APPENDIX J – SEWER STUDY

Moreno Valley Mall Redevelopment

Sewer Study

Moreno Valley, CA

March 2022

Kimley»Horn

TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

ACRONYMS

AC	Acre
APN	Assessor's Parcel Number
CFS	Cubic Feet Per Second
District	Eastern Municipal Water District
EDU	Equivalent Dwelling Units
EMWD	Eastern Municipal Water District
GPD/AC	Gallons per Day per Acre
GPM	Gallons per Minute
HDR	High Density Residential
Hwy	Highway
IN	Inch
LDR	Low Density Residential
LF	Linear Feet
MG	Million Gallons
MGD	Million Gallons per Day
MDR	Medium Density Residential
MHDR	Medium High Density Residential
OS-CH	Open Space-Conservation Habitat
OS-R	Open Space Recreation
OS-R/Basin	Open Space Recreation/Basin
PA	Planning Area
POC	Point of Connection
SP	Specific Plan

1. INTRODUCTION

Objective

Kimley-Horn was tasked with analyzing the existing and proposed sewer facilities which will serve the Moreno Valley Mall redevelopment (Project). The results of Kimley-Horn's analysis are presented in this Sewer Study.

Project Description

The Moreno Valley Mall Project is proposing to redevelop 58.6 of the existing 80.1 acres of the existing Moreno Valley Mall land area to include four new apartment complexes, two new hotel buildings, and a new office building. In total, the proposed redevelopment will result in an additional 1,246 equivalent dwelling units (see **Table 1**). The Project will be served by Eastern Municipal Water District (EMWD or District). The Project is located in Moreno Valley, CA, south of State Route 60 between the Day Street and Frederick Street, and is bounded by Town Circle. **Figure 1** depicts the project location and surrounding vicinity.

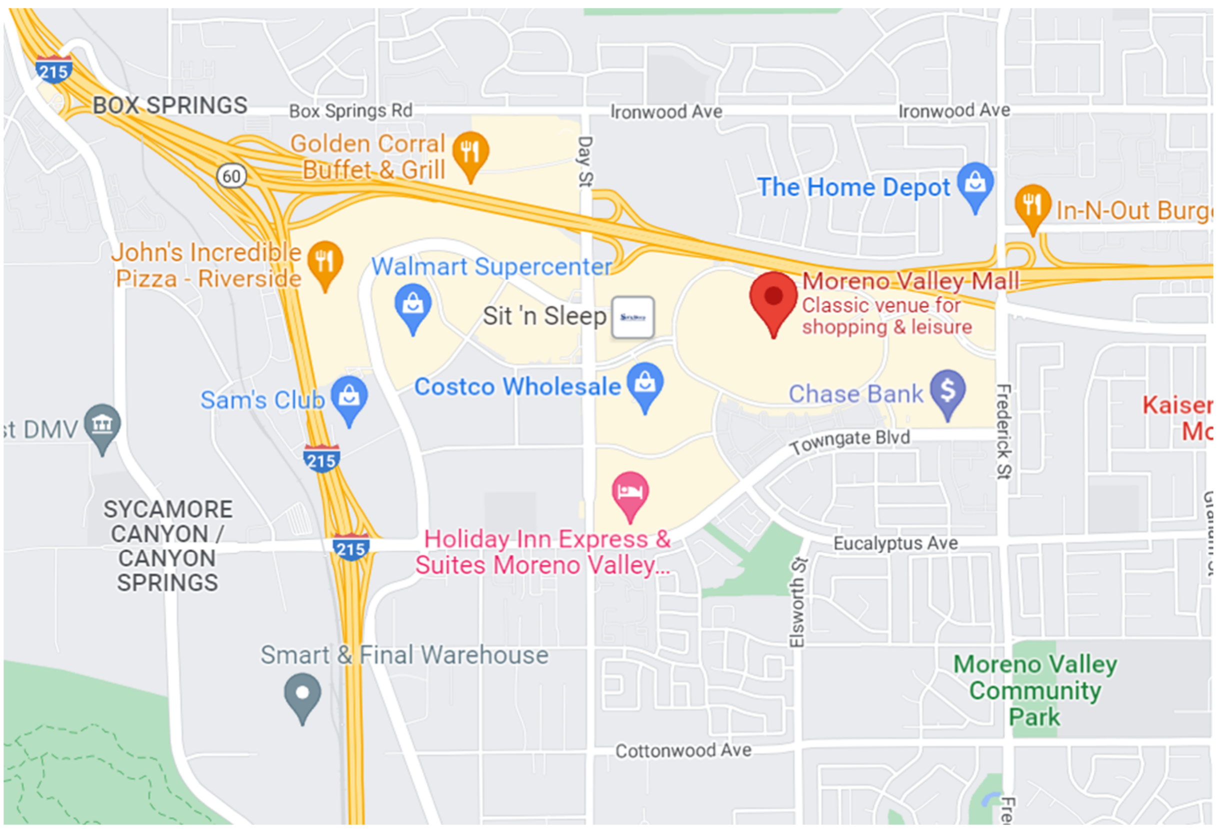


Figure 1 – Project Vicinity

Table 1 – Moreno Valley Mall Redevelopment Project Summary

Existing					
Building	**Acreage**	**Use**	**Dwelling Units**	**EDU/ACRE**	**EDU**
Mall	80.1	Commercial Retail	-	5	401

Proposed					
Building	**Acreage**	**Use**	**Dwelling Units**	**EDU/DU**	**EDU**
Hotel A	-	Hospitality	150	0.65	98
Hotel B	-	Hospitality	120	0.65	78
Res. A	-	Residential	596	0.65	387
Res. B	-	Residential	216	0.65	140
Res. C	-	Residential	565	0.65	367
Res. D	-	Residential	250	0.65	163
Office	2.66	Commercial Office	-	5	13

Summary		
Total Dwelling Units		1647
Density (Gross)[1] (DU/Acre)		20.6
Land Use		
	Existing	Retail
	Proposed	Retail / Residential / Office
APNs	291-110-032	
	291-110-033	
	291-110-034	
	291-110-035	
	291-110-036	
	291-110-037	

[1]Based on 1647 Dwelling Units and 80.1 acres developable area.

2. ANALYSIS CRITERIA

This sewer study has been prepared in accordance with EMWD planning criteria, utilizing Project information provided by the Applicant and land use information published by City of Moreno Valley. The following reference documents and tools were utilized in the preparation of this sewer study:

- EMWD 2015 Wastewater Collection System Master Plan: Planning and Sizing Criteria
- EMWD Sanitary Sewer System Planning and Design (revised September 1, 2006)
- EMWD Sewer Record Drawings

- Bentley Systems FlowMaster 10.02.00.01 (released December 19, 2018)

Flow Estimation

The EMWD service area receives little rainfall, therefore wastewater collection system capacities within the District are based on peak dry weather flows. An allowance for wet weather flows is provided by adopting maximum depths of flow in the pipe sizing criteria. Wastewater flows are based on land use development type, development density, and flow rate by land use.

Land use development types are assigned an equivalent dwelling unit (EDU) conversion factor. Residential development EDUs are determined based on dwelling units (DU), and other developments are based on acreage. Hotel EDUs are determined based on number of rooms, using the same conversion factor as Very High Density Residential developments. These factors are provided by EMWD and are shown in **Table 2**. Average dry weather flows (ADWF) are then obtained by applying a standard value of 235 gpd per EDU. Peak dry weather flows (PDWF) are calculated by multiplying ADWF with a peaking factor (PF), which has a maximum value of 2.87.

For average dry weather flows greater than 0.1 MGD, the peaking factor is given by the following equation:

$$PF = 2.13 \times Q_{ADWF}{}^{-0.13}$$

Where Q_{ADWF} is in MGD.

Table 2 – Wastewater Flow Estimation Criteria

Development Density[1]		
Commercial Retail	5	EDU/AC
Residential Very High Density (17 DU/AC)	0.65	EDU/DU
Commercial Office	5	EDU/AC
ADWF Factor	235	gpd/EDU
Maximum Peaking Factor		2.87
Minimum Peaking Factor		2.41

[1]See EMWD 2015, Table 1. Hotel EDU/DU ratio is assumed equal to Very High Density Residential

Pipe Capacity

Wet weather flows are accommodated by ensuring the peak dry weather flows do not exceed maximum depths of flow established by EWMD. As shown in **Table 3**, the maximum depths of flow (d/D) are 0.5 for pipes less than 15 inches in diameter and 0.7 for pipes equal or greater than 15 inches.

Flow depths are determined using Manning's formula:

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Where Q is the peak dry weather flow (cfs), n is Manning's number, A is the pipe cross sectional area in (ft^2), R is the hydraulic radius (feet), and S is the pipe slope (ft/ft).

Pipe slopes are set to ensure minimum scour velocity and to prevent wear due to excessive flow velocity, with a recommended velocity if 3 ft/s. To achieve this, minimum pipe slopes are established according to pipe diameter. These criteria are presented in **Table 3**.

Table 3 – Pipe Capacity Design Criteria

Manning's n	0.015
Flow Velocity	
Minimum	2 ft/s
Maximum	10 ft/s
Recommended	3 ft/s
Minimum Pipe Slope	
8-inch pipe	0.40%
10-inch pipe	0.32%
12-inch pipe	0.24%
15-inch pipe	0.16%
PDWF Flow Depth (d/D)	
Diameter < 15 inches	< 0.5
Diameter ≥ 15 inches	< 0.7

An 8-inch diameter pipeline has been established by EMWD as the minimum sewer pipe size in order to prevent maintenance problems and allow for sufficient space to convey sewage and debris downstream.

3. SEWER ANALYSIS

Existing Sewer Facilities

The existing mall facility has five existing points of connection (POC) to the EMWD sewer system. Per EMWD record drawings (see **Appendix D**), each POC varies in the number and size (either 6- or 8-inches) of connections. Using Manning's equation, one can deduce that a 6-inch pipe flowing at EMWD's design capacity of $d_n/D = 0.5$ has 46% of the flow capacity of an 8-inch pipe flowing at EMWD's design capacity, assuming consistent roughness coefficients and slopes.

As shown in **Table** 4, the existing mall generates 65.359 GPM of sewage in the ADWF condition. In total, there are six 8-inch laterals out of the building and ten 6-inch laterals out of the building. Assuming all laterals were designed to capacity, sewage flows allocated to each lateral are defined as follows:

$E = 8 - inch\ lateral$
$S = 6 - inch\ lateral$
$S = 0.46E$

$6E + 10S = 65.359\ GPM$
$6E + 10(0.46E) = 65.359\ GPM$
$=> 10.6E = 65.359\ GPM$
$=> E = 6.166\ GPM$ (each 8-inch pipe carries 6.166 GPM sewage in the ADWF condition)

$S = 0.46(6.166\ GPM)$
$=> S = 2.836\ GPM$ (each 6-inch pipe carries 2.836 GPM sewage in the ADWF condition)

Sewage generated from the existing mall will be remain the same in the proposed condition. See **Table 5** for the sewage flow allocation to each building point of connection, and **Appendix A** for the location of each point of connection.

Proposed Sewer Facilities

The Project area includes a network of both public and private sewer lines, ranging from 8-inch to 15-inch lines. The Project will also incorporate a private sewer lift station and 750 FT of force main (see Pipe 9). Sewer lines generally run from northeast to southwest, sloping between 0.0032ft/ft and 0.073ft/ft.

A portion of the existing sewer system along the eastern side of the Project will be relocated within Town Circle to avoid the proposed developments. The existing sewer line within Town Circle will be upsized to accommodate the proposed flows.

At the point of connection to the existing public sewer line, the proposed sewer system will have approximately 35FT of cover. At the most up-stream location, the sewer line will have approximately 8 FT of cover.

The Project intends to connect to the existing public sewer main within Memorial Way and Town Circle. EMWD will determine the capacity of the existing sewer line within Memorial Way. See Appendix A for the Existing and Proposed Sewer Exhibit.

Sewer Service Capacity Check

Onsite pipes will be 8 to 12-inch diameter gravity sewer lines. Flows will enter the existing sewer system at a single point of connection as shown on **Appendix A**.

An analysis showing the assumed sewer generation rates, including estimated peak flows from the Project is presented in **Table 4**.

Table 4 – Proposed Wastewater Flows

			EXISTING				
Building	**Residential Density**	**Acres**	**DU**	**EDU/AC[1]**		**EDU**	**ADWF[2] (gpm)**
Mall	Very High	80.1	-	5		400.5	65.359
			PROPOSED				
Building	**Residential Density**	**Acres**	**DU**	**EDU/DU**	**EDU/AC[1]**	**EDU**	**ADWF[2] (gpm)**
Hotel A	Very High	-	150	0.65	-	97.5	15.911
Hotel B	Very High	-	120	0.65	-	78.0	12.729
Res. A	Very High	-	596	0.65	-	387.4	63.222
Res. B	Very High	-	216	0.65	-	140.4	22.913
Res. C	Very High	-	565	0.65	-	367.3	59.933
Res. D	Very High	-	250	0.65	-	162.5	26.519
Office		2.66	-	-	5	13.3	2.1705
			SUMMARY				
Total (Existing plus Proposed):						1646.9	268.76

[1]See Table 2. For Very High residential density developments, a value of 0.65EDU/DU is assumed

[2]Using a standard factor of 235 gpd/EDU

The results of sewer hydraulic calculations are presented in **Table 5**. Bentley FlowMaster was used calculate velocity and flow depth, employing the Manning friction method as discussed in Section 2. Complete FlowMaster program output is provided in Appendix F.

