Appendix G

Sanitary Sewer Capacity Assessment

Civic Center Family Housing Project
Initial Study

City of Santa Clara

Charities Housing

1601 Civic Center Drive Sewer Flow Monitoring Capacity Study

Prepared for:

Charities Housing
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Date:

December 2021

Prepared by:

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V&A Project No. 21-0341

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1 Introduction

V&A Consulting Engineers, Inc. (V&A) was retained by Charities Housing to perform sanitary sewer flow monitoring and capacity analysis within the City of Santa Clara (City), California. Open-channel flow monitoring was performed at two manholes for one week from November 29, 2021, through December 06, 2021 (S46-MH71) and December 06, 2021, through December 10, 2021 (S46-MH37). The purpose of this study was to identify the average and peak flows and to determine the available capacity of the subject pipes for the future Charities Housing development of 1601 Civic Center Drive, Santa Clara, CA.

Flow monitoring sites are identified as the manholes where the flow monitors were secured and the pipelines wherein the flow sensors were placed.

The flow monitoring sites were selected and approved by the City of Santa Clara. Information regarding the flow monitoring locations are listed in Table 1-1. Figure 1-1 illustrates the location of the project site at 1601 Civic Center Drive, Santa Clara, CA and its proximity to the flow monitoring sites. Detailed descriptions of the flow monitoring sites, including photographs, are included in Appendix A.

Table 1-1. Description of Flow Monitoring Location

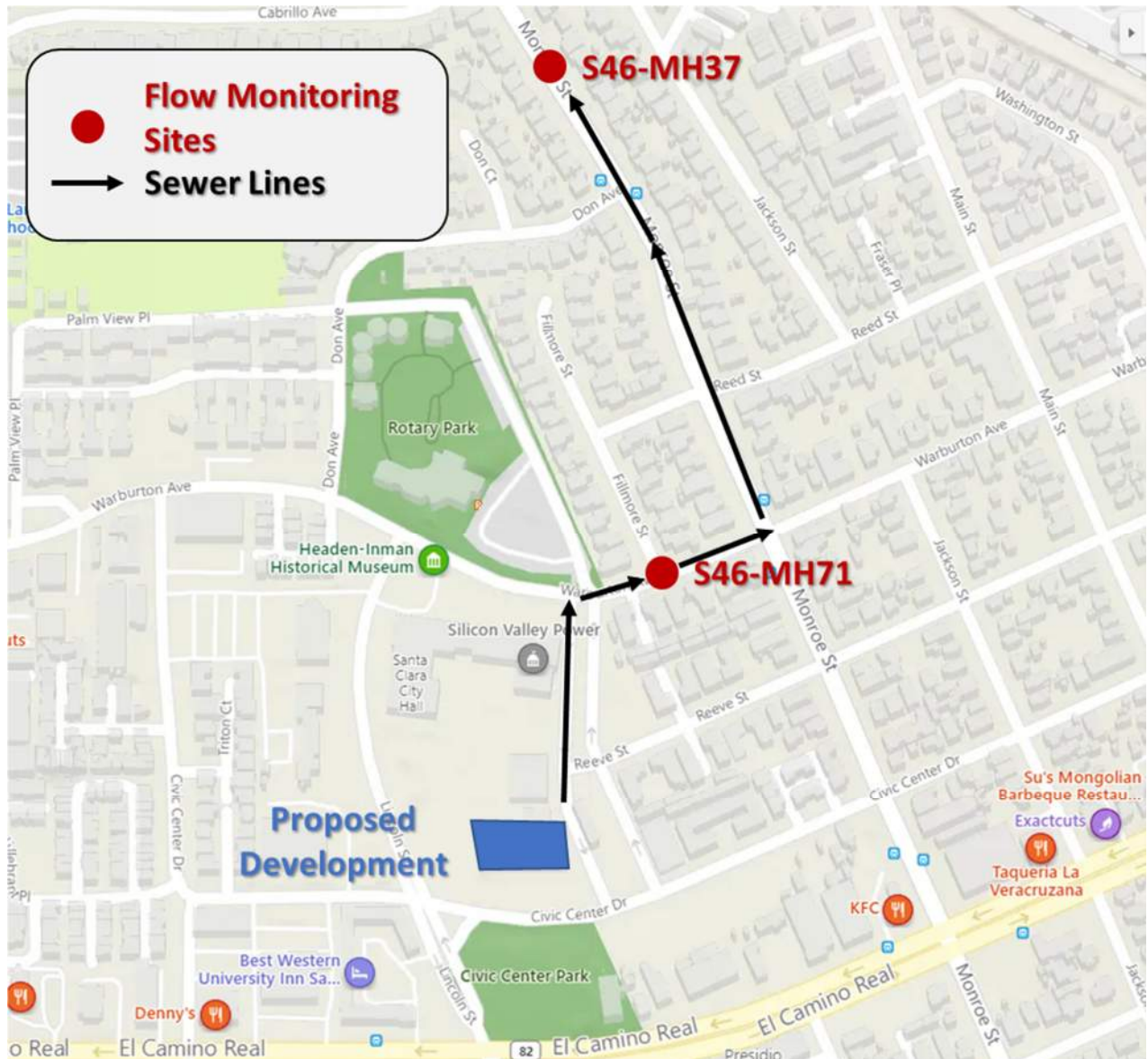| Manhole ID	Location	Pipe Diameter	Pipe Material	Inlets Monitored
S46-MH37	Monroe St btwn Cabrilo Ave & Don Ave (37.358980°, -121.954083°)	8 inches	VCP	Southeast
S46-MH71	Warburton Ave at Fillmore St (37.355580°, -121.953189°)	8 inches	VCP	West

Figure 1-1. Location of Development and Flow Monitoring Sites

2 Methods and Procedures

2.1 Confined Space Entry

A confined space (Photo 2-1) is defined as any space that is large enough and so configured that a person can bodily enter and perform assigned work, has limited or restricted means for entry or exit and is not designed for continuous employee occupancy. In general, the atmosphere must be constantly monitored for sufficient levels of oxygen (19.5% to 23.5%), and the presence of hydrogen sulfide (H_2S) gas, carbon monoxide (CO) gas, and lower explosive limit (LEL) levels. A typical confined space entry crew has members with OSHA-defined responsibilities of Entrant, Attendant, and Supervisor. The Entrant is the individual performing the work. He or she is equipped with the necessary personal protective equipment needed to perform the job safely, including a personal four-gas monitor (Photo 2-2). If it is not possible to maintain line-of-sight with the Entrant, then more Entrants are required until line-of-sight can be maintained. The Attendant is responsible for maintaining contact with the Entrants to monitor the atmosphere using another four-gas monitor and maintaining records of all Entrants, if there is more than one. The Supervisor is responsible for developing the safe work plan for the job at hand prior to entering.

