

APPENDIX E5

Fiddymment Ranch SPA No. 3 & Phase 2 Sanitary Sewer Study

**FIDDYMENT RANCH SPA No. 3
& Phase 2**

Sanitary Sewer Study

Prepared For:

Signature Properties

City of Roseville / Placer County, CA

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- Appendix B: RMC Technical Memorandum (TM) No. 3a
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- Appendix D: RMC TM No. 2a
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List of Abbreviations:

ac	acres
ADWF	average dry weather flow
BSF	base sanitary flow
CC	Commercial
CMU	Commercial Mixed Use
du, DU	dwelling unit
ea	each
ft	feet
gpd	gallons per day
GWI	ground water infiltration
LDR	Low Density Residential
MDR	Medium Density Residential
mgd	million gallons per day
OS	Open Space
PGC	Pleasant Grove Creek
P/QP	Public / Quasi-Public
PGWWTP	Pleasant Grove Waste Water Treatment Plant
PWWF	peak wet weather flow
RDI/I	rainfall dependant infiltration/inflow
SPA3	Specific Plan Amendment No. 3
Systems Evaluation	South Placer Regional Wastewater and Recycled Water Systems Evaluation (December 2009)
TM	Technical Memorandum
UGA	Urban Growth Area
WRSP	West Roseville Specific Plan



I. INTRODUCTION

Study Purpose and Objectives

The purpose of this Sanitary Sewer Study is to define the Sanitary Sewer backbone infrastructure needed to support the development intensification defined by the Fiddymment Ranch Specific Plan Amendment No.3 (SPA3) and adjacent Urban Growth Area Placer Ranch as outlined in the South Placer Regional Waste Water and Recycled Water System Evaluation Report (Systems Evaluation) dated December 2009. The process includes identification of the Sanitary Sewer service area, evaluation and calculation of wastewater flow, and sizing of sewer siphon and pipe networks.

Study Area

The Fiddymment Ranch development, a primarily residential community of approximately 1,678 acres located near the intersection of Blue Oaks Boulevard and Fiddymment Road in northwest Roseville, is bounded at the north by the Placer County Boundary and future Placer Ranch Development, at the east by the existing Crocker Ranch community, at south by the concurrent West Park Development and the west by the existing Pleasant Grove Wastewater Treatment Plant (PGWWTP) Facility and portions the planned Creekview community. This study will be considering wastewater flow contributions from the overall Fiddymment Ranch development area (6,112 dwelling units), both existing and proposed. Flow contributions from Placer Ranch will also be considered as it relates to the existing Pleasant Grove Creek East Crossing. A regional vicinity map locating the Fiddymment Ranch boundary is shown in the following **Figure 1-1**.



Sanitary Sewer Study for Fiddyment Ranch

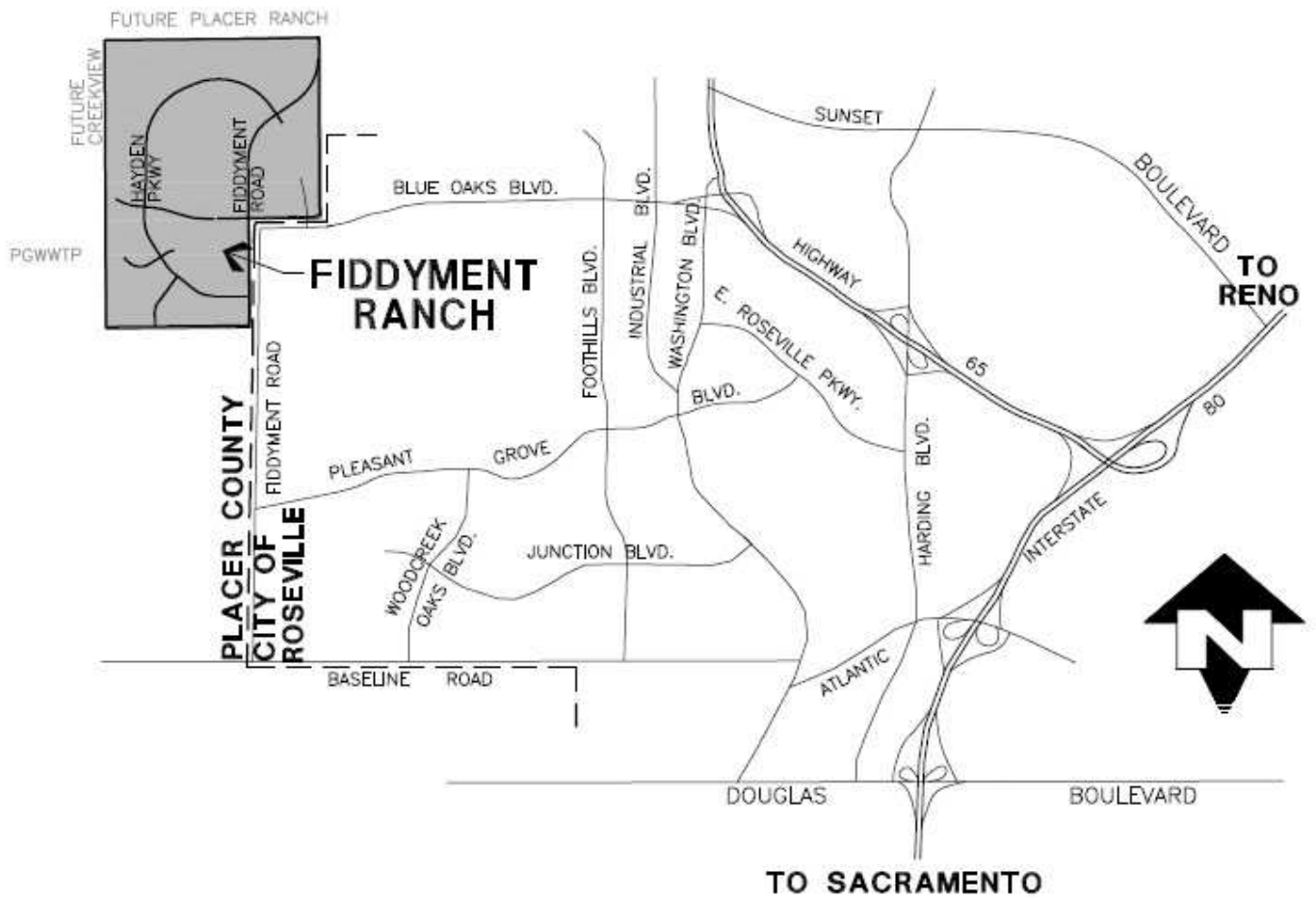


Figure 1-1 Regional Location Map



Background

The basis of this study was taken from multiple previously submitted and approved sewer study documents for Fiddymment Ranch including:

- 1) “Preliminary Investigation of Wastewater system for the West Roseville Specific Plans” by Mortin Pitalo dated October 2003.
- 2) “Master Sewer Study for Fiddymment Ranch – Phase 1” by Wood Rodgers dated December 2004.
- 3) “Alternative Sewer Study for Fiddymment Ranch – Phase 2” by Wood Rodgers dated April 12, 2007
- 4) “Sewer Study for Fiddymment Ranch – HDR Increased Density – Parcels F-21 Thru F-24” by Wood Rodgers dated March 12, 2008.

And the findings presented in

- 5) “South Placer Regional Wastewater and Recycled Water Systems Evaluation by RMC dated December 2009 (Systems Evaluation).

The Systems Evaluation was conducted to:

- Document the June 2004 capacity and loading on regional trunk sewer, wastewater treatment, and recycled water infrastructure and facilities present in June 2004.
- Project buildout conditions based upon regional planning documents and planned regional developments in southwestern Placer County.
- Present a Regional System evaluation with system deficiencies identified and capital projects forecasted, which will inform the South Placer Wastewater Authority (SPWA) partners in identifying their June 2004 and buildout ability to provide service for planned and proposed development.

Information in the December 2009 Systems Evaluation included updated land use assumptions for Fiddymment Ranch and West Park developments, encompassing all land plan changes available to date since the original WRSP EIR. The revised ADWF contribution value from WRSP is published in the Systems Evaluation as 2.07 mgd.

Although the Systems Evaluation does not specifically itemize the Fiddymment Ranch flow contribution to the PGWWTP (as it was part of a larger area referenced West Roseville Specific Plans (WRSP), including flow from concurrent development West Park), the City of Roseville Environmental Utilities Department’s own internal 2009 System Evaluation found



Sanitary Sewer Study for Fiddymment Ranch

Fiddymment Ranch ADWF to be 1.15 mgd (for a total of 6,501 units). Below is a comparison of ADWF values as for the original WRSP and the latest December 2009 Systems Evaluation Report.

Table 1-1: ADWF Values from Previous Publications

Previous Published Document			
	Original Flow per WRSP	December 2009 Systems Evaluation	Proposed 2010 Re-Zones
Fiddymment Ranch	0.80 mgd	1.15 mgd	1.09 mgd
West Park	0.91 mgd	0.92 mgd	0.94 mgd
TOTAL	1.71 mgd	2.07 mgd	2.03 mgd

Average Dry Weather Flow projections for Placer Ranch have been taken from recent email correspondence between the City of Roseville Environmental Utilities Department, RMC, and Wood Rodgers (see **Appendix F**) with details as follows:

Table 1-2: Placer Ranch Flow Projections (RMC April 2010)

SPWA_LU	Acres	Acres or Dwelling Units	BSF Unit Factor (gpd/unit)	Base Sanitary Flow (gpd)	ADWF Unit Factor (gpd/unit)	ADWF (gpd)
Commercial	402	402	800	321,288	850	341,369
Light Industrial	2,159	2,159	800	1,727,493	850	1,835,461
Mixed Use	34	34	2160	73,802	2300	78,585
Open Space	329	329	0	0	0	0
Parks > 10 Acres	36	36	10	364	10	364
Public/Quasi-Public	48	222	620	137,372	660	146,235
Residential Mult. DU	502	6,652	120	798,240	130	864,700
Schools	40	40	160	6,427	170	6,828
Point Sources						
University	173			500,000		500,000
Toad Hill Estates	-			25,000		25,000
Total	3,725	acres		3,589,986		3,798,542
GWI (100 gpd/acre)	372,487	gpd				



Study Process

This study analyzes the hydraulics of the proposed sanitary sewer pipe facilities using the information from the current land use plan, SPA3, for Fiddymment Ranch and implements the design guidelines outlined in the Systems Evaluation Report to generate the sanitary sewer flows and size the pipe network. The design guidelines outlined in the Systems Evaluation Report have also been adopted by the City and are additionally listed in the City's 2010 Design Standards; both were used as the basis of this Study's evaluation criteria.

The methods of evaluation and design used in this study are broken into two categories, 1) Design of 15" diameter and smaller, and 2) Design of pipe larger than 15" diameter (trunk sewer). Both methods are listed in greater detail below.

Category (1) Design of 15" diameter pipe and smaller

Determining the flows needed for sizing the pipes within this category follow a series of simple formulas, as outlined in the 2010 City of Roseville Design Standards, which are listed below:

- (Land Use) x (ADWF Unit Flow Factor) = **ADWF**
- (ADWF) x (**Safety Factor**) = Factored Flow
- (Factored Flow) x (Peaking Factor) = **PWWF**

The following are details of each step:

Average Dry Weather Flow (ADWF)

The first step in determining the sanitary sewer ADWF generated is to multiply the proposed land use for a particular area by the defined ADWF unit flow factor. Land uses are identified according to the "Consolidated Land Use Codes" table described in RMC TM 1b, referenced in **Appendix A**. The ADWF unit flow factors used for sizing smaller pipe facilities are the same as that used in treatment plant analysis and are shown in **Table 1-3**, and can additionally be referenced in **Appendix B** (Systems Evaluation TM 3a). These factors include the average flow coming from the specific land use area and an allowance for dry season Groundwater Infiltration (GWI) due to pipe system defects.



Table 1-3: ADWF Unit Flow Factors Used for Treatment Plant Analysis

Land Use Designation	Units	Flow Factor (gpd/unit)
Commercial	gpd per acre	850
Heavy Industrial	gpd per acre	850
Light Industrial	gpd per acre	850
Mixed Use	gpd per acre	2300
Public/Quasi-Public	gpd per acre	660
Schools	gpd per acre	170
Residential 1 DU	gpd per DU	190
Residential 2 DU	gpd per DU	190
Residential 3 DU	gpd per DU	190
Residential Multiple DU	gpd per acre	2,040
	or gpd per DU	or 130
Open Space	gpd per acre	0
Parks > 10 Acres ⁽¹⁾	gpd per acre	10
Vacant	gpd per acre	0

1. Parks less than 10 ac. do not generate a significant amount of flow, and were not evaluated in this study.

Safety Factor

Following calculation of the ADWF, a safety factor of 2.0 is incorporated to establish the Factored Flow. As defined in the Systems Evaluation TM 3a (**Appendix B**), this safety factor accommodates for the following:

- Account for changes that may occur over time in the behavior of residential and nonresidential contributors to the sewer systems, such as increased indoor water use;
- Account for changes in environmental conditions (higher groundwater table and consequent higher GWI) and changes in infrastructure (aging pipes, etc.);
- Provide for safety to adequately size the infrastructure to avoid any sanitary sewer overflows due to under-sizing;
- Account for the increasing friction losses (increase in the roughness coefficient) due to pipe aging; and,
- Account for nominal pipe diameter decreases due to accumulation of material adhering to the walls of the sewer piping and restricting capacity.



Peak Wet Weather Flow (PWWF)

Before sizing the pipe in the collection system a Peaking Factor will need to be applied to the Factored Flow to determine the PWWF value. The Systems Evaluation Report (and the City Standards) provides a graphical curve used in determining the Peaking Factor which is shown in **Figure 1-3**. This curve accounts for the following:

- Diurnal Peaking factor ranging from 1.8 to 3.0 depending on area size
- GWI at 150 gpd/ac
- RDI/I at 700 gpd/ac
- Peak diurnal flow concurrent with Peak RDI/I flow

Reference to this curve and additional details of its derivation are provided in the Systems Evaluation TM 3a (**Appendix B**).