Table 5 – Proposed Sanitary Sewer Hydraulics

Pipe Section	Node									Flow Depth	
No.	Start	End	Tributary Flows	ADWF (MGD)	Peaking Factor	Peak Flow (gpm)	Diameter (in)	Slope (ft/ft)	Velocity (ft/s)	d (in)	d/D
1	A	B	1/2 Res D	0.019	2.87	38.1	8	0.004	1.3	1.9	0.24
2	B	C	1ET	0.009	2.87	17.7	8	0.005	1.13	1.3	0.16
3	C	D	1/2 Res D + 1ET	0.028	2.87	55.8	8	0.005	1.58	2.2	0.28
4	D	E	1ET	0.009	2.87	17.7	8	0.018	1.76	0.9	0.11
5	E	F	1/2 Res D + 2ET	0.037	2.87	73.4	8	0.018	2.68	1.8	0.23
6	G	I	1/2 Res D	0.019	2.87	38.1	8	0.007	1.59	1.7	0.21
7	H	I	3SX + 1ET	0.021	2.87	42.1	8	0.004	1.34	2	0.25
8	I	J	1/2 Res D + 3SX + 1ET	0.040	2.87	80.2	8	0.008	2.07	2.4	0.30
9	J	K	1/2 Res D + 3SX + 1ET	0.040	2.87	80.2	4	(+)0.004	min 2	4	1.00
10	L	N	Hotel A/B	0.041	2.87	82.2	8	0.004	1.62	2.9	0.36
11	M	N	Office	0.003	2.87	6.2	8	0.004	0.76	0.8	0.10
12	N	K	Hotel A/B + Office	0.044	2.87	88.4	8	0.004	1.65	3	0.38
13	K	X	1/2 Res D + 3SX + 1ET + Hotel A/B + Office	0.085	2.87	168.6	8	0.013	3.03	3.1	0.39
14	O	Q	1/2 Res C	0.043	2.87	86.0	8	0.007	2.01	2.5	0.31
15	P	Q	1/2 Res C	0.043	2.87	86.0	8	0.007	2.01	2.5	0.31
16	Q	S	2/2 Res C	0.086	2.87	172.0	8	0.007	2.43	3.7	0.46
17	R	S	Res B	0.033	2.87	65.8	8	0.007	1.87	2.2	0.28
18	S	U	Res C + Res B	0.119	2.81	232.6	10	0.007	2.6	3.9	0.39
19	T	U	Res A	0.091	2.87	181.4	8	0.007	2.46	3.8	0.48
20	U	W	Res A + Res B + Res C	0.210	2.61	381.0	12	0.007	2.95	2.95	0.25
21	V	W	2ET + 4SX	0.034	2.87	68.0	8	0.005	1.67	2.5	0.31
22	W	X	Res A + Res B + Res C + 2ET + 4SX	0.244	2.56	434.2	12	0.005	2.7	5.6	0.47
23	X	Z	Res A + Res B + Res C + 3ET + 7SX + 1/2 Res D + Hotel A/B + Office	0.329	2.46	562.3	12	0.026	4.91	3.6	0.30
24	Y	Z	1ET + 3SX	0.021	2.87	42.1	8	0.073	3.74	1	0.13
25	Z	F	Res A + Res B + Res C + 4ET + 10SX + 1/2 Res D + Hotel A/B + Office	0.350	2.44	593.6	15	0.004	2.68	6.3	0.42

* ET = 8-inch lateral from mall, SX = 6-inch lateral from mall. See section 3 for definition

4. CONCLUSION

Based on the calculations, an onsite 8-inch to 12-inch diameter sewer system will be designed for the project. Flows will be conveyed to the existing and proposed public 8-inch to 15-inch sewer system within Town Circle before connecting to the existing public sewer system at the intersection of Memorial Way and Town Circle. EMWD will determine the capacity of the existing sewer line within Memorial Way.

Tammie Moreno, P.E.

C 74417 Exp. 9/30/23

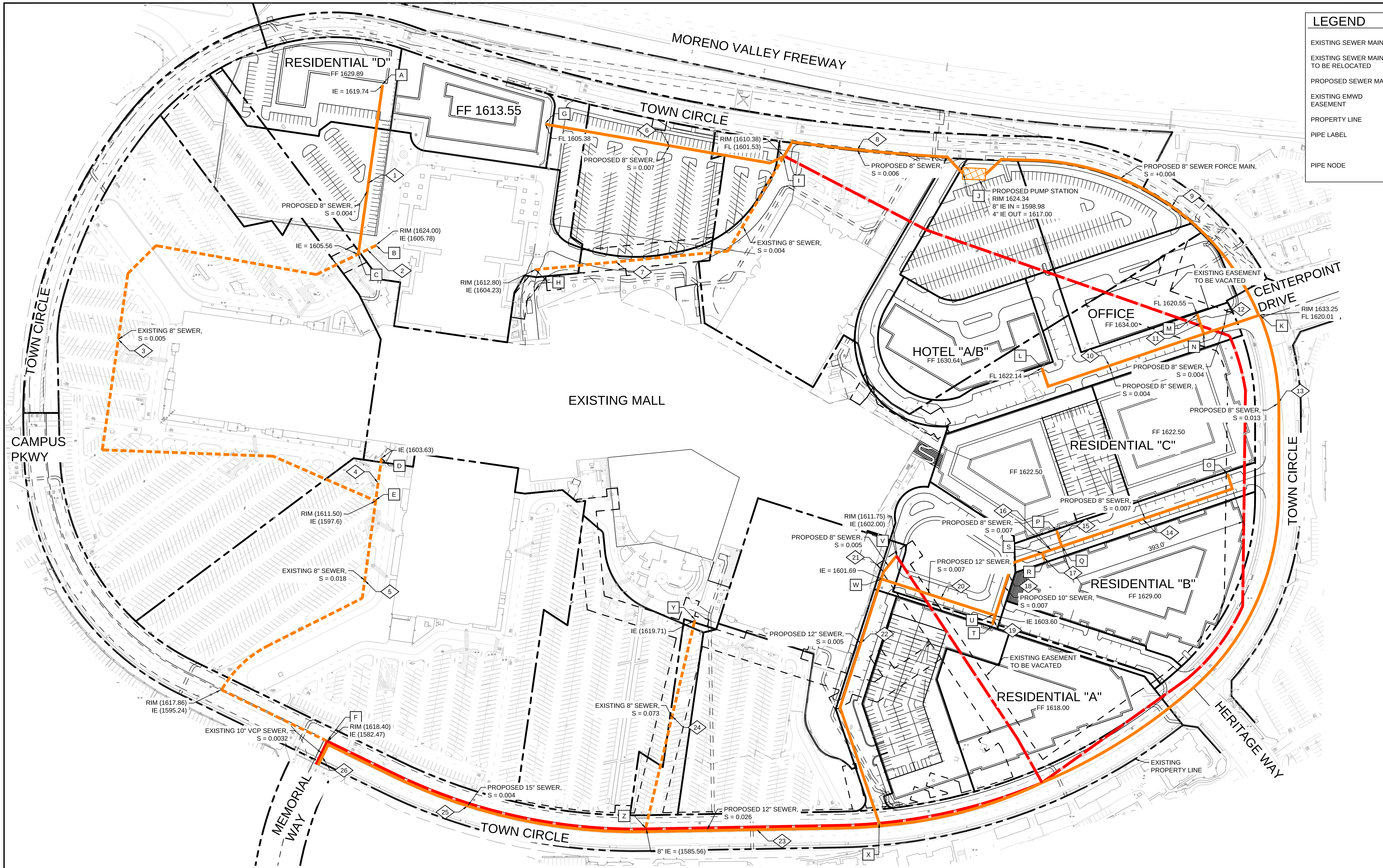
5. REFERENCES

1. EMWD 2015, Wastewater Collection System Master Plan, Master Plan Supplement, Planning and Sizing Criteria (accessed July 6, 2020). https://www.emwd.org/sites/main/files/file-attachments/sewer_master_plan_supplement_2015_wwfmp_planning_and_sizing_criteria_appendix_3a.pdf

2. EMWD 2006, Sanitary Sewer System Planning and Design (revised September 1, 2006). https://www.emwd.org/sites/main/files/file-attachments/emwdsewer_system_design.pdf.

APPENDIX A

Existing and Proposed Sewer Exhibit



LEGEND

EXISTING SEWER MAIN	
EXISTING SEWER MAIN TO BE RELOCATED	
PROPOSED SEWER MAIN	
EXISTING EMWD EASEMENT	
PROPERTY LINE	
PIPE LABEL	XX
PIPE NODE	XX

SEWER FLOWS		
PIPE	SOURCE	PEAK FLOW (GPM)
1	1/2 RES D	38.1
2	1ET	17.7
3	1/2 RES D + 1ET	55.8
4	1ET	17.7
5	1/2 RES D + 2ET	73.4
6	1/2 RES D	38.1
7	3SX + 1ET	42.1
8	1/2 RES D + 3SX + 1ET	80.2
9	1/2 RES D + 3SX + 1ET	80.2
10	HOTEL A/B	82.2
11	OFFICE	6.2
12	HOTEL A/B + OFFICE	88.4
13	1/2 RES D + 3SX + 1ET + HOTEL A/B + OFFICE	168.6
14	1/2 RES C	86.0
15	1/2 RES C	86.0
16	2/2 RES C	172.0
17	RES B	65.8
18	RES C + RES B	232.6
19	RES A	181.4
20	RES A + RES B + RES C	381.0
21	2ET + 4SX	68.0
22	RES A + RES B + RES C + 2ET + 4SX	434.2
23	RES A + RES B + RES C + 3ET + 7SX + 1/2 RES D + HOTEL A/B + OFFICE	562.3
24	1ET + 3SX	42.1
25	RES A + RES B + RES C + 4ET + 10SX + 1/2 RES D + HOTEL A/B + OFFICE	593.6

NORTH

GRAPHIC SCALE IN FEET
0 50 100 200

Kimley»Horn

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EXISTING AND PROPOSED SEWER AND WATER EXHIBIT
MORENO VALLEY MALL
MORENO VALLEY, CALIFORNIA

APPENDIX B

EMWD Wastewater Collection Sewer Master Plan
Planning and Sizing Criteria

Master Plan Supplement

FINAL

Planning and Sizing Criteria

2015 WASTEWATER COLLECTION SYSTEM MASTER PLAN

B&V Project No. 187976

BLACK & VEATCH
Building a world of difference.

emwd EASTERN MUNICIPAL WATER DISTRICT

APPENDIX 3A – PLANNING CRITERIA

3A.1 PLANNING CRITERIA

The purpose of a master plan is to plan for future development and assess the impact of the development to existing infrastructure performance. As part of the master plan process, areas of future growth are projected, additional infrastructure needs to serve future growth areas are identified, and recommendations are made for improvements to existing infrastructure impacted by growth. Recommendations are made using planning criteria specific to the service provider.

The following technical memorandum outlines the planning criteria used for the Eastern Municipal Water District's (District) Wastewater Collection System Master Plan Update (2015 Master Plan). The District serves five collection systems: Moreno Valley, Temecula Valley, Perris Valley, Sun City, and San Jacinto. The Sun City operational boundary is generally combined with the Perris Valley operational boundary since they are both served by the Perris Valley Regional Water Reclamation Facility (RWRF). These criteria have been developed to allow the District to evaluate their existing facilities and plan for the future, while maintaining a reliable and safe wastewater collection system:

- Wastewater Flows
  - Land use density
  - Flow per equivalent dwelling unit (EDU)
  - Peaking factors and diurnal patterns
- Pipe Capacity and Sizing
  - Allowable depth
  - Slope
  - Velocity
  - Roughness factors
- Hydraulic Modeling Approach
- Lift Station Capacity and Sizing

Note that this master planning effort does not negate the need for developers to prepare a site-specific wastewater planning studies to demonstrate that new development or redevelopment does not have negative impacts on the existing wastewater system or to identify required improvements.

3A.2 WASTEWATER FLOWS

Wastewater flows in a collection system vary significantly depending on the time of day and climatic conditions. During dry weather conditions wastewater flows are produced based on wastewater generated from various land uses, while during wet weather conditions, wastewater flows may be significantly impacted by rainfall entering the wastewater collection system. Figure 1 shows typical wastewater flow components.

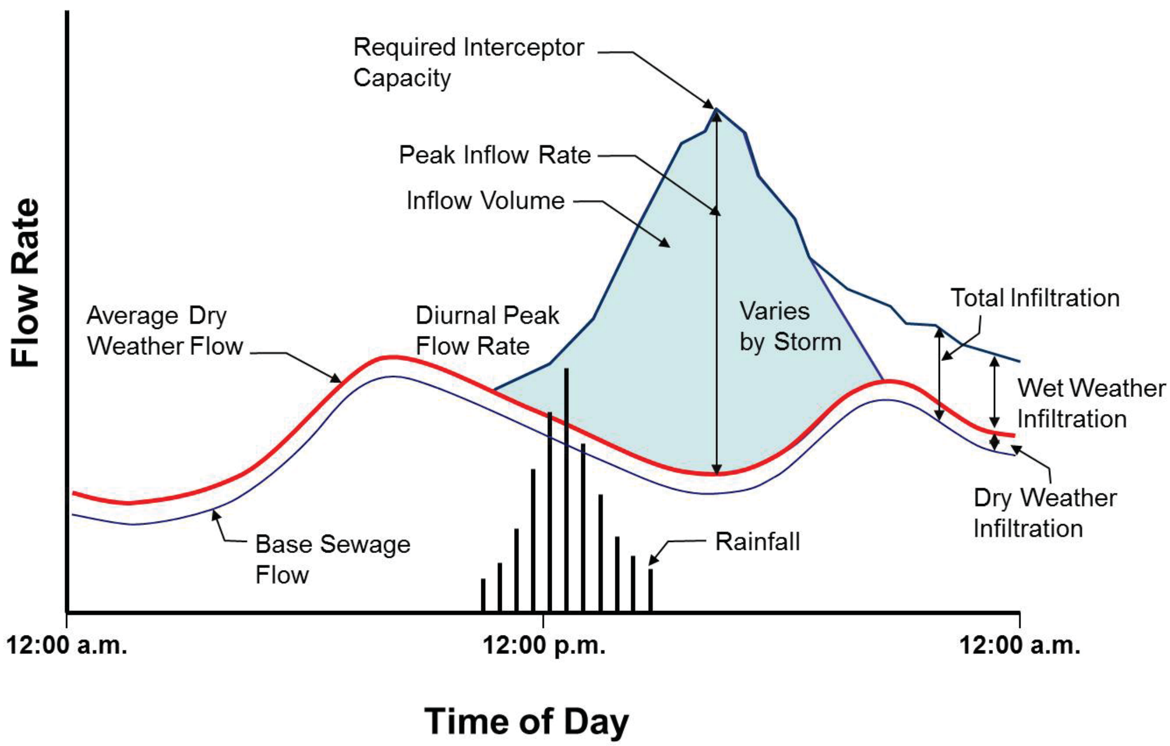


Figure 1: Typical Wastewater Flow Components

As shown, wastewater components include:

- Base sewage flow is the portion of the flow that is the return flow from customer water use.
- Average dry weather flow (ADWF) comprises of base sewage flow and dry weather infiltration. ADWF is the expected wastewater flow on a day with no precipitation events. ADWF can vary seasonally as groundwater levels change (causing fluctuations in dry weather infiltration).
- Diurnal Pattern is the change in ADWF over the course of the day and is attributable to variations in domestic, industrial, and commercial base wastewater generation.
- Infiltration is groundwater that seeps into a collection system through defective pipes, pipe joints, and manhole structures below the manhole corbel and chimney. The rate of infiltration depends on the depth of groundwater above the defects, the size of the defects, and the percentage of the collection system that is submerged. Variation in groundwater levels and the associated infiltration is both seasonal and weather dependent.
- Wet weather flows are comprised of wet weather infiltration and inflow. Wet weather infiltration is the additional infiltration that occurs due to rainfall induced higher groundwater conditions and is typically seen in the hours or days following significant rain events. Inflow is rainfall related

water that enters a collection system from sources such as private laterals, downspouts, manhole defects, foundation piping, and cross-connections with storm sewers.