Photo 2-1. Confined Space Entry

Photo 2-2. Typical Personal Four-Gas Monitor

2.2 Flow Meter Installation

V&A installed two Isco 2150 area-velocity flow meters for temporary metering within the collection system. Isco 2150 meters use submerged sensors with a pressure transducer to collect depth readings and an ultrasonic Doppler sensor to determine the average fluid velocity. The ultrasonic sensor emits high-frequency (500 kHz) sound waves, which are reflected by air bubbles and suspended particles in the flow. The sensor receives the reflected signal and determines the Doppler frequency shift, which indicates the estimated average flow velocity. The sensor is typically mounted at a manhole inlet to take advantage of smoother upstream flow conditions. The sensor may be offset to one side to lessen the chances of fouling and sedimentation where these problems are expected to occur. Manual level and velocity measurements were taken during the installation of the flow meters and again when they were removed and compared to simultaneous level and velocity readings from the flow meters to ensure proper calibration and accuracy. Figure 2-1 shows a typical installation for a flow meter with a submerged sensor.
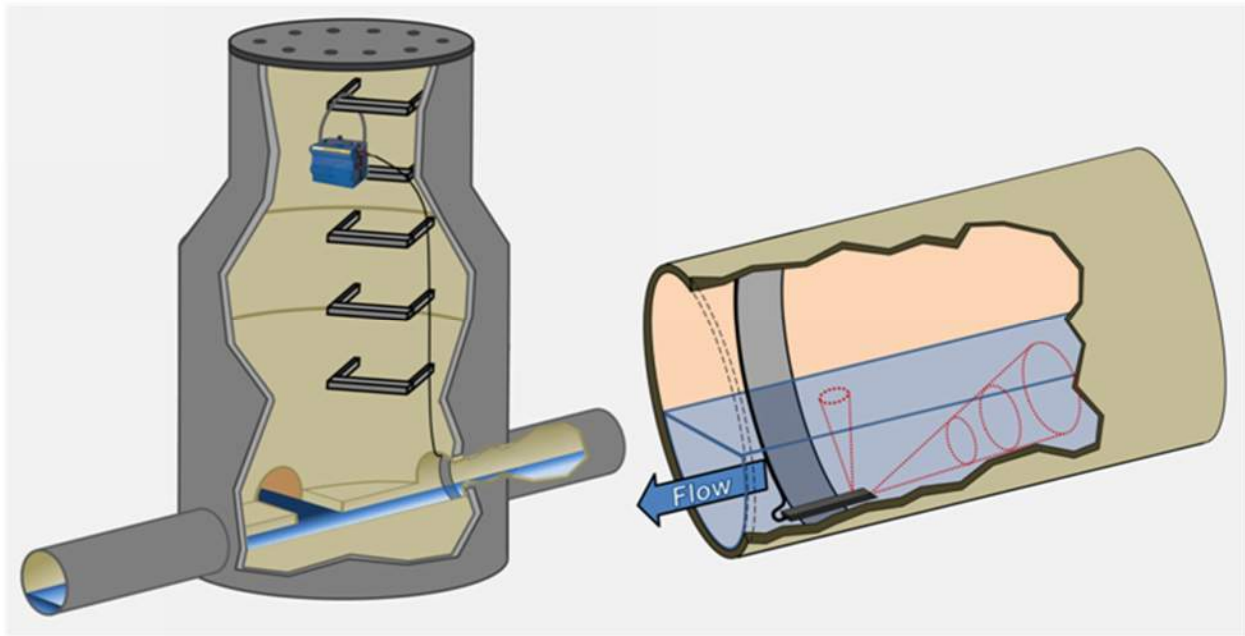

Figure 2-1. Typical Installation for Flow Meter with Submerged Sensor

3 Results and Analysis

3.1 Design Flow Determination

The flow monitoring design flow determination as defined by the City Standard is as follows:

$$Q_D = Q_M + Q_{WWGWI} + Q_{RD\ I/I} + Q_{PD}$$

Where:

Q_D	= Design Flow
Q_M	= Monitored Flow
Q_{WWGWI}	= Wet Weather Groundwater Infiltration
$Q_{RD\ I/I}$	= Rainfall-Dependent Infiltration and Inflow
Q_{PD}	= Proposed Development Peak Flow

3.2 Flow Monitoring Results

Table 3-1 lists the ADWF, peak measured flow and other calculated factors used to determine the pipeline capacity. Detailed graphs of the flow monitoring data are included in *Appendix A*.

Table 3-1. Dry Weather Flow Monitoring Summary

Item	S46-MH37 Southeast	S46-MH71 West
Pipe Diameter (in):	8.0	8.0
Measured Sediment (in):	0	0
Overall ADWF (gpm):	66.9[1]	1.1
Peak Flow (gpm):	113.4	6.7
Peak Level (in):	3.51	1.18
Peaking Factor:	1.7	6.1[2]
d/D Ratio:	0.44	0.15

[1]The flows for S46-MH37 were taken from December 6, 2021 through December 10, 2021 due to meter failure the prior week.
[2]The peaking factor for Site 2 is skewed high due to low flow conditions.

The following information should be noted:

- There was no observable inflow and infiltration response at S46-MH37 from the small rain event that occurred December 7, 2021.

3.3 City Standard "Monitored Flow"

Monitored Flow: Per the City's Standards for the flow monitoring design flow determination, the monitored flow (Q_M) is the greater of the following:

Q_M = Monitored Peak Flow

OR

Q_M = 2.5 X Monitored Average Flow

Table 3-2. Q_M, Monitored Flow

Item	S46-MH37 Southeast	S46-MH71 West
Monitored Peak Flow (gpm)	113.4	6.7
2.5 x Monitored Average Flow (gpm)	167.3	2.8
Q_M, Monitored Flow (gpm)	167.3	6.7

3.4 Pipeline Capacity Analysis

The pipeline capacity was estimated by using the Manning equation:

$$Q = \frac{669 \times R^{2/3} \times S^{1/2} \times A}{n}$$

where

A: Cross-sectional area of flow (ft²)
R: hydraulic radius (ft), calculated from flow level *d* and pipe diameter *D*
S: Pipeline slope (ft/ft)
n: Roughness coefficient (unitless)
Q: Flow rate (ft³/s)

The following factors were selected to determine the pipeline capacity.