Pipe Sizing Criteria

Following are additional criteria used in sizing the pipe of smaller collection systems from the 2010 City of Roseville Design Standards:

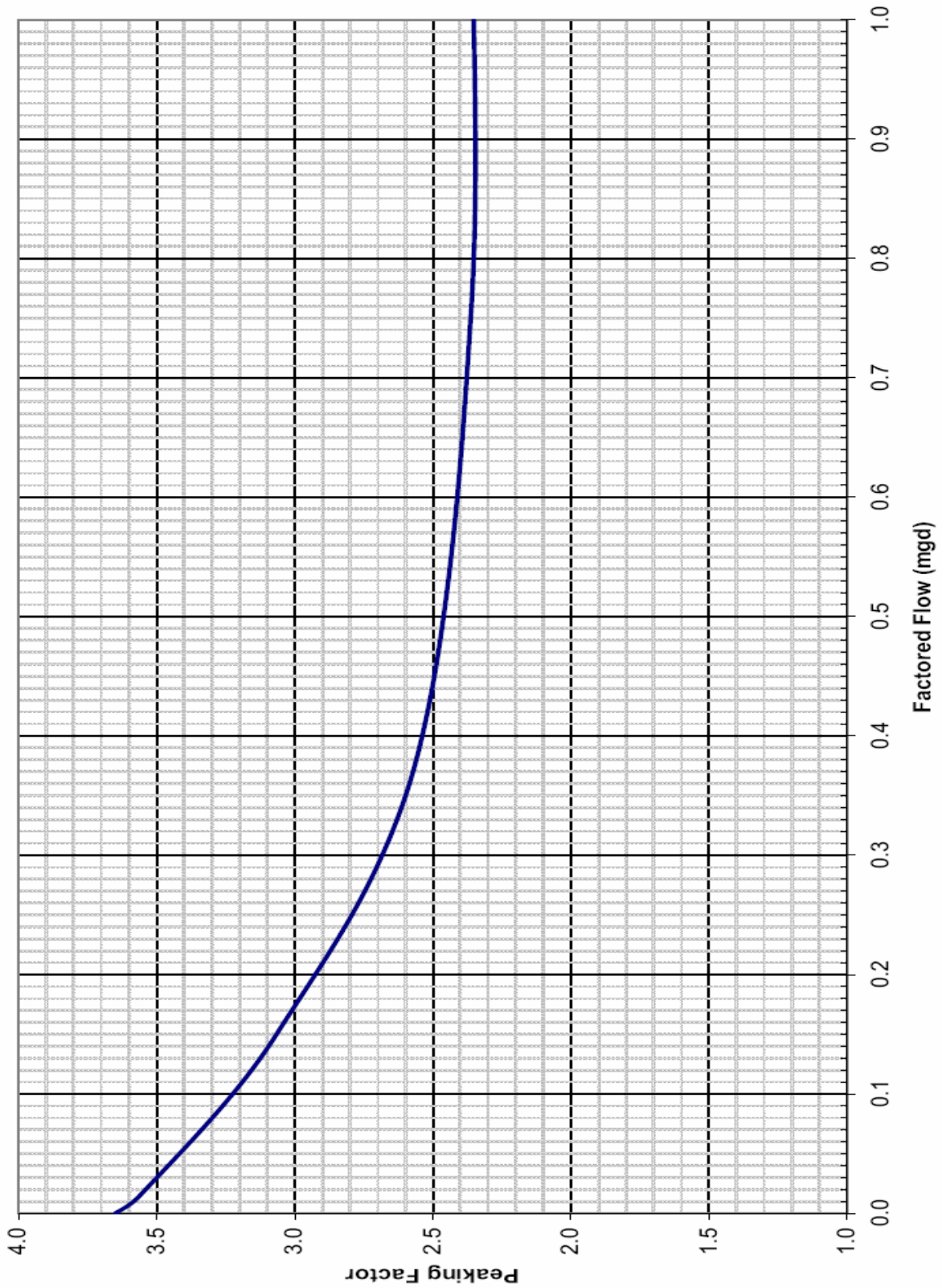
- A Manning’s “n” value of 0.013 for all gravity pipe flow calculations
- A Hazen-Williams roughness coefficient of 120 for all force main pipe
- Pipes 10” diameter and smaller are to be designed to flow at 70% capacity
- Pipes 12” and 15” in diameter are designed to flow full, unless direct individual service connections occur, then pipe is designed to flow 70% full. **Table 1-4** below lists the gravity pipe flow capacities when at a minimum slope.

Table 1-4: Minimum Pipe Slope and Flow Capacities

Pipe Diameter (in)	Slope (ft/ft)	Capacity at .7 depth	Capacity Flowing Full
6	0.005	0.22 MGD	-
8	0.0035	0.38 MGD	-
10	0.0025	0.58 MGD	-
12	0.002	0.85 MGD	1.00 MGD
15	0.0015	1.32 MGD	1.60 MGD



Figure 1-3: City of Roseville Design Peaking Factor Curve



Category (2) Pipe that is larger than 15” diameter (Trunk Sewer)

Accurately sizing the trunk sewer facilities consistent with the Systems Evaluation Report requires the use of dynamic sewer modeling software H₂O Map Sewer Pro. The model for this Study was set up using the following criteria:

- Calculation of the **BSF** for a particular sewer shed area
$$(\text{Land Use}) \times (\text{BSF Unit Flow Factor}) = \text{BSF}$$
- Application of a City of Roseville Specific land use diurnal peaking factor as previously developed by RMC with the Systems Evaluation
$$(\text{BSF}) \times (\text{Diurnal Peaking Curve}) = \text{Model Output Base Flow}$$
- Calculation of shed area where Wet Season GWI and Wet Season RDI/I will be calculated
$$(\text{Sub Basin Area}) \times (\text{Wet Season GWI rate}) = \text{Wet Season GWI}$$

$$(\text{Sub Basin Area}) \times (\text{Unit hydrograph} + \text{hyetograph}) = \text{RDI/I}$$
- Run H₂O Map Sewer Model using a 72 hour simulation time (“DESIGN72”)

The following are details of each step:

Base Sanitary Flow (BSF)

There are a separate set of flow factors, Base Sanitary Flow (BSF) unit flow factors, used in the evaluation of trunk sewer pipe collection systems larger than 15” diameter. The BSF unit flow factors are listed below in **Table 1-5** and can additionally be referenced in the System Evaluation: Chapter 3, provided in Appendix C. The BSF unit flow factors differ from the ADWF unit flow factors in that they do not include allowances for dry season GWI. For this particular Study the dry season GWI will be zero. The Systems Evaluation TM 2a (Appendix D) validates that the Pleasant Grove Creek Sewer Shed was determined to be a “tight” system and is reported to have no dry season GWI.



Table 1-5: BSF Unit Flow Factors Used for Trunk Sewer Modeling

Land Use Designation	Units	Flow Factor (gpd/unit)
Commercial	gpd per acre	800
Heavy Industrial	gpd per acre	800
Light Industrial	gpd per acre	800
Mixed Use	gpd per acre	2160
Public/Quasi-Public	gpd per acre	620
Schools	gpd per acre	160
Residential 1 DU	gpd per DU	180
Residential 2 DU	gpd per DU	180
Residential 3 DU	gpd per DU	180
Residential Multiple DU	gpd per acre <u>or</u> gpd per DU	1,920 or 120
Open Space	gpd per acre	0
Parks > 10 Acres ⁽¹⁾	gpd per acre	10
Vacant	gpd per acre	0

1. Parks less than 10 ac. do not generate a significant amount of flow, and were not evaluated in this study

Diurnal Peaking Curve

Three diurnal peaking factor curves were previously developed with the Systems Evaluation Dynamic Model. These curves describe the different peaking produced by the Residential, Commercial, and Industrial flow classes. **Table 1-6** indicates how the diurnal curves were applied to the BSF from each land use description.

Sub-Basin Area

Wet Season GWI and RDI/I are calculated using two different methods. Using the defined sub-basin area for a particular shed and multiplying by a predefined wet season GWI rate of 100 gpd/ac, for the Pleasant Grove Wastewater Treatment plan shed (see TM 2c, **Appendix E**), the wet season GWI is input as a point load at the loading manhole. Consistent with the System Evaluation (TM 2c, **Appendix E**) wet season GWI was not applied to parks and open space. H₂O Map Sewer Pro independently calculates RDI/I through the definition of a synthetic



hydrograph and hyetograph for the study area and its dynamic application to a particular sub basin area. This Study utilized the previously established unit hydrograph (“UGA”) and the design storm hyetograph (“DESIGNSTORMREV”), as defined within the System Evaluation Model, for analysis of all Fiddymment Ranch trunk sewer pipe networks.

Table 1-6: Application of Diurnal Curve in H20 Map Sewer Model

Land Use Designation	Diurnal Curve
Commercial	COMMERCIAL
Heavy Industrial	INDUSTRIAL
Light Industrial	INDUSTRIAL
Mixed Use	COMMERCIAL
Public/Quasi-Public	COMMERCIAL
Schools	COMMERCIAL
Residential 1 DU	RESIDENTIAL
Residential 2 DU	RESIDENTIAL
Residential 3 DU	RESIDENTIAL
Residential Multiple DU	RESIDENTIAL
Open Space	N/A
Parks > 10 Acres ⁽¹⁾	COMMERCIAL
Vacant	N/A



II. SUMMARY OF LAND USAGE

Fiddymment Ranch Overall – Phase 1, 2 & 3

The Fiddymment Ranch land use table below reflects the SPA3 proposal dated July 22, 2010, and includes as built conditions for existing villages and other developed areas in Phase 1 and 2.

The accompanying Fiddymment SPA 3 land use plan can be seen in **Figure 2-1**.

Table 2-1: Fiddymment SPA 3 Land Use by Development Phase (July 22, 2010)

Lineitems denoted in **bold** are revisions from SPA 000035 to SPA 000040 (Fiddymment Ranch Phase 3 SPA)

PARCEL	GENERAL PLAN LAND USE (Specific Plan Land Use)	LAND USE ACRES		CURRENTLY ALLOCATED UNITS (units)	SPA#3 UNITS (units)	DENSITY (du/acre)
		CURRENT (acres)	PROPOSED (acres)			
FIDDYMENT RANCH PHASE 1						
F-1A	LDR (Residential)	19.27	19.27	93	93	4.8
F-1B	LDR (Residential)	21.00	21.00	83	83	4.0
F-2	LDR (Residential)	31.59	31.59	127	127	4.0
F-3	LDR (Residential)	24.57	24.57	135	135	5.5
F-4	LDR (Residential)	34.64	34.64	78	78	2.3
F-5	LDR (Residential)	51.62	51.62	157	157	3.0
F-17	MDR (Residential)	17.52	17.52	131	131	7.5
F-20	HDR (Residential)	6.93	6.93	156	156	22.5
F-21	HDR (Residential)	14.46	14.46	289	361	20.0 to 25.0
F-22	HDR (Residential)	10.33	10.33	207	258	20.0 to 25.0
F-23	HDR (Residential)	11.72	11.72	234	293	20.0 to 25.0
F-24	HDR (Residential)	12.62	12.62	253	315	20.0 to 25.0
F-30	CC (Commercial)	8.59	8.59			
F-31	CC (Commercial)	13.83	13.83			
F-35	CC (Commercial)	1.88	1.88			
F-53	PR (Park)	6.31	6.31			
F-56	PR (Sports Complex)	45.35	45.35			
F-65	PQP (Substation)	1.55	1.55			
F-67	PQP (Well)	0.17	0.17			
F-72	PQP (High School)	52.85	52.85			
F-73	PQP (Fire Station)	2.51	2.51			
F-86	OS (Open Space)	12.94	12.94			
F-87	OS (Open Space)	8.98	8.98			
F-88	OS (Open Space)	18.32	18.32			
F-89	OS (Open Space)	0.74	0.74			
F-99	LDR (Pocket Park)	2.77	2.77			
F-100	LDR (Pocket Park)	2.52	2.52			
PHASE 1 TOTAL		435.58	435.58	1943	2187	



Sanitary Sewer Study for Fiddymment Ranch

PARCEL	GENERAL PLAN LAND USE (Specific Plan Land Use)	LAND USE ACRES		CURRENTLY ALLOCATED UNITS (units)	SPA#3 UNITS (units)	DENSITY (du/acre)
		CURRENT (acres)	PROPOSED (acres)			
FIDDYMENT RANCH PHASE 2						
F-7*	LDR (Residential)	38.03		87		2.3
F-7	LDR (Residential)		22.59		115	5.1
F-9	LDR (Residential)	100.13		378		3.8
F-9A	LDR (Residential)		21.38		108	5.1
F-9B	LDR (Residential)		21.11		96	4.5
F-9C	LDR (Residential)		21.20		107	5.0
F-9D	LDR (Residential)		12.38		35	2.8
F-12*	LDR (Residential)	53.24		117		2.2
F-12	LDR (Residential)		22.03		113	5.1
F-13	LDR (Residential)	54.95		121		2.2
F-13A	LDR (Residential)		19.81		90	4.5
F-13B	LDR (Residential)		33.22		159	4.8
F-14	LDR (Residential)	104.66	104.66	422	422	4.0
F-15A	LDR (Residential)	17.74	17.74	76	76	4.3
F-15B	LDR (Residential)	12.00	12.00	45	45	3.8
F-15C	LDR (Residential)	12.48	12.48	46	46	3.7
F-16	LDR (Residential)	29.27	29.27	110	110	3.8
F-19	LDR (Residential)	27.01		104		3.9
F-19A	LDR (Residential)		27.30		135	4.9
F-19B	LDR (Residential)		34.64		135	3.9
F-25	HDR (Residential)	5.49	5.49	137	137	25.0
F-26	HDR (Residential)	5.60	5.60	140	140	25.0
F-32	CC (Commercial)	4.67	4.67			
F-33	CC (Commercial)	4.68	4.68			
F-50	PR (Park)	7.80	7.80			
F-52	PR (Park)	6.33	6.33			
F-66	PQP (Well)	0.23	0.23			
F-70	PQP (Elementary School)	8.51	8.51			
F-80	OS (Open Space)	131.80	131.89			
F-81*	LDR (Residential)	1.98		0		4.0
F-81	CC (Commercial)		2.27		0	0.0
F-90	OS (Paseo)	1.32				
F-90A	OS (Paseo)		0.28			
F-90B	OS (Paseo)		0.56			
F-90C	OS (Paseo)		0.96			
F-92	OS (Paseo)	2.35				
F-92A	OS (Paseo)		0.96			
F-92B	OS (Paseo)		0.72			
F-93	OS (Paseo)	1.66	0.95			
F-95	LDR (Pocket Park)	4.01	1.27			
F-96	LDR (Pocket Park)	2.51	1.30			
F-97	LDR (Pocket Park)	2.72	1.32			
F-98	LDR (Pocket Park)	2.00	2.00			
F-101	LDR (Pocket Park)		1.00			
PHAES 2 TOTAL		643.17	600.60	1783	2069	



Sanitary Sewer Study for Fiddymment Ranch

PARCEL	GENERAL PLAN LAND USE (Specific Plan Land Use)	LAND USE ACRES		CURRENTLY ALLOCATED UNITS (units)	SPA#3 UNITS (units)	DENSITY (du/acre)
		CURRENT (acres)	PROPOSED (acres)			

FIDDYMENT RANCH PHASE 3						
F-6	LDR (Residential)	60.86		140		2.3
F-6A	LDR (Residential)		32.29		155	4.8
F-6B	HDR (Residential)		7.80		195	25.0
F-6C	MDR (Residential)		26.63		300	11.3
F-6D	CC (Commercial)		5.00			
F-8	LDR (Residential)	32.17		74		2.3
F-8A	HDR (Residential)		11.08		277	25
F-8B	MDR (Residential)		11.80		127	10.8
F-8C	LDR (Residential)		14.94		83	5.6
F-8D	LDR (Residential)		11.60		35	3.0
F-10	LDR (Residential)	83.14		183		2.2
F-10A	LDR (Residential)		29.03		122	4.2
F-10B	LDR (Residential)		22.23		118	5.3
F-10C	LDR (Residential)		20.42		90	4.4
F-11	LDR (Residential)	38.26		84		2.2
F-11A	LDR (Residential)		31.34		172	5.5
F-11B	MDR (Residential)		17.37		182	10.5
F-34	CC (Commercial)	5.32	5.32			
F-51	PR (Park)	8.91	11.89			
F-54	PR (Fiddymment Park)	95.56	95.56			
F-55	PR (Sports Complex)	29.76	29.80			
F-71	PQP (Elementary School)	8.70	10.60			
F-83	OS (Open Space)	59.17	59.17			
F-84	OS (Open Space)	81.20	81.22			
F-85	OS (Open Space)	26.91	26.92			
F-91	OS (Paseo)	1.38				
F-91A	OS (Paseo)		0.83			
F-91B	OS (Paseo)		0.45			
F-91C	OS (Paseo)		1.00			
F-94	LDR (Pocket Park)	4.01	1.25			
PHASE 3 TOTAL		535.35	565.54	481	1856	

F-200	ROW (Right of Way)	63.42	75.8			
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FIDDYMENT RANCH TOTAL		1677.52	1677.52	4207	6112	
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III. SANITARY SEWER ADWF TABLES & H₂O MAP SEWER OUTPUT

Fiddymment Ranch – Phase 1, 2, & 3

The following **Table 3-1, Table 3-2, Table 3-3, & Table 3-4** summarize the flows generated from all Fiddymment Ranch parcels, both existing and proposed. Each major sewer shed and its trunk connection point, to either the head works structure or the 72”/78” Pleasant Grove Trunk Sewer, have been separated into sewer phases 1a, 1b, 2, and 3 in conformance with the land used plan phase boundaries. These tables show both the calculations and results using the ADWF unit flow factors for sizing pipe 15” and smaller, and the BSF unit flow factors for use with the dynamic model. Output from the H₂O Map Sewer model for the trunk sewer segments are also shown and independently noted. The tables in this section list the input nodes as shown in the *Fiddymment Ranch SPA#3 Overall Sanitary Sewer Shed Map (Appendix K)*, and are additionally replicated on that map.



