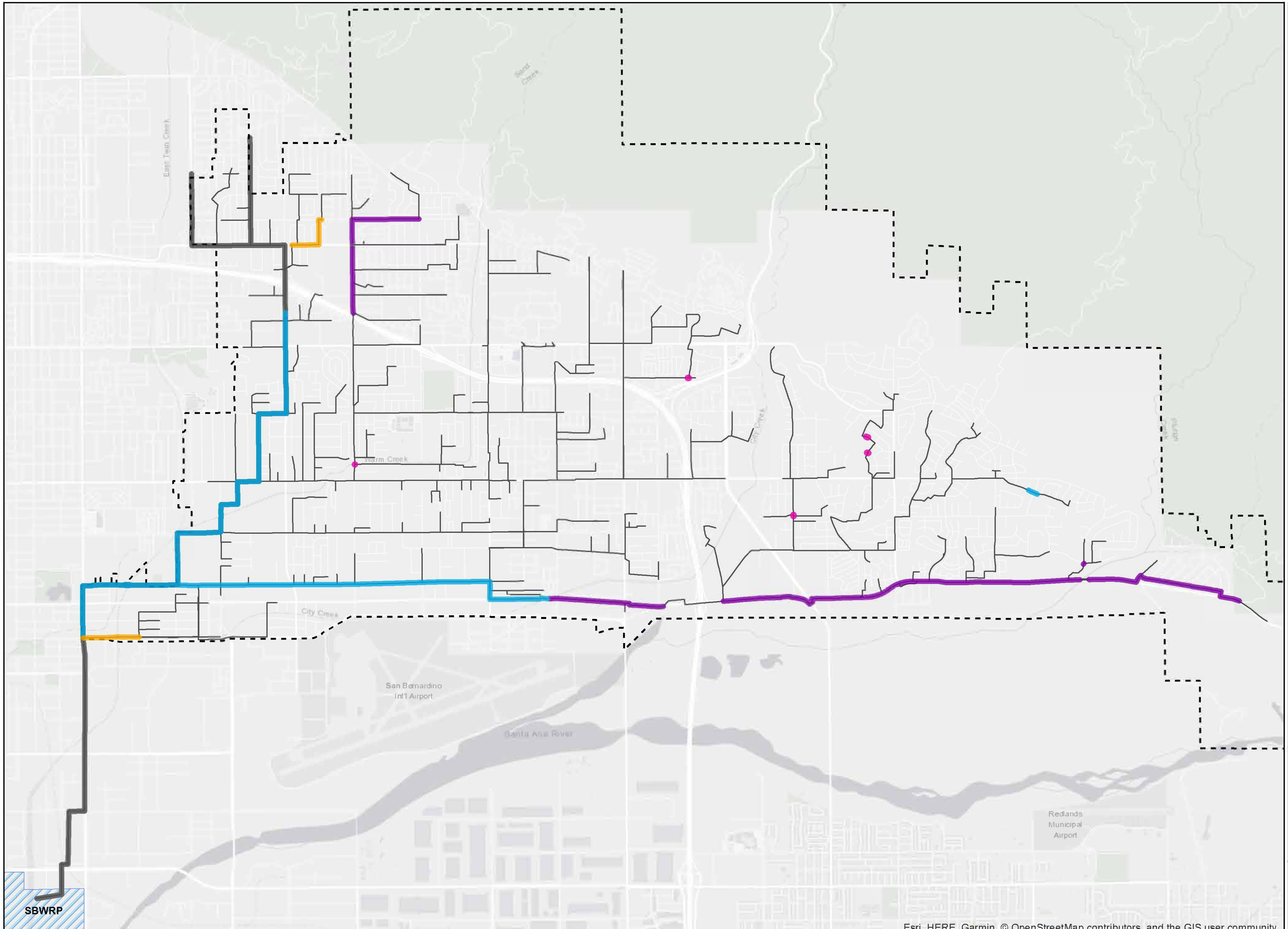


Figure 8-1
Recommended Capacity Projects

Date: 12/20/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: \\uspas1s01\MUNI\Clients\East Valley WD\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 7-1 Capacity Projects.mxd



N

0 0.25 0.5 1 Miles

Legend

Projects

- Existing
- 2025
- 2040
- Areas to Monitor
- Modeled Pipes
- EVWD Service Area
- East Trunk Sewer
- SBWRP

East Valley Water District

Stantec

Figure 8-2

Capacity Recommendations by Planning Horizon

Date: 12/20/2018

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Sewer\Figure 7-2 Projects by Horizon.mxd

Table 8-4: Summary of Capacity Improvements

Planning Horizon	Project Name	Description	Driver	Original Diameter	New Diameter	Length (LF)	Estimated Construction Cost ($)	Contingency (20% of Construction Cost) ($)	Engineering, Legal & Administration (30% of Construction Cost) ($)	Total Project Cost ($)
Existing	**E-1**[1]	Upsize 5,900 LF of 27"-48" pipe with 30"-54" pipe, including a possible siphon upsize. East Trunk Sewer project.	Existing DWF	27	36	1,366	7,873,000	1,574,600	2,361,900	11,809,500
				33	42	2,127				
				39	42	662				
				39	48	1,025				
				48	54	663				
	E-2[1]	Upsize 6,500 LF of 21"-30" pipe with 30"-36" pipe. East Trunk Sewer project.	Existing DWF	21	30	880	7,093,000	1,418,600	2,127,900	10,639,500
				24	30	1,875				
				27	36	2,068				
				30	36	1,650				
	E-3[1]	Upsize 8,500 LF of 15"-24" pipe with 18"-30" pipe. East Trunk Sewer project.	Existing WWF	15	18	326	5,586,000	1,117,200	1,675,800	8,379,000
				15	21	5,176				
				18	21	2,103				
				24	30	835				
	E-4[1]	Upsize 15,000 LF of 21"-24" pipe with 30" pipe. Provides and SNRC sewer relief.	Existing WWF	21	30	9,861	15,273,000	3,054,600	4,581,900	22,909,500
				24	30	5,113				
	E-5	Replace 400 LF of 8" pipe with modified slope in order to address areas of flat slope that cause non-ideal flow conditions	Existing WWF	8	8	383	99,000	19,800	29,700	148,500
	E-6	Upsize 30 LF of 8" pipe to 10" pipe.	Existing WWF	8	10	31	10,000	2,000	3,000	15,000
Subtotal							**35,924,000**	**7,184,800**	**10,777,200**	**53,886,000**
Near-Term	**N-1**	Upsize 6,200 LF of 8"-12" pipe to 15" pipe. Development driven (Casino Expansion).	Near-Term DWF and Casino Expansion	8"	15"	4,565	2,943,000	588,600	882,900	4,414,500
				12"	15"	1,670				
	N-2	Upsize 20,200 LF of 12"-18" pipe to 18"-21" pipe. Development driven (Harmony and Sunland/Mediterra).	Near-Term DWF	12"	18"	13,219	11,648,000	2,329,600	3,494,400	17,472,000
				15"	18"	3,060				
				15"	21"	3,543				
				18"	21"	346				
	N-3	Upsize 4,500 LF of 24" pipe to 30" pipe. Development driven.	Near-Term WWF Dependent upon assumed development	24"	30"	4,542	4,633,000	926,600	1,389,900	6,949,500
Subtotal							**19,224,000**	**3,844,800**	**5,767,200**	**28,836,000**
Build-out	**B-1**	Upsize 2,100 LF of 6"-8" pipe to 10" pipe.	Build-out WWF	6"	10"	1,092	687,000	137,400	206,100	1,030,500
				8"	10"	1,034				
	B-2[2]	Upsize 2,200 LF of 15" pipe with 18" pipe, including a possible siphon upsize.	Build-out WWF	15"	18"	2,077	1,176,000	235,200	352,800	1,764,000
Subtotal							**1,863,000**	**372,600**	**558,900**	**2,794,500**
Pipes to Monitor	**M-1**	Pipe S-SM-I9-1012.	Build-out WWF	10		27	-			
	M-2	Pipe S-SM-J11-1020.	Build-out WWF	8		75	-			
	M-3	Pipe S-SM-J11-1042.	Build-out WWF	10		44	-			
	M-4	Pipe S-SM-J5-1052.	Build-out WWF	21		8	-			
	M-5	Pipe S-SM-K10-1047.	Build-out WWF	18		50	-			
Total Capital Cost							**57,011,000**	**11,402,200**	**17,103,300**	**85,516,500**

[1]: These projects may be relieved by the SNRC interceptor and should be monitored to assess if the deficiencies require immediate attention or can be monitored until the interceptor is operational and flows can be reassessed.
[2]: This project should be reassessed in a future update with the SNRC interceptor final dimensions in order to assess the extant to which the interceptor has relieved flows and if the improvement is still necessary.

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8.3 CONDITION ASSESSMENT

Stantec analyzed recent CCTV records for EVWD sewer pipes televised since the previous SSMP. Condition scoring was provided for 3,108 unique pipes with a total length of roughly 138.9 miles, or 46 percent of the total pipe length in the EVWD system. Stantec applied the analysis performed in the 2013 SSMP to estimate the capital cost to repair and rehabilitate the pipeline assets.

EVWD CCTV inspections use the standard Pipeline Assessment Certification Program's (PACP) rating system per the National Association of Sewer Service Companies (NASSCO). The PACP rating system is used to rate structural and maintenance defects as they are observed by the CCTV camera operator. A code is assigned to defects identified in the pipeline, ranging from one to five in increasing severity. PACP Quick Ratings summarize the overall findings by listing the top two defect codes and their respective number of occurrences in a four-digit score. For example, a Quick Rating of 5436 represents a pipeline that had four occurrences of grade five defects and six occurrences of grade three defects.

For this analysis, Quick Ratings were used to estimate a rehabilitation/replacement length for each pipeline and associated estimated capital cost. Length of pipeline in need of rehabilitation was calculated by multiplying the number of occurrences of the two most severe defects for each pipe by an assumed length needed to replace those defects, not to exceed the total length of the pipeline. Defect codes were assigned the following assumed lengths needing replacement: 5 = 40 feet, 4 = 30 feet, 3 = 20 feet, 2 = 10 feet, and 1 = 4 feet. The capital cost was then calculated by multiplying the total length of pipe needing replacement by the unit cost based on the pipe's diameter, assuming an 8 ft average depth for all pipelines.

For example, a 12-inch diameter pipeline with a Quick Rating of 5436 would have an estimated rehabilitation/replacement length of 280 ft ([4 x 40 ft] + [6 x 20 ft]) and an estimated capital cost of $99,008 (280 ft x $353.60 per lf. [unit cost for a 12-inch diameter pipe at 8 ft. installation depth as presented in unit costs submitted to EVWD]).

8.3.1 EVWD Service Area

Stantec used the sewer system hydraulic model to calculate existing peak flows for each pipeline, along with the Quick Ratings for each pipeline to establish a prioritization for rehabilitation. The matrices presented below prioritize rehabilitation projects by maximum defect code and the amount of flow conveyed during the maximum existing scenario in the model. Table 8-5 presents the number of occurrences of each category; Table 8-6 presents the total length of pipeline; and Table 8-7 presents the estimated capital cost to replace each category of pipeline. The different categories of pipelines then organized into four levels of prioritization as expressed in the color coding on each matrix and summarized by cost in Table 8-8. The color coding in the tables represents the priority ranking as defined in Table 8-8.

Table 8-5: Number of Pipes by Max Defect and Flow

Flow	Maximum Defect Rating					Total Instances by Flow
	1	2	3	4	5	
>1.5 mgd	0	0	0	0	0	0
>1.0 mgd	0	0	0	0	0	0
>0.5 mgd	0	0	1	0	0	1
<0.5 mgd	9	27	70	16	11	133
Not Modeled	39	57	157	27	32	312
Total Instances by Defect Rating	**48**	**84**	**228**	**43**	**43**	**446**

Table 8-6: Pipeline Replacement Length by Max Defect Rating and Flow

Flow	Maximum Defect Rating					Total Length of Pipeline by Flow (ft.)
	1	2	3	4	5	
>1.5 mgd	-	-	-	-	-	-
>1.0 mgd	-	-	-	-	-	-
>0.5 mgd	-	-	40	-	-	40
<0.5 mgd	44	474	5,620	1,819	1,510	9,467
Not Modeled	176	756	12,014	2,958	3,325	19,229
Total Length of Pipeline by Defect Rating (ft.)	**220**	**1,230**	**17,674**	**4,777**	**4,835**	**28,736**

Table 8-7: Matrix of Estimated Cost to Rehabilitate Pipelines (dollars)

Flow	Maximum Defect Rating					Total Capital Cost by Flow ($)
	1	2	3	4	5	
>1.5 mgd	-	-	-	-	-	-
>1.0 mgd	-	-	-	-	-	-
>0.5 mgd	-	-	10,000	-	-	10,000
<0.5 mgd	11,000	125,000	1,456,000	474,000	391,000	2,457,000
Not Modeled	45,000	196,000	3,104,000	764,000	859,000	4,968,000
Total Capital Cost by Defect Rating ($)	**56,000**	**321,000**	**4,570,000**	**1,238,000**	**1,250,000**	**7,435,000**

Table 8-8: Prioritized List of Pipeline Condition Rehabilitation

Priority	Number of Pipelines	Estimated Length (ft.)	Project Cost ($)
Priority 1	43	4,835	1,250,000
Priority 2	43	4,777	1,238,000
Priority 3	228	17,674	4,570,000
Priority 4	132	1,450	377,000
Total	**446**	**28,736**	**7,435,000**

8.3.2 East Trunk Sewer

No inspection data or updated information was available for the East Trunk Sewer as part of this master plan update. As such, this Section 8.3.2 is a presentation of the condition assessment findings presented in EVWD's 2013 SSMP. The assessment is limited to an understanding of the pipelines materials, age, hydraulic characteristics, and experience with similar types of gravity sewers.

8.3.2.1 Pipeline Background and Understanding

The main portion of the East Trunk Sewer begins at Del Rosa Avenue and Lynwood Drive. It was constructed in 1957 and includes approximately 26,900 feet of 15- to 36-inch VCP and approximately 14,000 feet of 39- to 54-inch RCP. The system includes two siphons under Highland Creek: west of Cooley Street on 6th Street and south of Valley Street on Waterman Avenue.

8.3.2.2 Life-cycle Factors

The typical published useful life for VCP is up to 100 years. RCP useful life is typically 70 to 100 years. However, the useful life of a pipeline is subject to many factors that can significantly extend or decrease the useful life of a gravity sewer pipeline. Factors that can shorten the useful life include:

- Improper installation including pipe bedding, bedding compaction, joint connections, depth of pipe, root intrusion, and/or damage during installation.
- Internal corrosion due to H_2S.

In addition to these factors, damage from other utility installation or nearby construction activities can also damage pipelines.

Installation practices for VCP in the 1950s typically did not include water tight joints. Therefore, VCP may be affected by infiltration and inflow and root intrusion that will require repair of the joints or removal of blockages from root growth. Beneficially, VCP is chemically inert and is resistant to the effects of sulfide generated acid, most industrial wastes and solvents, or aggressive soils. In addition, VCP is a rigid pipe made of a ceramic material that is resistant to scouring from sediment, debris, and other materials that are carried in the sewers and can cause scouring of the pipe at higher velocities. VCP, however, is brittle and multiple new connections over the years can shorten the useful life.

The use of RCP was common for larger diameter pipelines in the 1950s. RCP provided the structural characteristics needed to address external flows and installation did not require stringent bedding requirements. However, hydrogen sulfide gas is a common cause of corrosion of the interior of the RCP and a major cause of pipe failures. When CCTV inspection is conducted at low flow conditions this corrosion can be observed with the formation of a “shelf” at the normal water level. Although hairline cracks in RCP have been of concern regarding the structural integrity, studies have shown that hairline cracks are not a major factor in pipe failure.

8.3.3 Recommended Actions

To confirm the estimated remaining life expectancy of approximately 10 years (based on a 70 useful life) and prioritize rehabilitation projects further inspection data will need to be collected. The following inspection and evaluation methods should be considered:

- CCTV allows visual observation of the pipe and is useful for identifying larger defects such as leaking joints, leaking lateral connections, cracks in the pipe wall, and joint alignment. CCTV technology has improved over the years and now includes “panorama” and pan and tilt capabilities.
- Laser scanning is a newer technology that provides accurate measurement of the ovality of the pipe, a measurement of wall loss above the waterline, and any defects in the pipe wall. This is an improvement over the visual CCTV because it provides actual measurements of the pipe interior in addition to visual observations.
- Sonar profiling is another new technology for inspection of partially full sewer pipes and produces an image below the waterline and can be used to identify build-up of sediment or other material in the pipelines and any major defects. Previously, inspections could not provide information below the water surface. This information is helpful when planning for cleaning of the pipe to provide accurate quantities.

8.4 GENERAL RECOMMENDATIONS

This section summarizes recommendations made throughout this SSMP. These recommendations have not been costed as part of the final CIP but are offered to improve system operations and aid in future analyses of the system.