The District service area receives little rainfall, making it difficult to collect meaningful rainfall data to correlate rainfall to the wet weather response in the collection system. In response to lack of rainfall data and historically low observed rates of wet weather infiltration and inflow, the District has elected to evaluate their wastewater collection system capacity based on peak dry weather flows. An allowance for wet weather flows is provided by adopting a conservative allowable depth of flow in the pipe sizing criteria, as described in Section 4.1.3.

3A2.1 EXISTING AND PROJECTED FLOWS

The District's service area includes both existing and future development. Wastewater flows are based on land use development type, development density, and flow rate by land use (gallons per day [gpd] per acre). Wastewater flows for existing and future development are calculated separately, as described in the following sections.

3A2.1.1 Existing Development

Prior to the Master Plan update, the District performed flow monitoring and sewer model calibration studies for each wastewater service area. The data obtained during the flow monitoring studies was used to calibrate the model, calculate typical unit flow factors, and develop diurnal patterns for various types of development within the service areas.

The District provided GIS land use layers for the existing development areas served by the District. The existing development flows are based on the model-calibrated unit flow factors for each land use type. Actual flows from the calibrated model were used to evaluate and analyze existing collection system capacity.

3A2.1.2 Future Development

The District maintains a Database of Proposed Projects (DOPP). The DOPP tracks information from the planning departments of cities, Riverside County, and District staff regarding proposed developments. The DOPP provides information about the type of development, size, and the anticipated number of EDUs.

In addition to the information from the known developments tracked in the DOPP, General Plan Land Use data was obtained from the cities and Riverside County to project future development to build out conditions. Development in these areas is based on less specific information than the DOPP; generally land use category and acreage.

In addition to the DOPP and general land use planning, the District also maintains detailed information about special development areas (Special Projects). These areas include unusual types of development, or redevelopment of existing areas. The anticipated development from the Special Projects is included in the future development and is described in more detail in Chapter 3.

Future development for each land use and DOPP was assigned a number of EDUs per acre for each land use category. Table 1 summarizes the assumed development densities for various land uses.

Table 1: Development Densities

LAND USE CATEGORY	UNITS	AVERAGE RESIDENTIAL DENSITY (DU/ACRE)	RESIDENTIAL (EDU/DU)	DEVELOPMENT DENSITY (EDU/ACRE)
Residential Land Use				
Estate Density	DU	0.5	1.5	0.8
High Density	DU	12	0.7	8.4
Low Density	DU	2	1.3	2.6
Medium Density	DU	4.5	1	4.5
Medium High Density	DU	6	0.9	5.4
Mobile Home Park	DU	10	0.65	6.5
Rural Mountainous (1)	DU	0.1	3	0.3
Rural (1)	DU	0.2	3	0.6
Very High Density	DU	17	0.65	11.1
Very Low Density (1)	DU	1	1	1.5
Non-Residential Use				
Agriculture (1)	acre			0
Business Park/Light Industrial	acre			5
Business Park/Light Industrial/Warehouse	acre			1.25
Commercial Office	acre			5
Commercial Retail	acre			5
Heavy Industrial	acre			7.5
Hospital	acre			5
Mixed Use Policy Area	acre			5
Open Space (Conservation, Landscape, Recreation, Rural, or Water) (1)	acre			5
Public Facilities (Municipal or School)	acre			5

(1) The following uses were assumed to be served by septic systems and do not contribute flow to the wastewater collection system: Rural Mountainous, Rural, Very Low Density, and Agriculture, and Open Space.

3A2.1.3 Flow Per Equivalent Dwelling Unit

For all types of development, the land use categories were converted to EDUs based on Table 1. Wastewater flow (ADWF) was calculated by multiplying the number of EDUs per land parcel by a rate of 235 gpd/EDU; the District's criteria used for regional planning.

3A2.2 PEAKING FACTORS AND DIURNAL PATTERNS

Peaking factors and diurnal curves are applied to the existing and projected wastewater flows and are used to evaluate the collection system capacity and to appropriately size recommended improvements.

3A2.1.4 Peaking Factor Curve

A peaking factor curve was developed based on the results from the calibration studies to project peak dry weather flow for a given average dry weather flow. The peaking curve is used for sizing pipe replacements or extensions.

The curve is shown in Figure 2 and is described by the equation PF = 2.13 $Q_{ADWF}^{-0.13}$, where Q_{ADWF} is the average dry weather flow and PF is the peaking factor. The peak flow is estimated by multiplying Q_{ADWF} times PF. The maximum peaking factor was identified as 2.87, so all flows less than or equal to 0.1 mgd are assumed to have a peaking factor of 2.87.

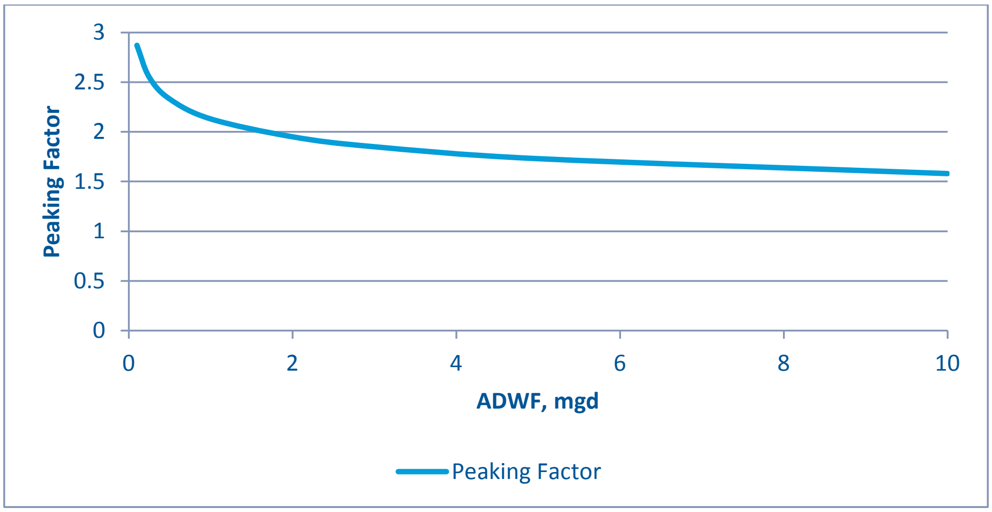


Figure 2: Peaking Factor Curve

3A2.1.5 Diurnal Patterns

The diurnal patterns developed during the calibration studies will be used to evaluate and analyze existing collection systems. For modeling future development, two diurnal patterns were developed; one for use with residential land use and the other for non-residential land use. Each pattern represents a 7-day period beginning at 1:00 a.m. on Saturday and continuing to midnight on Friday. The patterns were developed using the following rules:

- Each day, a peaking factor of 2.87 is achieved for two hours
- The flows are normalized over a 24-hour period (average PF of 1)
- Diurnal patterns can only be applied to loads ≤ 0.1 mgd (~425 EDUs)
- Patterns were based on typical residential or office/retail curves to establish the timing of the peak and minimum flows

Figure 3 shows the standard residential and non-residential diurnal patterns to be used in the model for future flows.

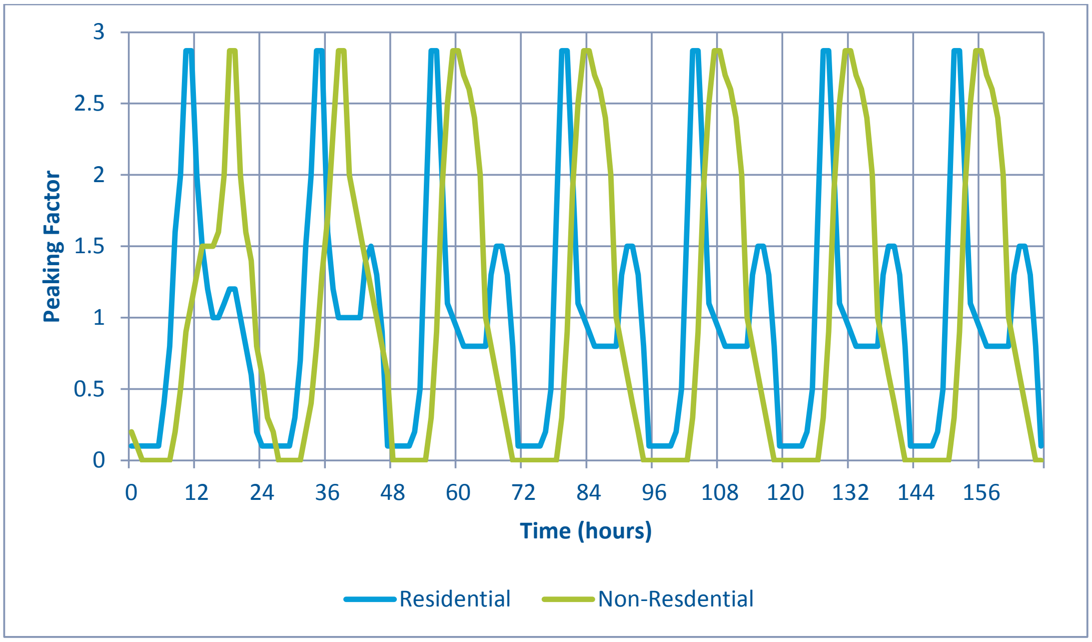


Figure 3: Residential and Non-Residential Patterns

Additional diurnal patterns were created for two of the Special Projects in Temecula Valley, Old Town and Wine Country, to account for the impacts of special events that take place within these areas. These areas in Temecula Valley have been observed to have higher peaking factors at different times in comparison to other areas due to the additional flow generated during special events, such as festivals. These patterns follow the same rules as the standard curves with the exception of having a peaking factor of 3.00 instead of 2.87. Figure 4 shows the patterns for old town and wine country.

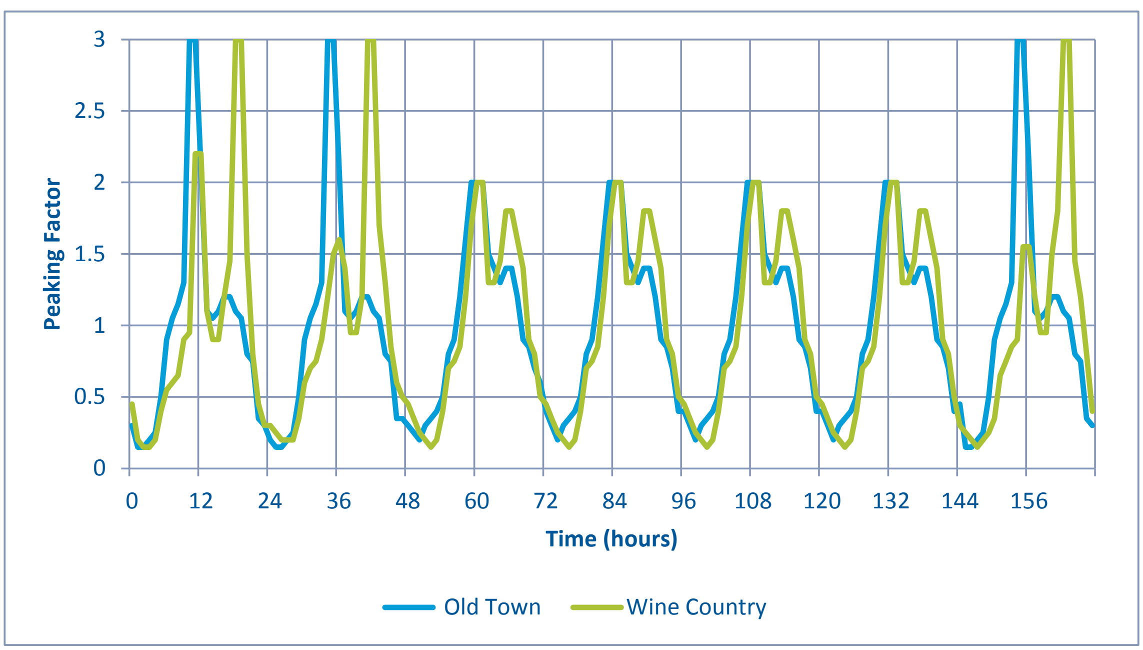


Figure 4: Old Town and Wine Country Patterns

3A.3 HYDRAULIC MODELING APPROACH

The District's existing calibrated wastewater models for each basin use an extended period simulation to analyze their existing collection systems under average dry weather flow and peak dry weather flow. To analyze the collection systems for future growth, various approaches were discussed with the District. Black & Veatch prepared a pilot model using the Moreno Valley hydraulic model to test three different approaches for peaking future flows. The three approaches and general results are summarized below.

- **Approach 1:** Perform steady state runs using a peaking factor equation. This approach may overestimate expected flows, but provides a level of protection/conservatism.

- **Approach 2:** Existing flows are peaked using the calibrated diurnal patterns and future flows are applied to the model using a constant peaking factor of 2.87 (extended period simulation). This approach generally overestimates results as compared to the PF equation.

- **Approach 3:** Existing flows are peaked using the calibrated diurnal patterns (extended period simulation). Representative diurnal patterns identified in Section 2.2.2 reflect the typical shape of the calibration patterns but are adjusted to meet the 2.87 peaking factor. This approach generally underestimates results as compared to the PF equation, but may provide results that better align with existing or expected system flows.

It was decided that the system would be evaluated using Approach 3 to identify CIP projects and Approach 1 will be used to size the new facilities. Approach 3 will generate the most likely/expected flows caused by future development. Model results will be assessed against the District's planning criteria and CIP projects will be identified where the criteria are not met. Where deficiencies are identified using Approach 3, the peaking factor equation (Approach 1) will be used to estimate the projected wastewater flow for the new facility. It has been established that new facilities will be sized for build out conditions, so it is expected that Approach 1 would only be performed under the build-out modeling scenario.

3A.4 CAPACITY AND SIZING CRITERIA

The capacity and sizing criteria are used both to evaluate existing capacity due to future growth and to size new facilities to serve future developments. In some cases the existing facilities are allowed to exceed the criteria especially if additional growth in the area is not expected and no problems with operations have been reported.