▪ **Roughness coefficients:** 0.013 for VCP pipe is a widely accepted number for sanitary sewer design.

▪ **Pipeline Slope:** The slope for S46-MH71 was provided by City of Santa Clara field measurements. The slope for S46-MH37 was derived from flow data hydraulic conditions. The City of Santa Sanitary Sewer Maps did not state pipe slope for this location.

▪ **Design Flow Depth:** The City Standard requires that sewer should be designed for peak flow rate not to exceed 75% full pipe.

Table 3-3. Pipeline Capacity

Item	S46-MH37 Southeast	S46- MH71 West
Capacity		
Pipe Diameter (in.)	8	8
Pipeline Slope	0.0040[1]	0.0051[2]
Mannings roughness, n	0.013	0.013
Full-Pipe Capacity (gpm)	344.1	387.3
City Allowable Peak Flow at 0.75 d/D (gpm)	313.8	353.2

[1]Derived from flow data hydraulic measurements. City maps did not state surveyed slope of pipeline. See Figure 3-1 below.
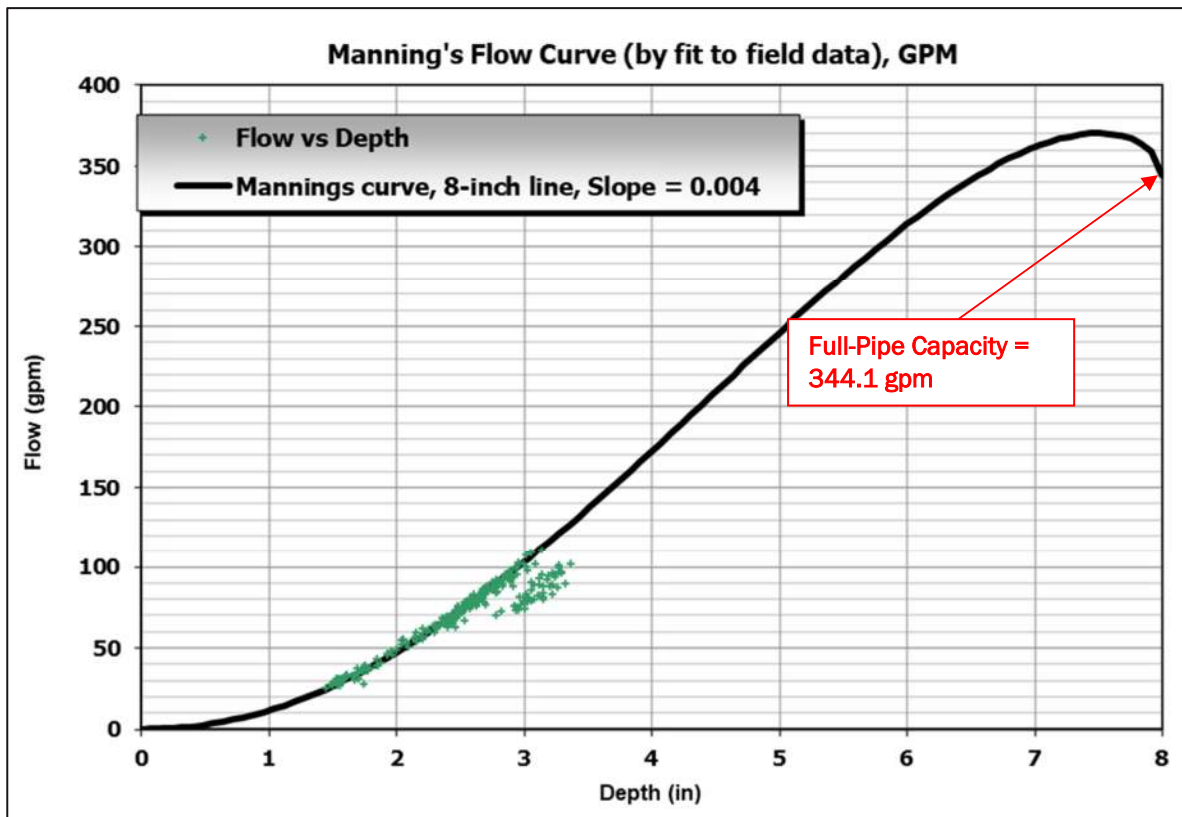[2]City of Santa Clara verified the slope between S46- MH70 and S46- MH71 on 12/03/21.

Figure 3-1. S46-MH37 Manning's Flow Curve

3.5 Derived Flow Results

3.5.1 Proposed Development Flows

The proposed development is a mix of commercial and residential space. The peak development flow is calculated in Table 3-4. The Base Wastewater Unit Flow Factors established by the City can be found in Appendix B.

Table 3-4. Flow Generation from Proposed Developments

Development	City	Use/Type	Unit or ft²	Sewage Generation Rate[1]	Flow (Gal/Day)
1601 Civic Center Drive	Santa Clara	Residential	112 units	154 gpd/DU	17,248 gpd
		Q_{PD}, **Proposed Development Peak Flow (Total)**			**17,248 gpd (12.0 GPM)**

THEREFORE,

$$Q_{PD} = 12.0 \text{ gpm}$$

3.5.2   Wet Weather Groundwater Infiltration (Q_{WWGWI})

The wet weather groundwater infiltration (Q_{WWGWI}) is derived from multiplying the wet weather groundwater infiltration (factor) by the tributary area served by the sanitary sewer main being monitored. The tributary areas upstream of the monitored site are shown in Figure 3-1. The project site is located within the tributary area M_15 (Appendix B). The factor for this area is 700 gpd/acre established by the City Standard as shown in Appendix B.

QWWGWI Site   = WWGWI x Tributary Area

= 700 gpd/acre x 66.6 acres = 46,620 gpd or 32.4 gpm (S46-MH37)

= 700 gpd/acre x 33.9 acres = 23,730 gpd or 16.5 gpm (S46-MH71)