Manholes:

- There are some connections in the system that cause non-ideal flow dynamics in localized areas including service laterals and main lines that enter manholes at 90-degree angles. These lines may or may not be modeled depending on the size. It is recommended that EVWD consider reforming channels in existing manhole bases or installing new manholes in these areas to correct the problem, and in extreme cases realign the pipelines to avoid 90-degree flow patterns.
- The recommended maximum spacing allowable between manholes is 400 feet unless otherwise approved.

Sewer Flows and Projections:

- Based on the current usage data, the recommended per capita sewer flow is 70 gpcd, which accounts for decreased flows due to conservation while allowing for some increase in per capita use based on drought recovery and the lifting of drought restrictions. EVWD should periodically update this usage number based on new data to further refine the model

Septic Conversion:

- In order to maximize potential flow to the SNRC, EVWD should prioritize projects with a high density of septic customers in the same area for conversion to sewers. The map shown on Figure 4-8 shows the areas recommended for prioritizing.

Pipelines:

- New pipelines should be sized for partially-full conditions at peak dry weather flow (PDWF). Peak dry weather flow be determined using the following criteria:
    - For collector sewers less than 18-inch in diameter, the design PDWF should be equal to 3 times the average dry weather flow.
    - For trunk sewers greater than or equal to 18-inch in diameter, the design PDWF should be equal to 2.5 times the average dry weather flow.
    - These peak dry weather flows for design do not include increases in flow rates due to Rainfall-Derived Infiltration and Inflow (RDII).

System Analysis:

- While improvements are recommended for those pipe segments identified as having insufficient capacity, a d/D threshold of 0.85 is recommended as a "trigger" point to necessitate implementation of a relief project. Any modeled pipes with a d/D ratio over 0.85 at PDWF will be recommended for improvement, either immediately for existing pipes, or at the appropriate planning horizon.

Implementation and Continued Monitoring:

- Before EVWD decides to design or construct any of the recommended improvements, the need for the project should be confirmed through field investigation, flow monitoring, and additional detailed analysis.
- "Pipes to monitor" or watch areas are single pipes showing capacity deficiency in the future planning horizon during wet weather flow and should be monitored to verify the need for replacement and possibly realignment once significant growth has occurred in the service area. The deficiencies in the watch areas may be due to pipe slope or hydraulics and are localized enough that a project in not recommended in this SSMP until the deficiency can be field verified in the future.
- The following inspection and evaluation methods should be considered:
    - CCTV allows visual observation of the pipe and is useful for identifying larger defects such as leaking joints, leaking lateral connections, cracks in the pipe wall, and joint alignment. CCTV technology has improved over the years and now includes "panorama" and pan and tilt capabilities.

- Laser scanning is a newer technology that provides accurate measurement of the ovality of the pipe, a measurement of wall loss above the waterline, and any defects in the pipe wall. This is an improvement over the visual CCTV because it provides actual measurements of the pipe interior in addition to visual observations.

- Sonar profiling is another newer, yet proven, technology for inspection of partially full sewer pipes and produces an image below the waterline and can be used to identify build-up of sediment or other material in the pipelines and any major defects. Previously, inspections could not provide information below the water surface. This information is helpful when planning for cleaning of the pipe to provide accurate quantities.

GIS management

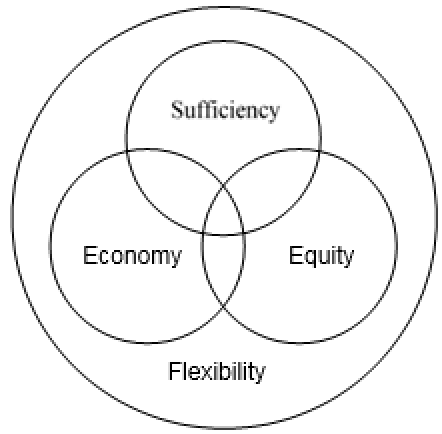
- Add GIS information as delineated in Table 7-2. Fields that should be amended or added included:
    - **FacilityID**: Relationship between different model elements is maintained through connectivity and a unique ID. A unique ID, which is mapped to the FacilityID attribute in GIS, should be unique not only in individual layers, but amongst all layers associated with the model. In the case of abandoning features, IDs should not be reused.
    - **ElevationDatum**: Often as-builts can reference different datums. This can have an impact elevation data integrity and consistency in the model. It's important to know which datum elevation data references to apply adjustments as necessary.
    - **InModel**: A Boolean field used to identify GIS features to be included in a hydraulic model. For example, a service line would be marked with a value of NO while an active sewer pipe would be marked with a value of YES.
- Maintain a UniqueID across all features. Tools such as Attribute Assistant can be used for this purpose.
- Ensure each pipe maintains a TO_ and FROM_ node (UpManhole, DownManhole) to properly designate direction of flow in the network and establish connectivity.
- Use accurate elevations in GIS, especially considering EVWD's system is a gravity system.
- As needed when adding any facilities, consider representing the facility in detail in GIS to more seamlessly translate to the model.
- Utilize the typical connectivity checks described in Section 3, available topology rules, and data reviewer checks to develop a QA/QC process to ensure data quality and integrity.

9.0 FUNDING CONSIDERATIONS

9.1 FINANCING OBJECTIVES

Successful finalizing of large capital programs depends on optimizing three overarching financial objectives:

- Produce capital in sufficient amounts when needed;
- Produce capital at lowest cost; and
- Produce capital with greatest equity among customers, including the principle that growth-pays-for-growth.



Financing Objectives

Because the EVWD projects will be implemented and refined over many years, the financial plan should be robust, yet flexible to accommodate changes in project timing, capital requirements, system and constituency requirements or changes in law

9.1.1 Funding Sources

There are several possible funding sources available for the successful implementation of sewer projects, including pay-as- you-go, Clean Water State Revolving Fund Loan Program, general obligation bonds, revenue bonds, Certificates of Participation, commercial paper (short term notes), developer impact or connection fees, and other state grants and loans. These methods are further described below.

9.1.1.1 Pay-As-You-Go

Pay-as-you-go funding requires that an agency (or group of agencies) have adequate revenue generation or reserves to fund capital improvements and would be funded by sewer rates. Reserves can be built up in advance to pay for future facility requirements by raising fees prior to the need for capital facilities. The funds can provide for either all or part of the capital costs. Using pay-as-you-go funding reduces the overall costs of capital facilities by avoiding the costs associated with arranging financing (bond issue costs, legal and financial advisers, etc.) as well as interest on borrowed money.

Pay-as-you-go funding often leads to inequities since customers today are paying the full costs for facilities that will provide benefits to future customers. To achieve a more equitable sharing of the cost burden, other funding source usually are utilized in addition to pay-as-you-go, due to the differences in timing between accumulation of reserves and the capital spending requirements.

9.1.1.2 Clean Water State Revolving Fund Loan Program

Through a jointly financed program between the federal EPA and the State of California, and administered by the State Water Board, the Clean Water State Revolving Fund (CWSRF) Loan Program can provide low interest loans to wastewater utilities to help pay for improvements and are loaned to a single utility/agency. Under the program, loans are issued for up to 30-years, at a fixed interest rate equal to 50 percent of the State’s average interest rate paid on general obligation bonds sold during the previous calendar year. Repayment under the program must begin within twelve months after completion of the project.

Beginning in 2019, loans will be granted based on a points based or scoring system. The primary scoring criteria is based on the type of project and whether it is a corrective or preventative improvement project. Secondary scoring criteria includes points for climate action, whether the project is regional in nature and whether it provides multiple environmental benefits. The final scoring category is for project readiness, with projects that have completed the CWSRF application process and have completed plans and specifications receiving more points. Since financing its first project in 1989, the CWSRF program has executed more than $11 billion in financial assistance with over 300 unique recipients.

9.1.1.3 Water Recycling Funding Program

The CWSRF program also administers the Water Recycling Funding Program. This program's focus is to promote the beneficial use of treated municipal wastewater (water recycling) in order to augment fresh water supplies in the state by providing technical and financial assistance to agencies and other stakeholders in support of water recycling projects and research. Water recycling projects can receive loans through the CWSRF program. In addition, planning grants are available for up to 50 percent of eligible project costs up to a maximum of $75,000. Grants are provided for studies to determine the feasibility of using recycled water and selecting a recommended alternative to offset or augment the use of fresh/potable water from state and/or local supplies.

9.1.1.4 General Obligation Bonds

General Obligation (G.O.) bonds are backed by the full faith and credit of the issuer. As such, they also carry the pledge of the issuer to use its taxing authority to guarantee payment of interest and principal. The issuer's general obligation pledge is usually regarded by both investors and ratings agencies as the highest form of security for bond issues.

Because G.O. bonds are viewed as having lower risk than other types of bonds, they are usually issued at lower interest rates, have fewer costs for marketing and issuance, and do not require the restrictive covenants, special reserves, and higher debt service coverage typical of other types of bond issues. Issuance of G.O. bonds requires electoral approval by two-thirds of the voters.

The ultimate security for G.O. bonds is the pledge to impose a property tax to pay for debt service. G.O. bonds are typically issued by a single utility/agency. Use of property taxes, assessed on the value of property, may not fairly distribute the cost burden in line with the benefits received by the customers. While the ability to use the taxing authority exists, the utility/agency seeking G.O. bonds could choose to fund the debt service from other sources of revenues, such as sewer rates or from development impact fees. Use of development impact fees to pay the debt service would provide the most equitable matching of benefits with costs, since debt service on projects that benefit primarily new customers would be paid from fees collected from those new customers.

G.O. bonds are attractive due to lower interest rates, fewer restrictions, greater market acceptance, and lower issuing costs. However, the difficulties in securing a two-thirds majority of the qualified electorate make them less attractive than other alternatives, such as revenue bonds and certificates of participation.

9.1.1.5 Revenue Bonds

Revenue bonds are long-term debt obligations for which the revenue stream of the issuer is pledged for payment of principal and interest. Because revenue bonds are not secured by the full credit or taxing authority of the issuing agency, they are not perceived as being as secure as general obligation (G. O.) bonds. Since revenue bonds are perceived to have less security and are therefore considered riskier, they are typically sold at a slightly higher interest rate (frequently in the range of 0.5 percent to 1.0 percent higher) than the G.O. bonds. The security pledged is that the system will be operated in such a way that sufficient revenues will be generated to meet debt service obligations.

Typically, issuers provide the necessary assurances to bondholders that funds will be available to meet debt service requirements through two mechanisms. The first is provision of a debt service reserve fund or a surety. The debt service reserve fund is usually established from the proceeds of the bond issue. The amount held in reserve in most cases is based on either the maximum debt service due in any one year during the term of the bonds or the average annual debt service over the term. The funds are deposited with a trustee to be available in the event the issuer is otherwise incapable of meeting its debt service obligations in any year. The issuer pledges that any funds withdrawn from the reserve will be replenished within a short period, usually within a year.

The second assurance made by the borrower is a pledge to maintain a specified minimum coverage ratio on its outstanding revenue bond debt. The coverage ratio is determined by dividing the net revenues of the borrower by the annual revenue bond debt service for the year, where net revenues are defined as gross revenues less operation and maintenance expenses. Based on this, the perceived risk minimum coverage ratios are usually within the range of 1.1 to 1.3, meaning that net revenues would have to be from 110 percent to 130 percent of the amount of revenue bond debt service. To the extent that the borrower can demonstrate achievement of coverage ratios higher than required, the marketability and interest rates on new issues may be more favorable.

Issuance of revenue bonds may be authorized pursuant to the provisions of the Revenue Bond Law of 1941. Specific authority to issue a specified amount in revenue bonds requires approval by a simple majority of voters casting ballots, and would typically be limited to a single agency seeking a revenue bond. To limit costs (and risks) associated with seeking approval through elections, authorization is typically sought for the maximum amount of bonds that will be needed over the planning period. Upon receiving authorization, the agency actually issues bonds as needed, up to the authorized amount.

9.1.1.6 Certificates of Participation

Certificates of Participation (COPs) are a form of lease-purchase financing that has the same basic features of revenue bonds except they do not require voter approval through an election. COPs represent participation in an installment purchase agreement through marketable notes, with ownership remaining with the agency. COPs typically involve four different parties — the public agency as the lessee, a private leasing company as the lessor, a bank as trustee and an underwriter who markets the certificates. Because there are more parties involved, the initial cost of issuance for the COP and level of administrative effort may be greater than for bond issues. Due to the widespread acceptance of COPs in financial markets, COPs are usually easier to issue than other forms of lease purchase financing, such as lease revenue bonds.

The certificates are usually issued in $5,000 denominations, with the revenue stream from lease payments as the source of payment to the certificate holders. From the standpoint of the agency as the lessee, any and all revenue sources can be applied to payment of the obligation, not just revenues from the projects financed, thereby providing more flexibility. Unlike revenue bonds, COPs do not require a vote of the electorate and have no bond reserve requirements, although establishing a reserve may enhance marketability. In addition, since they are not technically debt instruments, COP issues do not count against debt limitations for the agency.

While interest costs may be marginally higher than for revenue bonds, a COP transaction is a flexible and useful form of financing that should be considered for financing of the Master Plan projects. COP transactions would be typically limited to a single sewer agency obtaining a COP for a specific project.

9.1.1.7 Commercial Paper (Short Term Notes)

To smooth out capital spending flows without the costs of frequent bond issues, many public agencies with sufficient revenue streams use short-term commercial paper debt to attenuate the peaks and valleys of capital expenses year to year. Similar to bonds issued by public agencies, commercial paper instruments are typically tax-exempt debt, thus demanding a lower interest cost to the agency than would prevail if the commercial paper were taxable. Commercial paper is usually issued for terms ranging from as short as a few days to as long as a year depending on market conditions. As the paper matures, it is resold ("rolled over") at the then prevailing market rate. Consequently, the paper can in effect "float" over an extended time, being constantly renewed. The short-term rates paid on commercial paper are frequently much lower than those on longer term debt.

The primary advantage in using commercial paper is to provide interim funding of capital projects when revenues and reserves are insufficient to fund capital projects fully. In this scenario either (1) the total amount needed is too small to justify a bond issue or (2) the funds are not currently available, but will be building up in the immediate future to a level sufficient to repay the borrowing. Commercial paper funding can provide the "bridge" to smooth out the flow of funds. As with other forms of debt financing, there are costs associated with issuing commercial paper. Many of the costs are similar to those of issuing bonds. With commercial paper, however, there is often a requirement that a line of credit be established that will guarantee payment of the commercial paper should it not be possible to roll the commercial paper over at any given maturity date. The cost of the credit line is usually based on the full amount of commercial paper authorized, whether issued or not, so the total commercial paper authorization must be carefully determined to maximize the benefit while minimizing costs.

While the interest rate for a particular commercial paper issue is fixed until its maturity, the short maturities and frequent rollovers of the debt effectively make commercial paper much like a long-term variable rate bond.

Consequently, there is some exposure to interest rate risk in using commercial paper as a funding mechanism. However, unless inflationary pressure is great, the risk is relatively low.

The strategy now being used by a number of utilities/agencies is to issue commercial paper up to the authorized limit, then pay-off the commercial paper outstanding through a revenue bond issue. The agency gets the benefit of low short-term interest rates while still being able to convert to long term fixed rates through a bond issue. This is an appropriate strategy during relatively stable interest rates, but not when interest rates are rising or expected to rise substantially. Commercial paper programs are typically limited to a single agency, and the agency pursuing commercial paper will need to confer with their legal and financial advisors to determine if sufficient authorization currently exists to implement a commercial paper program.

9.1.1.8 Property Related Debt

For many years, California has allowed a form of financing where the properties that benefit from projects pay debt service in proportion to the benefit received. The California Streets and Highways Code allows bonds to be sold under the 1911 Improvement Act or 1913 Municipal Improvement Act, under the procedure of the 1913 Act and the 1931 Majority Protest Act. Mello Roos Community Facilities District Act (1982) financing is another variation of this theme. Assessment financing, as the method was called, is useful for allocating shares of cost and debt service to properties within specific areas (called assessment districts) within which all of the financed project's benefit accrued. Assessment districts are typically used for defined geographic areas to finance specific projects which benefit the property's in that geographic area. The voting requirement of the Tax Payers' Right to Vote Act (Proposition 218) and more recent court decisions challenging certain methods of apportionment, has made the procedure less attractive. [In cases where the required sewer infrastructure would serve only new development, such as in newly developing areas, this type of financing mechanism can be useful.]

9.1.1.9 Private Sector Equity

Some utilities find it convenient to enter into agreements with a private sector service provider to perform certain well-defined functions. The service provider provides the assets as well as human resources, materials, supplies and other costs of business and includes those costs in the amount charged to the utility. This procedure becomes, de facto, a financing technique for the utility in that the capital cost of the assets are financed by the private sector service provider since the assets are owned by it. The financing costs and interest rates are often more expensive than traditional public financing methods as the private equity firm's cost of capital is generally higher and there are income taxes considerations. The specifics can depend much on the private equity firm's other portfolio assets, but this method can reduce the capital requirement to be financed by the utility and may offer greater flexibility and creativity than other financing options.