3A4.1 GRAVITY PIPES

The capacity of a gravity pipe is a function of its slope, diameter, and roughness. Manning's formula for open-channel flows is used to calculate flow capacity in gravity mains:

$Q = (1.486/n)\ AR^{2/3}\ S^{1/2}$

Where:

Q = flows, cfs
n = Manning's coefficient of roughness
A = cross sectional area of pipe, cu ft
R = hydraulic radius (flow area divided by wetted perimeter), ft
S = slope of the pipe, ft/ft

The District assumes a Manning's coefficient of 0.013 for all wastewater pipe material and uses a minimum pipe size of 8 inches for new collection system pipe. While the District utilizes n=0.013 for Capital Improvement Projects, all private development projects shall use n=0.015 to account for long term pipe conditions.

3A4.1.1 Velocity Criteria

Velocity is an important criterion for proper operation of a wastewater collection system. The District requires that pipe velocities be designed for 2 fps to 10 fps.

The minimum allowable velocity is 2 fps at calculated peak dry weather flow to avoid excessive deposition of solids in the collection system. In pipes where the minimum criterion will not be achieved on a regular basis, or will not be achieved for many years, the District will need to make arrangements to clean the pipes on a regular basis.

Velocities in excess of 10 fps could result in excessive wear on the pipe due to the abrasive nature of grit in the wastewater flow. Typically, drop manholes can be used to avoid peak velocities in excess of 10 fps, but may cause odor problems.

3A4.1.2 Slope

A minimum slope is set for each pipe size to help ensure acceptable velocity and avoid solids deposition in the collection system. Table 2 summarizes the minimum slope for various pipe sizes used for the Master Plan.

Table 2: Minimum Pipe Slopes

PIPE SIZE (INCHES)	MINIMUM SLOPE (FT/FT)	PIPE SIZE (INCHES)	MINIMUM SLOPE (FT/FT)
8	0.0040	21	0.0012
10	0.0032	24	0.0010
12	0.0024	27	0.0010
15	0.0016	30	0.0010
18	0.0014	36	0.0010

3A4.1.3 Depth to Diameter (d/D) Criteria

Depth to Diameter (d/D) is the ratio of the depth of wastewater to the diameter of the pipe. The table below shows the design criteria for gravity mains. All new sewer mains less than 15 inches in diameter shall be sized to carry the projected PDWF at a depth not greater than half of the diameter of the pipe (d/D not to exceed 0.5). New sewer mains 15 inches and larger shall be sized to carry the projected PDWF at a depth of flow not greater than 70 percent of the diameter of the pipe (d/D not to exceed 0.7). Table 3 provides a summary of pipe design criteria for capacity evaluation.

Table 3: Gravity Pipe Capacity Design Criteria

INFRASTRUCTURE	PEAK ADWF D/D	MANNING'S N	MINIMUM VELOCITY (FPS)	MAXIMUM VELOCITY (FPS)
Diameter < 15 inches	< 0.5	0.013	2	10
Diameter ≥ 15 inches	< 0.7	0.013	2	10

Note: The minimum pipe size for new collection system pipe is 8 inches.

3A4.2 LIFT STATIONS AND FORCE MAINS

Based on historical flow data, the District has determined that a 20% allowance for wet weather flows is adequate for lift station capacity planning. The District's lift stations and force mains are evaluated based on the ability to service the Peak LS Flow (Peak ADWF x 1.2).

3A4.1.4 Lift Stations

Lift station capacity is evaluated in terms of total capacity and firm capacity. The total capacity is the maximum capacity of the lift station with all pumps operating. The firm capacity is defined as the capacity of the lift station with the largest pump out of service. Lift stations will be evaluated to determine both total and firm capacity of the station.

The capacity of a lift station is dependent upon the pumping capacity and the system head that is experienced in the downstream force main. The system head is determined by the static pumping requirements as well as the head loss experienced through the force main under the varying flow conditions. The system head is determined using the force main diameter, length, assumed C-factor, and static pump requirements (wet well and discharge elevation).

For each station, the pump curves will be plotted against the system head curve that is expected to occur under the peak lift station flow for all planning years. Figure 5 shows an example lift station capacity assessment graph for the Day Street Lift Station.

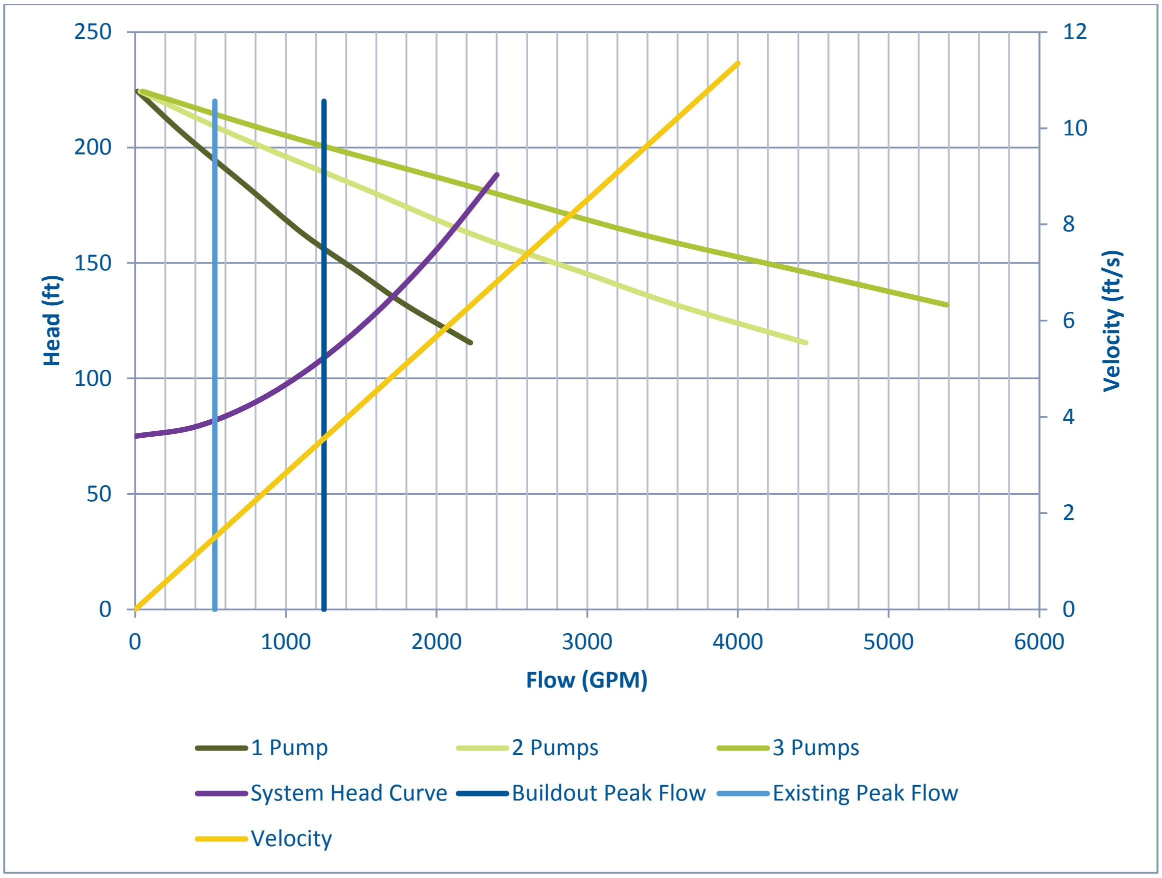


Figure 5: Day Street Lift Station Capacity Assessment

The capacity assessment graph for each lift station will determine the existing lift station capacity as well as future flow and head pumping requirements. All lift stations will be sized to provide adequate firm capacity to pump Peak LS Flow at build-out conditions

3A4.1.5 Force Mains

The capacity of a force main pipe is a function of the velocity in the pipe. The Hazen-Williams equation is used to calculate flows in force mains:

$V = 1.318CR^{0.63}S^{0.54}$

Where:

V = Velocity, fps
C = Hazen-Williams coefficient of roughness
R = hydraulic radius (flow area divided by wetted perimeter), ft
S = Slope of energy grade line, ft/ft

The District assumes a Hazen-Williams coefficient value of 100 for all force mains. Velocity is the major criterion when sizing force mains. In general, force mains should be sized to convey Peak LS Flows at build out conditions with a velocity between 2 fps and 6 fps. Velocities less than 2 fps will result in wastewater spending additional time in the force main, which can cause downstream operational problems. Force mains with a velocity greater than 6 fps tend to have excessive head loss and can affect the ability of the lift station to operate properly.

APPENDIX 3B – COORDINATION WITH WATER MASTER PLAN

3B.1 COORDINATION WITH WATER MASTER PLAN

The 2015 Update is being developed concurrently with the District's Water System Master Plan which is being updated by a separate consultant. The District is interested in maintaining consistency and comparable appearance between its wastewater and potable water hydraulic models. In an effort to maintain consistency, the District provided the following information for the both sewer and potable water models:

- Additional user information fields for the nodes and pipeline tables in the models.
- Model scenarios for all planning years: 2014, 2016, 2018, 2020, 2022, 2025, 2030, 2035, 2045, 2065, 2099 (build-out).
- Pre-set database queries.

3B.1.1 Additional Hydraulic Model Fields

The District added additional fields to the "Element Information" tables in the wastewater hydraulic model for manholes and pipelines. No existing information fields were removed from the table and no existing information was cleared. Table 3B-1 shows the additional fields: 23 additional fields for the manhole table and 8 additional fields for the pipeline table.

Table 3B-1 Wastewater Hydraulic Model Additional Informational Fields

TABLE	LS_LOCAL	LS_REGNL	FLOW_NODE	ALT	CIP_ID	COMMENT	DOPP_NODE	DOPP_ID	METER_Q	METER_YEAR	SUBAGENCY	2016_DOPP	2018_DOPP	2020_DOPP	2022_DOPP	2025_DOPP	2030_DOPP	2035_DOPP	2045_DOPP	2065_DOPP	ULT_DOPP	ULT_LU_Q	ULT_SS_Q	DOPP_PIPE	EXST_D/D	EXST_Q
MH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Pipe	X	X		X	X	X																		X	X	X

3B.1.2 Hydraulic Model Scenarios

All four hydraulic models provided by the District included separate hydraulic model scenarios for each planning year: 2014 (Existing), 2016, 2018, 2020, 2022, 2025, 2030, 2035, 2045, 2065, and Build-out. Each year contains two scenarios: capacity analysis and capital improvement program (CIP) analysis. The capacity analysis uses existing 2014 facilities for all scenarios; however, the flows vary in each scenario, corresponding to respective years. The CIP analysis uses CIP facilities and flows corresponding to each respective year. All scenarios in the model utilize the same pipe data set; however node data changes for each planning year.

3B.1.3 Hydraulic Model Queries

The District created database queries in the wastewater model similar to the queries created in the water model. These queries include database queries for MHs, Pipes (PI), Pumps (PU), and Wet Wells (WW) based on facility installation year. Existing and new facilities are retired or become active based on the [Installation Year] and [Retirement Year] field. Queries are used to select the appropriate facilities for each scenario. The field called YR_INST is populated with year of installation and the queries can be used to identify facilities needed based on each planning year. The years for these queries correspond to the District's plan for existing and future capital improvements. The same years are used for facility selection as seen in model scenarios: 2014 (Existing), 2016, 2018, 2020, 2022, 2025, 2030, 2035, 2045, 2065, and build-out. The queries have the following naming convention with YA referring to the active year of installation:

- [YA_20XX_MH/PI/PU/WW]. For example for year 2020 pipe query, the naming for that query is YA_2020_PI.

3B.1.4 Future Wastewater Flows

As discussed in Chapter 3, future ADWF is allocated in the model along with corresponding diurnal patterns to simulate flow fluctuations, including the PDWF, within the collection system. The District estimates future wastewater flows using future land use categories and the DOPP. The District owns and maintains the DOPP to track planned development. For the 2015 Update, future development data was extracted from this database into point, line and polygon shapefiles in GIS. The polygons represent the physical area of the proposed / future developments / projects. The point layer places a point at the center of the polygon (called a DOPP point), and the line layer displays a pipe (called a DOPP pipe) from the DOPP point to an existing manhole, which represents the entrance of the flow into the wastewater collection system. The District determines the entrance point (either an existing or future MH) by performing a locating routine using GeoWizard to automatically attribute a downstream manhole to the DOPP pipe based on proximity.

A second step was performed by the District to verify downstream manhole locations for each DOPP node and pipe. This included the following process to verify the location of the downstream manholes and update the DOPP pipe and node databases.

A field called (LOC_VERF) was added to the DOPP pipeline database to document verification progress and populated with the following information:

- "Yes" – Downstream location is verified.
- "Yes, updated" – Downstream location was updated to a more appropriate MH. The length field was recalculated and [Facility] field was updated with correct manhole number (MHXXX).
- "No, large DOPP" – DOPP basin covers a large area over multiple MHs; the DOPP will need to be evaluated and flows split to appropriate MHs as part of the 2015 Update.
- "No, split DOPP" – DOPP basin polygon is not contiguous; the DOPP will need to be evaluated and flows split to appropriate MHs as part of the 2015 Update.
- "No, MP to review" – Downstream location unclear; the DOPP will need to be evaluated and flow allocated to appropriate MHs as part of the 2015 Update.

1. Verified downstream connection using contour layer, existing pipe network and DOPP polygon.
   - Contour layer – Checked direction of grade to verify correct downhill manhole
   - Existing pipe network – Checked existing pipeline to confirm the DOPP pipe is not crossing a property
   - DOPP polygon – Checked if polygon is near the stub-out of another development, if so, track back to that line
2. Added fields to DOPP
   - DOPP MH attribute table (for both commercial and single family residential (SFR)):
     - [INSTALL_YR], [RETIRE_YR], [MHRIM_FT], [MHINV_FT], [DOPP_Node], [MH_DIA_FT], [DOPP_ID]
   - DOPP pipe attribute table (for both commercial and SFR):
     - [INSTALL_YR], [RETIRE_YR], [DOPP_ID], [DOPP_Pipe], [DIA_IN], [MANN_N], [LENGTH_FT], [UpMH], [DnMH], [DnMH_GIS], [Pipe_ID], [UPINV_FT], [DNINV_FT]

As a final step, flows into the appropriate MHs were verified and the DOPP files were populated with information fields for use in importing DOPP nodes and pipes into the wastewater model.