**Table 3-1:
FIDDYMENT RANCH SEWER FLOW ANALYSIS
Phase 1a SPA3 (Sept 2010)**

REFERENCE NODE	CONTRI-BUTING FLOW	SINGLE FAM. UNITS (LDR/MDR)			MULTI- FAMILY UNITS (HDR)			SCHOOL			COMMERCIAL/IND/BP			PARK			TOTAL	FACTORED	PEAK	TOTAL	EX. PIPE	EX. PIPE	% FULL (3)	% FULL (4)	
		UNITS	CUM UNITS	Q(ADWF)	UNITS	CUM UNITS	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	Q(ADWF)	FLOW	FACTOR	Q(PWWF)	SIZE	SLOPE	Q(PWWF)	Q(PWWF)	
#		#	#	MGD	#	#	MGD	ac	ac	MGD	ac	ac	MGD	ac	ac	MGD	MGD	MGD	MGD	IN.	FT/FT	(d/D)	(d/D)		
A1	F-1A	93	93	0.0177													0.0177	0.0353							
	F-1B	83	83	0.0158													0.0158	0.0315							
	F-2	127	127	0.0241													0.0241	0.0483							
	F-3	135	135	0.0257													0.0257	0.0513							
	F-4	78	78	0.0148													0.0148	0.0296							
	F-5	157	157	0.0298													0.0298	0.0597							
	F-20				156	156	0.0203										0.0203	0.0406							
	F-34										5.3	5.3	0.0045				0.0045	0.0090							
	F-53													6.3	6.3	0.0000	0.0000	0.0000							
	F-72							52.9	52.9	0.00898							0.0090	0.0180							
	F-73										2.5	2.5	0.0021				0.0021	0.0043							
	F-99													2.8	2.8	0.0000	0.0000	0.0000							
	F-100													2.5	2.5	0.0000	0.0000	0.0000							
	ADWF SUBTOTAL		673	0.1279		156	0.0203		52.9	0.00898		7.81	0.0066		11.6	0.0001	0.1639	0.3278	2.640		0.8653	15	0.0015	52	54
	BSF SUBTOTAL		673	0.1211 ¹		156	0.0187 ¹		52.9	0.00846 ¹		7.8	0.0062 ¹		11.6	0.0001 ¹	0.1547	See H2OMAP Hydraulic Sewer Model Calculations		0.4560 ²	15	0.0015	36	29	

Notes:

1. Average sanitary flows calculated using the Base Sanitary Flows (for Trunk Sewer Modeling) per the South Placer Regional Wastewater and Recycled Water Systems Evaluation report (Chapter 3) prepared by RMC dated December 2009.
2. Total peak sewer flow calculated using H2OMAP hydraulic modeling software.
3. % Full calculated using "Flow Master" program (a Haestad Methods Software)
4. % Full calculated using hand calculation method

**Table 3-2:
FIDDYMENT RANCH SEWER FLOW ANALYSIS
Phase 1b SPA3 (Sept 2010)**

REFERENCE NODE	CONTRI-BUTING FLOW	SINGLE FAM. UNITS (LDR/MDR)			MULTI- FAMILY UNITS (HDR)			SCHOOL			COMMERCIAL/IND/BP			PARK			TOTAL	FACTORED	PEAK	TOTAL	EX. PIPE	EX. PIPE	% FULL (3)	% FULL (4)
		UNITS	CUM UNITS	Q(ADWF)	UNITS	CUM UNITS	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	Q(ADWF)	FLOW	FACTOR	Q(PWWF)	SIZE	SLOPE	Q(PWWF)	Q(PWWF)
#		#	MGD	#	MGD	ac	ac	MGD	ac	ac	MGD	ac	ac	MGD	MGD	MGD	MGD	MGD	MGD	IN.	FT/FT	(d/D)	(d/D)	
B1	F-65, F-30, F-21				361	361	0.0469				10.2	10.2	0.0087				0.0556	0.1112	3.180	0.3536	8	0.0035	66	65
B2	B1 & F-35				361	361	0.0469				1.9	12.1	0.0103				0.0572	0.1144	3.180	0.3639	8	0.0145	43	67
B3	F-17	131	131	0.0249												0.0249	0.0498	3.410	0.1697	8	0.0035	42	31	
B4	B3 & F-24 & F23		131	0.0249	608	608	0.0790									0.1039	0.2079	2.890	0.6007	12	0.0020	55	49	
B5	B4 & F-22 & F-31		131	0.0249	258	866	0.1126				13.8	13.8	0.0117				0.1492	0.2984	2.680	0.7997	12	0.0020	66	66
B5A	B5		131	0.0249		866	0.1126				13.8	0.0117				0.1492	0.2984	2.680	0.7997	15	0.0020	46	50	
B6	B2 & B5a		131	0.0249		1227	0.1595				25.9	0.0220				0.2064	0.4128	2.530	1.0445	15	0.0062	39	*	
B6	ADWF SUBTOTAL		131	0.0249		1227	0.1595				25.9	0.0220				0.2064								
B6	BSF SUBTOTAL		131	0.0236 ¹		1227	0.1472 ¹				25.9	0.0207 ¹				0.1915	See H2OMAP Hydraulic Sewer Model Calculations		0.3770 ²	15	0.0062	23	*	

Notes:

1. Average sanitary flows calculated using the Base Sanitary Flows (for Trunk Sewer Modeling) per the South Placer Regional Wastewater and Recycled Water Systems Evaluation report (Chapter 3) prepared by RMC dated December 2009.
 2. Total peak sewer flow calculated using H2OMAP hydraulic modeling software.
 3. % Full calculated using "Flow Master" program (a Haestad Methods Software)
 4. % Full calculated using hand calculation method
- * = Hand Calculation (Linear Approximation) not shown due to slope value greater than minimum

**Table 3-3:
FIDDYMENT RANCH SEWER FLOW ANALYSIS
Phase 2 SPA3 (Sept 2010)**

REFERENCE NODE	CONTRI-BUTING FLOW	SINGLE FAM. UNITS (LDR/MDR)			MULTI- FAMILY UNITS (HDR)			SCHOOL			COMMERCIAL/IND/BP			PARK			TOTAL	FACTORED	PEAK	TOTAL	PIPE	PIPE	% FULL (3)	% FULL (4)
		UNITS	CUM UNITS	Q(ADWF)	UNITS	CUM UNITS	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	Q(ADWF)	FLOW	FACTOR	Q(PWWF)	SIZE	SLOPE	Q(PWWF)	Q(PWWF)
#		#	#	MGD	#	#	ac	ac	MGD	ac	ac	MGD	ac	ac	MGD	MGD	MGD	MGD	MGD	IN.	FT/FT	(d/D)	(d/D)	
C1	F-19A, F-13B, F14A1, F-14A2, F-14D1, F-14D2, F-70 & F-50	328	328	0.0623			8.5	8.5	0.00145				7.8	7.8	0.0000	0.0638	0.1275	3.100	0.3953	10	0.0025	53	48	
C2	C1 & F-14B1, F-14B2, F-14C1, F-14C2, F-81, F-98	218	546	0.1037				8.5	0.00145	2.3	2.3	0.0019	2.0	7.8	0.0000	0.1071	0.2142	2.850	0.6106	10	0.0026	71	*	
C3	C2 & F-32, F-33		546	0.1037				8.5	0.00145	9.4	11.7	0.0099		7.8	0.0000	0.1151	0.2302	2.820	0.6492	12	0.0020	58	53	
C4	C3 & F-25, F-26		546	0.1037	277	277	8.5	0.00145	0.0360		11.7	0.0099		7.8	0.0000	0.1511	0.3022	2.660	0.8039	12	0.0020	67	66	
C4A	C4		546	0.1037		277	8.5	0.00145	0.0360		11.7	0.0099		7.8	0.0000	0.1511	0.3022	2.660	0.8039	18	0.0123	22		
C5	F-19A, F-19B	230	230	0.0437												0.0437	0.0874	3.280	0.2867	8	0.0035	57	53	
C6	C5 & F-9A, F-9B, F-96	126	356	0.0676									1.3	1.3	0.0000	0.0676	0.1353	3.100	0.4194	10	0.0025	55	51	
C7	C6 & F-9C, F-16A, F-16B	124	480	0.0912										1.3	0.0000	0.0912	0.1824	2.980	0.5436	12	0.0020	52	45	
C8	C4 & C7 & F-52		1026	0.1847 ¹		277	8.5	0.00136 ¹	0.0332 ¹		11.7	0.0093 ¹	6.3	15.4	0.0002	0.2288	See H2OMAP Hydraulic Sewer Model Calculations		0.6040 ²	18	0.0012	35		
C9	C8 & F-15A, F-15B, F-15C	131	1157	0.2083 ¹		277	8.5	0.00136 ¹	0.0332 ¹		11.7	0.0093 ¹		15.4	0.0002	0.2524	See H2OMAP Hydraulic Sewer Model Calculations		0.6670 ²	18	0.0012	36		
C10	ADWF SUBTOTAL	36	1193	0.2267		277	8.5	0.00145	0.0360		11.67	0.0099		15.4	0.0002	0.2742								
C10	C9 & F-15C	36	1193	0.2147 ¹		277.0	8.5	0.00136 ¹	0.0332 ¹		11.7	0.0093 ¹		15.4	0.0002	0.2588	See H2OMAP Hydraulic Sewer Model Calculations		0.6790 ²	18	0.0012	37		
C12	PLACER RANCH ADWF SUBTOTAL															3.7985								
C11	PLACER RANCH															3.5900	See H2OMAP Hydraulic Sewer Model Calculations		7.7330 ³	30	0.0243	29		
C12	ADWF SUBTOTAL		1193	0.2267		277	8.5	0.00145	0.0360		11.67	0.0099		15.4	0.0002	4.0727								
C12	C10 & C11		1193	0.2147 ¹		277	8.5	0.00136 ¹	0.0332 ¹		11.67	0.0093 ¹		15.4	0.0002	3.8488	See H2OMAP Hydraulic Sewer Model Calculations		8.4110 ²	36	0.0010	57		

Notes:

1. Average sanitary flows calculated using the Base Sanitary Flows (for Trunk Sewer Modeling) per the South Placer Regional Wastewater and Recycled Water Systems Evaluation report (Chapter 3) prepared by RMC dated December 2009.
 2. Total peak sewer flow calculated using H2OMAP hydraulic modeling software.
 3. Allocated flow for Placer Ranch as shown in the Appendix F is ADWF=3.799 & BSF=3.590 mgd
 3. % Full calculated using "Flow Master" program (a Haestad Methods Software)
 4. % Full calculated using hand calculation method
- * = Hand Calculation (Linear Approximation) not shown due to slope value greater than minimum

**Table 3-4:
FIDDYMENT RANCH SEWER FLOW ANALYSIS
Phase 3 SPA3 (Sept 2010)**

REFERENCE NODE	CONTRI-BUTING FLOW	SINGLE FAM. UNITS (LDR/MDR)			MULTI- FAMILY UNITS (HDR)			SCHOOL			COMMERCIAL/IND/BP			PARK			TOTAL	FACTORED	PEAK	TOTAL	PIPE	PIPE	% FULL (3)	% FULL (4)	
		UNITS	CUM UNITS	Q(ADWF)	UNITS	CUM UNITS	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	AREA	CUM-AREA	Q(ADWF)	Q(ADWF)	FLOW	FACTOR	Q(PWWF)	SIZE	SLOPE	Q(PWWF)	Q(PWWF)	
#		#	#	MGD	#	#	MGD	ac	ac	MGD	ac	ac	MGD	ac	ac	MGD	MGD	MGD	MGD	IN.	FT/FT	(d/D)	(d/D)		
D1	F13B & F101	75	75	0.0143										1.0	1.0	0.0000	0.0143	0.0285	3.500	0.0998	6	0.0050	43	32	
D2	D1 & F12 & F105	113	188	0.0357										1.3	2.3	0.0000	0.0357	0.0714	3.340	0.2386	8	0.0035	51	44	
D3	F13A	90	90	0.0171													0.0171	0.0342	3.480	0.1190	6	0.0050	48	38	
D4	D2 & D3		278	0.0528											2.3	0.0000	0.0528	0.1056	3.210	0.3391	8	0.0035	64	62	
D5	F11A	172	172	0.0327													0.0327	0.0654	3.360	0.2196	8	0.0035	49	40	
D6	F10A	41	41	0.0078													0.0078	0.0156	3.560	0.0555	6	0.0050	32	18	
D7	D4, D5 & D6		491	0.0933											2.3	0.0000	0.0933	0.1866	2.960	0.5523	10	0.0025	66	67	
D8	D7, F10A	41	532	0.1011											2.3	0.0000	0.1011	0.2022	2.910	0.5883	12	0.0020	54	48	
D9	F10A, F10B, F10C, & F94	249	249	0.0473									1.3	1.3	0.0000	0.0473	0.0946	3.250	0.3075	8	0.0035	60	57		
D10	F11B	182	182	0.0346													0.0346	0.0692	3.330	0.2303	8	0.0035	50	42	
D11	D8, D9, D10		963	0.1830											3.6	0.0000	0.1830	0.3659	2.580	0.9441	12	0.0020	75	78	
D12	D11, F6D		963	0.1830							5.0	5.0	0.0043		3.6	0.0000	0.1872	0.3744	2.560	0.9586	12	0.0020	76	79	
D13	F6B				195	195	0.0254										0.0254	0.0507	3.410	0.1729	6	0.0050	60	55	
D14	D12 & D13		963	0.1830		195	0.0254						5.0	0.0043		3.6	0.0000	0.2126	0.4251	2.510	1.0671	15	0.0015	59	67
D15	F71							10.6	10.6	0.0018							0.0018	0.0036	3.610	0.0130	6	0.0050	15	4	
D16	D15 & F51								10.6	0.0018			11.9	11.9	0.0001	0.0019	0.0038	3.600	0.0138	6	0.0050	16	4		
D17	D14 & D16		963	0.1830		195	0.0254						5.0	0.0043		15.5	0.0002	0.2145	0.4291	2.500	1.0726	15	0.0015	60	67
D18	F9B	78	78	0.0148													0.0148	0.0296	3.500	0.1037	6	0.0050	44	33	
D19	D18 & F9C	93	171	0.0325													0.0325	0.0650	3.360	0.2183	6	0.0050	71	69	
D20	F9D	35	35	0.0067													0.0067	0.0133	3.580	0.0476	6	0.0050	29	15	
D21	D19, D20 & F95		206	0.0391										1.3	1.3	0.0000	0.0391	0.0783	3.320	0.2599	8	0.0035	54	48	
D22	D21 & F8D	35	241	0.0458											1.3	0.0000	0.0458	0.0916	3.260	0.2986	8	0.0035	59	55	
D23	F7	115	115	0.0219													0.0219	0.0437	3.450	0.1508	6	0.0050	55	48	
D24	D23 & F8C	83	198	0.0376													0.0376	0.0752	3.310	0.2490	8	0.0035	52	46	
D25	D22 & D24		439	0.0834											1.3	0.0000	0.0834	0.1668	3.010	0.5021	10	0.0025	62	61	
D26	D25 & F8B	127	566	0.1075													0.1075	0.2151	2.880	0.6194	12	0.0020	56	51	
D27	D26 & F8A		566	0.1075	277	277	0.0360										0.1436	0.2871	2.700	0.7752	12	0.0020	65	64	
D28	D17 & D27		1529	0.2752 ¹		472	0.0566 ¹		10.6	0.0018 ¹			5.0	0.0040 ¹		16.8	0.0002 ¹	0.3378	See H2OMAP Hydraulic Sewer Model Calculations	0.8260 ²	15	0.0015	51	52	
D29	D28 & F6C	75	1604	0.2887 ¹		472	0.0566 ¹		10.6	0.0018			5.0	0.0040 ¹		16.8	0.0002	0.3513	See H2OMAP Hydraulic Sewer Model Calculations	0.8450 ²	15	0.0015	51	53	
D30	F6A		155	0.0295													0.0295	0.0589	3.390	0.1997	6	0.0050	66	64	
D31	F6C & D30	75	230	0.0437													0.0437	0.0874	3.280	0.2867	8	0.0035	57	53	
D32	D29 & D31		1834	0.3301 ¹		472	0.0566 ¹		10.6	0.0018 ¹			5.0	0.0040 ¹		16.8	0.0002 ¹	0.3927	See H2OMAP Hydraulic Sewer Model Calculations	0.9300 ²	15	0.0015	54	58	
D33	ADWF SUBTOTAL	150	1984	0.3770		472	0.0614		10.6	0.0018			5	0.0043		16.79	0.0002	0.4445							
D33	F6C & D32	150	1984	0.3571 ¹		472	0.0566 ¹		10.6	0.0018 ¹			5.0	0.0040 ¹		16.8	0.0002 ¹	0.4197	See H2OMAP Hydraulic Sewer Model Calculations	0.9850 ²	15	0.0015	56	62	