Specific projects for engaging a private sector equity participant have not been identified. Further, any cost savings associated with this approach might depend on the specific projects, so this approach is not considered further in this financing plan. Again, this method can be a valuable tool for application in certain situations and should be considered when appropriate.

9.1.1.10 Developer Impact or Connection Fees

Developer impact fees or connection fees are commonly used alone, or more commonly in conjunction with user rates to finance capacity related sewer system improvements and to recover previous sunk costs paid by existing system users that benefit future growth. The use of the connection fees to recover sunk facility costs and to provide service to accommodate new customers is completely appropriate. Connection fees are generally calculated by estimating the overall cost of infrastructure necessary to support future growth plus the recovery of sunk costs and allocating those costs to the various benefit zones, usually by sewer service size. Wastewater agencies have discretion in setting connection fees for wastewater collection and treatment as long as established computation methodologies are followed.

9.1.1.11 Federal Funding

Water Infrastructure Finance and Innovation Act (WIFIA)

The WIFIA program was established by the Water Infrastructure Finance and Innovation Act of 2014 and provides long-term, low cost supplemental loans for public infrastructure projects, including projects to build and upgrade wastewater and drinking water treatment systems. This competitive program is administered by the EPA and will provide loan funding up to 49% of the project cost at interest rates based on US Treasury rates. The minimum project size for a large community is $20 million and the project must be of a “regional or national significance”. As WIFIA loans only fund up to 49% of project costs, they are intended to be combined with various funding sources such as private equity, revenue bonds, grants, and SRF loans and the repayment structure can be somewhat flexible to accommodate other potential lenders.

The application process can take up to two years and is largely a two-step process. Applicants must first submit a letter of interest. After review of these letters of interest, EPA selects projects to invite to submit a full application. The process requires significant due-diligence and up-front funding in terms of an application fee ($100,000) and credit processing fee, if project is invited to submit a full application (estimated to range from $250,000 - $500,000, to which the application fee can be applied). The amount of credit assistance offered through WIFIA is contingent on the size of congressional appropriations. The Congressional appropriation was $30 million in 2017 and $63 million in 2018. The first project applicants were approved funding in 2017 ($2.3 billion in loans). In 2018, a second round of projects were awarded to 39 applicants for a total of $5 billion in loans. The program is anticipated to continue in 2019, however the congressional appropriation has not yet been approved.

Appendix A REFERENCES

East Valley Water District. Wastewater Collection System Master Plan. Prepared by Black and Veatch. October 2013

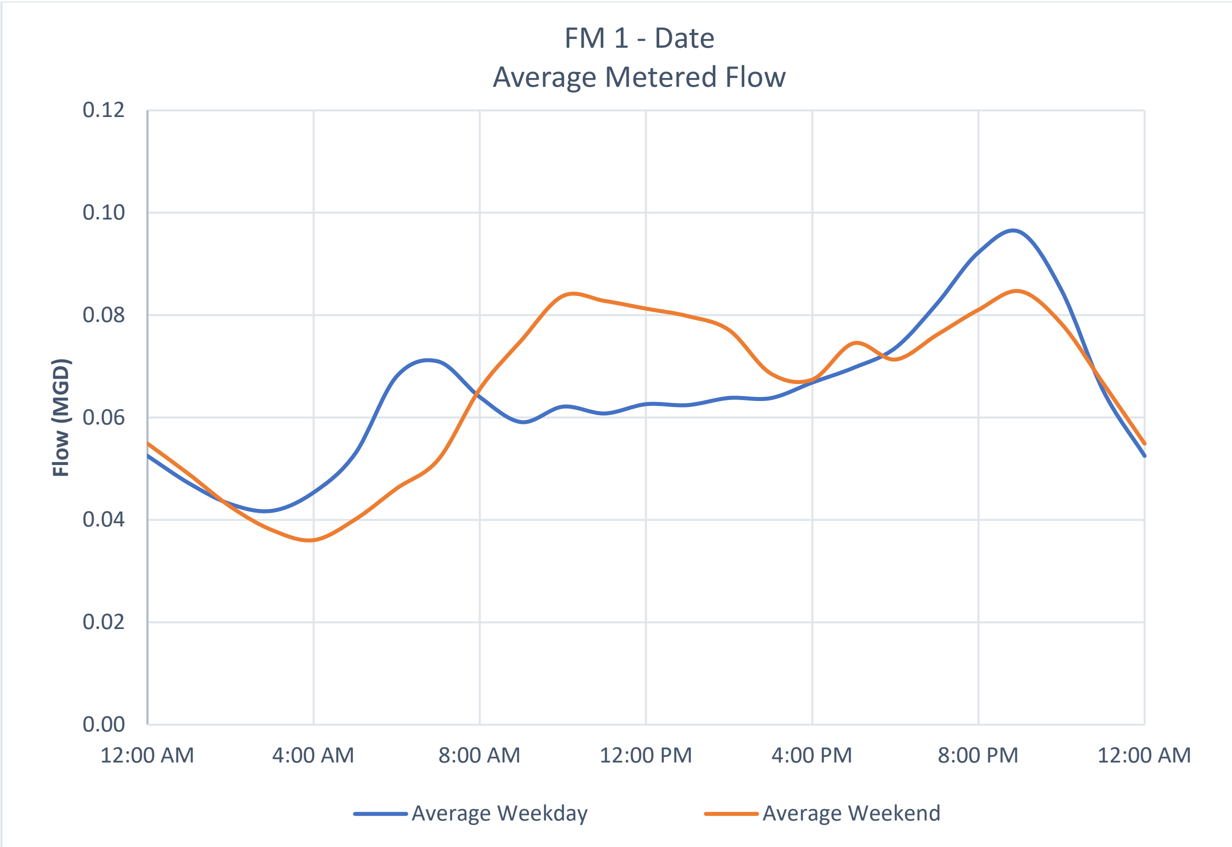
East Valley Water District. Sewer System Management Plan. 2014

East Valley Water District. Solids Separation Study. 2017

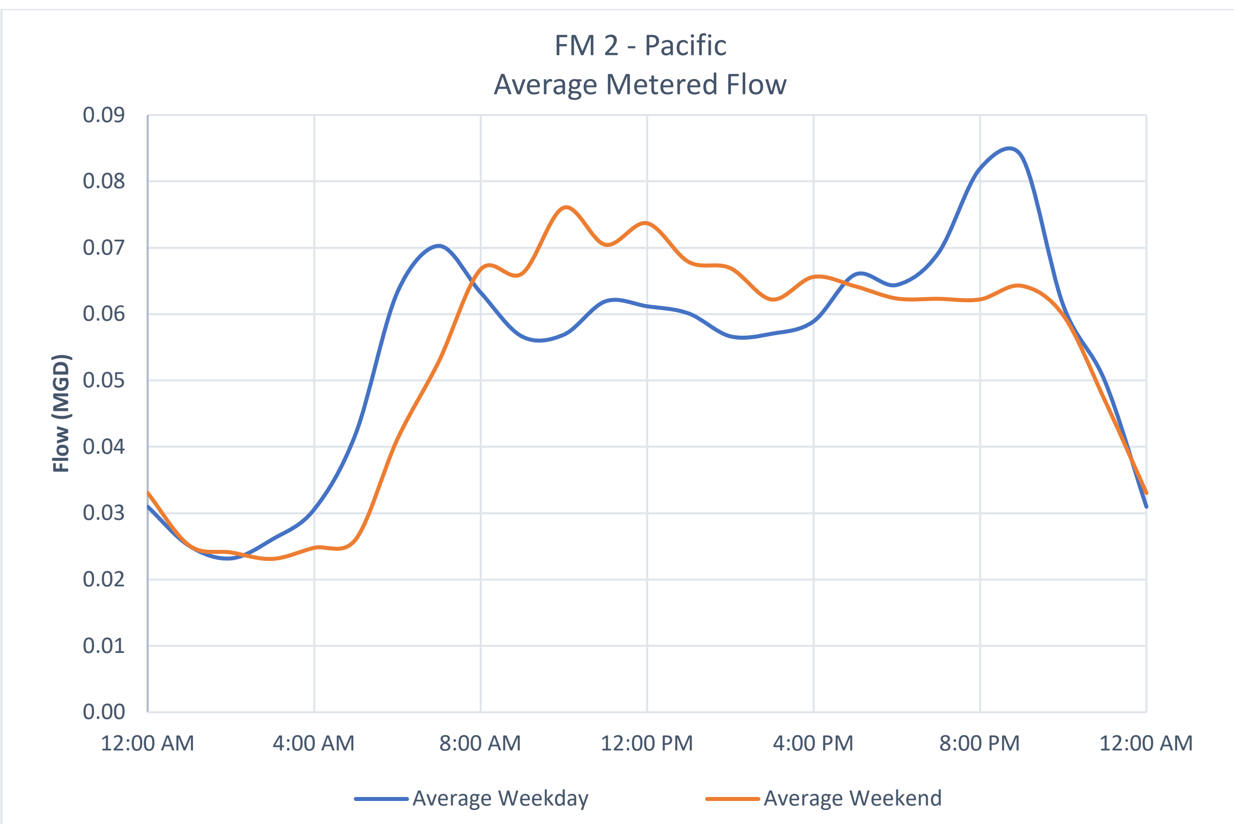
San Manuel Band of Mission Indians. Casino Sewer Flow Study 2018. Prepared by ADS LLC. June 2018

State of California, Clean Water State Revolving Fund, Intended Use Plan, 2018-2019,dated June 19, 2018, page 4.

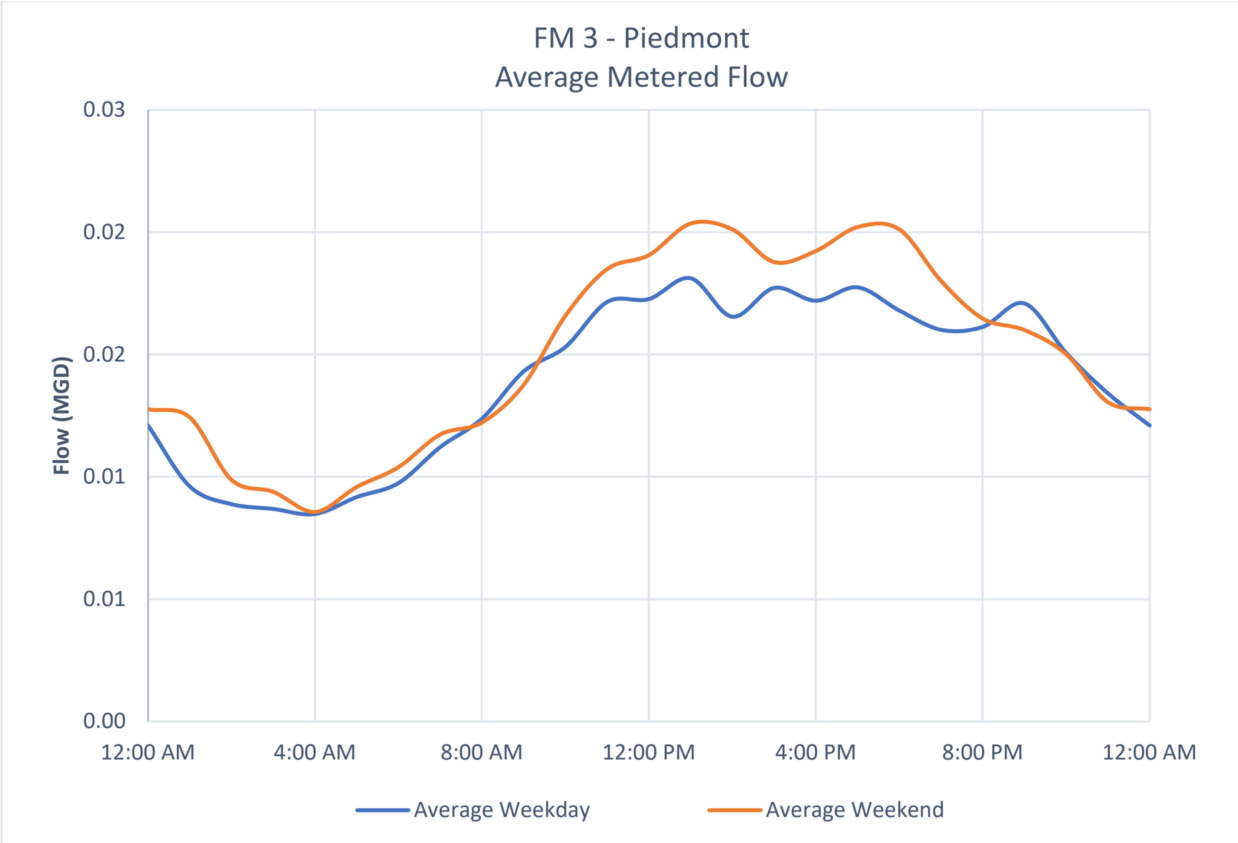
Appendix B DIURNAL CURVE



FM 1 - Date
Average Metered Flow
Flow (MGD)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend



FM 2 - Pacific
Average Metered Flow
Flow (MGD)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend


FM 3 - Piedmont
Average Metered Flow
Flow (MGD)
0.03
0.02
0.02
0.01
0.01
0.00
12:00 AM
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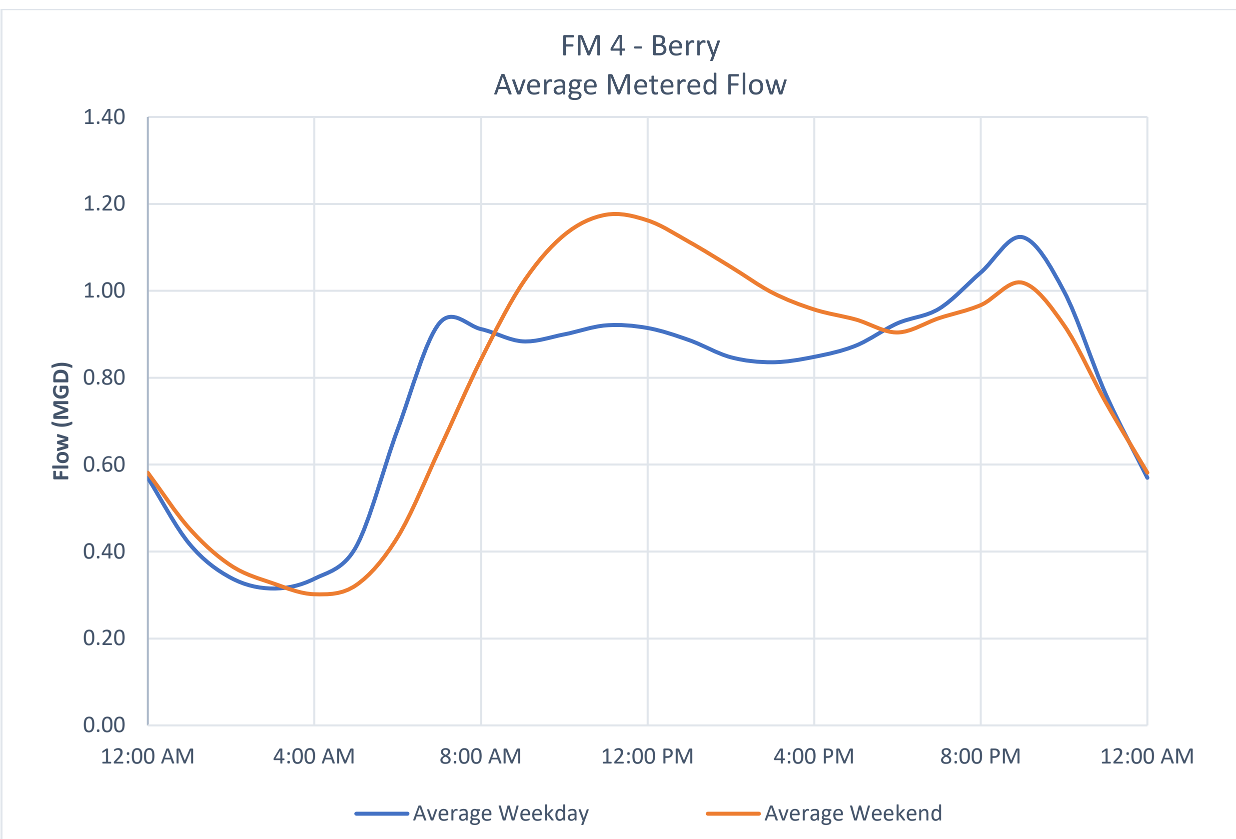
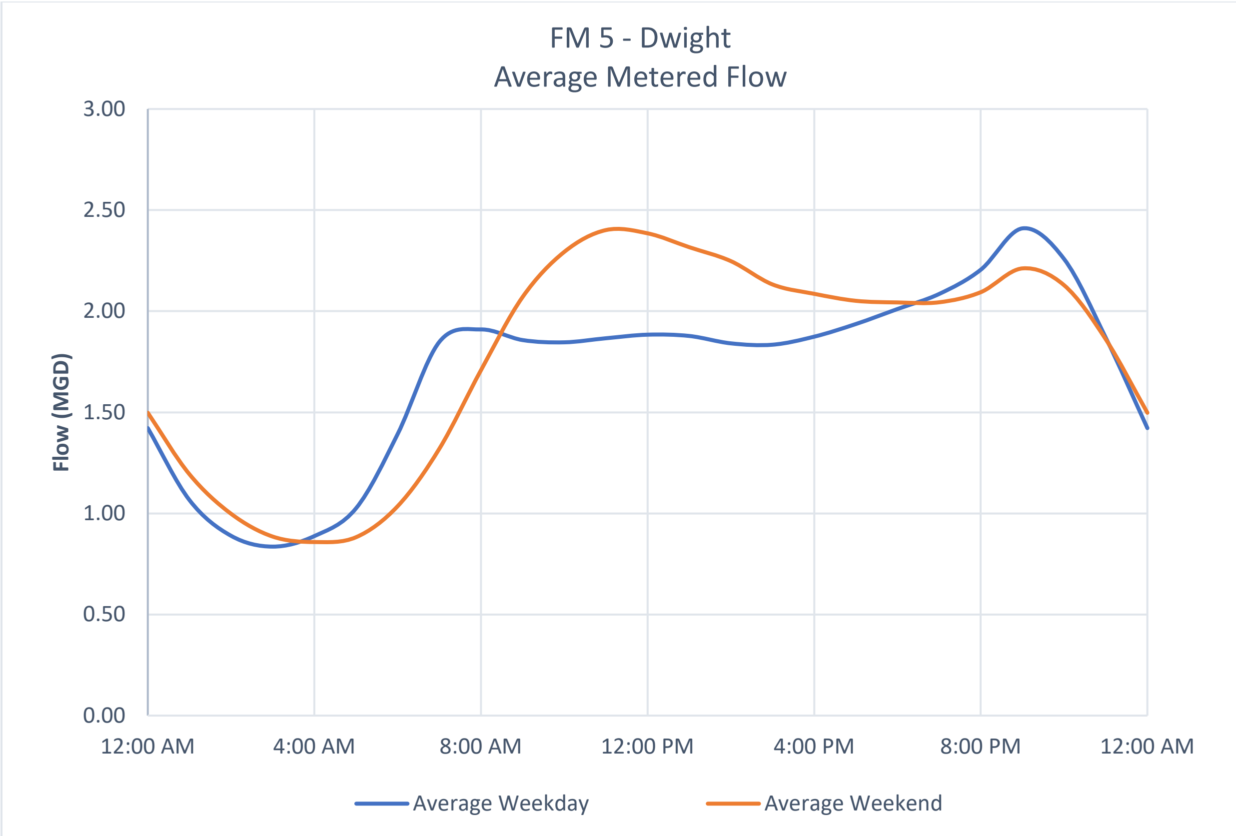
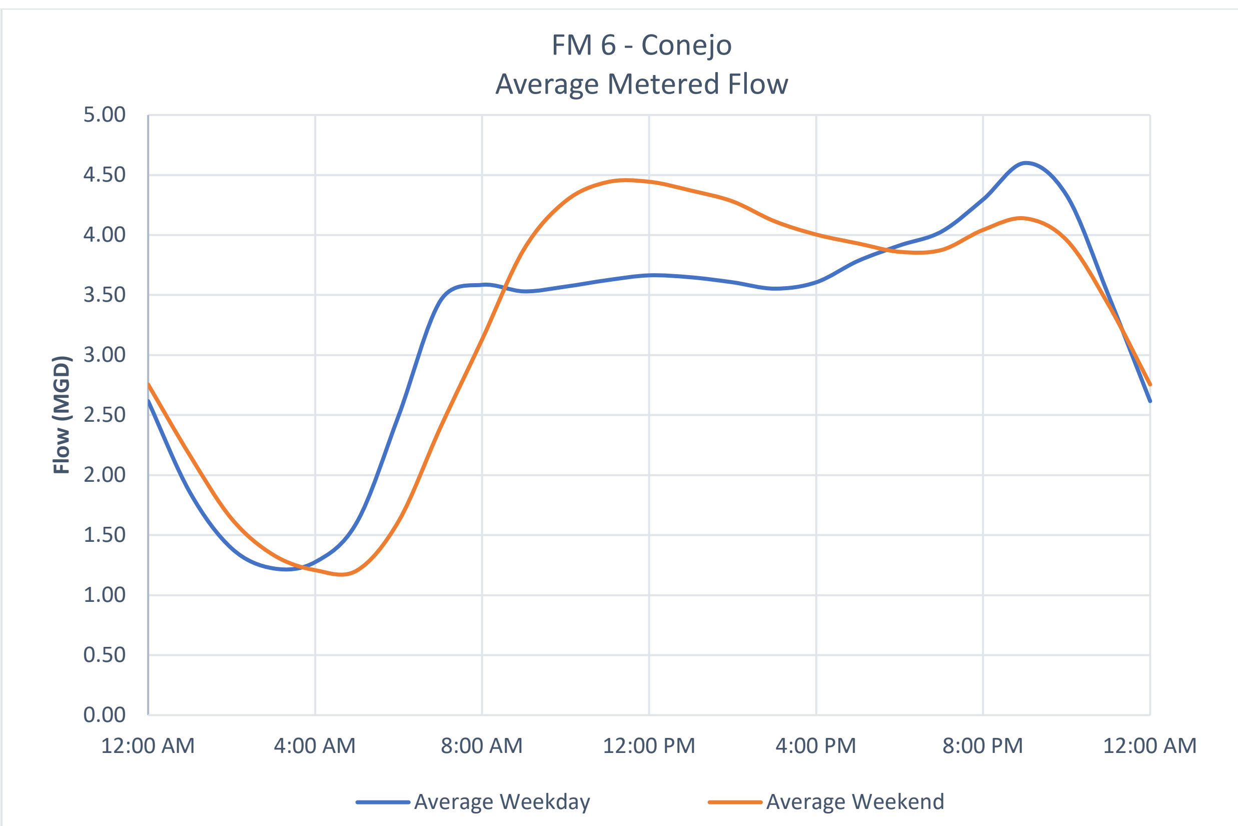
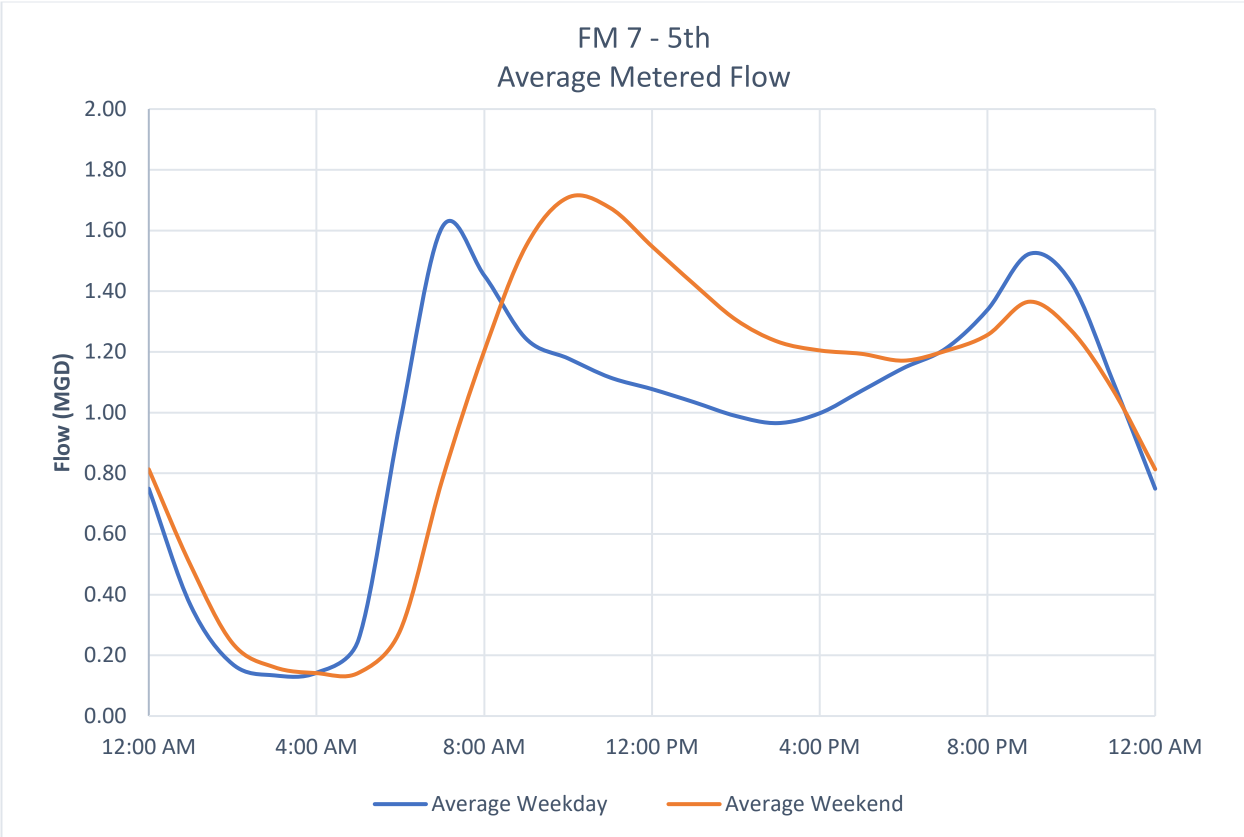
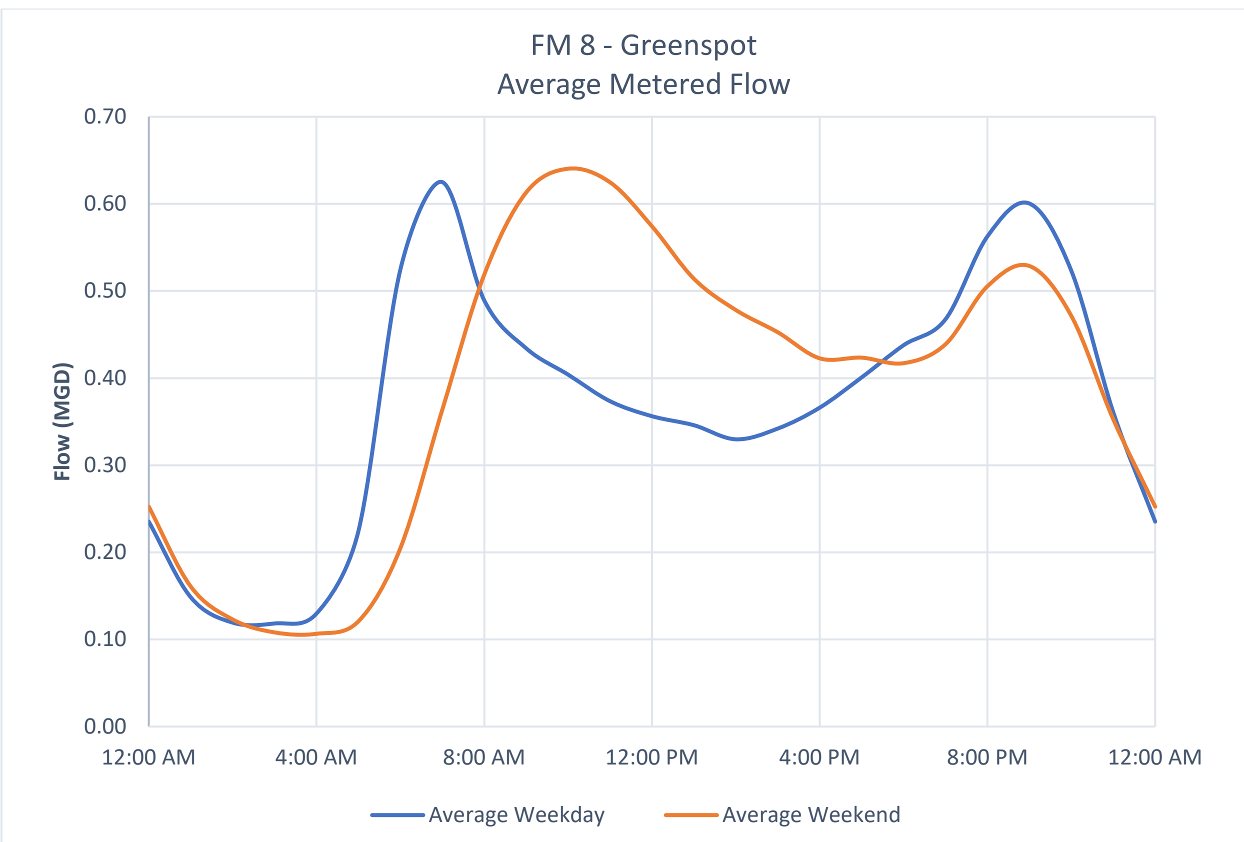
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

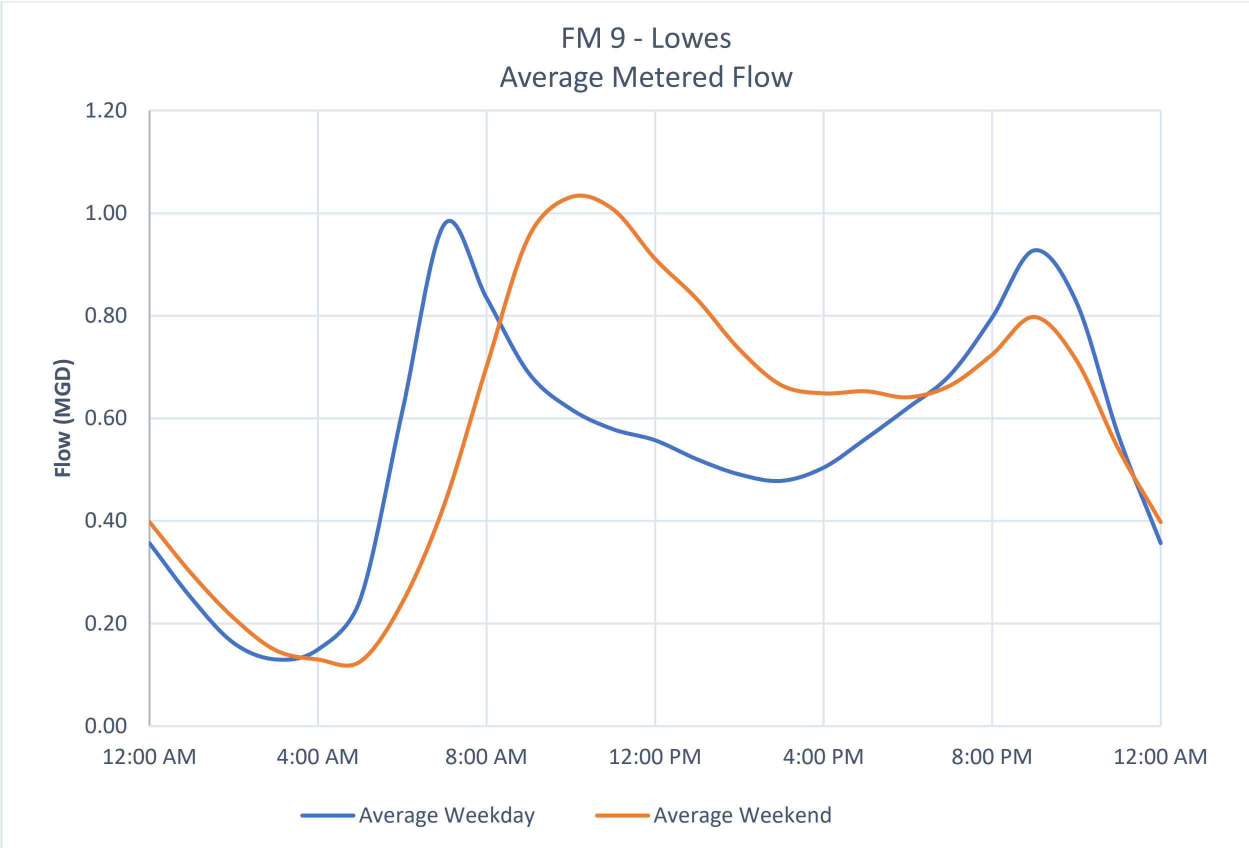

FM 4 - Berry
Average Metered Flow
Flow (MGD)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