THEREFORE,

Q_{WWGWI} = 32.4 gpm (S46-MH37)
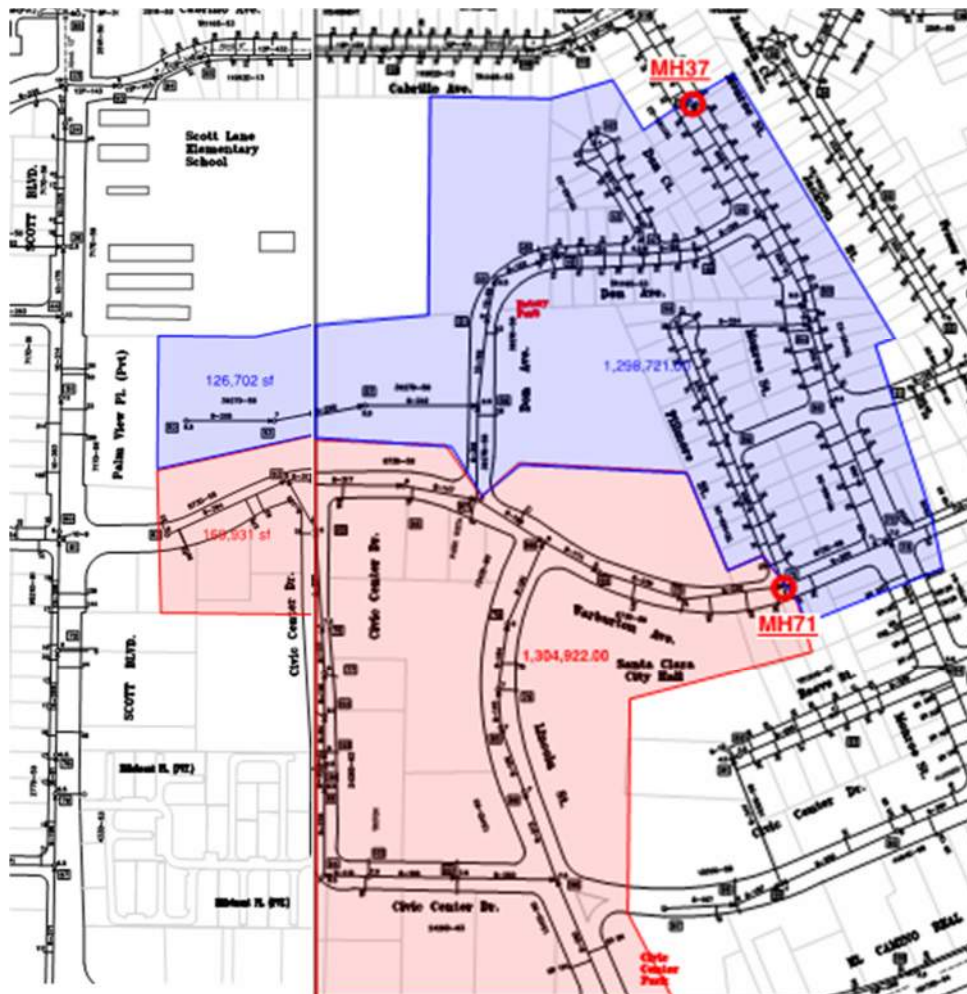Q_{WWGWI} = 16.5 gpm (S46-MH71)

Figure 3-2. Approximate Tributary Area of monitoring sites

3.5.3 Rainfall-Dependent Infiltration and Inflow ($Q_{RDI/I}$)

The rainfall-dependent infiltration and inflow ($Q_{RDI/I}$) is derived the same way as the wet weather groundwater infiltration. Per City Standards, 1,000 gpd/acre is used for $Q_{RDI/I}$ flow determination.

$Q_{RDI/I}$ = RDI/I x Tributary Area

= 1,000 gpd/acre x 66.6 acres = 66,600 gpd or 46.3 gpm (S46-MH37)

= 1,000 gpd/acre x 33.9 acres = 33,900 gpd or 23.5 gpm (S46-MH71)

THEREFORE,

$$Q_{RDI/I} = 46.3 \text{ gpm (S46-MH37)}$$
$$Q_{RDI/I} = 23.5 \text{ gpm (S46-MH71)}$$

3.5.4 Design Flow (Q_D)

Table 3-5 shows the summary of the design flow results including both monitored flow results and derived flow results.

Table 3-5. Design Flow Results

Item	S46-MH37 Southeast	S46-MH71 West
Q_M, Monitored Flow (gpm)	167.3	6.7
Q_{PD}, Proposed Development Peak Flow (gpm)	12.0	12.0
Q_{WWGWI}, Wet Weather Groundwater Infiltration (gpm)	32.4	16.5
$Q_{RDI/I}$, Rainfall Dependent Infiltration and Inflow (gpm)	46.3	23.5
Q_D, Design Flow (gpm)	258.0	58.7

3.5.5　Estimated Pipeline Capacity

Table 3-6 summarizes the capacity analysis for the pipelines that would be affected by the proposed development area.

Table 3-6. Pipeline Capacity Results Summary

No.	Item	S46-MH37 Southeast	S46-MH71 West
1	City Allowable Peak Flow at 0.75*d/D (gpm)	313.8[1]	353.2
2	Q_D, Design Flow (gpm)	258.0	58.7
3	Available Capacity (gpm) (No. 1 – No. 2)	55.8	294.5
4	Has Capacity For 100% of Development?	YES (82.2% of capacity)	YES (16.6% of capacity)

[1]City Allowable Peak Flow at 75% based on derived slope values in Section 3.4
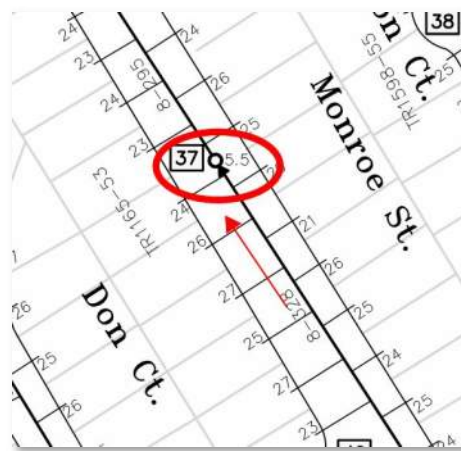
Appendix A
Flow Monitoring Site Report: Data, Graphs, Information

MH37 Satellite View

MH37 Street View

MH37 Sanitary Sewer Map
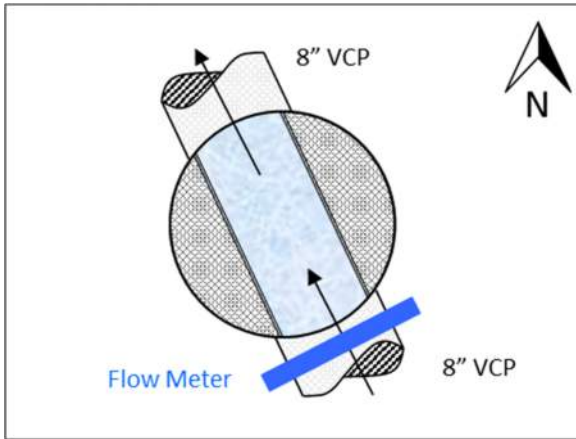
MH37 Flow Diagram