APPENDIX C
EMWD Sewer Design Standards

SANITARY SEWER SYSTEM PLANNING & DESIGN

PRINCIPLE

GUIDELINES

CRITERIA

Updated February 9, 1993

Revised 09/1/2006

SANITARY SEWER SYSTEM BASIS OF DESIGN

Eastern Municipal Water District
Engineering Manual

(BY BILL PLUMMER)

DESIGN FLOWS

In 1989, a survey of the District's sewer system was performed to determine flow generation rates from various land uses. This information is contained in the Wastewater Facilities Master Plan prepared by Black & Veatch dated 1990. The results of the survey showed variation in sewage generation not only by type of use but also by location (e.g. Sun City housing had a lower sewage generation per unit than Moreno Valley). However, for design purposes it is important that criteria be developed and used on a consistent basis. To achieve this goal a meeting was held to agree on the criteria for sewer design. The result of the meeting is a compromise of actual measurements vs design criteria. Table 1 attached shows the relationship of land use to the wastewater flow agreed to. The information in Table 1 shall be used by the District for future sewer design. This information has been adjusted to correspond to future conditions that are expected to uniformly occur as development takes place in all areas of the District.

The Wastewater Facility Master Plan also developed peak flow rates and obtained data which correlate peak flow rates with average flow rates. By a plot of this data, a curve has been established which is used in determining the peaking factor to be used in the design of the sewer. The peaking curve that is to be used in District design is shown on Table 2.

The procedure to be followed in determining design flows is to first determine the tributary drainage area for the sewer pipeline, determine the various average flows within the drainage area, add these average flows, and then convert these average flows to a peak flow for the design of the sewer (i.e., $Q_{Design} = Q_{AVE.}$ x Peaking Factor).

PIPE SIZE SELECTION

Sewers 12-inches in diameter and smaller are designed to flow at a maximum depth of one-half the diameter of the pipe. Sewers 15-inches in diameter and larger are designed to flow at a maximum of three-quarter depth of the pipe diameter.

It is important to maintain an air gap in the top of sewer pipes to convey sewer gases downstream along with the sewage flow. Maintaining the maximum depth of flow to pipe diameter ratio (D/d) conditions described above helps to ensure that sufficient space occurs to meet these conditions.

An 8-inch diameter pipeline has been established as the minimum sewer pipe size. This conclusion was established for two main reasons:

1. Maintenance problems can occur on smaller size pipes.

2. Sufficient space is necessary to convey sewage and debris down stream in the sewer pipe to avoid possible backflow up sewer laterals.

The only exceptions to the 8-inch minimum pipe size criteria are in the Communities of Romoland, Homeland and Green Acres, where 6-inch diameter sewer pipelines were installed due to grant conditions applied to the financing of sewers in these communities.

MANNING "n" VALUES

Pipe size is determined by using mannings equation which is shown below:

$Q= (1.486/n)\ AR^{2/3}\ S^{1/2}$

Q= flows (cfs) n= mannings coefficient

A= cross sectional area of pipe (feet^2)

R= hydrologic radius of the wetted cross-section of the pipe (feet)

S= slope of energy gradient

Refer to Handbook of Hydraulics by Brater and King or the Clay Pipe Engineering Manual for use of the equation.

PIPE SLOPES

The minimum slopes for sewer pipelines are based on obtaining a minimum velocity of 2 fps at design peak flow depth. This provides a means to resuspend solids deposited in the sewer during peak flows. Refer to Table 3 for minimum pipe slopes.

On small-size sewers, there is generally no particular concern with maximum slopes or velocities, except where water and ends of sewer may be insufficient in volume to move solids. On large-size sewers, it is necessary to design sewers which would have a peak velocity not exceeding 12 fps to avoid damage to plastic liners on RCP joints.

Table 1

EMWD - System Design and Loading Criteria

Average Daily Flow:

Residential	EDU's / Acre (1)		Population / EDU	GPD / Capita	GPD / Acre (2)
	Typical	Range			
Low Density (LDR)	2.5	0 to 2.9	4	105	1,050
Medium Density (MDR)	4.5	3 to 11	3.5	100	1,575
High Density (HDR)	12	12 to 16	2.5	80	2,400
Very High Density (VHDR)	17	17+	2.2	80	2,992
Mobile Homes (MH)	6	varies	2	80	960
Age Restricted Comm.	varies	varies	2	80	960

Non-Residential		
Commercial	1700	GPD / Acre
Industrial	1700	GPD / Acre
Institutional	1000	GPD / Acre
Hospital	250	GPD / Bed
Schools	20	GPD / Student

Manning's Coefficient "n": n = 0.013 (varies with depth for design)

use n = 0.015 (for sizing pipes)

Peaking Factor: See attached sheet (Table 2 - Peak Flow Rates)

Velocity: 2 ft/sec MINIMUM, 3 ft/sec recommended, & 10 ft/sec maximum

Notes:

(1) For calculation of actual flow, use actual Equivalent Dwelling Units (EDU) per Gross Acre

(2) Applies to Typical EDU's / Acre only

TABLE 3

PIPE MINIMUM PIPE SLOPES IN SEWER MAINS

Pipe Diameter	Preferred Minimum	Ordinary Minimum	Preferred Maximum slope (not mandatory)
8-inch	.0065	.0040	.12
10-inch	.0050	.0032	.085
12-inch	.0040	.0024	.066
15-inch	.0032	.0016	.050
18-inch	.0024	.0014	.037
21-inch	.0020	.0012	.030
24-inch	.0017	.0010	.025
27-inch	.0015	.0008	.022
30-inch	.0013	.0007	.018

a) House Connection Laterals

Pipe diameter	4-inch	6-inch	8-inch
Minimum slope	0.020	0.020	0.020

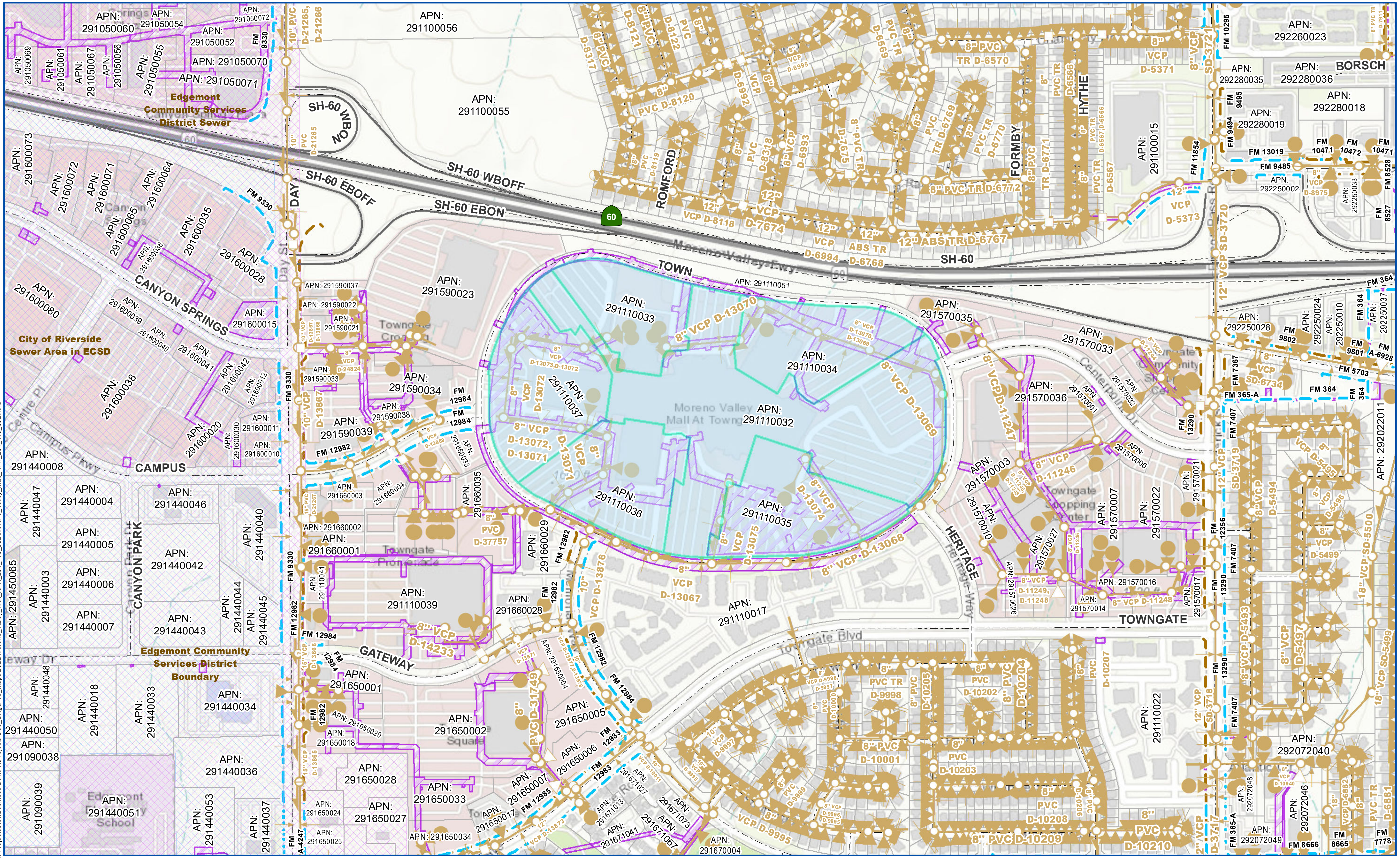
(0.010 Extreme Minimum with prior approval only)

APPENDIX D

EMWD Sewer Map & Record Drawings

emwd EASTERN MUNICIPAL WATER DISTRICT

Moreno Valley Mall APN 291-110-032 Sewer Map



Legend

- Coupling
- Flange
- Plug
- Saddled Outlet
- Taper
- Swr Interagency Tie
- Swr Lift Station
- Swr Lift Station Polygon
- Cleanout
- Manhole
- Monitoring
- Sampling
- Shallow
- Not Connected Yet
- Not Connected Yet, BF Required
- Connected
- Connected, BF Device
- Swr Service Lateral
- Dimensioning
- MainFlow
- As Built, Collection
- As Built, Distribution
- As Built, Effluent Force
- As Built, Influent Force
- As Built, Interagency
- As Built, Transmission
- CIP, Collection
- CIP, Effluent Force
- CIP, Influent Force
- CIP, Interagency
- CIP, Transmission
- Swr Main Abandoned
- Swr Main Murrieta
- Swr Treatment Plant
- Swr Interagency Tie Lines
- City of Hemet Sewer
- City of Perris Sewer
- City of Riverside Sewer
- City of Riverside Sewer Area in ECSD
- City of San Jacinto Sewer
- ECSD Facilities Serviced by City of Riverside
- Edgemont Community Services District Boundary
- Edgemont Community Services District Sewer
- Elsinore Valley Municipal Water District Sewer
- LHMWD & City of San Jacinto Sewer Service
- LHMWD Sewer Service & City of Hemet Sewer
- Lake Hemet Municipal Water District Sewer
- Murrieta Division of Western Sewer
- Rancho California Water District Sewer
- Western Municipal Water District Sewer
- EMWD District Boundary
- EMWD Main Office
- Highway
- Streets
- Water, Reimbursable
- Water, Paid
- Sewer, Reimbursable
- Sewer, Paid
- Recycled, Reimbursable
- Recycled, Paid
- Easements
- Riverside County Parcel Labels
- Riverside County Parcel Polygons

Notes

1 in = 647 ft

0 500 1,000 Feet

Map Produced 2/1/2022 By EMWD Staff

CITY OF MORENO VALLEY
FIRE PREVENTION BUREAU
APPROVED BY: Phil Allen
DATE: 2-11-92

COUNTY OF RIVERSIDE
DEPARTMENT OF HEALTH
APPROVED BY: John C. Vettus
DATE: 4.9.91

WATER / SEWER APPROVED BY
EASTERN MUNICIPAL WATER DISTRICT
Victor J. Banetz — 2/5/91
CIVIL ENGINEER OF SUBDIVISIONS — DATE

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ ENG	BR	1.9.91	SEWER OPER	—	—
PLANNING	—	—	CONSTRUCTION	—	—
WATER OPER	—	—	DESIGN	—	—

REFERENCES

NO	REVISION DESCRIPTION	INT	DATE	APPR D
1	REVISED SEWER MAIN LINE #4	ESCO	4-23-91	5/14/91
2	REVISED WATER MAIN LINE "A" PROFILE	ESCO		1/18/91
3	ADD 3" WATER SERVICE, RELOCATE FIRE HYDRANTS	HTEA	12/10/91	1/4/92
4	ADDED ESM'T. CHGD IRR. SERVICE TO RECLAIMED TYPE.	HTEA	5-12-92	5/21/92
5	As Constructed (- ADDED VALVE N°s AS CONSTRUCTED CD 47170/80 (C.R. 1 28-93)	KER 4-13-93	2/4/93	

REVISIONS AFTER 12/10/91 BY:
HARRISON, TEASLEY/EVANS & ASSOCIATES, INC
Consulting Engineers
792 MERIDIAN WAY SAN JOSE CALIFORNIA
408 297 8170 FAX 283 1990

APPROVED BY. 4-29-91
JOHN K. FEENSTRA — CITY OF MORENO VALLEY, CA
DEPUTY CITY ENGINEER
R.C.E. 13870 exp 3-31-93
DATE

ESCO ENGINEERING SERVICE CORPORATION
CONSULTANTS IN CIVIL ENGINEERING & LAND PLANNING
PREPARED UNDER THE SUPERVISION OF
R.C.E. # 13095 — 10/90
DESIGNED BY — P.E. — P.M. — W.O.

SCALE: AS SHOWN
BENCH MARK: SEE SHEET NO. 1

IMPROVEMENT DISTRICT •10 & U13

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE 1 AND WATER LINE A
STA 1+00.00 TO 12+00.00

W.O. — FOR: — F.B.

SERV AREA 41832
W.O. 91-302
C.O. 47170/80 (5)
COORD 6G
SHT 3 OF 17
D-13067
SD-14307
FILE NO.