Notes:

1. Average sanitary flows calculated using the Base Sanitary Flows (for Trunk Sewer Modeling) per the South Placer Regional Wastewater and Recycled Water Systems Evaluation report (Chapter 3) prepared by RMC dated December 2009.
2. Total peak sewer flow calculated using H2OMAP hydraulic modeling software.
3. % Full calculated using "Flow Master" program (a Haestad Methods Software)
4. % Full calculated using hand calculation method

IV. TRUNK SEWER BSF INPUT TABLE

H₂O MAP SEWER MODEL

The trunk sewer pipe network for Fiddymment Ranch as analyzed in this study is shown in **Appendix G**. This exhibit notes the manhole and pipe link identification numbers as they are listed in the model. The following **Table 4-1, Table 4-2, Table 4-3, & Table 4-4** lists the calculated values used in the model's input manhole nodes.

Table 4-1: Fiddymment Phase 1a Sewer Shed : H₂O Map Sewer Model Input Values

H2O Map Sewer Pro Manhole ID	Load 1 BSF (mgd)	Load Type	Load 2 BSF (mgd)	Load Type	Load 3 BSF (mgd)	Load Type	Load 4 BSF (mgd)	Load Type	Sub Basin Area (ac)	Hytograph	Hydrogrpah
A1	0.140	Residential	0.015	Commercial	0.000	Industrial	0.026	GWI (Wet)	261.22	DESIGNSTORMREV	UGA
A1-OUTLET	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.00	DESIGNSTORMREV	UGA

Table 4-2: Fiddymment Phase 1b Sewer Shed : H₂O Map Sewer Model Input Values

H2O Map Sewer Pro Manhole ID	Load 1 BSF (mgd)	Load Type	Load 2 BSF (mgd)	Load Type	Load 3 BSF (mgd)	Load Type	Load 4 BSF (mgd)	Load Type	Sub Basin Area (ac)	Hytograph	Hydrogrpah
B2	0.043	Residential	0.010	Commercial	0.000	Industrial	0.003	GWI (Wet)	26.56	DESIGNSTORMREV	UGA
B5A	0.128	Residential	0.011	Commercial	0.000	Industrial	0.007	GWI (Wet)	66.07	DESIGNSTORMREV	UGA
B6	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA
B6A-OUTLET	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA



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Table 4-3: Fiddymment Phase 2 Sewer Shed : H₂O Map Sewer Model Input Values

H2O Map Sewer Pro Manhole ID	Load 1 BSF (mgd)	Load Type	Load 2 BSF (mgd)	Load Type	Load 3 BSF (mgd)	Load Type	Load 4 BSF (mgd)	Load Type	Sub Basin Area (ac)	Hytograph	Hydrogrpah
C4A	0.132	Residential	0.011	Commercial	0.000	Industrial	0.016	GWI (Wet)	158.90	DESIGNSTORMREV	UGA
C7	0.086	Residential	0.000	Commercial	0.000	Industrial	0.012	GWI (Wet)	117.10	DESIGNSTORMREV	UGA
C8	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.00	DESIGNSTORMREV	UGA
C9	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.00	DESIGNSTORMREV	UGA
C9A	0.024	Residential	0.000	Commercial	0.000	Industrial	0.003	GWI (Wet)	30.00	DESIGNSTORMREV	UGA
C10	0.008	Residential	0.000	Commercial	0.000	Industrial	0.001	GWI (Wet)	8.20	DESIGNSTORMREV	UGA
C11*	0.798	Residential	0.534	Commercial	7.727	Industrial	0.372	GWI (Wet)	3725.00	DESIGNSTORMREV	UGA
C12	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.00	DESIGNSTORMREV	UGA
C12-OUTLET	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.00	DESIGNSTORMREV	UGA

* C11 also has additional point loads of "Load 5(BSF mgd) =0.500" & "Load 6(BSF mgd) =0.025"

Table 4-4: Fiddymment Phase 3 Sewer Shed : H₂O Map Sewer Model Input Values

H2O Map Sewer Pro Manhole ID	Load 1 BSF (mgd)	Load Type	Load 2 BSF (mgd)	Load Type	Load 3 BSF (mgd)	Load Type	Load 4 BSF (mgd)	Load Type	Sub Basin Area (ac)	Hytograph	Hydrogrpah
D17	0.197	Residential	0.006	Commercial	0.000	Industrial	0.021	GWI (Wet)	205.99	DESIGNSTORMREV	UGA
D27	0.135	Residential	0.000	Commercial	0.000	Industrial	0.012	GWI (Wet)	122.65	DESIGNSTORMREV	UGA
D28	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA
D29	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA
D29A	0.011	Residential	0.000	Commercial	0.000	Industrial	0.001	GWI (Wet)	6.650	DESIGNSTORMREV	UGA
D31	0.041	Residential	0.000	Commercial	0.000	Industrial	0.003	GWI (Wet)	34.770	DESIGNSTORMREV	UGA
D32	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA
D33	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA
D33B	0.027	Residential	0.000	Commercial	0.000	Industrial	0.001	GWI (Wet)	13.300	DESIGNSTORMREV	UGA
D33A-OUTLET	0.000	Residential	0.000	Commercial	0.000	Industrial	0.000	GWI (Wet)	0.000	DESIGNSTORMREV	UGA



V. STUDY RESULTS

Summary of Results

A complete summary of the results is shown in the Fiddymment Ranch SPA3 Overall Sanitary Sewer Shed Map in **Appendix K**. Supporting documentation for the trunk sewer pipe sizing, plotted from H₂O Map Sewer, is referenced in **Appendix H**.

In general, this study reveals that the intensification proposed with Fiddymment Ranch SPA3 will not exacerbate the currently approved flow projections, as presented in the December 2009 Systems Evaluation Report, for the Pleasant Grove Wastewater Treatment Plant or the capacities of any existing trunk pipe facility. Below in **Table 5-1 & Table 5-2** are summaries of this study's findings for the treatment plant analysis.

Table 5-1: SPA3 ADFW Summary

Average Dry Weather Flow (ADWF) comparison at the PGWWTP		
Fiddymment SPA3 Sewer Analysis	ADWF (mgd)	Total Residential Units
Phase 1a	0.164 (1)	828
Phase 1b	0.206 (1)	1,358
Phase 2	0.274 (1)	1,470
Phase 3	0.445 (1)	2,456
Total All Fiddymment Ranch Phases	1.089	6,112

(1) ADFW values shown reflect application of ADFW unit flow factors for WWTP flow projections as seen in Table 1-3.

Table 5-2: PGWWTP ADFW side-by-side Analysis Comparison

PGWWTP Flow Analysis (ADWF)			
	Original Flow per WRSP	Decemeber 2009 Systems Evaluation	Fiddymment SPA3
Fiddymment	0.80	1.15 mgd	1.09 mgd
West Park	0.92	0.92 mgd	0.94 mgd
WRSP Total	1.71 mgd	2.07 mgd	2.03 mgd
Demand Change since Original WRSP Approval	0.0	+0.36	+0.32



Sanitary Sewer Study for Fiddymment Ranch

Discussion of each of the 4 Fiddymment Trunk sewer connections are below and are also graphically shown in **Figure 5-1**.

Fiddymment Sewer Phase 1a: (Existing 15" Trunk facility)

Although this existing facility using the City of Roseville 2010 Design Criteria would fall under the hand calculation method for peak flow, the dynamic modeling method was applied to more accurately project the peak flow. Results are as follows:

$$\text{ADWF} = 0.164 \text{ mgd}$$

$$\text{PWWF} = 0.456 \text{ mgd}$$

$$\text{Pipe capacity utilized (\% full)} = 36\%$$

Fiddymment Sewer Phase 1b: (Existing 15" Trunk facility)

Similar to Phase 1a above this existing facility using the City of Roseville 2010 Design Criteria would fall under the hand calculation method for peak flow, the dynamic modeling method was also applied to more accurately project this peak flow. Results are as follows:

$$\text{ADWF} = 0.206 \text{ mgd}$$

$$\text{PWWF} = 0.377 \text{ mgd}$$

$$\text{Pipe capacity utilized (\% full)} = 23\%$$

Fiddymment Sewer Phase 2: (Existing 36" Trunk facility – Pleasant Grove Creek East Crossing)

Using the flow assumptions provided by RMC (**Appendix F**) combined with Fiddymment Phase 2 development area flow, yields the following capacity results for the existing 36" pipe segment supplying the creek crossing pipes.

$$\text{ADWF} = 0.274 \text{ mgd (Fiddymment)} + 3.799 \text{ mgd (Placer Ranch \& Offsites)} = \underline{4.073 \text{ mgd}}$$

$$\text{PWWF} = 0.679 \text{ mgd (Fiddymment)} + 7.733 \text{ mgd (Placer Ranch \& Offsites)} = \underline{8.411 \text{ mgd}}$$

$$\text{PWWF usage comparison} = 8.1\% \text{ (Fiddymment)} + 91.9\% \text{ (Placer Ranch \& Offsites)}$$

$$\text{Pipe capacity utilized (\% full)} = 56.8\%$$

$$\text{Available Capacity} = 5.22 \text{ mgd}$$



Sanitary Sewer Study for Fiddymment Ranch

Fiddymment Sewer Phase 2 (Continued):

For reference, **Figure 5-2** shows the as-built construction documents for the Pleasant Grove Creek East Crossing pipe configuration.

In a meeting between Wood Rodgers and the City, Environmental Utilities staff voiced concern that a particular existing segment of pipe was flowing at a higher level than that allowed by current City standard. This segment of pipe is seen in **Appendix K** as the 10" trunk sewer pipe between nodes C2 and C3. This segment was designed under the previous City design standard (prior to the 2010 release) which allowed 10" diameter pipe classified as a trunk (having no direct connections) to flow full. Minor sewer sheds in future development area F-19A have been revised in an effort to as closely as possible meet the current standard given the existing conditions. Current calculations place the peak flow at 71% full.

Fiddymment Sewer Phase 3: (Proposed 15" Trunk facility– Pleasant Grove Creek West Crossing)

Due to topography constraints imposed by Pleasant Grove Creek the Phase 3 Sewer will utilize an inverted siphon design to carry flow to the wastewater treatment plant head works structure. **Figure 5-3** presents a preliminary siphon design for the Pleasant Grove Creek West Crossing location. The construction method for this crossing is assumed to be similar to that of the existing East Creek Crossing, open cut trench method with use of temporary clear water diversion apparatus. The conveyance of this pressure flow crossing was modeled using the "LMNO Engineering, Research, Software, Ltd. Inverted Siphon Design Calculation Program". Additional supporting documentation and output from that software is located in **Appendix J**.

Similar to phase 1a & 1b above, the proposed trunk facility, using the City of Roseville 2010 Design Criteria would fall under the hand calculation method for peak flow, however the dynamic modeling method was also applied to the most downstream reaches adjacent the creek open space to more accurately project the peak flow experience by the siphon. Results are as follows:

ADWF= 0.445 mgd

PWWF= 0.985 mgd

Pipe capacity utilized (% full) = 56%



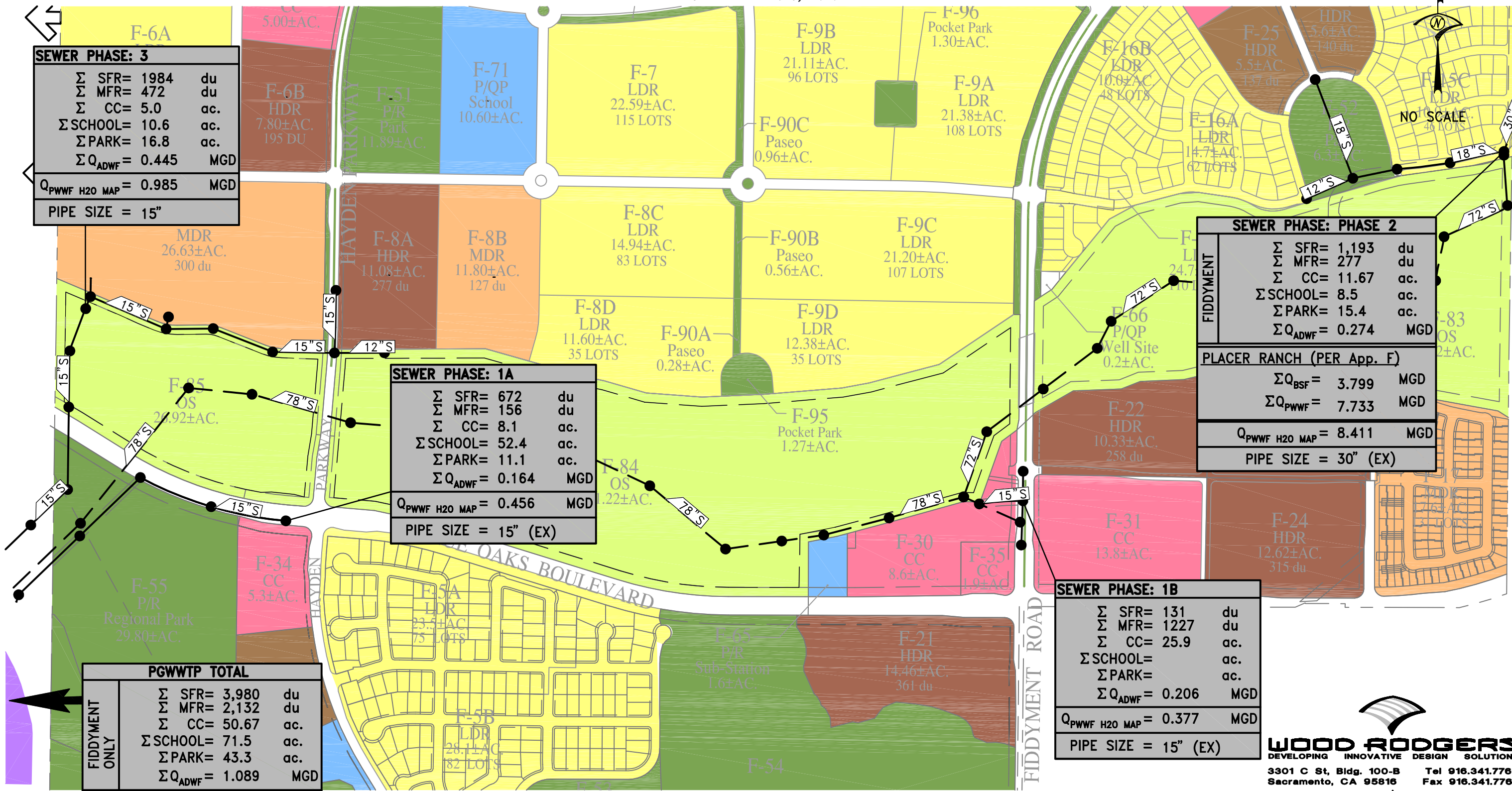
FIGURE 5-1 FIDDYMENT RANCH SPA3 SEWER SUMMARY