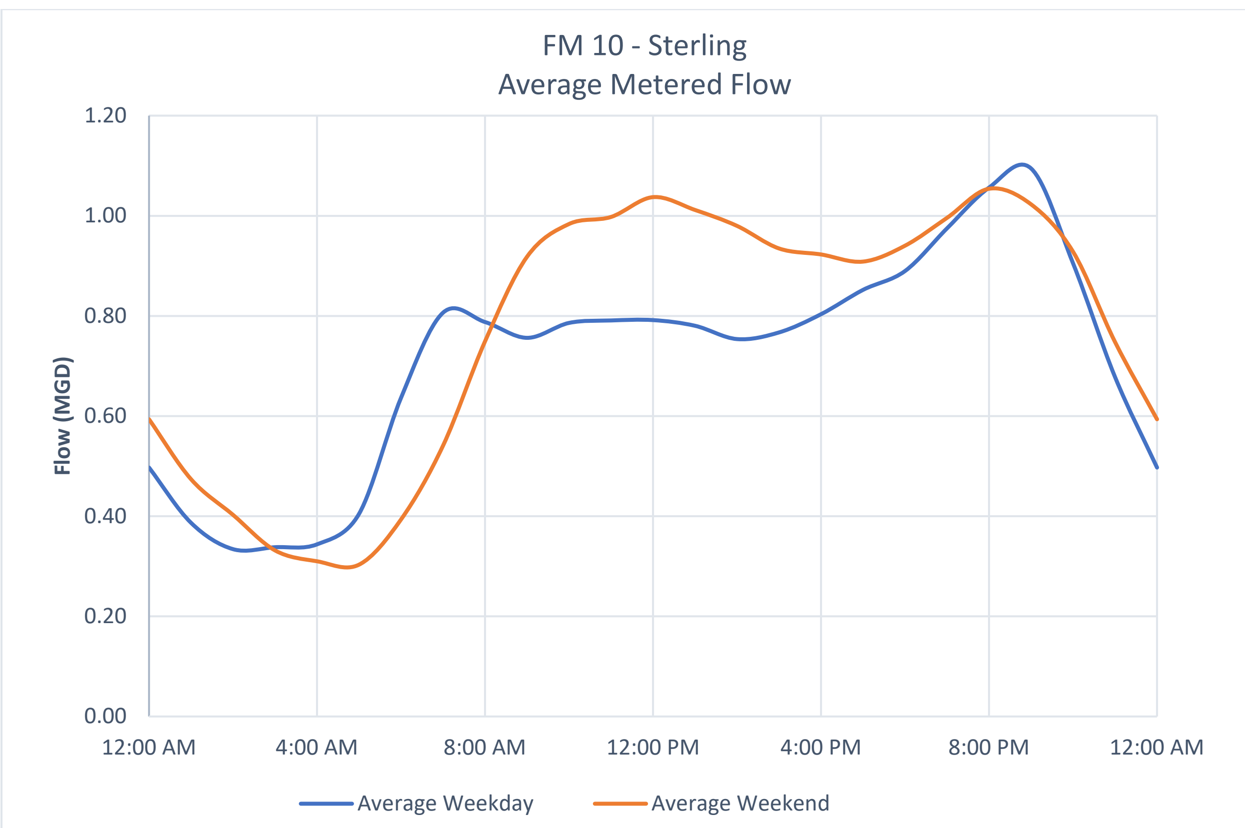

FM 5 - Dwight
Average Metered Flow
Flow (MGD)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

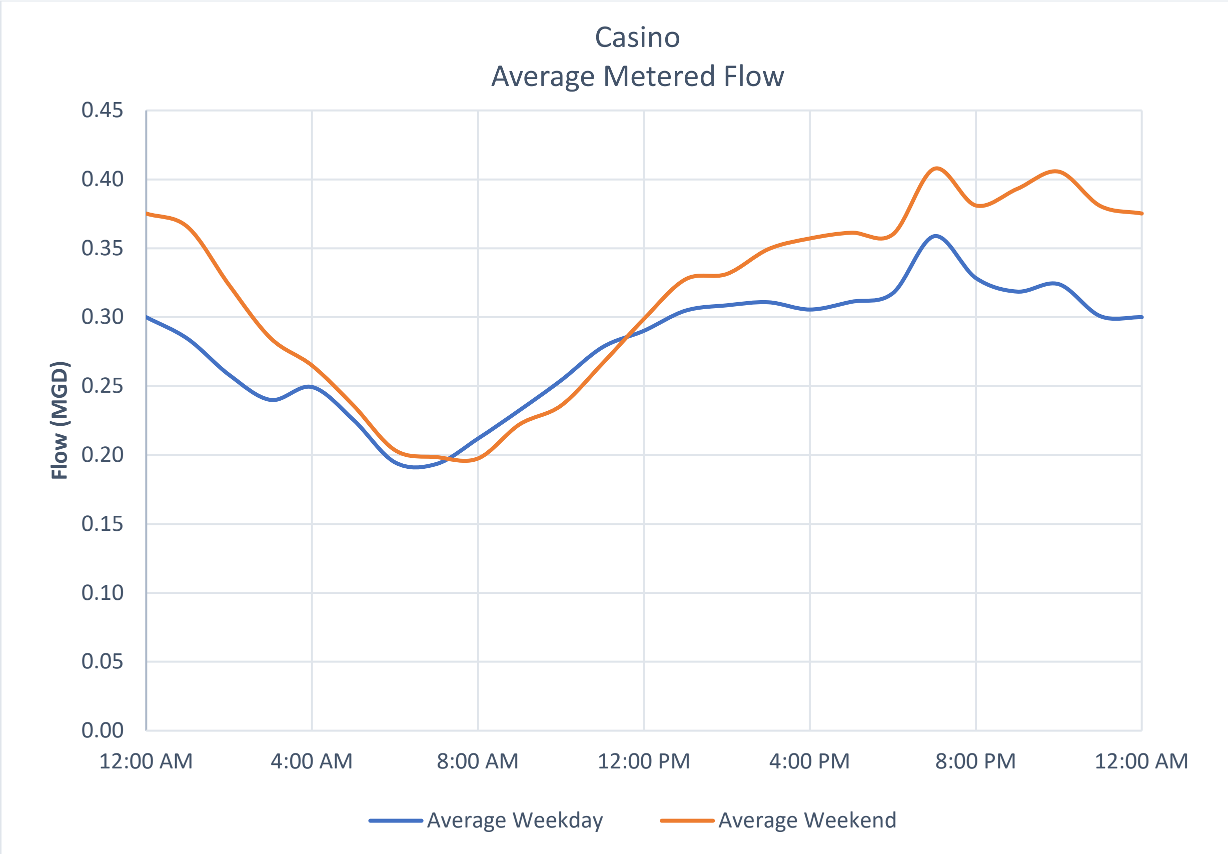

FM 6 - Conejo
Average Metered Flow
Flow (MGD)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend


FM 7 - 5th
Average Metered Flow
Flow (MGD)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

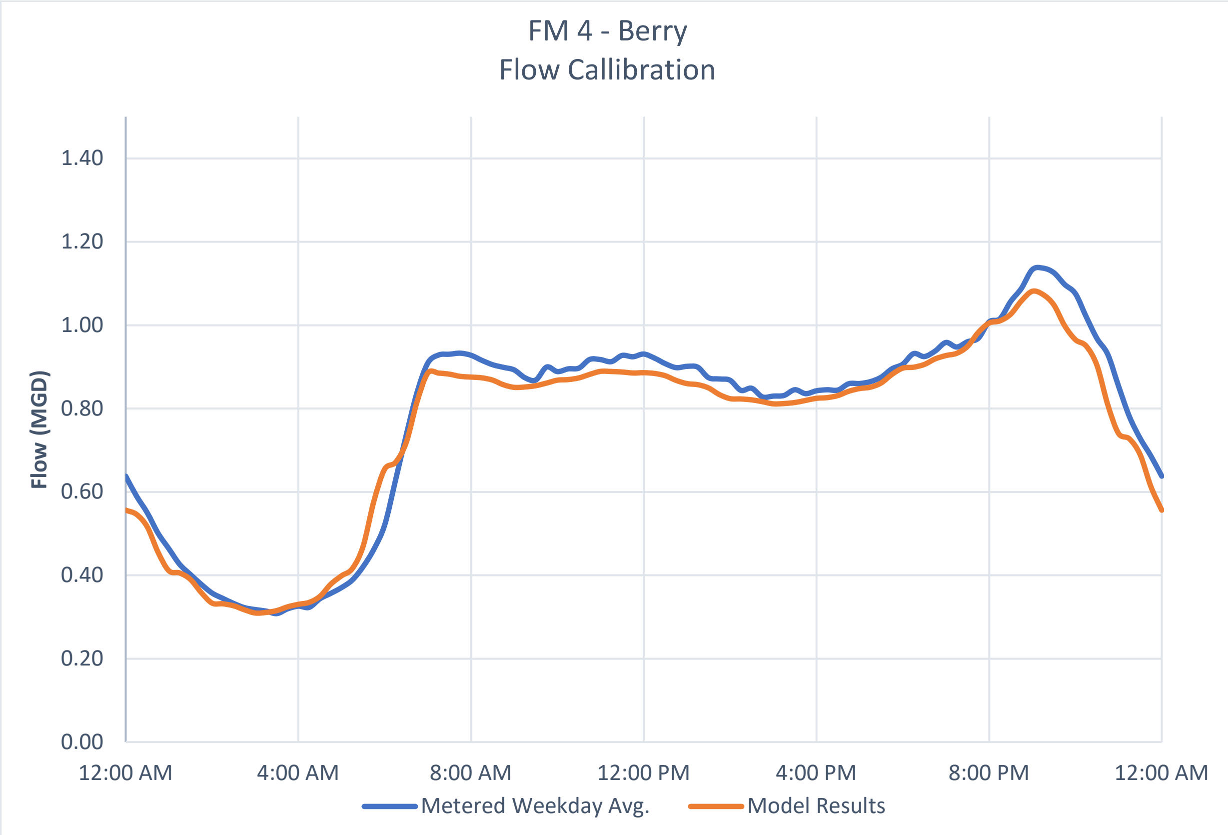

FM 8 - Greenspot
Average Metered Flow
Flow (MGD)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

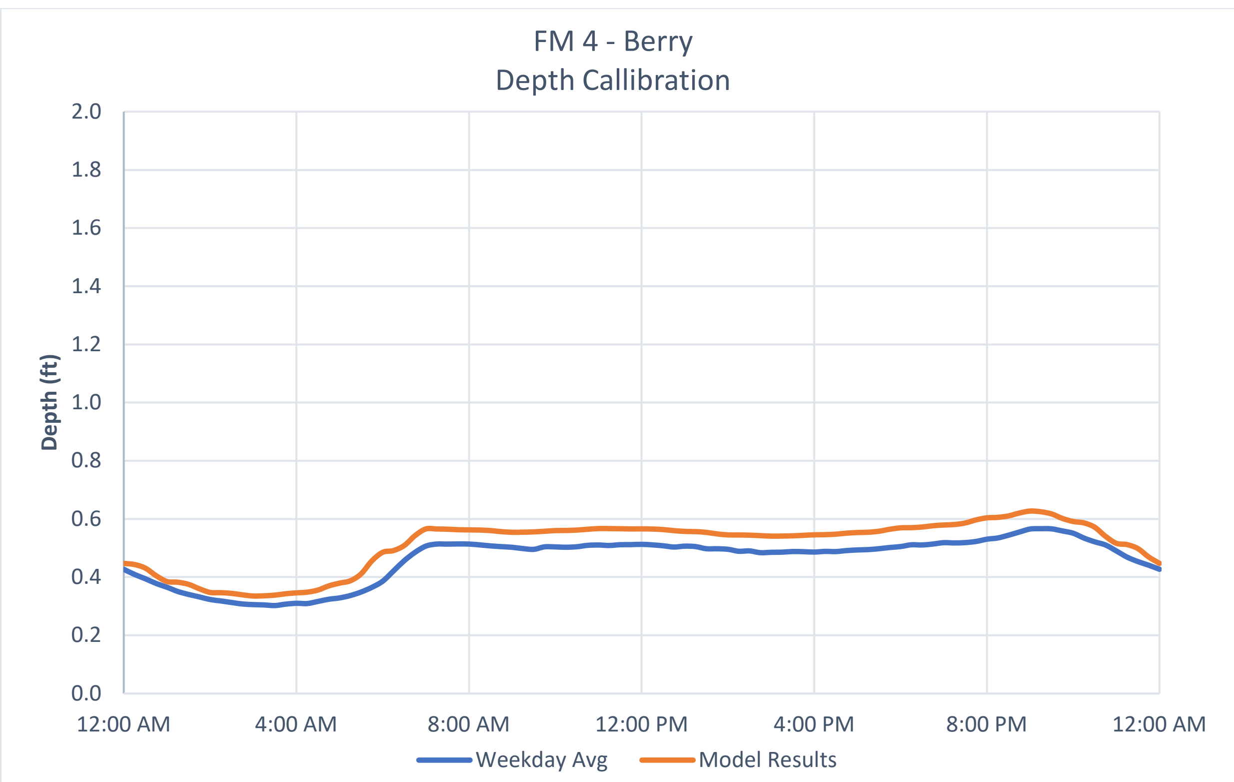

FM 9 - Lowes
Average Metered Flow
Flow (MGD)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

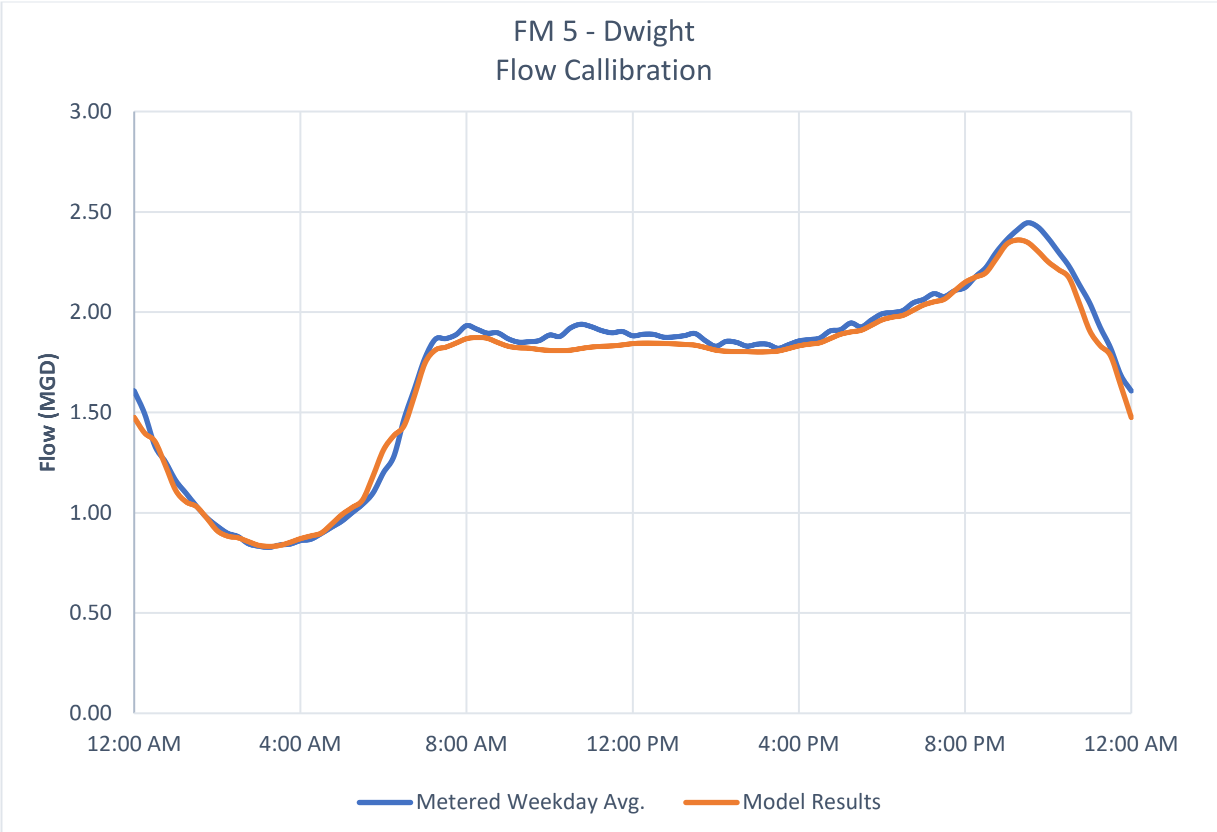

FM 10 - Sterling
Average Metered Flow
Flow (MGD)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