IMPROVEMENT DISTRICT •10 & U13

COUNTY OF RIVERSIDE DEPARTMENT OF HEALTH

APPROVED BY: John O. Vrtis

DATE: 4.9.91

WATER / SEWER APPROVED BY
EASTERN MUNICIPAL WATER DISTRICT
Victor J. Barreto 2/5/91
CIVIL ENGINEER OF SUBDIVISIONS DATE

APPROVALS	INITIAL	DATE		INITIAL	DATE
PROJ. ENG.	BR	1991	SEWER OPER		
PLANNING	—	—	CONSTRUCTION	—	—
WATER OPER	—	—	DESIGN		

REFERENCES

NO	REVISION DESCRIPTION	INT	DATE	APPR'D
1	REVISED SEWER MAIN LINES #1 & #3 AND WATER MAIN LINE "C"	ESCO	4.23.91	
2	REVISED PROFILE FOR WATER LINE "A" & REVISED BLDG. T.B.A.	ESCO	5.30.91	
3	RELOCATE FIRE HYDRANTS / ADDED 3" WATER SERVICE	HTEA	12/10/91	
4	ADDED DOMESTIC WATER SERVICES & DETECTOR CHECK	HTEA	6-12-92	
5	RELOCATE FH #28 PER FIELD NOTES	HTEA	11.25.92	
6	As Constructed - ADDED VALVE N°s AS CONSTRUCTED C.O. 47170/80 (CR 1-28-93)	KER 4-13-93	2/4/93	

REVISIONS AFTER 12/10/91 BY:
HARRISON, TEASLEY/EVANS & ASSOCIATES, INC.
Consulting Engineers
792 MERIDIAN WAY SAN JOSE CALIFORNIA
408 297-8170 FAX 283 1990

APPROVED BY:
JOHN K. FEENSTRA
CITY OF MORENO VALLEY CA
DEPUTY CITY ENGINEER
R.C.E. 13870 exp 3-31-93
DATE: 4.29.91

ESCO ENGINEERING SERVICE CORPORATION
CONSULTANTS IN CIVIL ENGINEERING & LAND PLANNING
SUITE B-204 CALIFORNIA 92388
PREPARED UNDER THE SUPERVISION OF:
R.C.E. # 13095
10/90 DATE

DESIGNED BY: S. Lee
W.O. 1012-7

SCALE: AS SHOWN
BENCH MARK: SEE SHEET NO. 1

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE #1 AND WATER LINE "A"
STA. 12+00.00 TO STA 22+90.00

W.O. | FOR | F.B.

SERV AREA 41832
W.O. 91-302
C.O. 47170/80
COORD 6G
SHT 4 OF 17
D-13068
SD-14308
FILE NO

THE AS-BUILT DATA SHOWN HEREON IS CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF, AND IS BASED UPON INTERPRETATION OF LOCATION DATA FURNISHED BY THE CONSTRUCTION CONTRACTOR AND WAS VERIFIED WHERE POSSIBLE BY USE OF AERIAL PHOTOGRAPHY. NO EXCAVATIONS WERE MADE TO PHYSICALLY LOCATE PIPELINES OR FITTINGS

CITY OF MORENO VALLEY FIRE PREVENTION BUREAU
APPROVED BY: [signature]
DATE 2-11-92

IMPROVEMENT DISTRICT •10 & U13

COUNTY OF RIVERSIDE
DEPARTMENT OF HEALTH
APPROVED BY: [signature]
DATE: 4-9-91

WATER / SEWER APPROVED BY:
EASTERN MUNICIPAL WATER DISTRICT
[signature] 2/5/91
CIVIL ENGINEER OF SUBDIVISIONS DATE

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ. ENG	BR	1991	SEWER OPER	—	—
PLANNING	—	—	CONSTRUCTION	—	—
WATER OPER			DESIGN		

REFERENCES

NO	REVISION DESCRIPTION	INT	DATE	APPR'D
1	REVISED SEWER ALIGNMENT FOR LINE #1	ESCO	4-22-91	
2	REVISED PROFILE FOR WATER MAIN LINE "A"	ESCO	5-30-91	
3	RELOCATE FIRE HYDRANTS~ADD 3" WATER SERVICE,	HTE/A	12/10/91	
4	CHANGE IRRIGATION SERVICE TO RECLAIM TYPE	HTEA	5-12-92	
5	As Constructed - AS CONSTRUCTED CD 47170/80 (CE 1-28-93) ADDED VALVE NUMBERS	KEE	2/4/93	

REVISIONS AFTER 12/10/91 BY
HARRISON, TEASLEY/EVANS & ASSOCIATES, INC.
Consulting Engineers

APPROVED BY: [signature]
JOHN K. FEENSTRA
CITY OF MORENO VALLEY CA
DEPUTY CITY ENGINEER
R.C.E. 13870 exp 3-31-93
DATE 4.29.91

ESCO ENGINEERING SERVICE CORPORATION
PREPARED UNDER THE SUPERVISION OF
R.C.E. # 13095

SCALE AS SHOWN
BENCH MARK: SEE SHEET NO 1

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE #1 AND WATER LINE "A"
STA 22+90.00 TO 34+50.00

W.O. 91-302
C.D. 47170/80
COORD 6G
SHT 5 OF 17
D-13069
SD-14309
FILE NO.

THE AS-BUILT DATA SHOWN HEREON IS CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF, AND IS BASED UPON INTERPRETATION OF LOCATION DATA FURNISHED BY THE CONSTRUCTION CONTRACTOR AND WAS VERIFIED WHERE POSSIBLE BY USE OF AERIAL PHOTOGRAPHY. NO EXCAVATIONS WERE MADE TO PHYSICALLY LOCATE PIPELINES OR FITTINGS.

IMPROVEMENT DISTRICT 10 & U13

COUNTY OF RIVERSIDE
DEPARTMENT OF HEALTH

APPROVED BY:
DATE:

WATER / SEWER APPROVED BY:
EASTERN MUNICIPAL WATER DISTRICT
CIVIL ENGINEER OF SUBDIVISIONS — DATE 7/19/91

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ. ENG.	E.R.	7/17/91	SEWER OPER	—	—
PLANNING	—	—	CONSTRUCTION	—	—
WATER OPER	—	—	DESIGN	—	—

REFERENCES

NO.	REVISION DESCRIPTION	INT.	DATE	APPR'D
1	REVISED WATER LINE "A" & SEWER LINE "1" & REVISED BLDG. CONFIGURATION	ESCO	5/30/91	
2	REVISED WATER LINE "A" & SEWER LINE "1" PER REVISED BLDG. & RING ROAD CONFIGURATION REPLACED PREVIOUS SHT. 6	ESCO	7/1/91	
3	RELO & ADD FH ASSYS; ADD 8" SEWERLATS; RECONFIG WATER INTERSECT; ADD PRIVATE SEWER LAT.	H'E/A	12/10/91	
4	ADD DOMESTIC WATER & FIRE SERVICES; EXTEND F.H. LATERAL	HTEA	5/12/92	
5	AS CONSTRUCTED		2/4/93	
6	AS CONST. S.O. 202879 C.R. 6/21/06	AJL		AJL

REVISIONS BY:
HARRISON, TEASLEY/EVANS ASSOCIATES, INC.
Consulting Engineers

APPROVED BY
JOHN K. FEENSTRA
DATE 7/19/91
CITY OF MORENO VALLEY, CA
DEPUTY CITY ENGINEER
R.C.E. 13870 EXP. 3-31-93

ENGINEERING SERVICE CORPORATION
PREPARED UNDER THE SUPERVISION OF

SCALE
BENCH MARK:

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE 1 STA 35+00 TO 46+75
WATER LINE A STA 35+00 TO 46+75

SERV. AREA 41632
W.O. 91-302
C.O. 47170.80
COORD 66
SHT 6 OF 17
D-13070
SD-14310
FILE NO.

IMPROVEMENT DISTRICT 10 & U13

COUNTY OF RIVERSIDE DEPARTMENT OF HEALTH	WATER / SEWER APPROVED BY: EASTERN MUNICIPAL WATER DISTRICT	REFERENCES
APPROVED BY:	Victor J. Banuelo 7/18/91	
DATE:	CIVIL ENGINEER OF SUBDIVISIONS DATE	

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ. ENG.	BR	7/17/91	SEWER OPER.		
PLANNING			CONSTRUCTION		
WATER OPER.			DESIGN		

NO.	REVISION DESCRIPTION	INT.	DATE	APPR'D
1	REVISED WATER LINE "C" & SEWER LINE 2/2 and REPLACED PROFILES, SHT. 7	ESCO	5/30/91	
2	RELO. F.H. ASSY, ADD 8" SEWER LAT., RECONFIG. WATER ANGLE POINTS	HTE/A	12/11/91	
3	RELOCATE F.H. ASSYMBLYS	HTEA	5-12-92	
4	As constructed	HER	2/4/93	

REVISIONS AFTER 12/10/91 BY: HARRISON TEASLEY/EVANS & ASSOCIATES, INC. Consulting Engineers

APPROVED BY: CITY OF MORENO VALLEY, CA. DEPUTY CITY ENGINEER R.C.E. 13870 exp. 3-31-93 DATE: 7/19/91

ESCO ENGINEERING SERVICE CORPORATION

SCALE: AS SHOWN | BENCH MARK: SEE SHEET NO. 1

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE #2 STA. 1+00 TO 11+50
WATER LINE "C" STA. 6+00 TO 11+50

SERV. AREA 41632
W.O. 91-302
C.O. 47170/80
COORD 8G
SHT 7 OF 17
D-13071
SD-14311
FILE NO.
W.O. | FOR: | F.B.

CITY OF MORENO VALLEY
FIRE PREVENTION BUREAU

APPROVED BY: Pltale
DATE: 2-11-92

THE AS-BUILT DATA SHOWN HEREON IS CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF, AND IS BASED UPON INTERPRETATION OF LOCATION DATA FURNISHED BY THE CONSTRUCTION CONTRACTOR AND WAS VERIFIED WHERE POSSIBLE BY USE OF AERIAL PHOTOGRAPHY. NO EXCAVATIONS WERE MADE TO PHYSICALLY LOCATE PIPELINES OR FITTINGS.

IMPROVEMENT DISTRICT 10 & U13

COUNTY OF RIVERSIDE
DEPARTMENT OF HEALTH

APPROVED BY: ____
DATE: ____

WATER / SEWER APPROVED BY:
EASTERN MUNICIPAL WATER DISTRICT
Victor J. Barreto — 7/18/91
CIVIL ENGINEER OF SUBDIVISIONS — DATE

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ. ENG.	BR	7/17/91	SEWER OPER.	—	—
PLANNING	—	—	CONSTRUCTION	—	—
WATER OPER.	—	—	DESIGN	—	—

REFERENCES

NO.	REVISION DESCRIPTION	INT.	DATE	APPR'D
1	REVISED SEWER & WATER ALIGNMENTS FOR LINE #2, LINE "B" & LINE "D" and REPLACED PREVIOUS SHT. 8	ESCO	5/30/91	VJB 7/18/91
2	RELOCATE FIRE HYDRANTS AND SERVICE LINES. ADD PRVT. SEWER LAT.	HTE/A	12/10/91	VJB
3	RELOCATE F.H. ASSYS.	HTEA	5-12-92	TW 6/3/92
4	As constructed - ADDED VALVE N°, AS CONSTRUCTED C.I.47170/80 (CR.1-28-93) 4-13-93	KER	2/4/93	

REVISIONS AFTER 12/10/91 BY:
HARRISON, TEASLEY/EVANS & ASSOCIATES, INC.
Consulting Engineers
792 MERIDIAN WAY · SAN JOSE · CALIFORNIA

APPROVED BY:
JOHN R. FEENSTRA — CITY OF MORENO VALLEY, CA. DEPUTY CITY ENGINEER R.C.E. 13870 exp. 3-31-93
DATE: 7/19/91

ESCO ENGINEERING SERVICE CORPORATION
PREPARED UNDER THE SUPERVISION OF:
EXP. 3-31-93

DESIGNED BY:
P.E. S. Lee
P.M.
V.O. 4013-7

SCALE: AS SHOWN
BENCH MARK: SEE SHEET NO. 1

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE #2 STA. 11+50 TO 22+00
WATER LINE "C" & "D"

V.O. | FOR: | F.B.

SERV. AREA 41632
V.O. 91-302
C.O. 47170/80
COORD. 6G
SHT. 8 OF 17
D-13072
SD-14312
FILE NO.