MH37 Plan View

MH37 Effluent Pipe

MH37 Monitored Southeast Influent Pipe
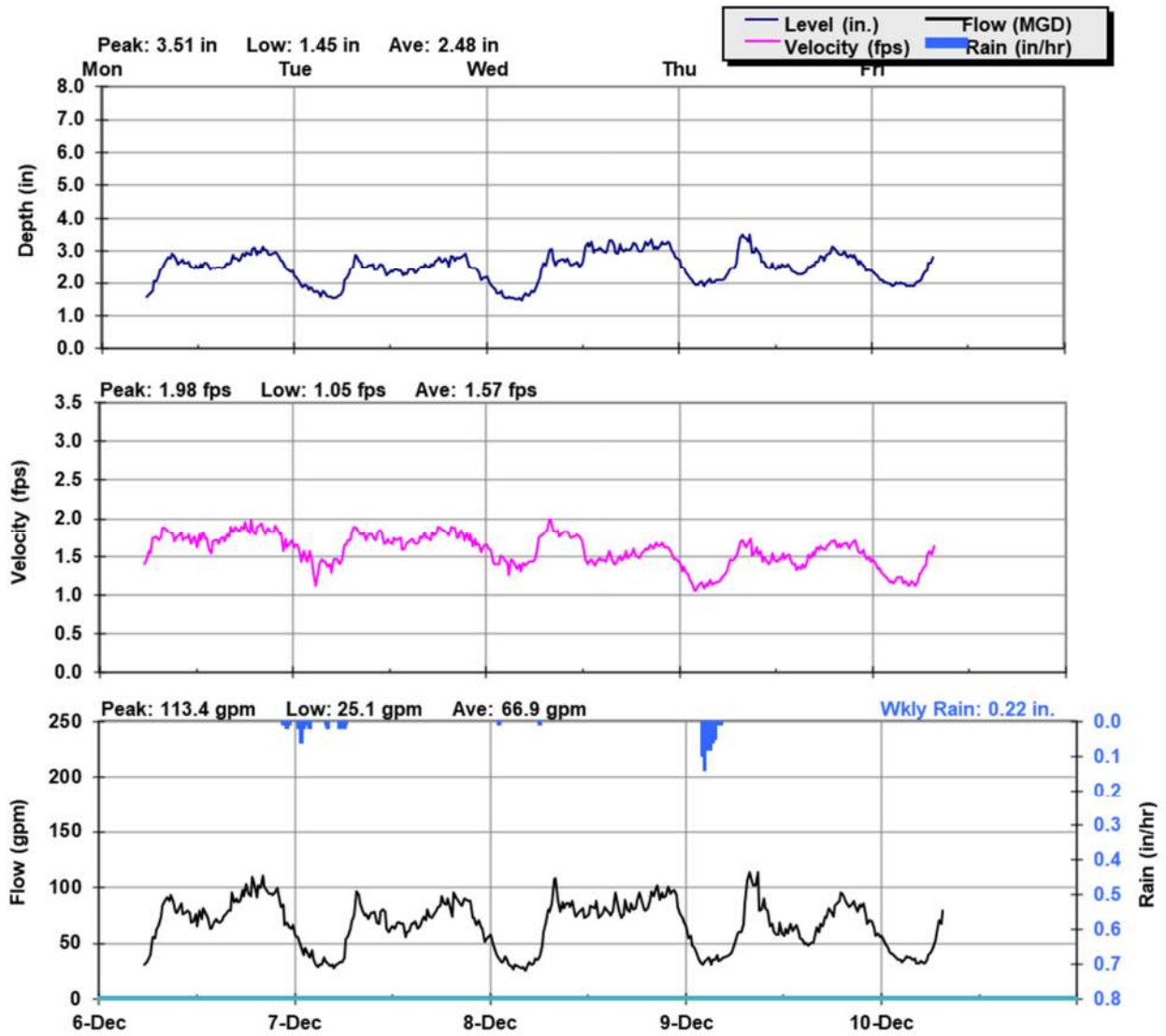
MH37 Flow Monitoring Details (12/06/21 to 12/10/21)
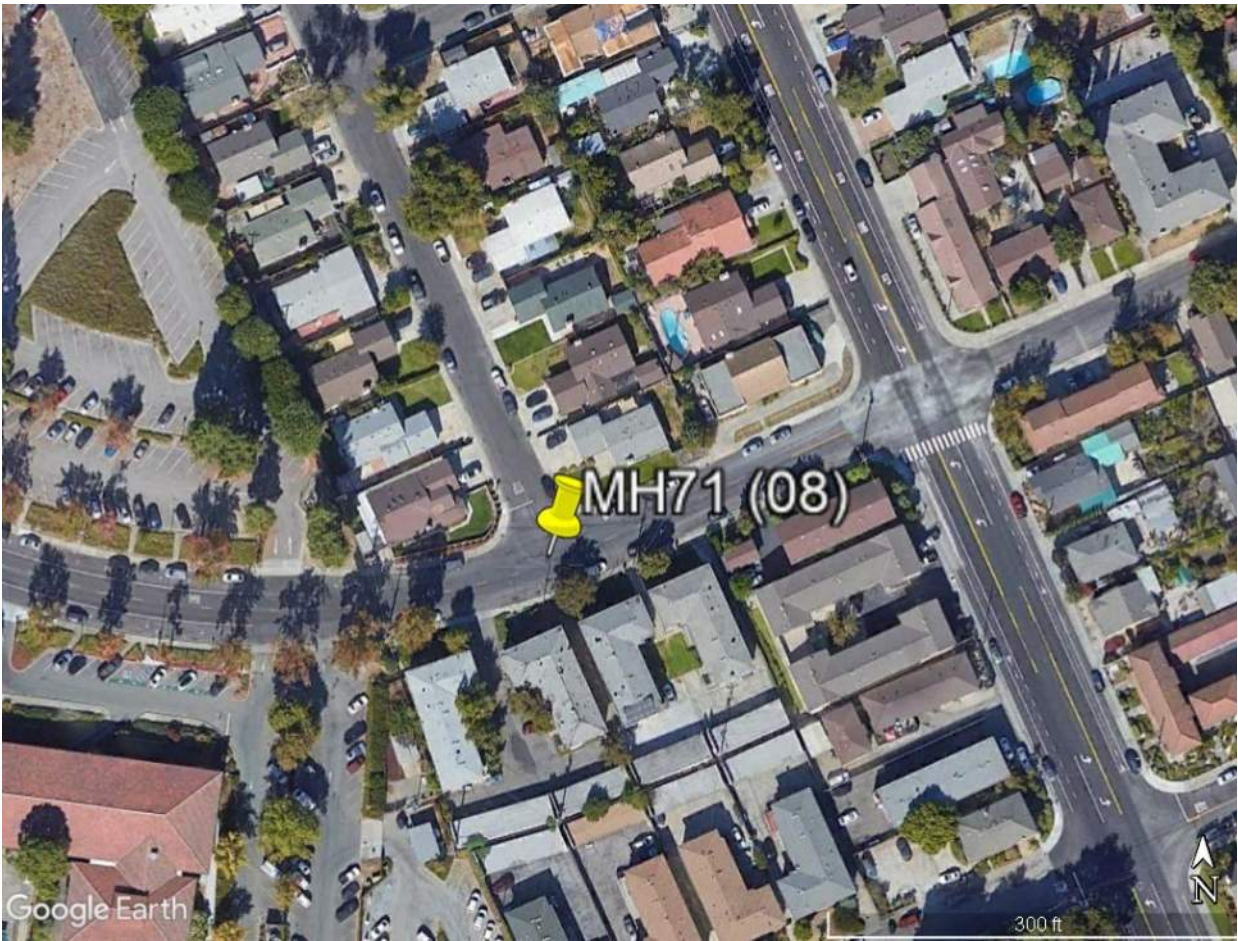
MH37 Satellite View