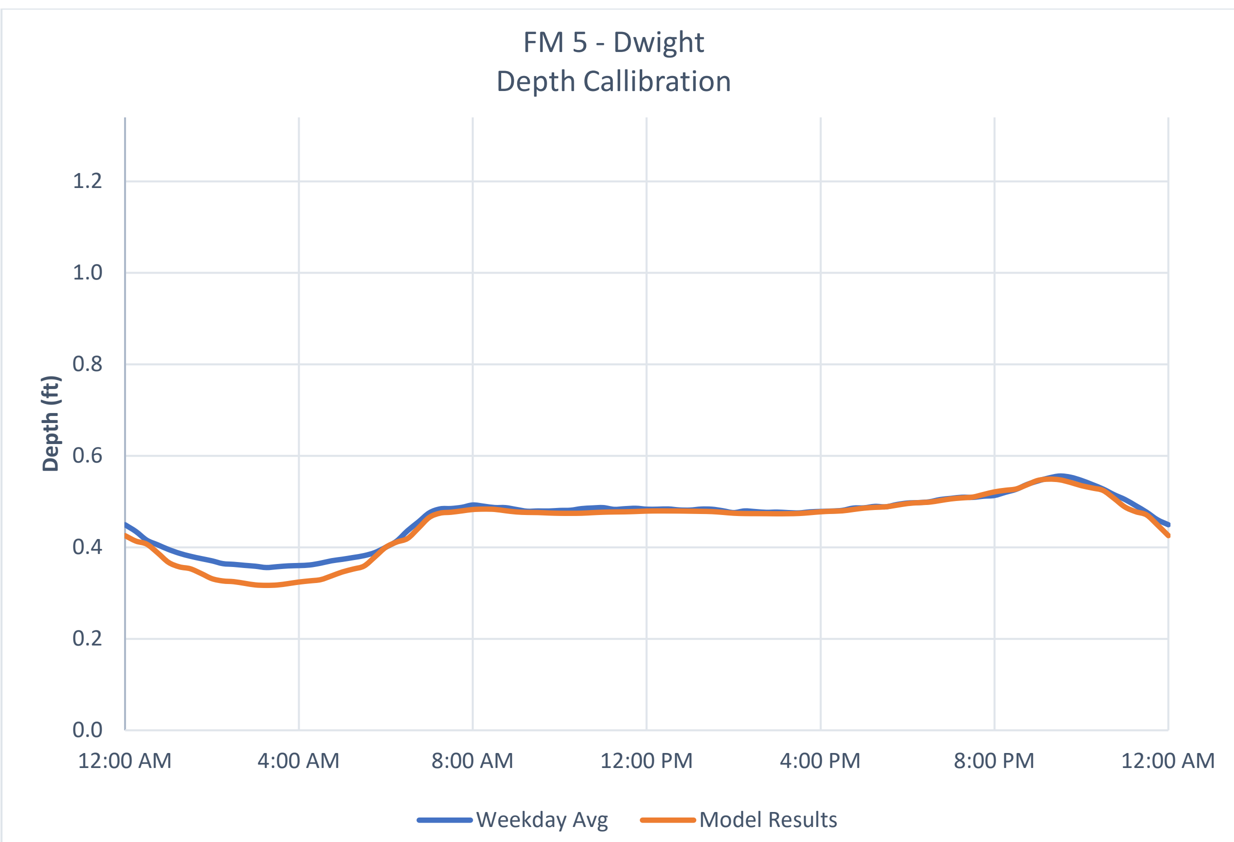

Casino
Average Metered Flow
Flow (MGD)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Average Weekday
Average Weekend

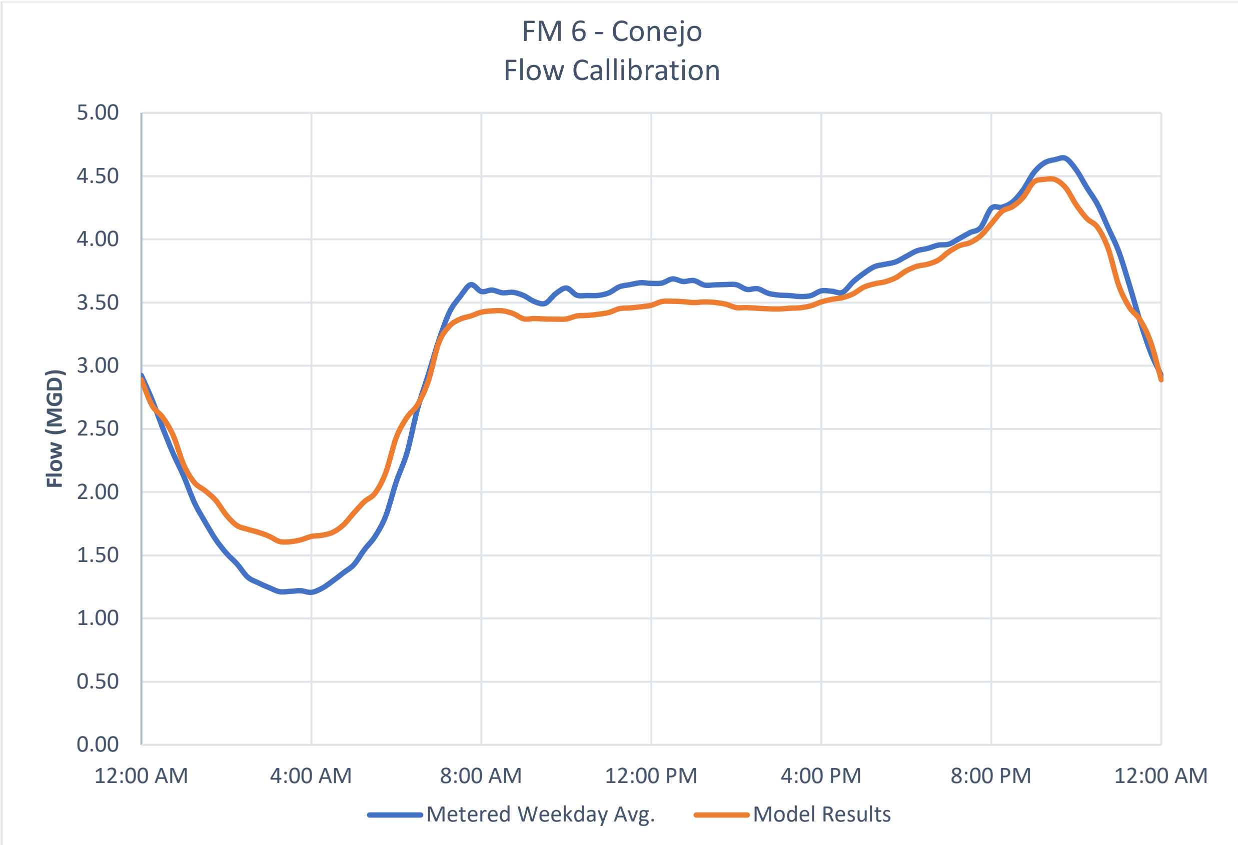
Appendix C CALIBRATION GRAPHS

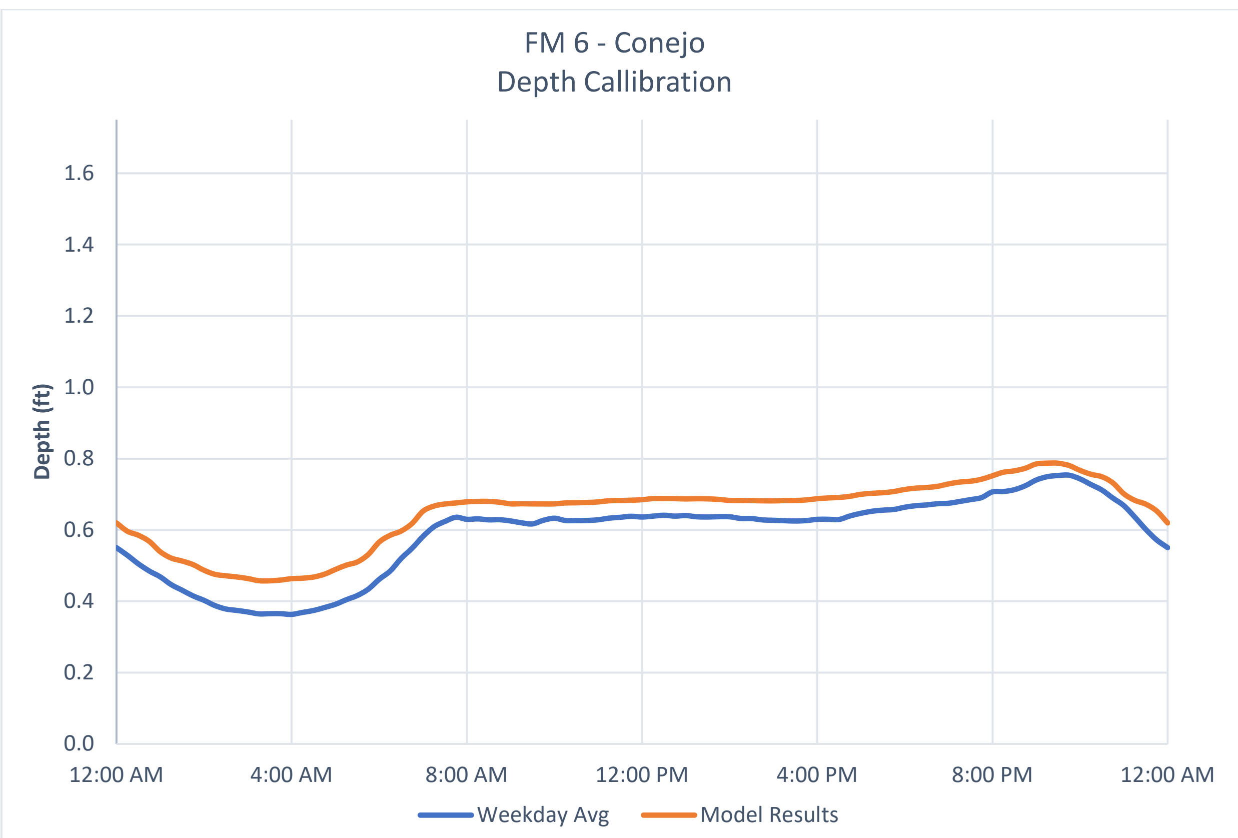

FM 4 - Berry
Flow Callibration
Flow (MGD)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results

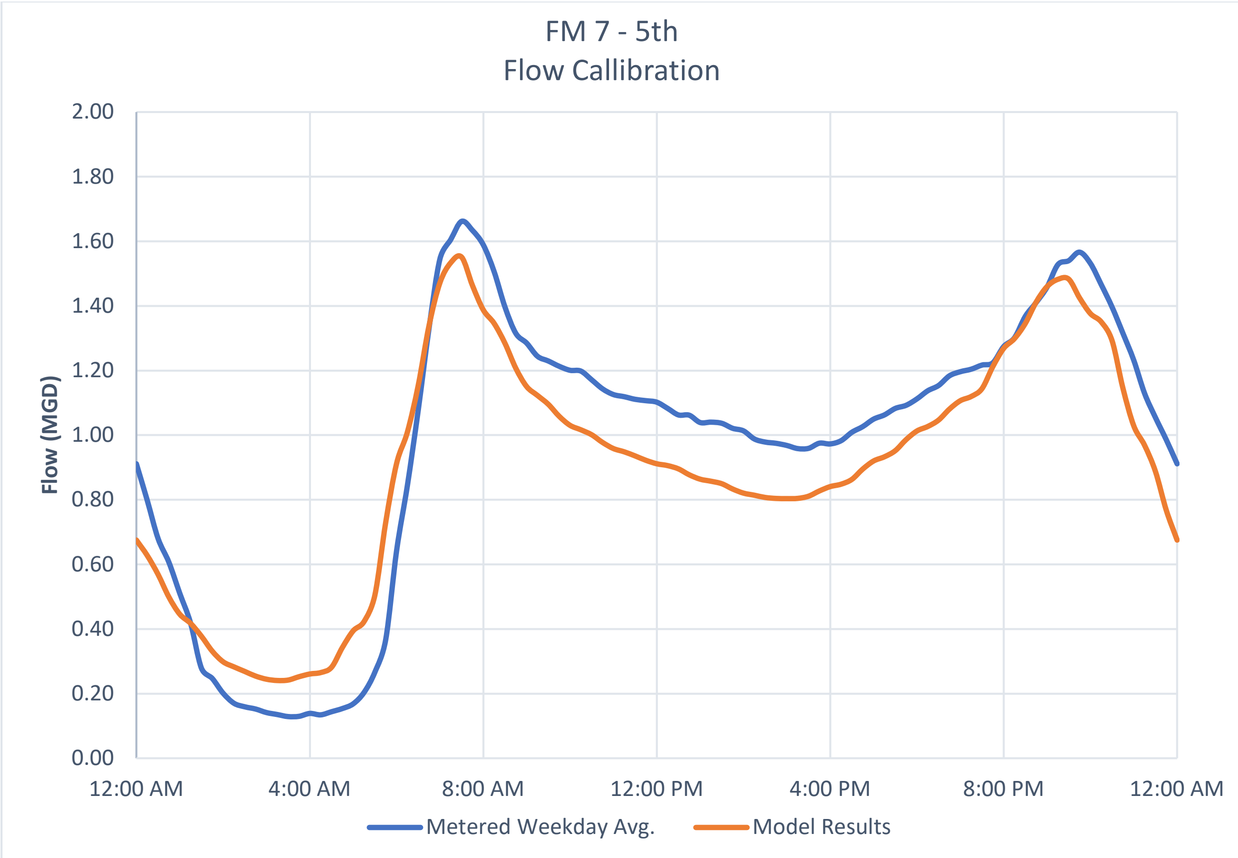

FM 4 - Berry
Depth Callibration
Depth (ft)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

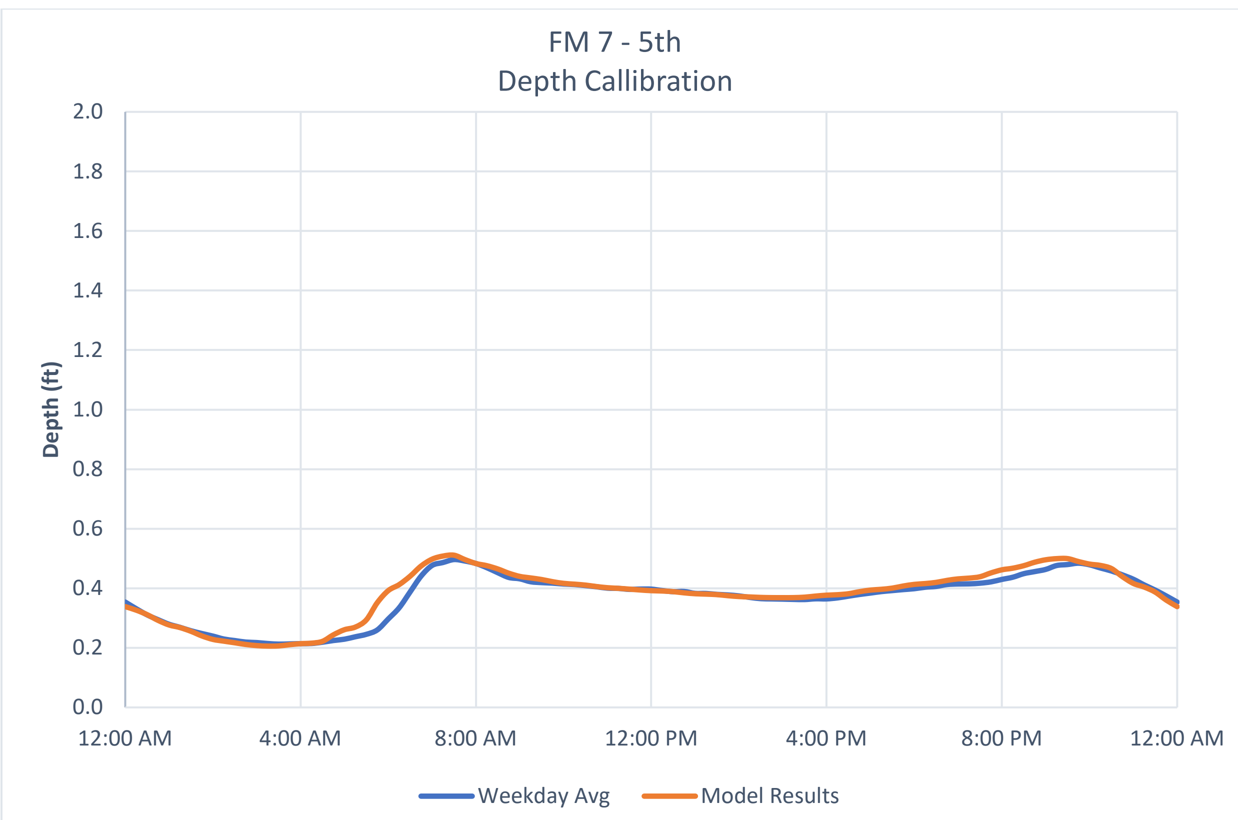

FM 5 - Dwight
Flow Callibration
Flow (MGD)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results