SIGNATURE PROPERTIES

ROSEVILLE

CALIFORNIA

SEPTEMBER 3, 2010




SEWER PHASE: 3		
Σ SFR=	1984	du
Σ MFR=	472	du
Σ CC=	5.0	ac.
Σ SCHOOL=	10.6	ac.
Σ PARK=	16.8	ac.
Σ Q _{ADWF}	0.445	MGD
Q _{PWWF H2O MAP}	0.985	MGD
PIPE SIZE = 15"		

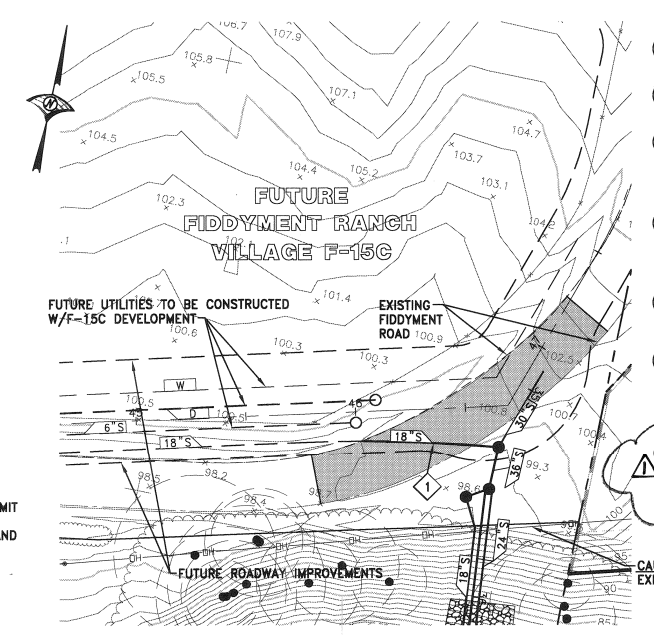
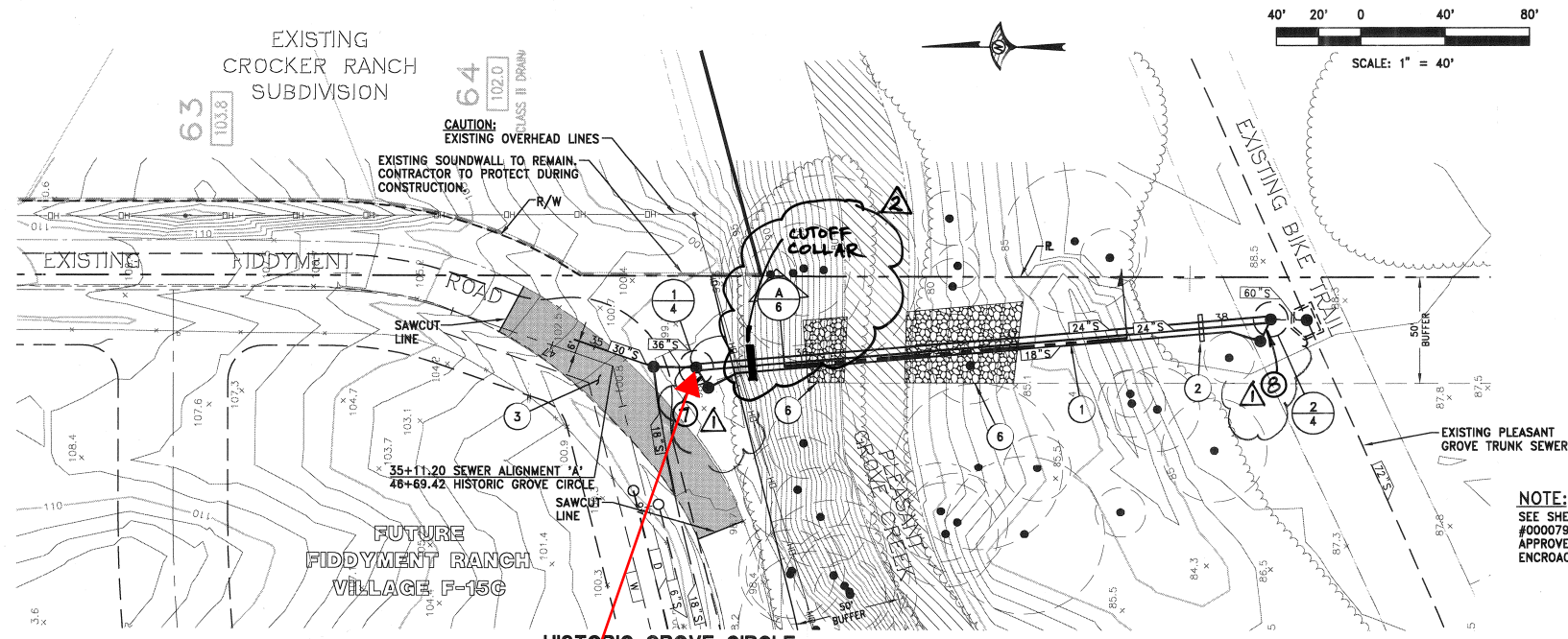
SEWER PHASE: 1A		
Σ SFR=	672	du
Σ MFR=	156	du
Σ CC=	8.1	ac.
Σ SCHOOL=	52.4	ac.
Σ PARK=	11.1	ac.
Σ Q _{ADWF}	0.164	MGD
Q _{PWWF H2O MAP}	0.456	MGD
PIPE SIZE = 15" (EX)		

SEWER PHASE: PHASE 2		
Σ SFR=	1,193	du
Σ MFR=	277	du
Σ CC=	11.67	ac.
Σ SCHOOL=	8.5	ac.
Σ PARK=	15.4	ac.
Σ Q _{ADWF}	0.274	MGD
PLACER RANCH (PER App. F)		
Σ Q _{BSF}	3.799	MGD
Σ Q _{PWWF}	7.733	MGD
Q _{PWWF H2O MAP}	8.411	MGD
PIPE SIZE = 30" (EX)		

SEWER PHASE: 1B		
Σ SFR=	131	du
Σ MFR=	1227	du
Σ CC=	25.9	ac.
Σ SCHOOL=		ac.
Σ PARK=		ac.
Σ Q _{ADWF}	0.206	MGD
Q _{PWWF H2O MAP}	0.377	MGD
PIPE SIZE = 15" (EX)		

PGWWTP TOTAL				
FIDDYMENT ONLY	Σ SFR=	3,980	du	
	Σ MFR=	2,132	du	
	Σ CC=	50.67	ac.	
	Σ SCHOOL=	71.5	ac.	
	Σ PARK=	43.3	ac.	
		Σ Q _{ADWF}	1.089	MGD

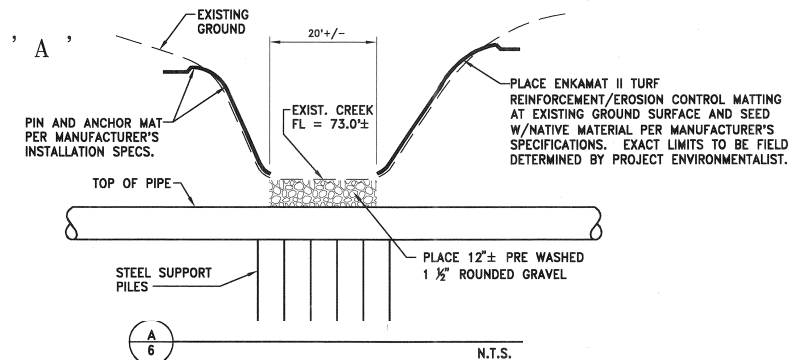

WOOD RODGERS
 DEVELOPING INNOVATIVE DESIGN SOLUTIONS
 3301 C St, Bldg. 100-B Tel 916.341.7760
 Sacramento, CA 95816 Fax 916.341.7767



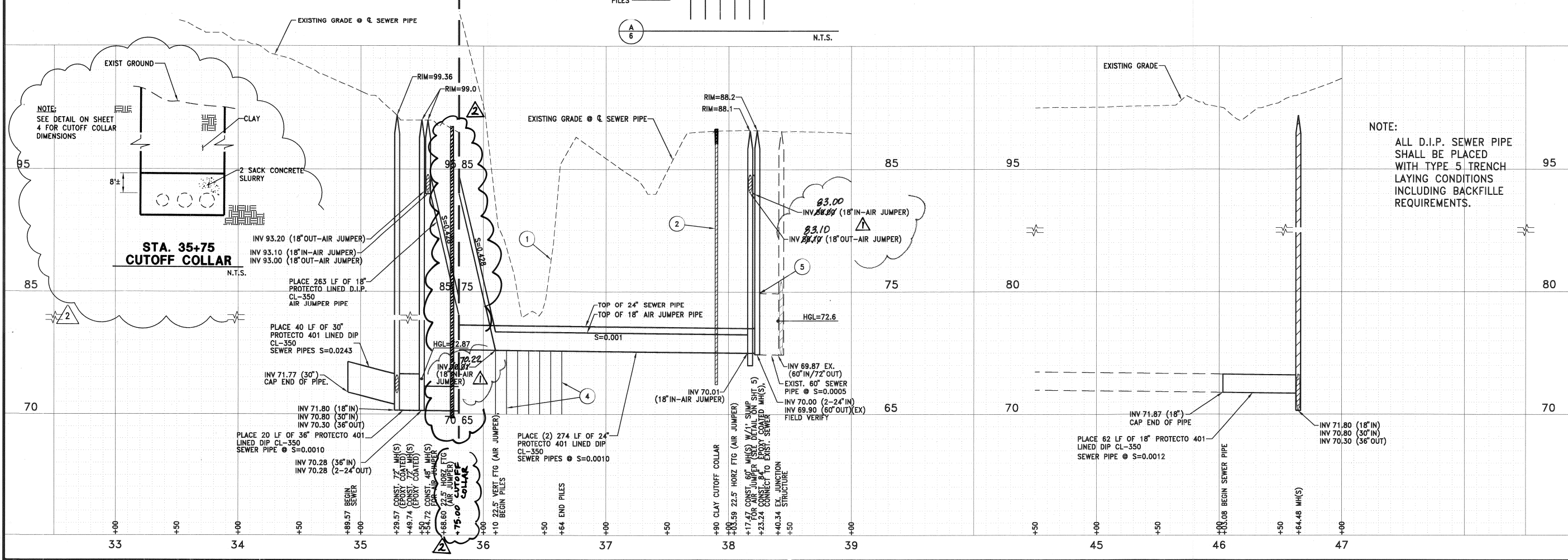
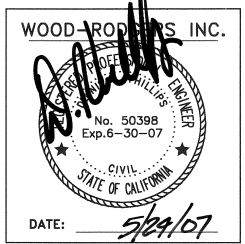
- CONSTRUCTION NOTES:**
- SEE DETAIL 'A' ON THIS SHEET FOR EROSION CONTROL PROTECTION.
 - CONSTRUCT CLAY CUTOFF COLLAR PER DETAIL 4 ON SHEET 4.
 - EXISTING PAVEMENT TO BE REMOVED AND REPLACED WITH 4" AC/10' AB. RESTRIPE TO MATCH EXISTING. (SHADED AREA)
 - STATION 36+10 TO 36+64 PLACE HP 8x36 x 30' STEEL PILES AT 9' OC SPACING. SEE PILING STRAP DETAIL ON SHEET 3.
 - CONNECT TO EXIST 60" SEWER STUB PER DETAIL 2 ON SHEET 4.
 - PLACE ENKAMAT II TURF REINFORCEMENT/EROSION CONTROL MATTING AT EXISTING GROUND SURFACE AND SEED W/NATIVE MATERIAL PER MANUFACTURER'S SPECIFICATIONS. EXACT LIMITS TO BE FIELD DETERMINED BY PROJECT ENVIRONMENTALIST.

NOTE:
SEE SHEET 8 AND TREE PERMIT #000079 AND #000092 FOR APPROVED TREE REMOVALS AND ENCROACHMENTS.

- ADWF (FIDDYMENT + PLACER RANCH) = 4.073 MGD
- PWWF (FIDDYMENT + PLACER RANCH) = 8.411 MGD
- PIPE CAPACITY UTILITZED (% FULL) = 56.8%



HISTORIC GROVE CIRCLE
 PLACE 11LF OF 18" PROTECTO LINED D.I.P. CL-350 AIR JUMPER PIPE @ S=0.0091.
 INV. @ 60" MH = 83.10
 INV. @ 84" MH = 88.00



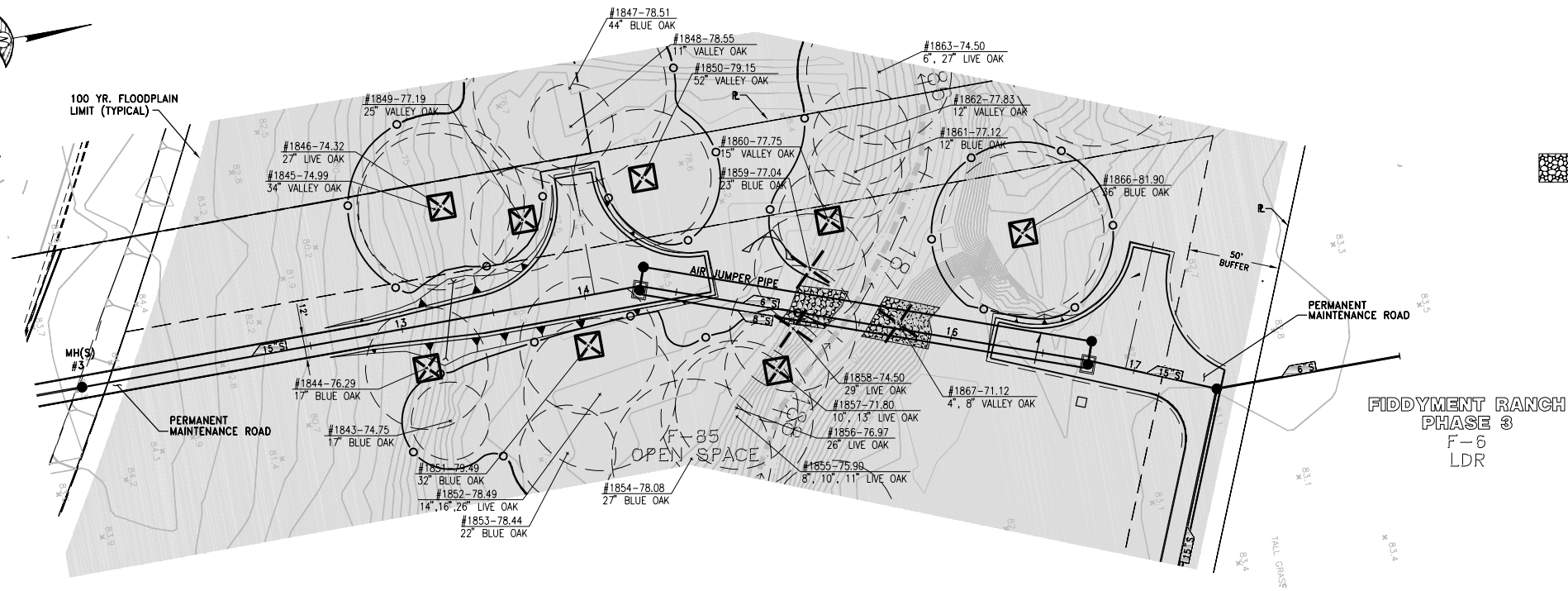
DATE: MAY 2007
 SCALE: H: 1"=40' V: 1"=4'
 DRAWN BY: SKR
 DESIGNED BY: RC/PB
 CHECKED BY: D. PHILLIPS
 INC.