MH71 Street View
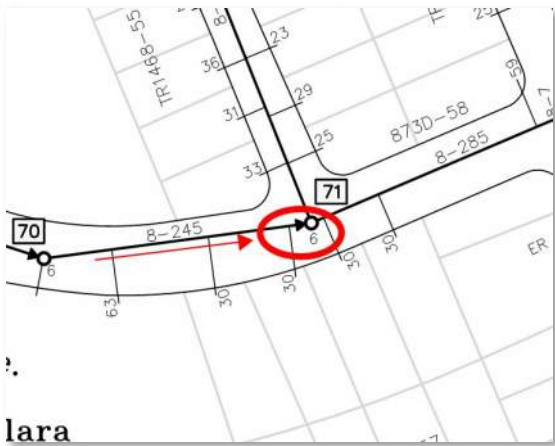
MH71 Sanitary Sewer Map
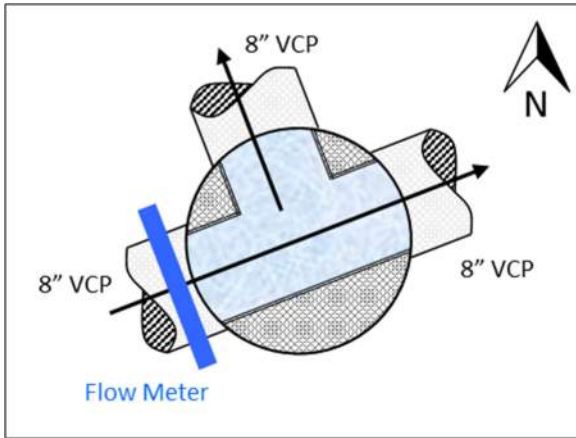
MH71 Flow Diagram

MH71 Plan View

MH71 North Effluent Pipe

MH71 East Effluent Pipe

MH71 Monitored West Influent Pipe
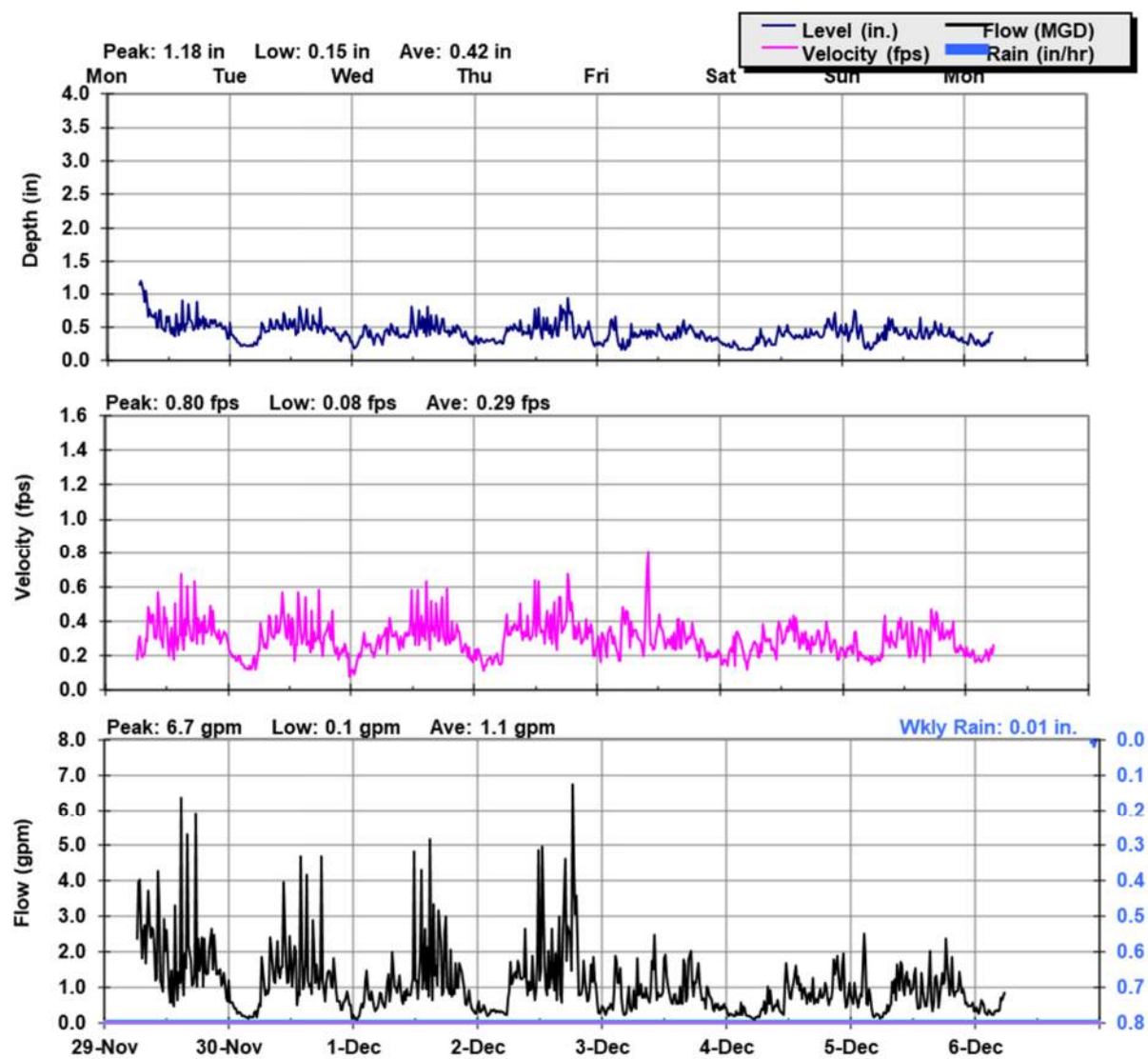
MH71 Flow Monitoring Details (11/29/21 to 12/06/21)