C.G. OF 12" D.I.P. WATER MAIN CL 50
C.G. OF 8" DIP LATERAL CL 50
PROP. GRADE OVER ℄ OF SEWER
(LOWER LEVEL) F.F. 1613.00
PROPOSED GRADE OVER ℄ OF SEWER
EXIST. GROUND @ ℄ SEWER
C.G. OF 12" D.I.P. WATER MAIN CL 50
S=-0.0075
S=+0.0144
S=+0.0050
S=0.0040
S=0.0368
EXIST. GROUND @ ℄ OF SEWER
USE SHORT JOINTS 2' MAX.
PROFILE SCALE
HORIZ. 1" = 40'
VERT. 1" = 4'
1592.45 BOTT. 54" RCP S.D.
1589.07 F.L.
1589.8 TOP OF 8" SUBDRAIN
1589.5 TOP OF 8" SUBDRAIN
1591.4 TOP OF 8" SUBDRAIN
1591.6 TOP OF 8" SUBDRAIN
1586.68 BOTTOM 60" RCP S.D.
1582.64 F.L. 8" SEWER ONSITE
1582.47 F.L. 10" SEWER ONSITE
1582.17 F.L.
USE SHORT JOINTS 2' MAX.
110' - 8" VCP SEWER
CLASS B BEDDING PER SB-76
479.39' - 8" V.C.P. SEWER
S=0.0032
93' - 10" SEWER
CLASS BB BEDDING PER SB-76
1610
1600
1590
BEARING DISTANCE
N 25°49'38"E 42.00'
8" V.C.P. SEWER MAIN LINE #1 SEE SHT. 7
LOT 2
T.B.A.
12" D.I.P. WATER MAIN LINE "C" SEE SHT. 14
8" V.C.P. SEWER MAIN LINE #1 SEE SHT. 3
TOWNGATE CIRCLE SEE SHT. 3
12" D.I.P. WATER MAIN LINE "A" SEE SHT. 3
LOT 5
SEARS
40' WIDE EASEMENT TO E.M.W.D. FOR WATER PURPOSES
0+74.12 LINE "E"
=16+74.56 LINE "A"
12F×12F×12F TEE
(3) 12 F×H RSGV
THRUST BLOCK B407
30' EMWD WATER EASEMENT
60' WIDE EASEMENT TO E.M.W.D. FOR WATER AND SEWER PURPOSES
8" D.I.P. WATER LINE "E" CLASS 50 10' S/℄ 60' ESM'T.
6+73.65
1" A.V. & A.R. PER B-598 TYPE B END PLUG PER B-414
EXIST. 8" PERF. SUBDRAIN
1+00.00 LINE #1
=1+00.00 LINE #2
=1+00.00 LINE #5
CONST. M.H. #1
6+86.39 END OF LINE #3
CONST. M.H. #33 WITH 4 - 6" PRIVATE LATERALS & AND 2 - 8" PRIVATE LATERALS & PLUG ENDS. TERMINUS MANHOLE PER SB-58.
1+31.00 LINE "H"
=1+25.00 LINE "A"
12 F×12F×12F TEE
(3) 12 F×H RSGV
THRUST BLOCK B407
12" D.I.P. WATER MAIN CLASS 50, LINE "H" 31' E OF ℄
1+73.00 12" COUPLING B-568
1+76.25 JOIN 12" WATER MAIN TO TEMP. B.O. ASSEMBLY
PROPOSED 12" WATER MAIN (BY OTHERS) PER D13876
1+77.22 12" H×6" H RED. 90° ELBOW 6" TEMP. B.O. ASSEMBLY B-568 THRUST BLOCK B-407
1+93.00 END OF LINE #5
CONST. M.H. #32 REMOVE TEMP. END PLUG AND JOIN PROP. 10" VCP SEWER PER SD15451 22049-2 OFFSITE IMPROVEMENT PLANS
EUCALYPTUS AVE.
PROP. 60" RCP S.D.
PROP. 78" RCP S.D.
PROP. 72" RCP S.D
1583.48 TOP OF 10" SEWER
1582.14 BOTTOM OF 60" RCP S.D.
10" V.C.P. SEWER MAIN LINE #5 6' E OF ℄
8" V.C.P. SEWER MAIN LINE #2 SEE SHT. 7
12" D.I.P. WATER MAIN LINE "B" SEE SHT. 7
N 21°04'56" W
N 34°08'16" W
479.39'
R=550'
Δ=11°27'33"
L=110'
T=55.18'
2+10.00 LINE "E" CONST. M.H. #28
2+10.00 LINE "E" 12" H×H 22.5° ELBOW THRUST BLOCK B-407
1+00.00 LINE #3 =17+08.00 LINE #1 CONST. M.H. #8
8" V.C.P. SEWER MAIN 10' N/℄ 60' ESM'T. SEWER LINE #3
12" D.I.P. WATER MAIN LINE "A" SEE SHT. 4
12" D.I.P. WATER MAIN CLASS 50 LINE "E" 10' S/℄ 60' ESM'T.
4+68.13 LINE "E" =1+66.96 LINE "C"
12 F×12F×12F TEE (W)
12" H×F R.S.G.V (W)
8" H×F R.S.G.V (N)
12" H×F R.S.G.V (S)
THRUST BLOCK B-407
12" F×8" F ECCENTRIC REDUCER (N)
6+63.65 LINE "E"
8" H×8" H×6" F TEE (E)
F.H. ASSEMBLY B-517
6" H×F R.S.G.V. (E)
(2) THRUST BLOCK B-407
8" H×F ADAPTER
CONST. 52 LF 6" DIP WATER TO FH #30
30' EMWD WATER EASEMENT
6" PRIVATE LATERAL
LOT 2
LOT 5
TOWNGATE CIRCLE
PROP. 54" RCP S.D.
CITY OF MORENO VALLEY FIRE PREVENTION BUREAU
APPROVED BY:
DATE: 2-11-92
THE AS-BUILT DATA SHOWN HEREON IS CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF, AND IS BASED UPON INTERPRETATION OF LOCATION DATA FURNISHED BY THE CONSTRUCTION CONTRACTOR AND WAS VERIFIED WHERE POSSIBLE BY USE OF AERIAL PHOTOGRAPHY. NO EXCAVATIONS WERE MADE TO PHYSICALLY LOCATE PIPELINES OR FITTINGS.
REVISIONS AFTER 12/10/91 BY:
HARRISON, TEASLEY/EVANS & ASSOCIATES, INC.
Consulting Engineers
GRAPHIC SCALE
IMPROVEMENT DISTRICT •10 & U13
COUNTY OF RIVERSIDE DEPARTMENT OF HEALTH
APPROVED BY:
DATE:
WATER / SEWER APPROVED BY:
EASTERN MUNICIPAL WATER DISTRICT
Victor J. Barett 5/16/91
CIVIL ENGINEER OF SUBDIVISIONS DATE
APPROVALS
PROJ. ENG. BR 5-16-91 SEWER OPER.
PLANNING CONSTRUCTION
WATER OPER. DESIGN
REFERENCES
REVISION DESCRIPTION
REVISED PLAN & PROFILE FOR SEWER MAIN LINE #3 & WATER MAIN LINE "E" REVISED AND REPLACED PREVIOUS SHEET 10
REVISED PROFILE FOR SEWER MAIN LINE #5 & WATER MAIN LINE "E"
RELOCATE FIRE HYDRANTS, ADD PRIVATE SEWER LATS.
As constructed
APPROVED BY:
REGISTERED CIVIL ENGINEER NO. 13096
JOHN K. FEENSTRA
CITY OF MORENO VALLEY CA. DEPUTY CITY ENGINEER R.C.E. 28738 exp. 9-30-90
DATE: 4-29-91
ESCO ENGINEERING SERVICE CORPORATION
PREPARED UNDER THE SUPERVISION OF:
SCALE: AS SHOWN
BENCH MARK: SEE SHEET NO. 1
TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINES #3 STA 1.00 TO 6 86.39
#5 STA 1.00 TO 1.93.00
WATER LINE "H" STA 1.31 TO 1.77.22
"E" STA 0.74 TO 6 73.65
W.O. 91-302
C.O. 47170/60
COORD. 6G
SHT. 10 OF 17
D-13074
SD-14314
FILE NO.

COUNTY OF RIVERSIDE DEPARTMENT OF HEALTH	
APPROVED BY:	
DATE: 4.9.91	

WATER / SEWER APPROVED BY: EASTERN MUNICIPAL WATER DISTRICT
Victor J. Baset 2/6/91
CIVIL ENGINEER OF SUBDIVISIONS — DATE

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ. ENG	BR	1.9.91	SEWER OPER.	—	—
PLANNING	—	—	CONSTRUCTION	—	—
WATER OPER.	—	—	DESIGN	—	—

REFERENCES

NO.	REVISION DESCRIPTION	INT.	DATE	APPR'D
1	REVISED SEWER MAIN LINE #4	ESCO	4/29/91	
2	REVISED WATER LINE "F" & SEWER LINE "4"	ESCO	5/30/91	
3	SHORTEN WATER LINE "F"; ADD WATER LINE "J"	HTE/A	12/19/91	
4	ADD DOMESTIC WATER & F.H. SERVICES	HTEA	5-12-92	
5	As Constructed	KEE	2/4/93	

REVISIONS AFTER 12/10/91 BY: HARRISON, TEASLEY/EVANS & ASSOCIATES, INC. Consulting Engineers

APPROVED BY:
JOHN R. TEENSTRA — CITY OF MORENO VALLEY, CA. DEPUTY CITY ENGINEER R.C.E. 13870 exp. 3-31-93
DATE: 4.29.91

ESCO ENGINEERING SERVICE CORPORATION
PREPARED UNDER THE SUPERVISION OF R.C.E. # 13095

SCALE: AS SHOWN — BENCH MARK: SEE SHEET NO. 1

IMPROVEMENT DISTRICT #10 & U13

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
SEWER LINE #4 STA. 1+00 TO 5+67.52
WATER LINE "F" STA. 1+00 TO 4+68

V.O. 91-302
C.O. 47170/80
COORD. 6-G
SHT 11 OF 17
D-13075
SO-14315
FILE NO.

CITY OF MORENO VALLEY
FIRE PREVENTION BUREAU

APPROVED BY: Phil Albn
DATE: 2-11-92

THE AS-BUILT DATA SHOWN HEREON IS CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF, AND IS BASED UPON INTERPRETATION OF LOCATION DATA FURNISHED BY THE CONSTRUCTION CONTRACTOR AND WAS VERIFIED WHERE POSSIBLE BY USE OF AERIAL PHOTOGRAPHY. NO EXCAVATIONS WERE MADE TO PHYSICALLY LOCATE PIPELINES OR FITTINGS.

REGISTERED PROFESSIONAL ENGINEER No. 14771 EXP. 3/31/93 CIVIL STATE OF CALIFORNIA

COUNTY OF RIVERSIDE
DEPARTMENT OF HEALTH

APPROVED BY:
DATE:

WATER / SEWER APPROVED BY:
EASTERN MUNICIPAL WATER DISTRICT
CIVIL ENGINEER OF SUBDIVISIONS — 7/18/91 DATE

APPROVALS

	INITIAL	DATE		INITIAL	DATE
PROJ. ENG.		7/17/91	SEWER OPER.		
PLANNING			CONSTRUCTION		
WATER OPER.			DESIGN		

REFERENCES

NO	REVISION DESCRIPTION	INT.	DATE
1	REVISED LINE "B" & LINE "I" and REPLACED PREVIOUS SHT 12	ESCO	5/30/91
2	RELO F.H. ASSYS; RECONFIG WATER INTERSECT; ADD 8" WATER LAT.	HTE/A	12/10/91
3	ADDED DET CHECK'S; ADD CONC. CAP AT (2) SD X-INGS	HTEA	5-12-92
4	RELOC. F.H. #54 PER FIELD NOTES	HTEA	11-25-92
5	As constructed	KER	2/4/93
6	RELO FH (CO 66336); ADD 3" METER & RP (SO 202879)	BBR	7/20/05
7	AS CONST. C.O. 66336 & S.O. 203629 C.R. 6/21/06	AJL	7/11/06

REVISIONS AFTER 12/10/91 BY:
HARRISON, TEASLEY/EVANS ASSOCIATES, INC.
Consulting Engineers

APPROVED BY:
JOHN K. FEENSTRA, CITY OF MORENO VALLEY, CA
DEPUTY CITY ENGINEER
R.C.E. 13870 exp. 3-31-93
DATE 7/19/91

ENGINEERING SERVICE CORPORATION
PREPARED UNDER THE SUPERVISION OF

SCALE: AS SHOWN
BENCH MARK: SEE SHEET NO. 1

IMPROVEMENT DISTRICT 10 & U13

TRACT NO. 22049
MORENO VALLEY MALL AT TOWNGATE
CITY OF MORENO VALLEY
SEWER/WATER PLAN AND PROFILE
WATER LINE "B" STA. 27+50 TO 33+90
WATER LINE "I" STA 1+00 TO 4+75

W.O. 91-302
C.O. 47176 "F"
COORD. 66
SHT 12 OF 17
0-13076
SD-14316
FILE NO.

APPENDIX E

FlowMaster Calculations

Pipe 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.004 ft/ft
Diameter	8.0 in
Discharge	38.10 gpm

Results	
Normal Depth	1.9 in
Flow Area	0.1 ft²
Wetted Perimeter	0.7 ft
Hydraulic Radius	1.1 in
Top Width	0.57 ft
Critical Depth	1.6 in
Percent Full	24.2 %
Critical Slope	0.009 ft/ft
Velocity	1.30 ft/s
Velocity Head	0.03 ft
Specific Energy	0.19 ft
Froude Number	0.679
Maximum Discharge	319.78 gpm
Discharge Full	297.27 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.9 in
Critical Depth	1.6 in
Channel Slope	0.004 ft/ft
Critical Slope	0.009 ft/ft

Pipe 2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.005 ft/ft
Diameter	8.0 in
Discharge	17.70 gpm

Results	
Normal Depth	1.3 in
Flow Area	0.0 ft²
Wetted Perimeter	0.5 ft
Hydraulic Radius	0.8 in
Top Width	0.48 ft
Critical Depth	1.1 in
Percent Full	15.7 %
Critical Slope	0.009 ft/ft
Velocity	1.13 ft/s
Velocity Head	0.02 ft
Specific Energy	0.12 ft
Froude Number	0.739
Maximum Discharge	357.52 gpm
Discharge Full	332.36 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.3 in
Critical Depth	1.1 in
Channel Slope	0.005 ft/ft
Critical Slope	0.009 ft/ft

Pipe 3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.005 ft/ft
Diameter	8.0 in
Discharge	55.80 gpm

Results

Normal Depth	2.2 in
Flow Area	0.1 ft²
Wetted Perimeter	0.7 ft
Hydraulic Radius	1.3 in
Top Width	0.60 ft
Critical Depth	1.9 in
Percent Full	27.7 %
Critical Slope	0.009 ft/ft
Velocity	1.58 ft/s
Velocity Head	0.04 ft
Specific Energy	0.22 ft
Froude Number	0.766
Maximum Discharge	357.52 gpm
Discharge Full	332.36 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.2 in
Critical Depth	1.9 in
Channel Slope	0.005 ft/ft
Critical Slope	0.009 ft/ft

Pipe 4

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.018 ft/ft
Diameter	8.0 in
Discharge	17.70 gpm

Results	
Normal Depth	0.9 in
Flow Area	0.0 ft²
Wetted Perimeter	0.5 ft
Hydraulic Radius	0.6 in
Top Width	0.43 ft
Critical Depth	1.1 in
Percent Full	11.5 %
Critical Slope	0.009 ft/ft
Velocity	1.76 ft/s
Velocity Head	0.05 ft
Specific Energy	0.13 ft
Froude Number	1.357
Maximum Discharge	678.35 gpm
Discharge Full	630.61 gpm
Slope Full	0.000 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	11.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.9 in
Critical Depth	1.1 in
Channel Slope	0.018 ft/ft
Critical Slope	0.009 ft/ft

Pipe 5

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.018 ft/ft
Diameter	8.0 in
Discharge	73.40 gpm

Results

Normal Depth	1.8 in
Flow Area	0.1 ft²
Wetted Perimeter	0.7 ft
Hydraulic Radius	1.1 in
Top Width	0.56 ft
Critical Depth	2.2 in
Percent Full	23.1 %
Critical Slope	0.009 ft/ft
Velocity	2.68 ft/s
Velocity Head	0.11 ft
Specific Energy	0.27 ft
Froude Number	1.437
Maximum Discharge	678.35 gpm
Discharge Full	630.61 gpm
Slope Full	0.000 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	23.1 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.8 in
Critical Depth	2.2 in
Channel Slope	0.018 ft/ft
Critical Slope	0.009 ft/ft

Pipe 6

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	8.0 in
Discharge	38.10 gpm

Results	
Normal Depth	1.7 in
Flow Area	0.1 ft²
Wetted Perimeter	0.6 ft
Hydraulic Radius	1.0 in
Top Width	0.54 ft
Critical Depth	1.6 in
Percent Full	21.0 %
Critical Slope	0.009 ft/ft
Velocity	1.59 ft/s
Velocity Head	0.04 ft
Specific Energy	0.18 ft
Froude Number	0.894
Maximum Discharge	423.03 gpm
Discharge Full	393.26 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.7 in
Critical Depth	1.6 in
Channel Slope	0.007 ft/ft
Critical Slope	0.009 ft/ft

Pipe 7

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.004 ft/ft
Diameter	8.0 in
Discharge	42.10 gpm