WOOD RODGERS
 ENGINEERING - PLANNING - SURVEYING
 3301 C St, Bldg. 100-B
 Sacramento, CA 95818
 Tel 916.341.7790
 Fax 916.341.7787

**IMPROVEMENT PLANS FOR
 FIDDYMENT RANCH - PHASE 2
 PLEASANT GROVE CREEK SEWER CROSSING
 SEWER ALIGNMENT 'A'**

PROJECT NO. 1027.073
 SHEET 7 OF 8

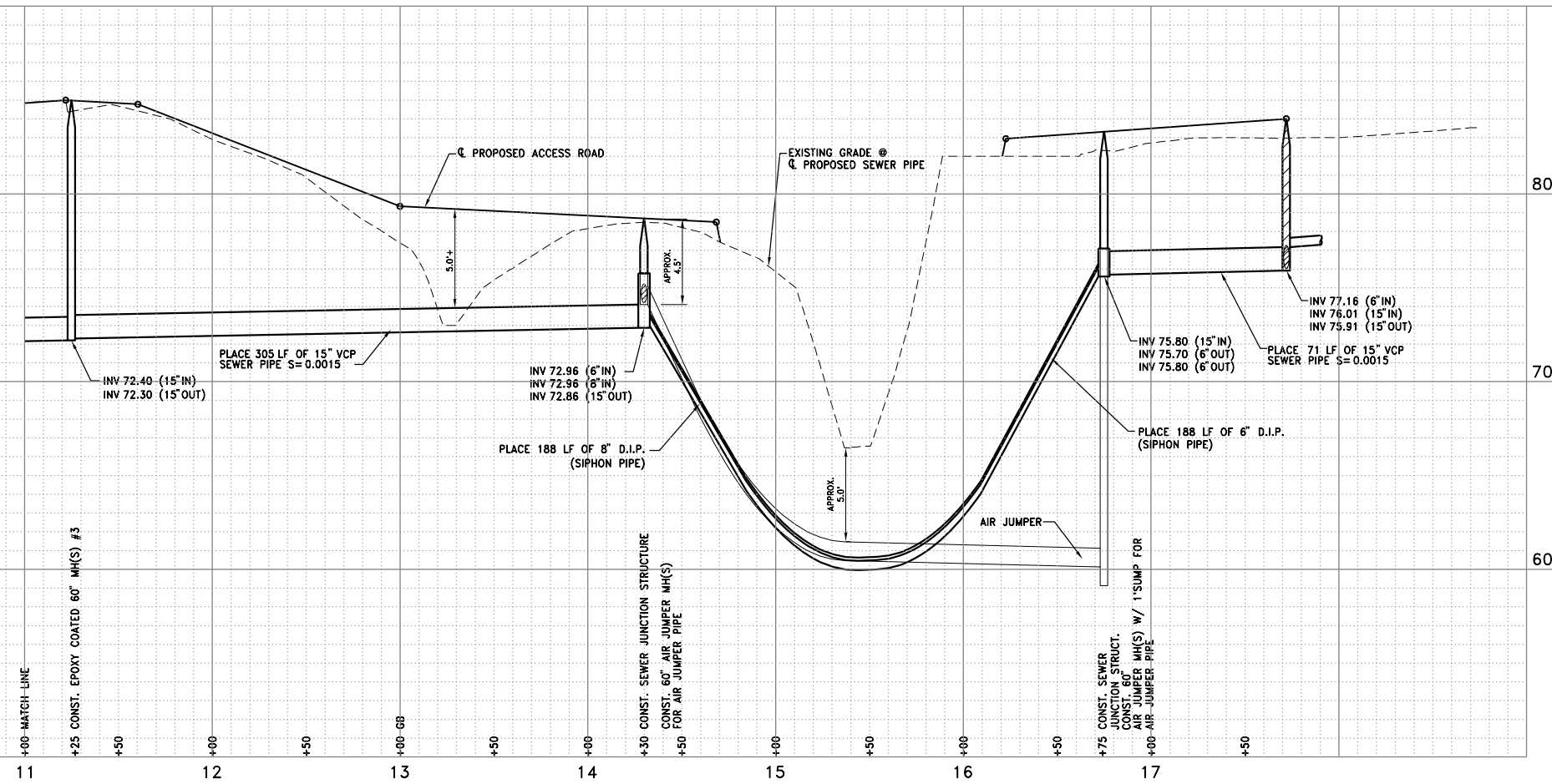
FIGURE 5-2 PLEASANT GROVE CREEK EAST CROSSING DESIGN (AS-BUILT)



NOTE:
 PRIOR TO CONSTRUCTION, FIELD DETERMINATION OF CONDITIONAL TREE REMOVALS TO BE FINALIZED BY PROJECT ARBORIST.

EROSION CONTROL

SEWER ALIGNMENT 1



DATE:	JULY 2010
SCALE:	H: 1"=40' V: 1"=4'
DRAWN BY:	P. TABOR
DESIGNED BY:	P. TABOR/P. BLUM
CHECKED BY:	D. PHILLIPS
NO.	
DESCRIPTION	
ENGR. INIT.	
BY	
DATE	

WOOD RODGERS
 ENGINEERING - MAPPING - PLANNING - SURVEYING
 3301 C St, Bldg. 100-B
 Sacramento, CA 95816
 Tel 916.341.7780
 Fax 916.341.7787

IMPROVEMENT PLANS FOR
FIDDYMENT RANCH - PHASE 3
PLEASANT GROVE CREEK WEST CROSSING
 CALIFORNIA
 CITY OF ROSEVILLE PLACER COUNTY

PROJECT NO.
SHEET 1 OF 1

FIGURE 5-3 PLEASANT GROVE CREEK WEST CROSSING DESIGN

Appendix A: *TM 1b – Current and Buildout Land Use*

Technical Memorandum

SOUTH PLACER WASTEWATER AUTHORITY (SPWA) WASTEWATER AND RECYCLED WATER SYSTEMS EVALUATION PROJECT

Subject: June 2004 and Buildout Land Use – (TM No. 1b)

Prepared For: Art O'Brien – City of Roseville

Prepared by: Pete Bellows/Chris Peters – Brown and Caldwell
Andy Smith – RMC

Reviewed by: Dave Richardson/Gisa Ju – RMC

Date: November 2, 2005; updated October 31, 2006, January 24, 2008 & September 3, 2009

Reference: 0091-004 Task 1

0 Previous TM Publication and Updates

Since the initial publication of technical memorandum (TM) 1b on November 2, 2005, changes in information available for the South Placer Wastewater and Recycled Water Systems Evaluation (Systems Evaluation), as well as changes in the data, have resulted in the need to identify and update out-of-date information. As part of the June 2007 publication of the Systems Evaluation, an Update Sheet was prepared for this TM, and is included in **Attachment A**. Subsequent changes have resulted in the need for further updates of the TM. The newest version of the TM is consistent with the updates summarized in the 2009 Update Sheet which is included in Attachment B.

1 Introduction

This TM documents and provides a summary of the June 2004 and buildout land use estimates for the South Placer Wastewater Authority (SPWA) Systems Evaluation. The identification of the 2005 Regional Service Area boundary, development of the land use database, and evaluation of June 2004 and buildout land use scenarios are critical tasks in order to understand June 2004 and buildout wastewater production to properly plan for and design collection, conveyance, and treatment systems and facilities. The land use database developed for the 2005 Systems Evaluation Project and summarized in this TM will be used to:

- Project June 2004 and buildout wastewater flows for the SPWA Regional Service Area;
- Identify June 2004 deficiencies in the regional collection system and plan for buildout expansion;
- Determine routing options for conveying wastewater flow from buildout urban growth areas (UGAs) to SPWA Regional Treatment Plants; and
- Plan for buildout expansion of wastewater treatment facilities.

The planned rezoning and intensification scenario in Roseville and Rocklin will be handled as a separate scenario for land use planning and are not included in this TM.

South Placer Regional Wastewater and Recycled Water Systems Evaluation

June 2004 and Buildout Land Use TM

This TM is organized as follows:

1. Introduction
2. Land Use Information Sources
3. 1996 and 2005 Regional Service Area Boundaries
4. Land Use within the 2005 Regional Service Area Boundary
5. Buildout Land Use within Urban Growth Areas
6. Land Use Database Documentation

2 Land Use Information Sources

The land use database for areas within the 2005 Regional Service Area boundary was developed by Environmental Science Associates, Inc. (ESA) based on the information sources presented below. In addition to these documented land use sources, ongoing discussions occurred with planners and developers for each of the Urban Growth Areas (UGAs) presented later in this TM. Final documentation and changes made to the land use database developed by ESA are discussed in Section 6 at the conclusion of this TM.

June 2004 General Plans

- City of Roseville (February 2004)
- City of Rocklin (April 1991)
- Town of Loomis (July 2001)
- Placer County (August 1994)
- Granite Bay Community Plan (May 1989)

Geographic Information System (GIS) Data in ESRI Shapefile Format

- City of Roseville GIS data (Roseville Land Inventory (RLI))
- Placer County GIS and County Assessor data
- 1996 Service Area Boundary, digitized by ESA.
- 2005 Regional Service Area Boundary, digitized by ESA.

Specific Plans

- Placer Vineyards (July 2007)
- Placer Ranch (February 2007)
- West Roseville (August 2003)
- Regional University (March 2005)

3 1996 and 2005 Regional Service Area Boundaries

The 1996 Wastewater Master Plan (1996 Master Plan) Environmental Impact Report (EIR) Service Area (Regional Service Area) boundary was established with the adoption of the 1996 Master Plan and associated EIR. The 2005 Systems Evaluation Project Regional Service Area boundary is an update of the 1996 Master Plan EIR Service Area boundary. The update includes ten areas outside of the 1996 Master Plan EIR Service Area (also known as “House-Keeping Areas”) that have been annexed by the SPWA partner agencies since 1996. Further discussion of these two service area boundaries and how they impact this evaluation is presented below.

3.1 1996 Master Plan Service Area Boundary

This 1996 Master Plan EIR Regional Service Area, shown in **Figure 1** at the end of this TM, will be used in the Systems Evaluation Project along with updated buildout land use projections and unit flow factors (developed as part of the Systems Evaluation Project) to generate revised buildout flow projections for the SPWA regional treatment facilities for comparative purposes. The revised buildout flow projections inside the 1996 Regional Service Area will be compared with the 1996 projected buildout flows to provide an update for the connection fee analysis to be performed by the SPWA financial advisor.

3.2 2005 Regional Service Area Boundary

The Systems Evaluation 2005 Regional Service Area boundary is shown in **Figure 2** at the end of this TM and was presented to the SPWA board in January 2005; the boundary was adopted by the SPWA board on March 1, 2006. Further discussion on the development of the Systems Evaluation Project 2005 Regional Service Area boundary is documented in the 2005 Regional Service Area Boundary TM No. 1a dated January 13, 2005.

4 Land Use within the 2005 Regional Service Area

Land use information provides the basis for developing unit wastewater flows and wastewater flow projections. Understanding the nature and distribution of urban development is important for proper planning and staging of sewer collection infrastructure and treatment facilities. Additionally, identification of parcels that are “connected” as of June 2004 to the collection system is required to balance wastewater unit flow factors and calibrate the sewer model for the June 2004 system. The key result from the land use analysis was the development of the land use map and associated database. The land use map and database are each parcel-based.

Land use map development was a multi-step process that included consolidating the June 2004 land use codes into a manageable system; identifying parcels connected to the wastewater collection system for June 2004 and buildout conditions; plotting June 2004 and buildout land use maps for review by the SPWA member agencies; and checking the land use data against June 2004 general plans for Roseville, Rocklin, Loomis, Granite Bay and Placer County. A review of land use maps developed from the project team’s database identified some minor discrepancies with the June 2004 published General Plans. These discrepancies were corrected to match the June 2004 General Plan status and are documented in Section 6 at the end of this TM.

4.1 Land Use Code Consolidation

The land use database developed by the project team (version no. 1) included approximately 114 land use codes previously used by the City of Roseville and Placer County. The project team consolidated these 114 codes into 17 general land use codes (version no. 2). The project team then further consolidated the 17 codes into 12 land use codes to simplify the process of projecting June 2004 and buildout wastewater flows in the hydraulic model (version no. 3). The version no. 3 consolidation process lumped all of the non-flow producing land use types into one “Open Space” category and introduced three new land use codes (Mixed Use, Schools and Parks > 10 Acres). The land use code consolidation is presented in Table 1.