Appendix B
City of Santa Clara: Sanitary Sewer Capacity Assessment Standards

DESIGN CRITERIA

for Improvements in Public Right-of-Ways and City Easements

City of Santa Clara

Public Works Department

September 2014

Prior to any flow monitoring work, the proposed monitoring location(s) shall be reviewed and approved by the Director of Public Works/City Engineer. Flow monitoring measurements to determine average and peak flows, in existing pipes, shall be done over a period of at least seven (7) consecutive days with continuous mechanical/electronic measurements in a manner acceptable to the Director of Public Works/City Engineer.

An Encroachment Permit (EP) is required to allow developer to monitor the sanitary sewer flows.

.   Design flow determination shall be as follows:

$$Q_D = Q_M + Q_{WWGWI} + Q_{RDI/I} + Q_{PD}$$

Where:

Q	=	Flow
D	=	Design
M	=	Monitored
WWGWI	=	Wet Weather Groundwater Infiltration
RDI/I	=	Rainfall-Dependent Infiltration and Inflow
PD	=	Proposed Development

Q_D	=	Design Flow
Q_M	=	The Monitored Peak Flow or 2.5 times the Monitored Average Flow, whichever is greater.
Q_{WWGWI}	=	The gpd/acre value is obtained by using Figure 3-3 on page 3-5 (see Exhibit "D" of this Design Criteria) and Table 3-2 on page 3-11 (see Exhibit "E" of this Design Criteria) of the Sanitary Sewer Capacity Assessment Report, May 2007. Multiply the factor by the Tributary Area served by the sanitary sewer main being monitored.
$Q_{RDI/I}$	=	Same as Q_{WWGWI} above. For now, use 1,000 gpd/acre.
Q_{PD}	=	Proposed Development Peak Flow.

5.5   At all changes of direction, a drop in flow line shall be installed equal to the velocity head times the ratio of angular change to 90 degrees.

$$\frac{V^2}{2g} \quad x \quad \frac{A^o}{90^o} \quad = \quad \text{Head Loss} \quad = \quad \text{drop in flow line*}$$

EXHIBIT D

Figure 3-3 of Sanitary Sewer Capacity Assessment Report, May 2007

City of Santa Clara
Sanitary Sewer Capacity
Assessment

**Flow Meter Areas Used for
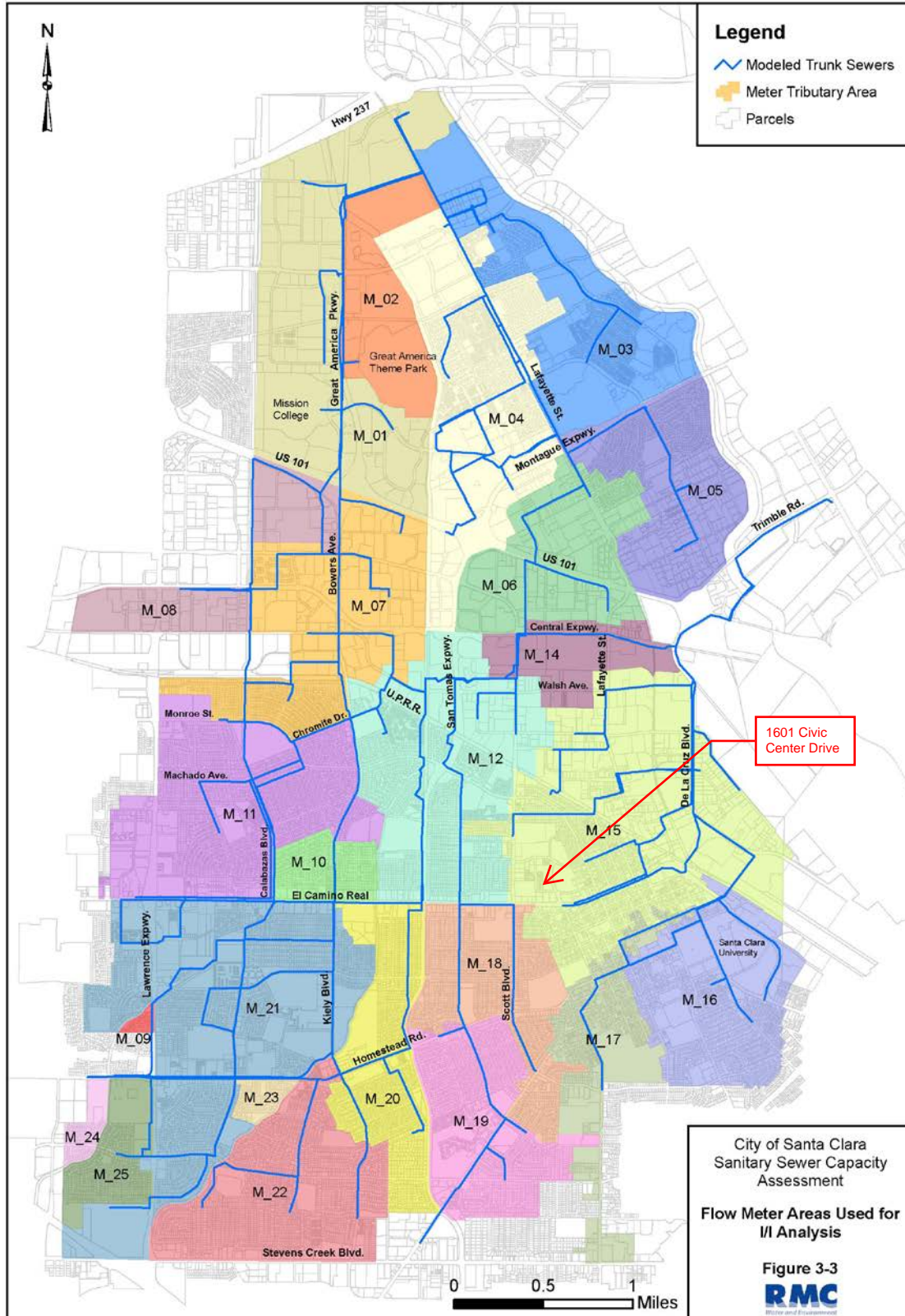I/I Analysis**

Figure 3-3

EXHIBIT E

Table 3-2 of Sanitary Sewer Capacity Assessment Report, May 2007

City of Santa Clara Sanitary Sewer Capacity Assessment   Chapter 3 Hydraulic Model Development