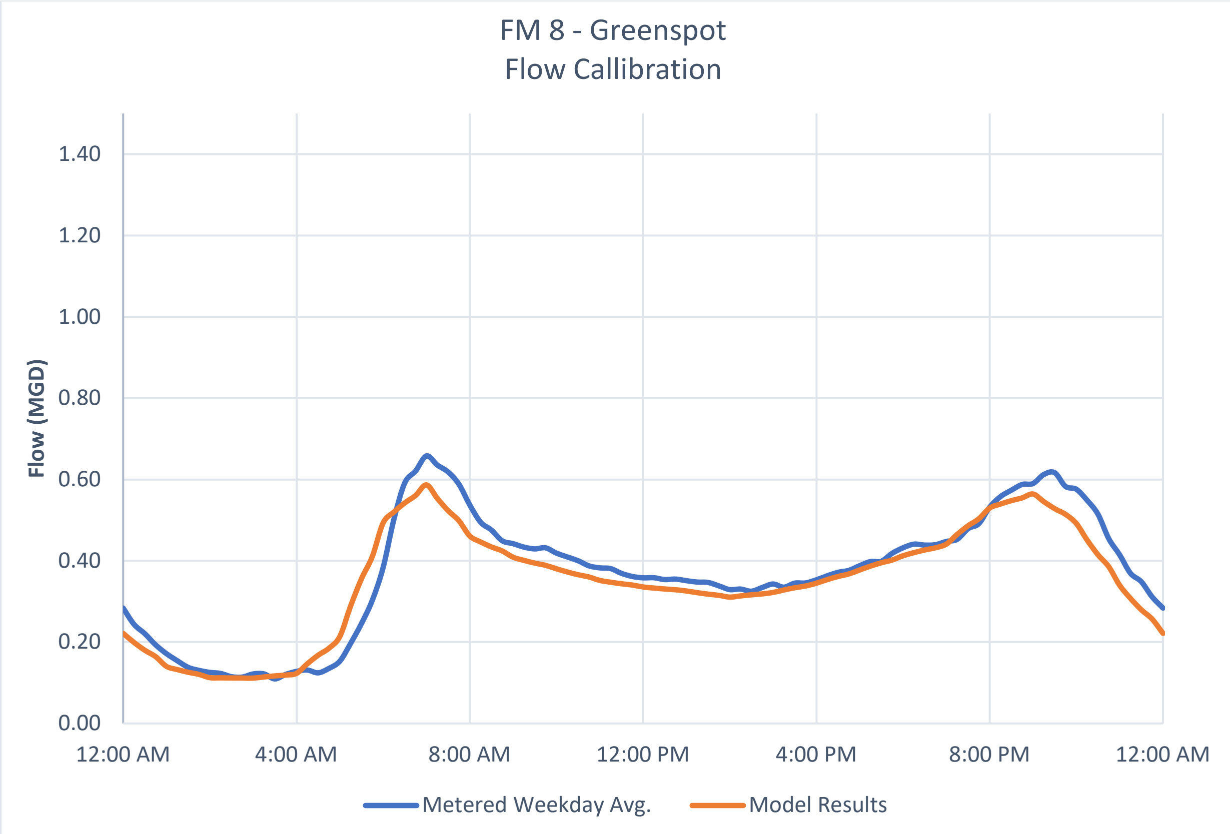

FM 5 - Dwight
Depth Callibration
Depth (ft)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

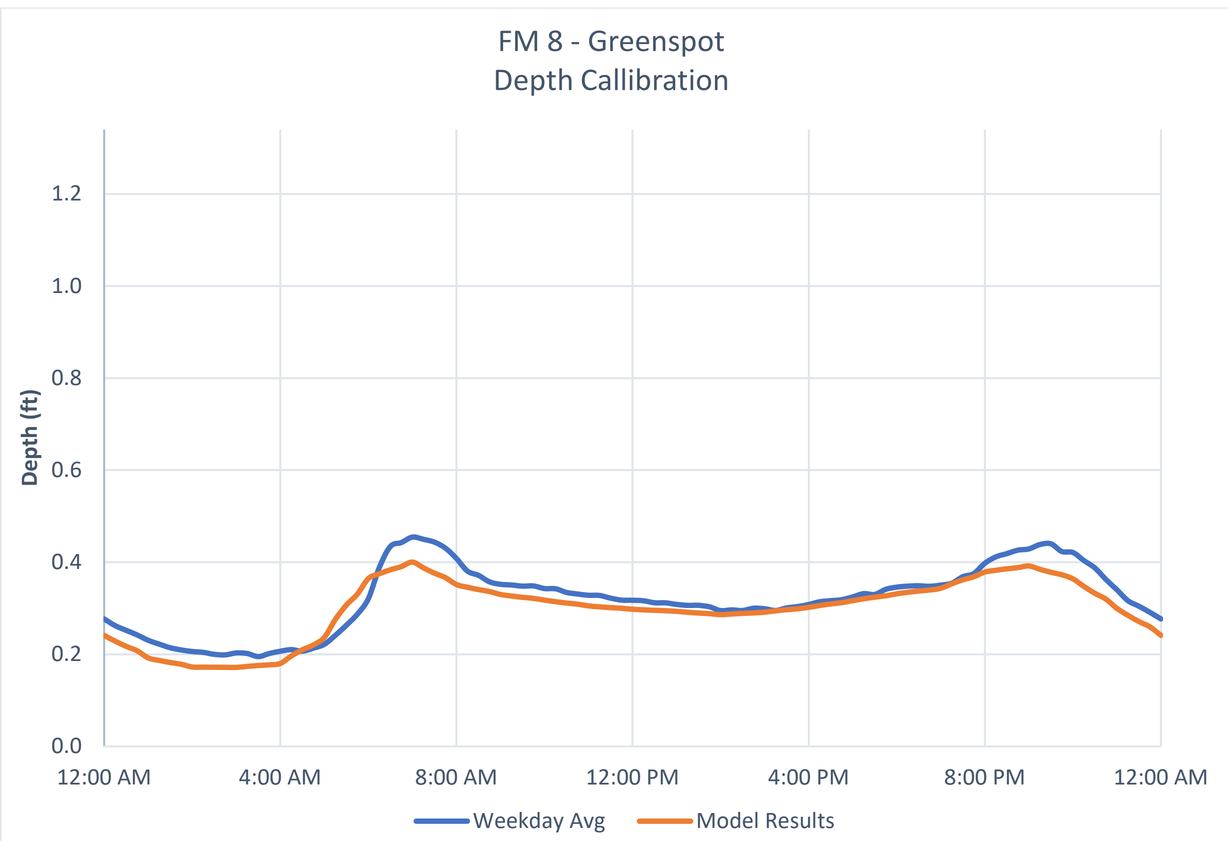

FM 6 - Conejo
Flow Callibration
Flow (MGD)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results

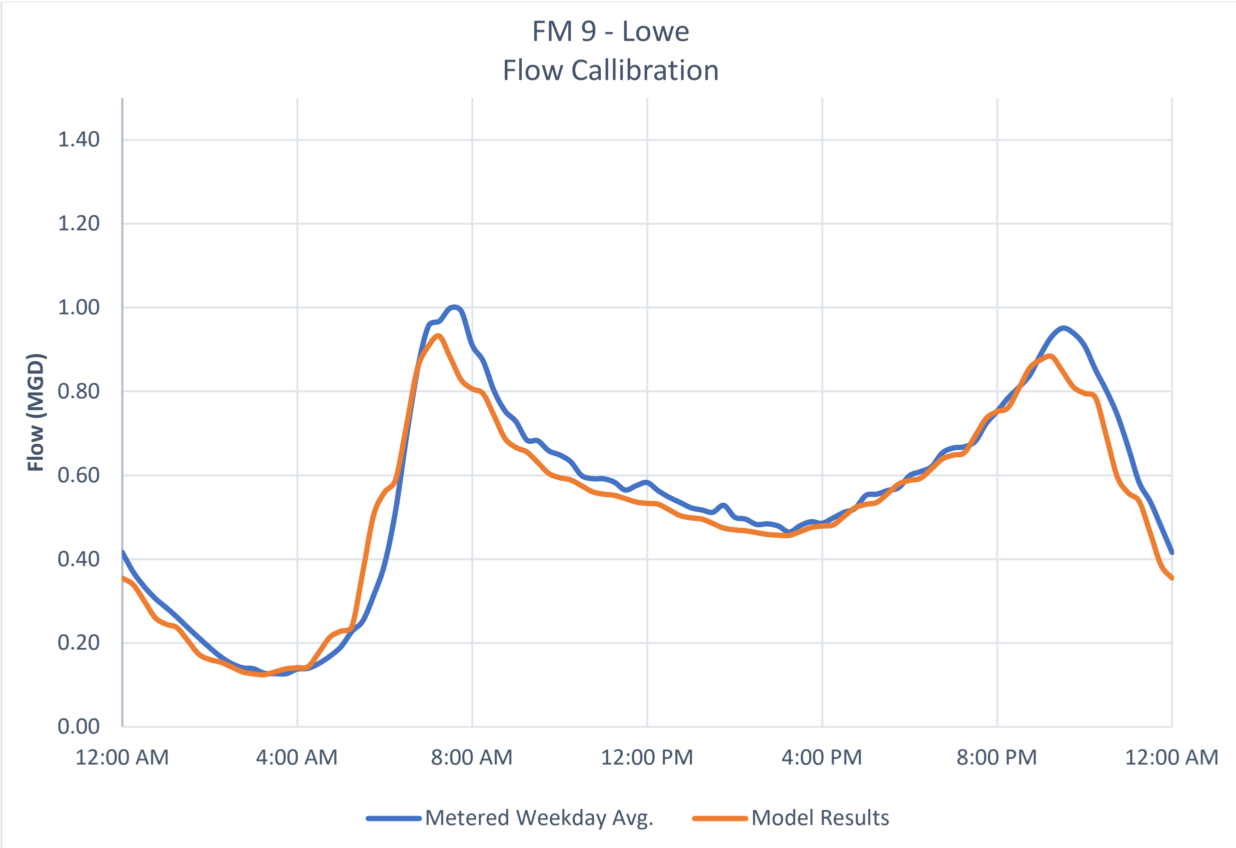

FM 6 - Conejo
Depth Callibration
Depth (ft)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

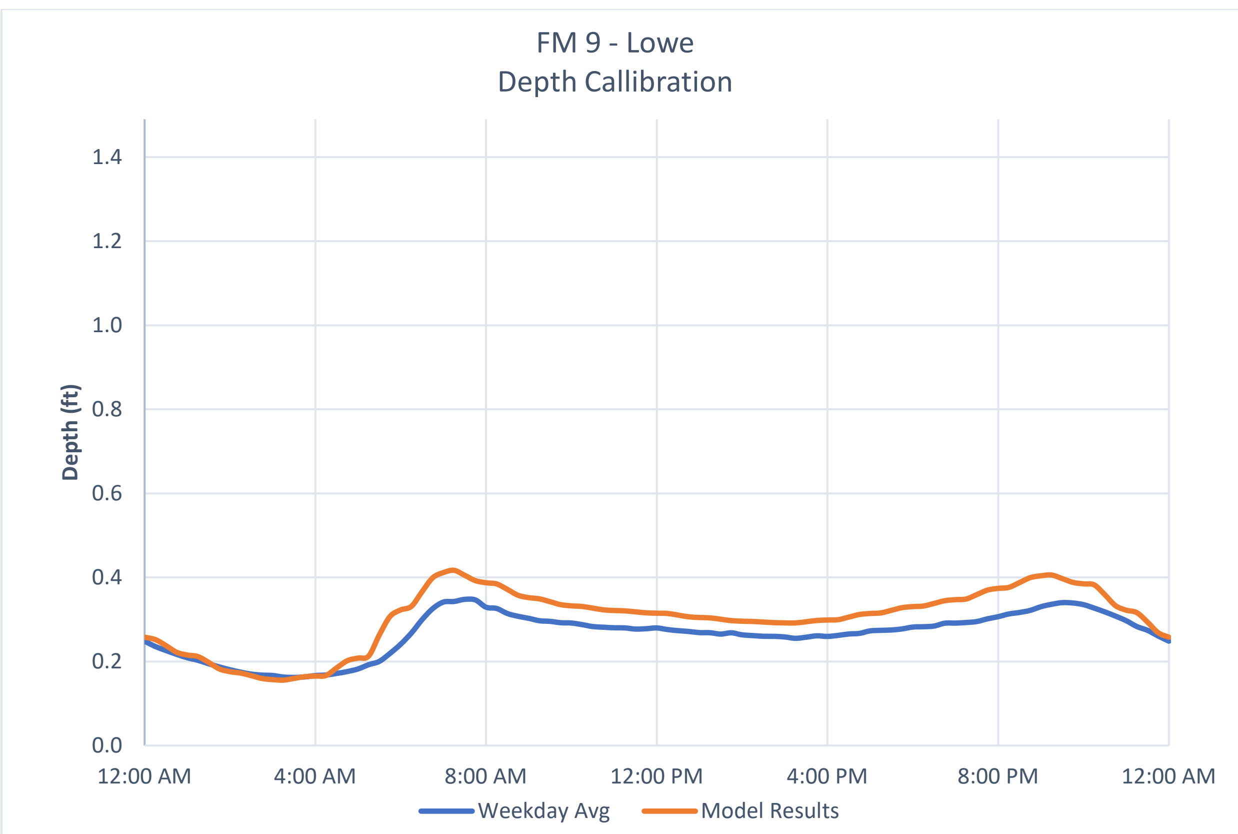

FM 7 - 5th
Flow Callibration
Flow (MGD)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results

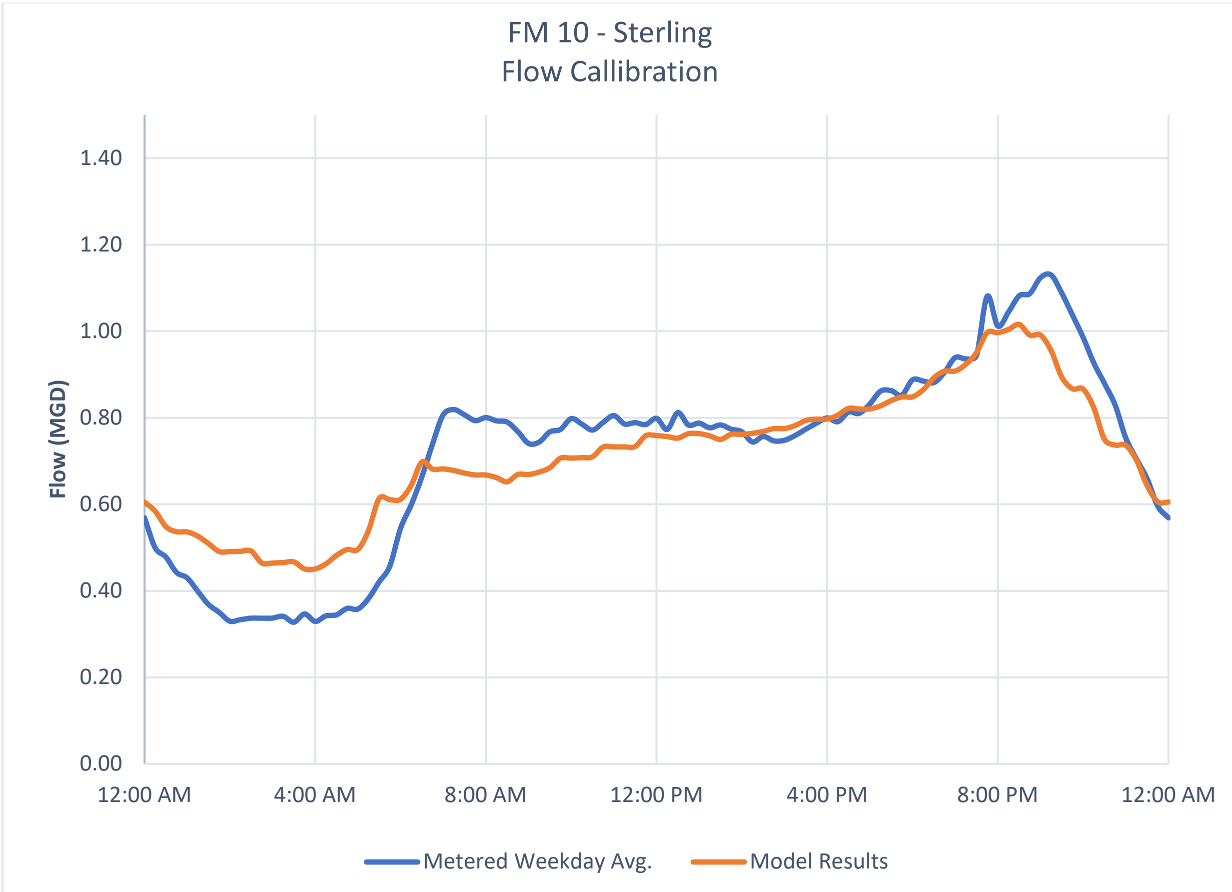

FM 7 - 5th
Depth Callibration
Depth (ft)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