South Placer Regional Wastewater and Recycled Water Systems Evaluation

June 2004 and Buildout Land Use TM

Table 1: Consolidated Land Use Codes

Final (Version No. 3) Land Use Code	Version No. 2 Land Use Code	Roseville/Placer County Land Use Code (Version No. 1)
Commercial	Commercial	Auto Sales, Repair Automotive Banks, S&L's, Credit Union Commercial Commercial Recreation Commercial Store Condominium Office Fast Food Restaurant Financial Building Hotel Hotel, Motels, Resorts Mini-Market with Gas Mini-Market, no Gas Miscellaneous Commercial Office Building Office General Office Medical/Dental Residential and Hotel Restaurant Restaurants, Cocktail Lounges Retail Service Station Shopping Center Small Food Suburban Store Theater, Bowling Alley
Heavy Industrial	Heavy Industrial	Food Processing Heavy Industrial Miscellaneous Industrial
Light Industrial	Light Industrial Storage	Business Industrial Park Condominium Industrial Industrial Condominium Light Industrial Light Manufacturing Mini-Storage, Covered Storage Self Storage Uncovered Storage, Wrecking Yard Warehouse
Mixed Use	n/a	Residential and Office Residential and Retail

South Placer Regional Wastewater and Recycled Water Systems Evaluation

June 2004 and Buildout Land Use TM

Final (Version No. 3)	Version No. 2	Roseville/Placer County
Land Use Code	Land Use Code	Land Use Code (Version No. 1)
Open Space	Agriculture Open Space Parks (Area < 10 Acres) Mining Right of Way	CLCA Restriction, Non-Renewal CLCA Restriction, Under Contract Irrigated Farm Orchards, Vineyards Poultry & Small Animals Rice Crop Vacant, Dry Farm Mineral Rights Mining Claims Mining Quarry Backyard Area Cemetery Cemeteries Creek Area Fairgrounds Golf Course Greenbelt Landscape Easement Open Space Rivers, Lakes, Reservoir, Canal Wetlands, Vernal Pools Camps & Parks, General Non-Profit Camps/Parks Park (Area < 10 Acres) Tennis/Swimming Clubs Highways, Roads, Streets Pipeline R/W Right of Way Utility Easement Parking Lot Parking Lots
Parks > 10 Acres	Parks (Area > 10 Acres)	Park (Area > 10 Acres)
Final (Version No. 3)	Version No. 2	Roseville/Placer County
Land Use Code	Land Use Code	Land Use Code (Version No. 1)
Public/Quasi Public	Public/Quasi-Public	Church Churches Club Convalescent Hospital Day Care Centers Hospital Hospitals Convalescent Lodges, Halls Misc. Public Buildings Miscellaneous Institutional Preschool Public Building Utilities, Public & Private Utility

South Placer Regional Wastewater and Recycled Water Systems Evaluation

June 2004 and Buildout Land Use TM

Final (Version No. 3) Land Use Code	Version No. 2 Land Use Code	Roseville/Placer County Land Use Code (Version No. 1)
Residential 1 DU	Residential 1 DU Residential Large Lot Mobile Home (Individual)	Condominium Residence on Commercial Land Single Fam Res, Condominium Single Fam Res, Half Plex Single Family Residence Timeshares Mobile Home Outside of Park
Residential 2 DU	Residential 2 DU	2 Single Fam Res, Duplex Duplex
Residential 3 DU	Residential 3 DU	3 Single Fam Res, Triplex Triplex
Residential Multiple DU	Residential Multiple DU Mobile Home (Park)	Apartment Apartments, 4 Units or More Mobile Home in M H Park Mobile Home Park
Schools	n/a	School Schools
Vacant ¹	Vacant	Business Potential Commercial Potential Common Area Industrial Potential Institutional Potential Residential Potential Residential, Auxiliary Imp Vacant Vacant Industrial Vacant, Commercial Vacant, Subdivided Residential

¹ The vacant land use code is only used for the June 2004 land use scenario. For the buildout land use scenario, vacant parcels are assigned the land use category as specified in their respective General Plan.

4.2 June 2004 Land Use within the 2005 Regional Service Area

Currently developed parcels were identified in the original (version no. 1) land use database based on their June 2004 land use code. The original land use database identified parcels that are not currently developed as “vacant”. However, not all of the developed parcels within the 2005 Regional Service Area contribute flow to the wastewater collection system. These developed parcels that do not contribute flow most likely have onsite septic wastewater treatment systems. To project June 2004 wastewater flow and calibrate the sewer model for the June 2004 system, parcels that are currently connected to the SPWA collection system were identified. The process used to identify connected parcels is documented in the January 26, 2005 TM No 1c entitled “Identification of Parcels Connected or Not Connected to Sewers in the SPWA Project Area”.

Generally, parcels within the City of Roseville were identified as connected based on their development status and the understanding that there are no septic tanks within the City of Roseville. Parcels within SPMUD were identified as connected based on their development status and whether or not they were located in an area designated as septic tank service by SPMUD. Parcels within Placer County were identified as connected if they currently receive a sewer bill from the County. Placer County provided sewer billing information that was linked to the parcel database provided by ESA. Parcels that linked to a sewer bill were designated as connected.

Appendix B: TM 3a– *Unit Flow Factor Sets and Sewer Design Criteria*

Technical Memorandum

South Placer Regional Wastewater & Recycled Water Systems Evaluation Project

Subject: Unit Flow Factor Sets and Sewer Design Criteria –TM No. 3a

Prepared For: Art O’Brien – City of Roseville

Prepared By: Mai-Tram Le - RMC; revised by Gisa Ju - RMC

Reviewed By: Dave Richardson - RMC
Pete Bellows – BC

Date: May 25, 2005; Final revision September 18, 2006

Reference: 0091-4.02

This technical memorandum (TM) provides a definition of the unit flow factors that have been developed and used in analyses of treatment and trunk sewer facilities as part of the South Placer Regional Wastewater and Recycled Water Systems Evaluation Project (Project). The TM also proposes criteria to be used by developers for design of new sewer facilities.

The various analyses and their associated application are as follows:

1. **Treatment Plant Analyses** – A set of average dry weather unit flow factors has been developed for the entire South Placer Wastewater Authority (SPWA) service area. These factors include the average flow coming from various areas based on specific land use designations, along with a base dry weather groundwater infiltration (GWI) component across the service area. The average unit flow factors were developed using water use and flow monitoring data, as presented in TM 2a, “Dry Weather Flow Projection for 2005 Service Area.” For example, the unit flow factor for single-family residential dwelling units, regardless of density, is 190 gpd, of which 10 gpd represents the dry weather GWI component. The unit flow factors used for treatment plant analyses are presented in **Table 1**.
2. **Hydraulic Model Calibration and Trunk Sewer Analyses** – The dry weather flows used for model calibration and analyses of trunk sewers consists of base sanitary flows (BSF) which have been developed using the same unit flow factor concept as for the treatment plant analyses discussed above. However, the dry weather GWI component of the unit flow factors has been included on an areal basis based on actual measured flows, rather than having been considered as a uniform base dry weather GWI load across the service area.

Trunk Sewer analyses also include additional components of wet weather GWI and rainfall-dependent infiltration and inflow (RDI/I) that vary across the SPWA service area to reflect actual conditions as verified by the wet weather flow monitoring data. The wet weather GWI factors are specific to each wastewater treatment plant (WWTP) service area and were determined from analysis of WWTP flows to be 200 gpd/acre in the Dry Creek WWTP basin and 100 gpd/acre in the Pleasant Grove WWTP basin. The GWI rates and RDI/I parameters used in the trunk sewer model are documented in TM 2c, “Wet Weather Flow Projection for the Ultimate SPWA Service Area.”

**Table 1 – Average Dry Weather Unit Flow Factors
 Used for Treatment Plant Analyses**

Land Use Designation	Units	Flow Factor (gpd/unit) ¹
Commercial	gpd per acre	850
Heavy Industrial	gpd per acre	850
Light Industrial	gpd per acre	850
Mixed Use	gpd per acre	2,300
Public/Quasi-Public	gpd per acre	660
Schools	gpd per acre	170
Residential 1 DU	gpd per DU	190
Residential 2 DU	gpd per DU	190
Residential 3 DU	gpd per DU	190
Residential Multiple DU ²	gpd per acre or gpd per DU	2,040 or 130
Open Space	gpd per acre	0
Parks > 10 Acres	gpd per acre	10
Vacant	gpd per acre	0

¹ Includes allowance for dry season GWI.

² Future development projects should use the factor that results in the highest flow .

3. **Design Flow Standards (Criteria) for Sizing Infrastructure** – For sizing future infrastructure facilities, the hydraulic model of the trunk sewer system should be used for pipes 15 to 18 inches in diameter and larger. For smaller facilities, the average dry weather unit flow factors for the treatment plant analyses can be used along with a safety factor of 2.0 and appropriate peaking factors. The safety factor of 2.0 will be used to factor the average dry weather unit flow factor in order to:

1. Account for changes that may occur over time in the behavior of residential and nonresidential contributors to the sewer systems, such as increased indoor water use;
2. Account for changes in environmental conditions (higher groundwater table and consequent higher GWI) and changes in infrastructure (aging pipes, etc.);
3. Provide for safety to adequately size the infrastructure to avoid any sanitary sewer overflows due to under-sizing;
4. Account for the increasing friction losses (increase in the roughness coefficient) due to pipe aging; and,
5. Account for nominal pipe diameter decreases due to accumulation of material adhering to the walls of the sewer piping and restricting capacity.

Peak wet weather flows will be accounted for using a system-wide peaking factor. A peaking factor curve was developed based on the following assumptions:

- Single family residential development at 4 DU/acre
- Design average dry weather flow (ADWF) based on a unit flow rate of 190 gpd/DU times a safety factor of 2.0

- Diurnal peaking factor ranging from 1.8 to 3.0 depending on area size (reflects the attenuation of peak flows through the sewer system as the tributary area increases – refer to Footnote 4 in Table 2))
- GWI at 150 gpd/acre
- RDI/I at 700 gpd/acre, estimated based on model parameters used for new development UGAs (Note: New development RDI/I parameters were assumed to be similar to those determined by flow monitoring and model calibration for relatively new areas of the system; see TM 2c for discussion.)
- Peak diurnal flow concurrent with peak RDI/I flow

The resultant peaking factor curve is presented in **Figure 1**. **Table 2** below shows the derivation of the peaking factor curve for areas ranging from 10 to 750 acres. (NOTE: the values in Table 2 are meant to support the derivation of the peaking factor curve, rather than to be published as design standards).

Table 2 - Derivation of Proposed Roseville/SPWA Design Peaking Factor Curve¹

Area (acres)	No. of DUs ¹	ADWF (mgd) ²	Factored Flow (mgd) ³	Diurnal PF ⁴	Wet GWI (mgd) ⁵	Peak RDI/I (mgd) ⁶	PWWF (mgd) ⁷	Peaking Factor	PF Curve
0			0						3.65
10	40	0.0076	0.0152	3.0	0.0015	0.0070	0.054	3.56	3.56
100	400	0.076	0.152	2.5	0.015	0.070	0.47	3.06	3.06
250	1,000	0.19	0.38	2.0	0.038	0.175	0.97	2.56	2.56
500	2,000	0.38	0.76	1.8	0.075	0.350	1.79	2.36	2.36
750	3,000	0.57	1.14	1.8	0.11	0.53	2.69	2.36	2.36

¹ Based on single-family residential development at 4 DUs/acre. 4 DUs/acre is considered to be a typical density for single family residences, and is not intended to be used as a design criterion.

² Based on 190 gpd/DU

³ Based on safety factor of 2.0

⁴ The diurnal PF values in this analysis are based on the peaking factor used for residential flows (PF = 1.8) in the hydraulic model, which was derived from dry weather flow monitoring data. Since that derivation was based on a large area, the PF value is increased progressively as the area decreases in order to account for decreased attenuation of peak flows. Selection of the upper limit of that range is based on engineering judgment and experience with similar analyses.

⁵ Based on 150 gpd/acre

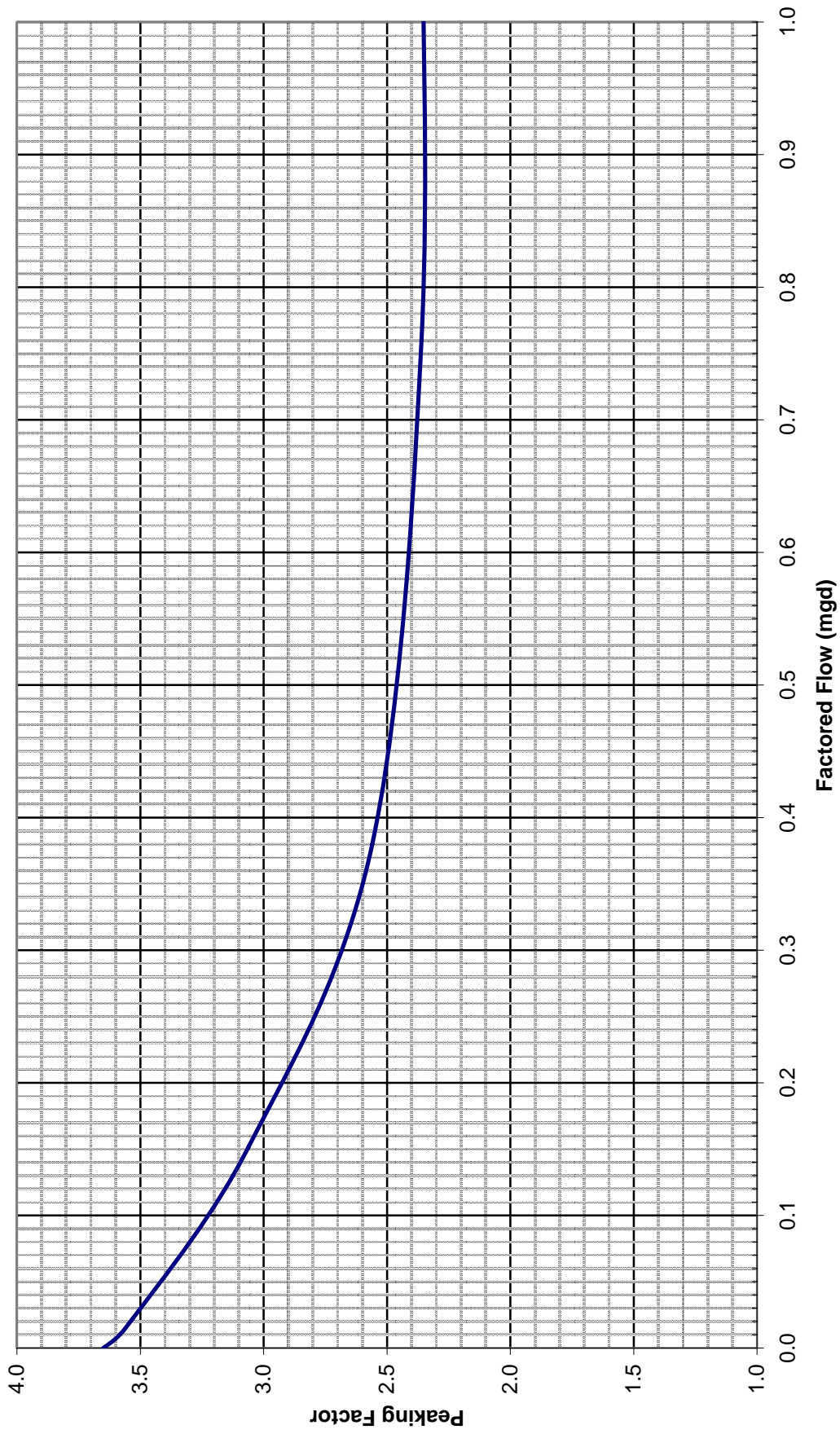
⁶ Based on 700 gpd/acre

⁷ Assumes peak RDI/I coincides with peak diurnal

Attachment A includes an example calculation illustrating the application of the peaking factor curve.

At the direction of SPWA member agencies, several planning-level criteria were developed to aid developers in the sizing and configuration of pump station and force main facilities. These criteria are presented in **Attachment B**.

Figure 1
Proposed SPWA Design Peaking Factor Curve



ATTACHMENT A: Example Design Flow Analysis for Sewers Smaller than 18-inches

Example calculation for application of peaking factor curve for 400-unit single family subdivision:

ADWF:

$$(400 \text{ DUs}) * (190 \text{ gpd/DU}) = \mathbf{76,000 \text{ gpd} = \text{ADWF}}$$

Factored Flow:

$$(\text{ADWF}) * (2.0) = (76,000 \text{ gpd}) * (2.0) = \mathbf{152,000 \text{ gpd} = \text{Factored Flow}}$$

PWWF:

$$(\text{Factored flow}) * (3.05^a) = (152,000) * (3.05) = \mathbf{464,000 \text{ gpd} = \text{PWWF}}$$

Per City of Roseville Improvement Standards, page SS-5, a 10-inch sewer at minimum slope is adequate for this PWWF.