Table 3-2 GWI and RDI/I Parameters by Meter Area

Meter Area[a]	Dry Weather GWI[b] (gpd/acre)	Wet Weather GWI[c] (gpd/acre)	R1 RDI/I Vol. (%) (2 hrs. to peak)	R2 RDI/I Vol. (%) (6 hrs. to peak)	R3 RDI/I Vol. (%) (12 hrs. to peak)
M_01	0	0	0.5	0.8	0.8
M_02	0	0	0.5	0.8	0.8
M_03	0	0	0.6	0.1	0.1
M_04	500	1,300	0.6	0.1	0.1
M_05	700	1,000	0.6	0.1	0.1
M_06	0	0	0.6	0.1	0.1
M_07	1,900	1,900	0.3	0.5	0.5
M_08	0	0	0.3	0.5	0.5
M_09	0	0	0.6	0.1	0.1
M_10	0	0	0.6	0.1	0.1
M_11	1,600	2,300	0.9	1.7	6.0
M_12	0	0	0.9	1.0	0.5
M_14	0	0	0.6	0.1	0.1
M_15	300	700	1.0	0.2	0.2
M_16	900	1,600	1.0	0.2	0.2
M_17	200	200	0.6	0.1	0.1
M_18	0	0	0.8	1.0	0.1
M_19	0	0	0.3	0.1	0.1
M_20	0	0	0.6	0.1	0.1
M_21	0	0	0.6	0.1	0.1
M_22	0	0	0.6	0.1	0.1
M_23	0	0	0.6	0.1	0.1
M_24	0	0	0.6	0.1	0.1
M_25	0	0	0.6	0.1	0.1
CuSD	0	0	0.5	0.2	0.4

(a) See Figure 3-3.
(b) Represents GWI during non-rainfall periods (e.g., early to mid-February) of the 2006 flow monitoring period.
(c) Represents GWI immediately following rainfall events.

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City of Santa Clara Water & Sewer Utility

Sewer System Management Plan

Approved by City Council: Resolution # [TBA]

Table 2-5 Base Wastewater Flow Unit Flow Factors

Type of Development	Unit Flow Factor	Basis
Single Family Detached	245 gpd/DU	3.5 people/DU @ 70 gpcd
Townhouses/Condominiums	175 gpd/DU	2.5 people/DU @ 70 gpcd
Apartments	154 gpd/DU	2.2 people/DU @ 70 gpcd
Hotels	100 gpd/room	
Commercial/Office	0.1 gpd/sq. ft.	
Office/R&D	0.15 gpd/sq. ft.	
Moderate Density Residential (Mixed Use)	3,200 gpd/acre	21 DU/acre @154 gpd/DU
Medium Density Residential (Transit-Oriented Mixed Use)	4,600 gpd/acre	30 DU/acre @ 154 gpd/DU
Commercial/Office/R&D Intensification[a]	+ 300 gpd/acre	+ 0.04 FAR @ 0.15 gpd/sq. ft.

(a)   Applied to areas of North Santa Clara where existing development is anticipated to increase in intensity from a current average floor-area-ratio (FAR) of 0.41 to a future average of 0.45.

2.3.3   Diurnal Base Wastewater Flow Patterns

In most sewer systems, BWF exhibits typical diurnal patterns depending on the type of land use. For Santa Clara, typical diurnal curves were developed for residential, commercial, and industrial areas, for both weekend and weekday conditions. These curves are shown in **Figure 2-4**. Each area of the system was assigned a diurnal curve according to its predominant land use type.

APPENDIX K

2009 SANITARY SEWER CAPACITY ASSESSMENT

Table 2-1: Base Wastewater Unit Flow Factors

Land Use	Unit Flow Factor	Basis
Low Density Residential	245 gpd/DU[a]	2007 Capacity Assessment
Medium Density Residential	154 gpd/DU	2007 Capacity Assessment
High Density Residential	154 gpd/DU	2007 Capacity Assessment
Retail & Residential[b]	154 gpd/DU	2007 Capacity Assessment
Commercial[c]	0.1 gpd/sq. ft.[d]	2007 Capacity Assessment
Hotel	0.48 gpd/sq. ft.	Standard Unit Flow Factor per SJ/SC WPCP[e]
Industrial/Office/R&D[f] (higher intensity)	0.15 gpd/sq. ft.	2007 Capacity Assessment
Warehouse Manufacturing	0.052 gpd/sq. ft.	Standard Unit Flow Factor per SJ/SC WPCP
Public/Institutional	0.15 gpd/sq.ft	Assumed to be similar to Office/R&D uses
Parks/Recreation	--	Assumed to generate little or no flow

a.   gpd/DU = gallons per day per dwelling unit
b.   Flow assumed to be primarily residential
c.   Including neighborhood and regional commercial services, retail, office, and auto sales
d.   gpd/sq. ft. = gallons per day per square foot of building floor space
e.   SJ/SC WPCP = San Jose / Santa Clara Water Pollution Control Plant
f.   R&D = Research & Development

In some cases, the demolition of existing development was identified by City staff. In these cases, the estimated flow from the existing development was subtracted out from the model baseline flow.

In general, the BWF generated by a development parcel was calculated as follow:

BWF = (Size of New Development x Unit Flow Factor) – (Demolition of Existing Development x Unit Flow Factor)

A table of the computed BWF for each sewer subbasin can be found in **Appendix B**.

Table 2-2 shows the estimated average dry weather flow (ADWF), peak dry weather flow (PDWF), and peak wet weather flow (PWWF) for each of the three General Plan Update phases. As per the 2007 Capacity Assessment, flows from Cupertino Sanitary District were included in the model up to the District's contracted maximum capacity in the City's sewer system.

Table 2-2: Summary of Wastewater Flow Estimates

Scenario	ADWF [a] (MGD)	PDWF [a] (MGD)	PWWF [b] (MGD)
Phase 1	26.8	34.9	53.5
Phase 2	28.7	37.2	56.0
Phase 3	30.6	39.5	57.8

a.   ADWF and PDWF represent a non-rainfall wintertime condition and include groundwater infiltration.
b.   PWWF represents peak flow for a 10-year frequency design storm.

![V&A consulting engineers]

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