Results

Normal Depth	2.0 in
Flow Area	0.1 ft²
Wetted Perimeter	0.7 ft
Hydraulic Radius	1.2 in
Top Width	0.58 ft
Critical Depth	1.7 in
Percent Full	25.4 %
Critical Slope	0.009 ft/ft
Velocity	1.34 ft/s
Velocity Head	0.03 ft
Specific Energy	0.20 ft
Froude Number	0.682
Maximum Discharge	319.78 gpm
Discharge Full	297.27 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.0 in
Critical Depth	1.7 in
Channel Slope	0.004 ft/ft
Critical Slope	0.009 ft/ft

Pipe 8

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.008 ft/ft
Diameter	8.0 in
Discharge	80.20 gpm

Results

Normal Depth	2.4 in
Flow Area	0.1 ft²
Wetted Perimeter	0.8 ft
Hydraulic Radius	1.4 in
Top Width	0.61 ft
Critical Depth	2.3 in
Percent Full	29.6 %
Critical Slope	0.009 ft/ft
Velocity	2.07 ft/s
Velocity Head	0.07 ft
Specific Energy	0.26 ft
Froude Number	0.966
Maximum Discharge	452.24 gpm
Discharge Full	420.41 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.4 in
Critical Depth	2.3 in
Channel Slope	0.008 ft/ft
Critical Slope	0.009 ft/ft

Pipe 9

Project Description

Friction Method	Hazen-Williams Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	100.000
Channel Slope	0.004 ft/ft
Normal Depth	4.0 in
Diameter	4.0 in
Discharge	54.71 gpm

Results

Discharge	54.71 gpm
Normal Depth	4.0 in
Flow Area	0.1 ft²
Wetted Perimeter	1.0 ft
Hydraulic Radius	1.0 in
Top Width	0.00 ft
Critical Depth	2.4 in
Percent Full	100.0 %
Critical Slope	0.009 ft/ft
Velocity	1.40 ft/s
Velocity Head	0.03 ft
Specific Energy	0.36 ft
Froude Number	(N/A)
Maximum Discharge	58.53 gpm
Discharge Full	54.71 gpm
Slope Full	0.004 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.0 in
Critical Depth	2.4 in
Channel Slope	0.004 ft/ft

GVF Output Data	
Critical Slope	0.009 ft/ft

Pipe 10

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.004 ft/ft
Diameter	8.0 in
Discharge	82.20 gpm

Results	
Normal Depth	2.9 in
Flow Area	0.1 ft²
Wetted Perimeter	0.9 ft
Hydraulic Radius	1.6 in
Top Width	0.64 ft
Critical Depth	2.4 in
Percent Full	36.0 %
Critical Slope	0.009 ft/ft
Velocity	1.62 ft/s
Velocity Head	0.04 ft
Specific Energy	0.28 ft
Froude Number	0.680
Maximum Discharge	319.78 gpm
Discharge Full	297.27 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.9 in
Critical Depth	2.4 in
Channel Slope	0.004 ft/ft
Critical Slope	0.009 ft/ft

Pipe 11

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.004 ft/ft
Diameter	8.0 in
Discharge	6.20 gpm

Results	
Normal Depth	0.8 in
Flow Area	0.0 ft²
Wetted Perimeter	0.4 ft
Hydraulic Radius	0.5 in
Top Width	0.40 ft
Critical Depth	0.6 in
Percent Full	10.0 %
Critical Slope	0.011 ft/ft
Velocity	0.76 ft/s
Velocity Head	0.01 ft
Specific Energy	0.08 ft
Froude Number	0.629
Maximum Discharge	319.78 gpm
Discharge Full	297.27 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.8 in
Critical Depth	0.6 in
Channel Slope	0.004 ft/ft
Critical Slope	0.011 ft/ft

Pipe 12

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.004 ft/ft
Diameter	8.0 in
Discharge	88.40 gpm

Results	
Normal Depth	3.0 in
Flow Area	0.1 ft²
Wetted Perimeter	0.9 ft
Hydraulic Radius	1.6 in
Top Width	0.65 ft
Critical Depth	2.4 in
Percent Full	37.4 %
Critical Slope	0.009 ft/ft
Velocity	1.65 ft/s
Velocity Head	0.04 ft
Specific Energy	0.29 ft
Froude Number	0.679
Maximum Discharge	319.78 gpm
Discharge Full	297.27 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.0 in
Critical Depth	2.4 in
Channel Slope	0.004 ft/ft
Critical Slope	0.009 ft/ft

Pipe 13

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.013 ft/ft
Diameter	8.0 in
Discharge	168.60 gpm

Results	
Normal Depth	3.1 in
Flow Area	0.1 ft²
Wetted Perimeter	0.9 ft
Hydraulic Radius	1.7 in
Top Width	0.65 ft
Critical Depth	3.4 in
Percent Full	38.5 %
Critical Slope	0.009 ft/ft
Velocity	3.03 ft/s
Velocity Head	0.14 ft
Specific Energy	0.40 ft
Froude Number	1.223
Maximum Discharge	576.49 gpm
Discharge Full	535.92 gpm
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	38.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.1 in
Critical Depth	3.4 in
Channel Slope	0.013 ft/ft
Critical Slope	0.009 ft/ft

Pipe 14

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	8.0 in
Discharge	86.00 gpm

Results	
Normal Depth	2.5 in
Flow Area	0.1 ft²
Wetted Perimeter	0.8 ft
Hydraulic Radius	1.4 in
Top Width	0.62 ft
Critical Depth	2.4 in
Percent Full	31.8 %
Critical Slope	0.009 ft/ft
Velocity	2.01 ft/s
Velocity Head	0.06 ft
Specific Energy	0.27 ft
Froude Number	0.903
Maximum Discharge	423.03 gpm
Discharge Full	393.26 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.5 in
Critical Depth	2.4 in
Channel Slope	0.007 ft/ft
Critical Slope	0.009 ft/ft

Pipe 15

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	8.0 in
Discharge	86.00 gpm

Results

Normal Depth	2.5 in
Flow Area	0.1 ft²
Wetted Perimeter	0.8 ft
Hydraulic Radius	1.4 in
Top Width	0.62 ft
Critical Depth	2.4 in
Percent Full	31.8 %
Critical Slope	0.009 ft/ft
Velocity	2.01 ft/s
Velocity Head	0.06 ft
Specific Energy	0.27 ft
Froude Number	0.903
Maximum Discharge	423.03 gpm
Discharge Full	393.26 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.5 in
Critical Depth	2.4 in
Channel Slope	0.007 ft/ft
Critical Slope	0.009 ft/ft

Pipe 16

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	8.0 in
Discharge	172.00 gpm

Results	
Normal Depth	3.7 in
Flow Area	0.2 ft²
Wetted Perimeter	1.0 ft
Hydraulic Radius	1.9 in
Top Width	0.66 ft
Critical Depth	3.5 in
Percent Full	46.3 %
Critical Slope	0.009 ft/ft
Velocity	2.43 ft/s
Velocity Head	0.09 ft
Specific Energy	0.40 ft
Froude Number	0.878
Maximum Discharge	423.03 gpm
Discharge Full	393.26 gpm
Slope Full	0.001 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.7 in
Critical Depth	3.5 in
Channel Slope	0.007 ft/ft
Critical Slope	0.009 ft/ft

Pipe 17

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	8.0 in
Discharge	65.80 gpm

Results	
Normal Depth	2.2 in
Flow Area	0.1 ft²
Wetted Perimeter	0.7 ft
Hydraulic Radius	1.3 in
Top Width	0.60 ft
Critical Depth	2.1 in
Percent Full	27.6 %
Critical Slope	0.009 ft/ft
Velocity	1.87 ft/s
Velocity Head	0.05 ft
Specific Energy	0.24 ft
Froude Number	0.906
Maximum Discharge	423.03 gpm
Discharge Full	393.26 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.2 in
Critical Depth	2.1 in
Channel Slope	0.007 ft/ft
Critical Slope	0.009 ft/ft

Pipe 18

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	10.0 in
Discharge	232.60 gpm

Results	
Normal Depth	3.9 in
Flow Area	0.2 ft²
Wetted Perimeter	1.1 ft
Hydraulic Radius	2.1 in
Top Width	0.81 ft
Critical Depth	3.8 in
Percent Full	39.3 %
Critical Slope	0.008 ft/ft
Velocity	2.60 ft/s
Velocity Head	0.11 ft
Specific Energy	0.43 ft
Froude Number	0.928
Maximum Discharge	767.00 gpm
Discharge Full	713.02 gpm
Slope Full	0.001 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.9 in
Critical Depth	3.8 in
Channel Slope	0.007 ft/ft
Critical Slope	0.008 ft/ft

Pipe 19

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	8.0 in
Discharge	181.40 gpm

Results	
Normal Depth	3.8 in
Flow Area	0.2 ft²
Wetted Perimeter	1.0 ft
Hydraulic Radius	1.9 in
Top Width	0.67 ft
Critical Depth	3.6 in
Percent Full	47.7 %
Critical Slope	0.009 ft/ft
Velocity	2.46 ft/s
Velocity Head	0.09 ft
Specific Energy	0.41 ft
Froude Number	0.873
Maximum Discharge	423.03 gpm
Discharge Full	393.26 gpm
Slope Full	0.001 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.8 in
Critical Depth	3.6 in
Channel Slope	0.007 ft/ft
Critical Slope	0.009 ft/ft

Pipe 20

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.007 ft/ft
Diameter	12.0 in
Discharge	381.00 gpm

Results	
Normal Depth	4.7 in
Flow Area	0.3 ft²
Wetted Perimeter	1.4 ft
Hydraulic Radius	2.5 in
Top Width	0.98 ft
Critical Depth	4.6 in
Percent Full	39.5 %
Critical Slope	0.008 ft/ft
Velocity	2.95 ft/s
Velocity Head	0.13 ft
Specific Energy	0.53 ft
Froude Number	0.957
Maximum Discharge	1,247.23 gpm
Discharge Full	1,159.45 gpm
Slope Full	0.001 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.7 in
Critical Depth	4.6 in
Channel Slope	0.007 ft/ft
Critical Slope	0.008 ft/ft

Pipe 21

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.005 ft/ft
Diameter	8.0 in
Discharge	68.00 gpm

Results

Normal Depth	2.5 in
Flow Area	0.1 ft²
Wetted Perimeter	0.8 ft
Hydraulic Radius	1.4 in
Top Width	0.61 ft
Critical Depth	2.1 in
Percent Full	30.7 %
Critical Slope	0.009 ft/ft
Velocity	1.67 ft/s
Velocity Head	0.04 ft
Specific Energy	0.25 ft
Froude Number	0.764
Maximum Discharge	357.52 gpm
Discharge Full	332.36 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.5 in
Critical Depth	2.1 in
Channel Slope	0.005 ft/ft
Critical Slope	0.009 ft/ft

Pipe 22

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.005 ft/ft
Diameter	12.0 in
Discharge	434.20 gpm

Results	
Normal Depth	5.6 in
Flow Area	0.4 ft²
Wetted Perimeter	1.5 ft
Hydraulic Radius	2.9 in
Top Width	1.00 ft
Critical Depth	5.0 in
Percent Full	46.6 %
Critical Slope	0.008 ft/ft
Velocity	2.70 ft/s
Velocity Head	0.11 ft
Specific Energy	0.58 ft
Froude Number	0.793
Maximum Discharge	1,054.10 gpm
Discharge Full	979.92 gpm
Slope Full	0.001 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.6 in
Critical Depth	5.0 in
Channel Slope	0.005 ft/ft
Critical Slope	0.008 ft/ft

Pipe 23

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.026 ft/ft
Diameter	12.0 in
Discharge	434.20 gpm

Results

Normal Depth	3.6 in
Flow Area	0.2 ft²
Wetted Perimeter	1.2 ft
Hydraulic Radius	2.0 in
Top Width	0.92 ft
Critical Depth	5.0 in
Percent Full	29.9 %
Critical Slope	0.008 ft/ft
Velocity	4.91 ft/s
Velocity Head	0.37 ft
Specific Energy	0.67 ft
Froude Number	1.865
Maximum Discharge	2,403.72 gpm
Discharge Full	2,234.55 gpm
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	29.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.6 in
Critical Depth	5.0 in
Channel Slope	0.026 ft/ft
Critical Slope	0.008 ft/ft

Pipe 24

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015
Channel Slope	0.073 ft/ft
Diameter	8.0 in
Discharge	42.10 gpm

Results

Normal Depth	1.0 in
Flow Area	0.0 ft²
Wetted Perimeter	0.5 ft
Hydraulic Radius	0.6 in
Top Width	0.44 ft
Critical Depth	1.7 in
Percent Full	12.5 %
Critical Slope	0.009 ft/ft
Velocity	3.74 ft/s
Velocity Head	0.22 ft
Specific Energy	0.30 ft
Froude Number	2.766
Maximum Discharge	1,366.10 gpm
Discharge Full	1,269.95 gpm
Slope Full	0.000 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	12.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.0 in
Critical Depth	1.7 in
Channel Slope	0.073 ft/ft
Critical Slope	0.009 ft/ft

Pipe 25

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.004 ft/ft
Diameter	15.0 in
Discharge	593.60 gpm

Results	
Normal Depth	6.3 in
Flow Area	0.5 ft²
Wetted Perimeter	1.8 ft
Hydraulic Radius	3.3 in
Top Width	1.24 ft
Critical Depth	5.4 in
Percent Full	42.3 %
Critical Slope	0.007 ft/ft
Velocity	2.68 ft/s
Velocity Head	0.11 ft
Specific Energy	0.64 ft
Froude Number	0.746
Maximum Discharge	1,709.44 gpm
Discharge Full	1,589.13 gpm
Slope Full	0.001 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	14.2 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.3 in
Critical Depth	5.4 in
Channel Slope	0.004 ft/ft
Critical Slope	0.007 ft/ft

Pipe 26

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.015
Channel Slope	0.003 ft/ft
Diameter	10.0 in
Discharge	647.60 gpm

Results	
Normal Depth	3.2 in
Flow Area	0.2 ft²
Wetted Perimeter	1.0 ft
Hydraulic Radius	1.8 in
Top Width	0.78 ft
Critical Depth	2.6 in
Percent Full	32.3 %
Critical Slope	0.008 ft/ft
Velocity	1.59 ft/s
Velocity Head	0.04 ft
Specific Energy	0.31 ft
Froude Number	0.635
Maximum Discharge	518.59 gpm
Discharge Full	482.09 gpm
Slope Full	0.000 ft/ft
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	37.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.2 in
Critical Depth	2.6 in
Channel Slope	0.003 ft/ft
Critical Slope	0.008 ft/ft