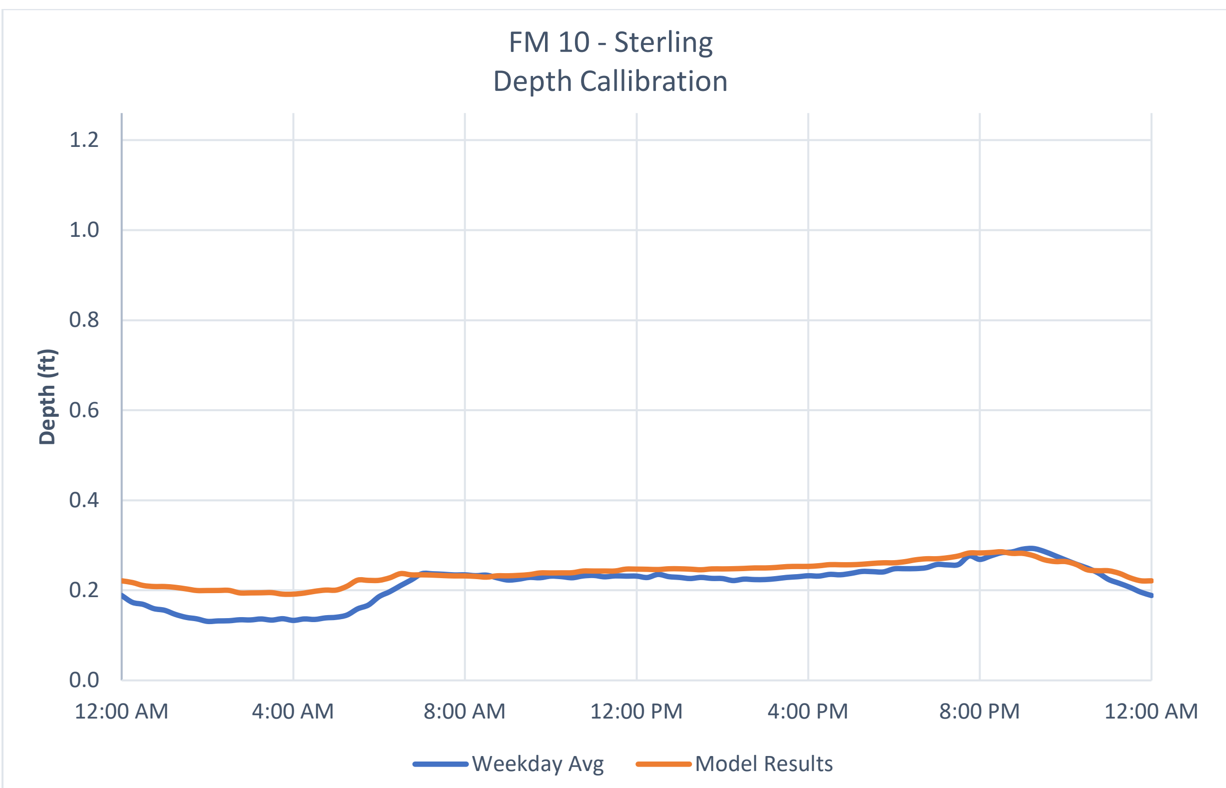

FM 8 - Greenspot
Flow Callibration
Flow (MGD)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results

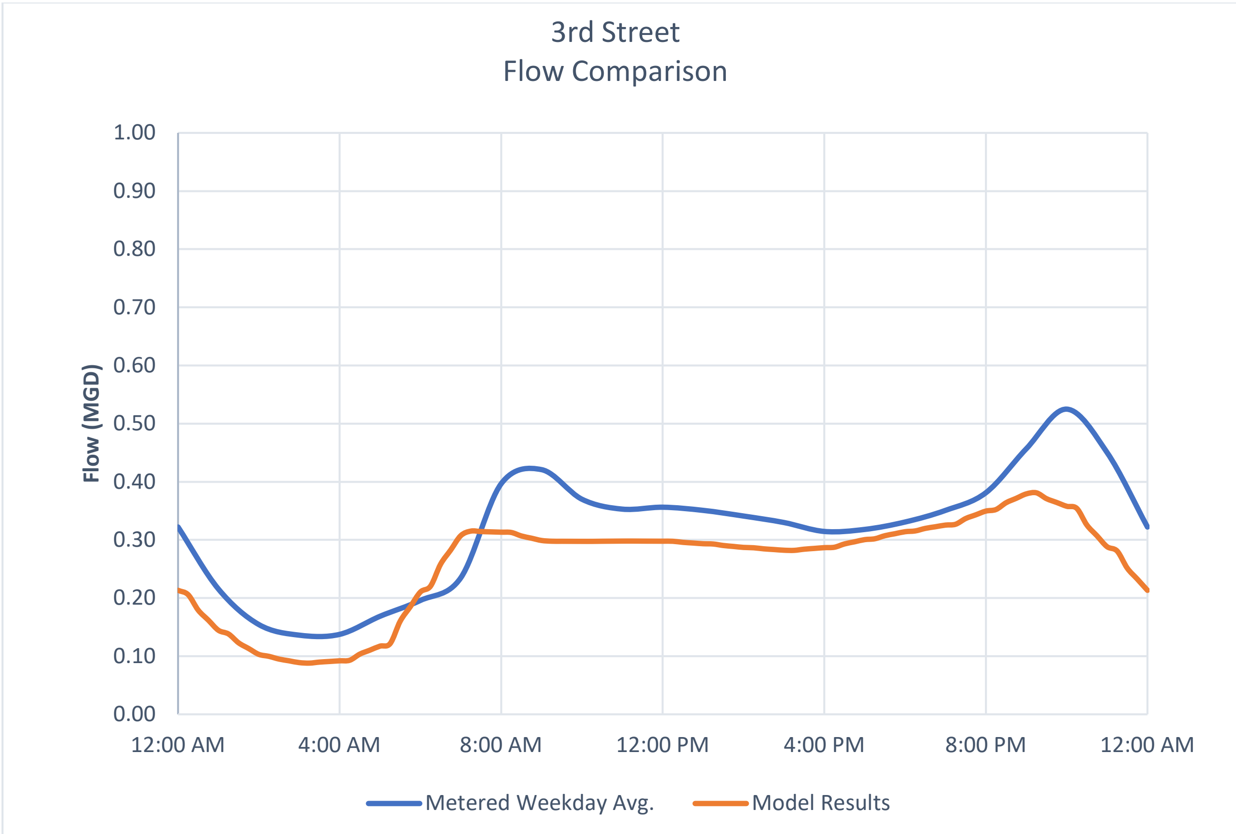

FM 8 - Greenspot
Depth Callibration
Depth (ft)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

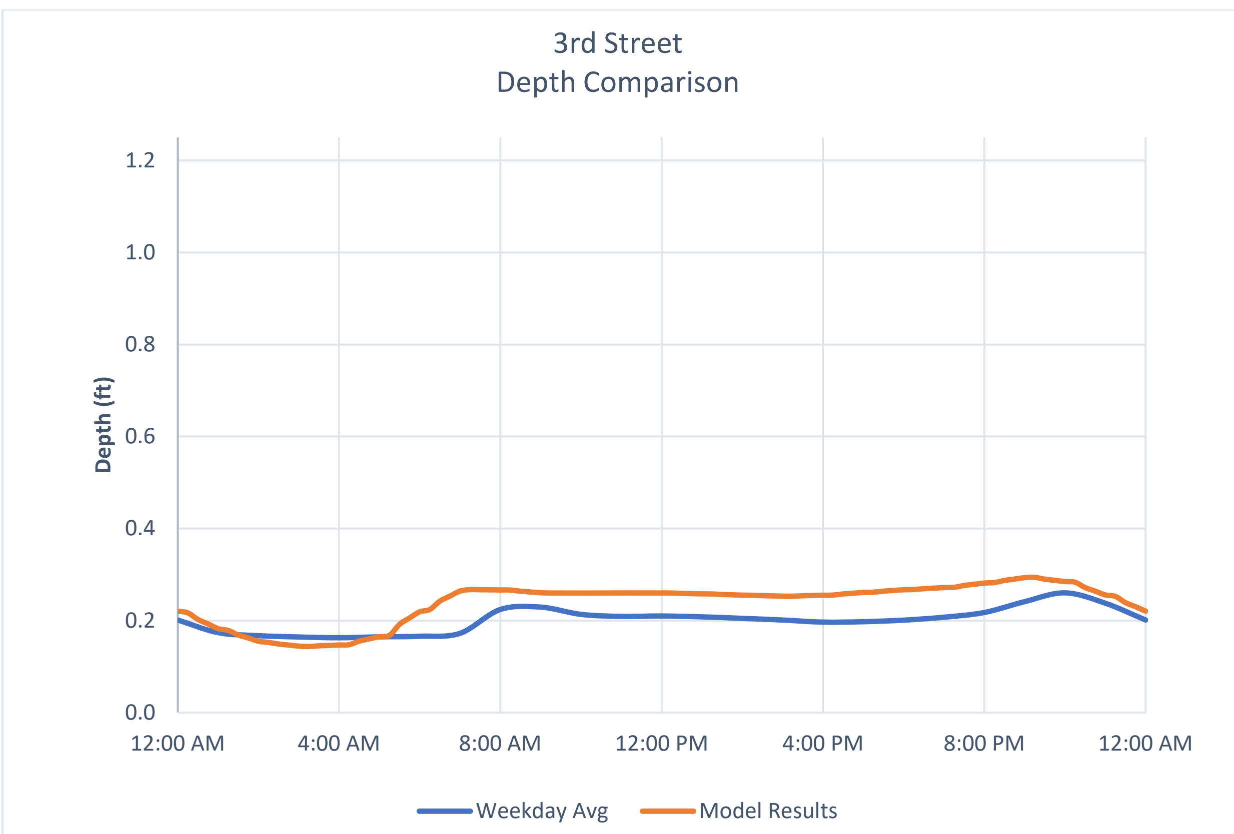

FM 9 - Lowe
Flow Callibration
Flow (MGD)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results

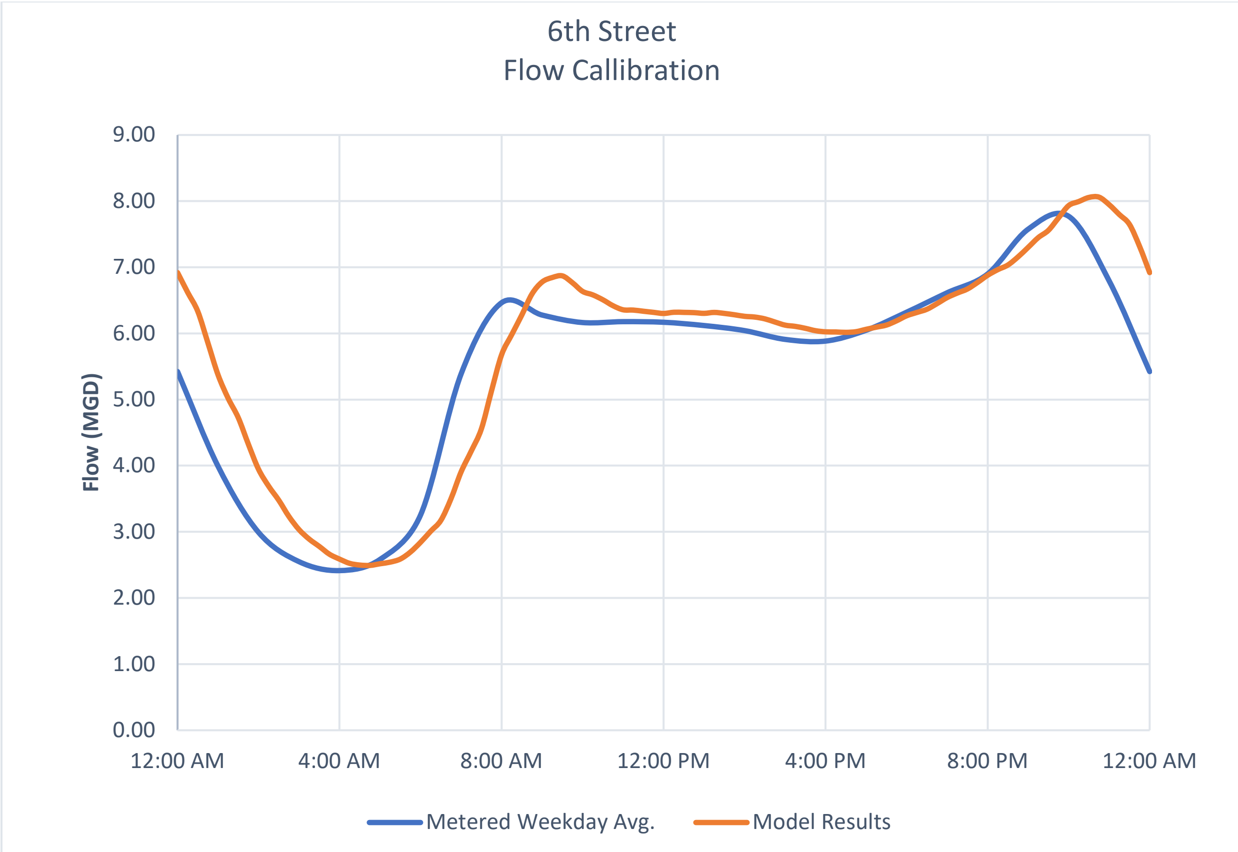

FM 9 - Lowe
Depth Callibration
Depth (ft)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

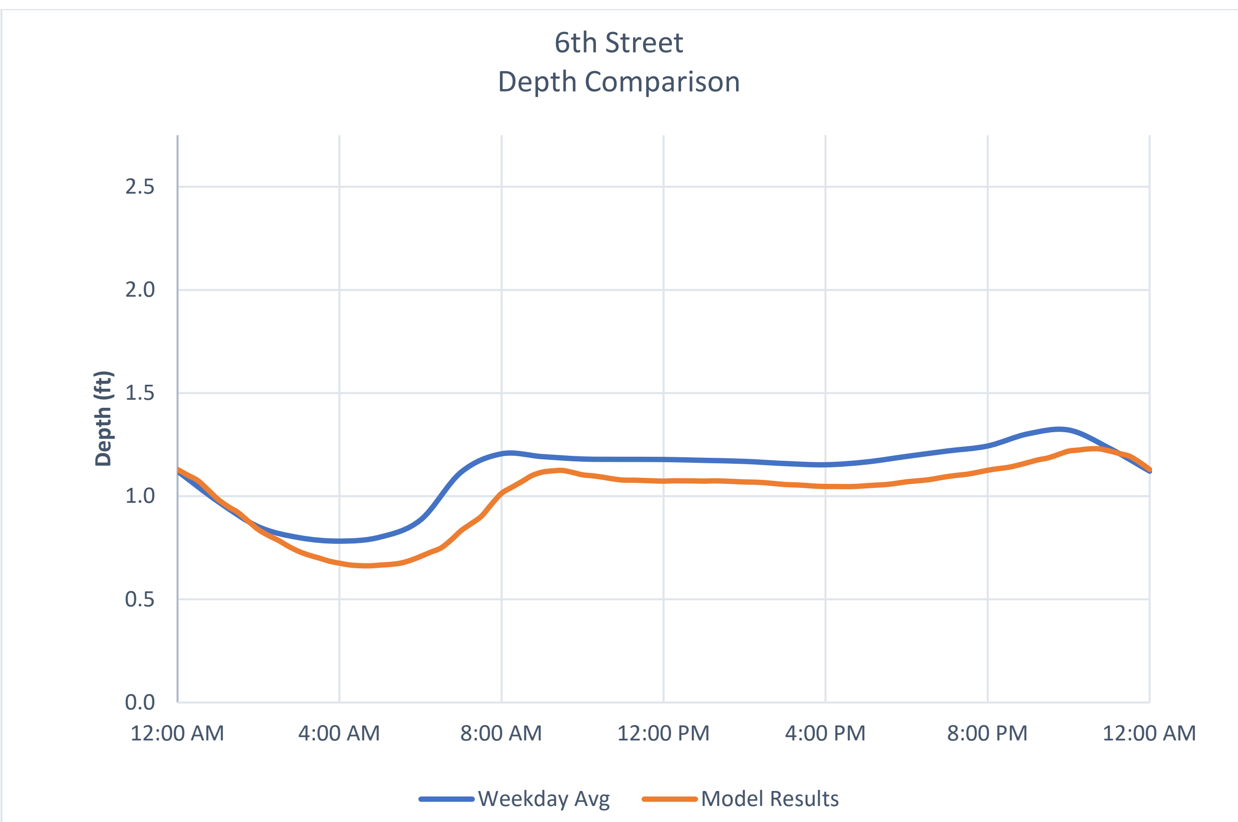

FM 10 - Sterling
Flow Callibration
Flow (MGD)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results


FM 10 - Sterling
Depth Callibration
Depth (ft)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results


3rd Street
Flow Comparison
Flow (MGD)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results


3rd Street
Depth Comparison
Depth (ft)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results


6th Street
Flow Callibration
Flow (MGD)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Metered Weekday Avg.
Model Results


6th Street
Depth Comparison
Depth (ft)
2.5
2.0
1.5
1.0
0.5
0.0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
Weekday Avg
Model Results

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Design with community in mind