^a From Figure 1: Proposed SPWA Design Peaking Factor Curve

ATTACHMENT B: Recommended Planning Level Criteria for Pump Stations and Force Mains

Table B-1 presents planning-level criteria for the design of pump stations and force mains within the SPWA service area; these criteria should be confirmed during design.

Table B-1: Recommended Planning Level Criteria for Pump Stations and Force Mains

Pump Stations	
Capacity	PWWF from hydraulic model (or ADWF – <i>factored flow</i> – with storage capacity)
Storage	24 hours, or 8 hours with an emergency generator
Operation	Lead/lag for duty pump(s), plus 1 standby pump
Maximum Pump Cycles	6 cycles/hour
Force Mains	
Headloss	Hazen-Williams roughness coefficient (C-factor) of 120
Maximum Velocity	7-10 feet per second
Minimum Velocity	3.5 feet per second

NOTE: Hydraulic transient, surge, and odor control analyses will need to be performed during final design.

Appendix C: Chapter 3 (Dec. 2009 Systems Report)
Unit Flow Factors and Flow Projections

Chapter 3 Unit Flow Factors and Flow Projections

3.1 Introduction

This chapter summarizes the development of unit flow factors and the subsequent dry weather and wet weather wastewater flow projections for buildout conditions within the Ultimate SPWA Service Area. The tasks for this portion of the Systems Evaluation are summarized in Table 3-1.

Table 3-1: Unit Flow Factor and Flow Projections Task Summary

Task	Subtask(s)
Determine Unit Flow Factors and Flow Projections	• Review Available Information
	• Flow Monitoring Planning
	• Flow Monitoring
	• Unit Flow Factors
	• Peaking Factors
	• Flow Projections

3.2 Dry Weather Flow Projections

3.2.1 Dry Weather Flow Monitoring Program

In order to establish “target” flows for a unit flow factor mass balance, average dry weather flow (ADWF) monitoring data from seven permanent flow monitoring sites in Roseville, SPMUD and Placer County were collected and reviewed during September and October 2004. A flow data summary from the monitoring period is presented in **Table 3-2**. Each of the two Roseville sites was located at one of the regional wastewater treatment plants (i.e., the Dry Creek and Pleasant Grove WWTPs). The five remaining sites were located at flumes where SPMUD and Placer County trunk sewers enter Roseville. The flow monitors in the Dry Creek watershed are tributary to the Dry Creek WWTP; similarly, flow monitors in the Pleasant Grove watershed are tributary to the Pleasant Grove WWTP. Hydrographs for the Springview, Strap Ravine and Old Auburn flow monitoring sites exhibited signs of groundwater infiltration (GWI). This assessment was confirmed by performing the unit flow factor mass balance calculations, as well as a review of temporary wet weather flow monitoring data from winter 2005.

Total GWI was estimated by subtracting total base sanitary flow (BSF) projections from total DWF as measured at the WWTP flow monitoring sites. The calculated GWI rate for the Dry Creek WWTP sewershed is approximately 1.70 mgd.

Table 3-2: Measured Flow Permanent Dry Weather Flow Monitoring Sites in September and October 2004

Site Name	Location	Sewershed	BSF (mgd)	GWI (mgd) ¹	ADWF (mgd)
Old Auburn	Placer County	Dry Creek	0.75	0.50	1.25
Strap Ravine	Placer County	Dry Creek	0.73	0.30	1.03
Highlands	SPMUD	Dry Creek	0.08	0.00	0.08
Springview	SPMUD	Dry Creek	2.19	0.80	2.99
Dry Creek WWTP	Roseville	Dry Creek	12.70	1.70	14.40
North Roseville	SPMUD	Pleasant Grove	1.84	0.00	1.84
Pleasant Grove WWTP	Roseville	Pleasant Grove	2.55	0.00	2.55

Footnotes:

1. GWI estimates based watershed area upstream of flow meter.

The resulting areal dry season GWI rates are shown in **Table 3-3**. Dry season GWI was not applied to parks, open space, or Union Pacific Railroad property.

Table 3-3: Dry Season GWI Rates

Sewershed	Tributary Area	Agency	Dry Season GWI Rate (gpd/acre)
DCWWTP	Dry Creek WWTP Flow Monitor	Roseville	20
	Springview Flow Monitor	SPMUD	210
	Highlands Flow Monitor	SPMUD	0
	Strap Ravine Flow Monitor	Placer County	120
	Old Auburn Flow Monitor	Placer County	350
PGWWTP	Pleasant Grove WWTP Flow Monitor	Roseville	0
	North Roseville Flow Monitor	SPMUD	0
	Sunset Industrial Park	Placer County	0

Based on discussions with SPWA partner agencies, seven point sources were identified within the 2005 Regional Service Area as of June 2004. Data for these point sources are summarized in **Table 3-4**. There are also three point sources located within UGAs; the flows from these point sources are included with the UGA flow projections in **Table 3-7**. June 2004 point sources in the 2005 Regional Service Area were identified from flow monitoring data and water billing information. The Placer County Landfill was also identified as a point source, as it generates very little wastewater flow relative to its size. Buildout flow projections from NEC and HP were provided by the City of Roseville and are based on buildout conditions for each development.

Table 3-4: June 2004 and Projected ADWF from Point Sources in the 2005 Regional Service Area

Point Source	Location	June 2004 Flow Data Source	June 2004 ADWF (gpd)	Projected Buildout ADWF (gpd)
Union Pacific Railroad	Roseville	City of Roseville	85,000	85,000
Landfill	Placer County	City of Roseville	5,000	5,000
NEC	Roseville	Flow Monitor Data	700,000	2,000,000
HP	Roseville	City of Roseville	150,000	484,000
Kaiser Hospital	Roseville	Water Use Data	50,000	50,000
Formica	Placer County	Placer County	60,000	60,000
Rio Bravo Power Plant	Placer County	Placer County	15,000	15,000

3.2.2 Unit Flow Factors

Development of unit flow factors included (1) gathering and analyzing land use-specific water billing and flow monitoring data, (2) calculating the corresponding unit flow factors for given land use categories, and (3) testing the appropriateness of the calculated unit factors for the June 2004 system in a mass balance calculation. Unit flow factors were developed using water billing data from the City of Roseville and from dry weather flow monitoring data from the locations listed in Table 3-2.

The unit flow factors, which were used to project BSF and ADWF for the trunk sewer evaluation (Chapter 4) and WWTP expansion evaluation (Chapter 5) segments of this Systems Evaluation, respectively, are presented in **Table 3-5**. BSF unit flow factors do not include dry season groundwater infiltration (GWI), and are therefore lower than the ADWF unit flow factors. Unit flow factors for the single family residential land use category are applied on a per-dwelling unit (du) basis, while unit flow factors for other land uses are applied on an areal basis. **Appendix E** presents a side-by-side comparison of the unit factors used in this Systems Evaluation and those used in the 1996 Master Plan and EIR.

Temporary flow monitoring data (collected following the analysis of data from the seven permanent flow monitoring sites discussed above) indicated wide variations in the unit flow factors for various land use types, and was not considered representative of the entire service area. Water billing data from the City of Roseville and the permanent flow monitoring data from Roseville, SPMUD and Placer County ultimately proved to be more representative of the entire service area. For further information on water billing data, refer to *TM 2b – Dry Weather Flow Projections for Ultimate Service Area (w/ UGAs)* in **Appendix D**.

Table 3-5: BSF and ADWF Unit Flow Factors

Land Use Category	Units	BSF Unit Flow Factor ¹ (for Trunk Sewer Modeling)	ADWF Unit Flow Factor ² (for WWTP Flow Projections)
Commercial	gpd per acre	800	850
Heavy Industrial	gpd per acre	800	850
Light Industrial	gpd per acre	800	850
Mixed Use	gpd per acre	2,160	2,300
Public/Quasi-Public	gpd per acre	620	660
Schools	gpd per acre	160	170
Residential 1 DU	gpd per du	180	190
Residential 2 DU	gpd per du	180	190
Residential 3 DU	gpd per du	180	190
Residential Mult. DU ³	gpd per acre	1,920	2,040
Open Space	gpd per acre	0	0
Parks > 10 Acres	gpd per acre	10	10
Vacant	gpd per acre	0	0

Footnotes:

1. Does not include allowance for GWI. Dry and wet season GWI were applied as gpd/acre rates on an area-specific basis.
2. Includes allowance for dry season GWI.
3. The proposed Residential Multiple DU unit flow factor can also be represented as 120 gpd per DU (BSF) or 130 gpd per DU (ADWF).

3.2.3 Average Dry Weather Flow Projections

Buildout ADWF projections within the 2005 Regional Service Area were based on the ADWF unit flow factors presented in Table 3-5. The projections do not include the impacts of proposed redevelopment/intensification within Roseville and Rocklin, which was analyzed as a separate scenario and is presented in Chapter 9. Buildout ADWF projections within the 2005 Regional Service Area are presented in **Table 3-6**.

Table 3-6: Buildout ADWF Projections within the 2005 Regional Service Area

Land Use	ADWF Unit Flow Factor	PGWWTP ³		DCWWTP ⁴		2005 Service Area	
		Buildout Units (acres or dus)	Buildout ADWF (mgd)	Buildout Units (acres or dus)	Buildout ADWF (mgd)	Buildout Units (acres or dus)	Buildout ADWF (mgd)
Commercial	850 gpd/ac	1,728	1.47	2,890	2.46	4,618	3.92
Heavy Industrial ¹	850 gpd/ac	1,680	1.43	263	0.22	1,943	1.65
Light Industrial ¹	850 gpd/ac	1,221	1.04	637	0.54	1,858	1.58
Mixed Use	2,300 gpd/ac	-	-	7	0.02	7	0.02
Public/Quasi-Public ¹	660 gpd/ac	282	0.19	851	0.56	1,133	0.75
Schools	170 gpd/ac	258	0.04	540	0.09	798	0.14
Residential 1 DU	190 gpd/du	26,893	5.11	42,866	8.14	69,759	13.25
Residential 2 DU	190 gpd/du	2	0.0004	2,122	0.40	2,124	0.40
Residential 3 DU	190 gpd/du	12	0.002	720	0.14	732	0.14
Residential Multiple DU	2,040 gpd/ac	594	1.21	606	1.24	1,200	2.45
Open Space	0 gpd/ac	6,034	-	3,171	-	9,205	-
Parks > 10 Acres	10 gpd/ac	270	0.003	361	0.004	631	0.01
Point Sources	Varies gpd/ac	1,043	2.56	91	0.14	1,134	2.70
Placer Ranch ²	Varies gpd/ac	1,027	0.90	-	-	1,027	0.90
West Roseville ⁵	Varies gpd/ac	3,162	2.07	-	-	3,162	2.07
Placer Vineyards ²	Varies gpd/ac	-	-	1,062	0.58	1,062	0.58
Rezones	Varies gpd/ac	-	0.50	-	0.17	-	0.67
Intensification	Varies gpd/ac	-	-	-	1.64	-	1.64
		Totals (mgd)	16.52		16.34		32.86

Footnotes:

1. Does not include the area of those parcels associated with the point sources identified in Table 3-4.
2. Includes the portion of the development located within the 1996 Master Plan Regional Service Area boundary (in this case, the 1996 Master Plan Regional Service Area boundary and the 2005 Regional Service Area boundary are the same).
3. Applies to the Pleasant Grove WWTP sewershed.
4. Applies to the Dry Creek WWTP sewershed.
5. Includes all of WRSP, located entirely inside of the 2005 Regional Service Area boundary, includes 0.37 mgd increase over Jan 2008 data for WRSP rezones

Buildout ADWF projections within the Ultimate SPWA Service Area are based on the proposed ADWF unit flow factors, and include flows generated within the 2005 Regional Service Area boundary and the UGAs, and are presented in **Table 3-7**. These flow projections include the results of proposed redevelopment/intensification within Roseville and Rocklin. Detailed flow projections for each UGA are presented in *TM 2b – Dry Weather Flow Projections for Ultimate Service Area (w/ UGAs)* in **Appendix D**.

Appendix D: *TM 2a – Dry Weather Flow Projection
for the 2005 Regional Service Area
Boundary*

Technical Memorandum



South Placer Regional Wastewater and Recycled Water Systems Evaluation

Subject: Dry Weather Flow Projection for the 2005 SPWA Regional Service Area
Technical Memorandum – (TM No. 2a)

Prepared For: Art O'Brien – City of Roseville

Prepared by: Pete Bellows/Chris Peters – Brown and Caldwell
Andy Smith – RMC

Reviewed by: Dave Richardson/Gisa Ju – RMC

Date: October 21, 2005; updated January 24, 2008 & September 3, 2009

Reference: 0091-004 Task 2

0 Previous TM Publication and Updates

Since the initial publication of technical memorandum (TM) 2a on October 21, 2005, changes in information available for the South Placer Wastewater and Recycled Water Systems Evaluation (Systems Evaluation), as well as changes in the data, have resulted in the need to identify and update out-of-date information. The newest version of the TM is consistent with the updates summarized in the 2009 Update Sheet which is included in Attachment A.

1 Introduction

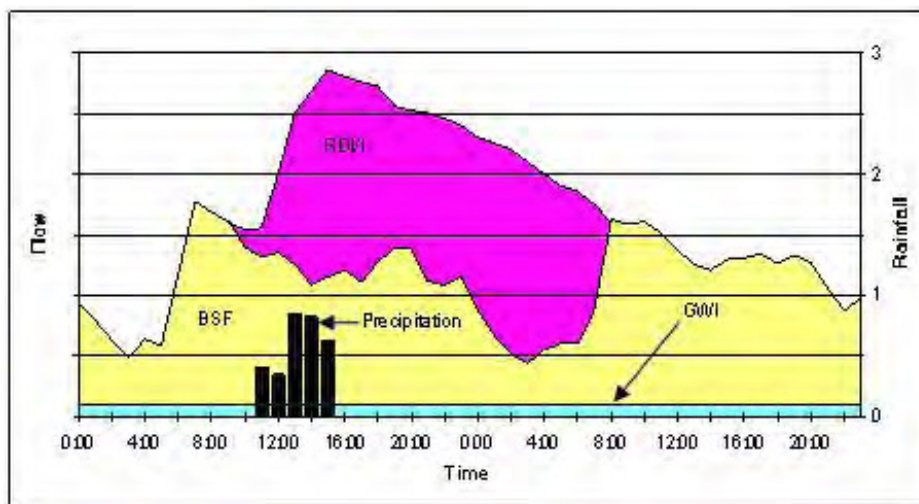
This TM summarizes the average dry weather wastewater flow (ADWF) projections for June 2004 and buildout conditions for the 2005 SPWA Regional Service Area boundary. ADWF projections are used to:

1. Project flows for the analysis of the SPWA wastewater treatment plants
2. Identify changes in average dry weather flow projections (within the 1996 Master Plan EIR Service Area) since the completion of the 1996 Wastewater Master Plan

2 Wastewater Flow Components

Typically, wastewater consists of three components: base sanitary flow (BSF), groundwater infiltration (GWI), and rainfall dependent infiltration and inflow (RDI/I). These components are shown on **Figure 1**. BSF and GWI during dry weather constitute ADWF. Base sanitary flow is generated from residential, commercial, industrial, and public sources that discharge into the wastewater collection system. Base sanitary flow varies during the day in a diurnal pattern with the lowest flow during early morning hours when most people are asleep and businesses are closed, and the highest flow in mid-morning after people prepare for their day's activities. GWI occurs when groundwater levels are above the inverts of the collection system pipes. RDI/I occurs during wet weather conditions and causes the wastewater flow to increase. RDI/I is discussed in a separate TM (TM No. 2c).

Figure 1: Wastewater Components



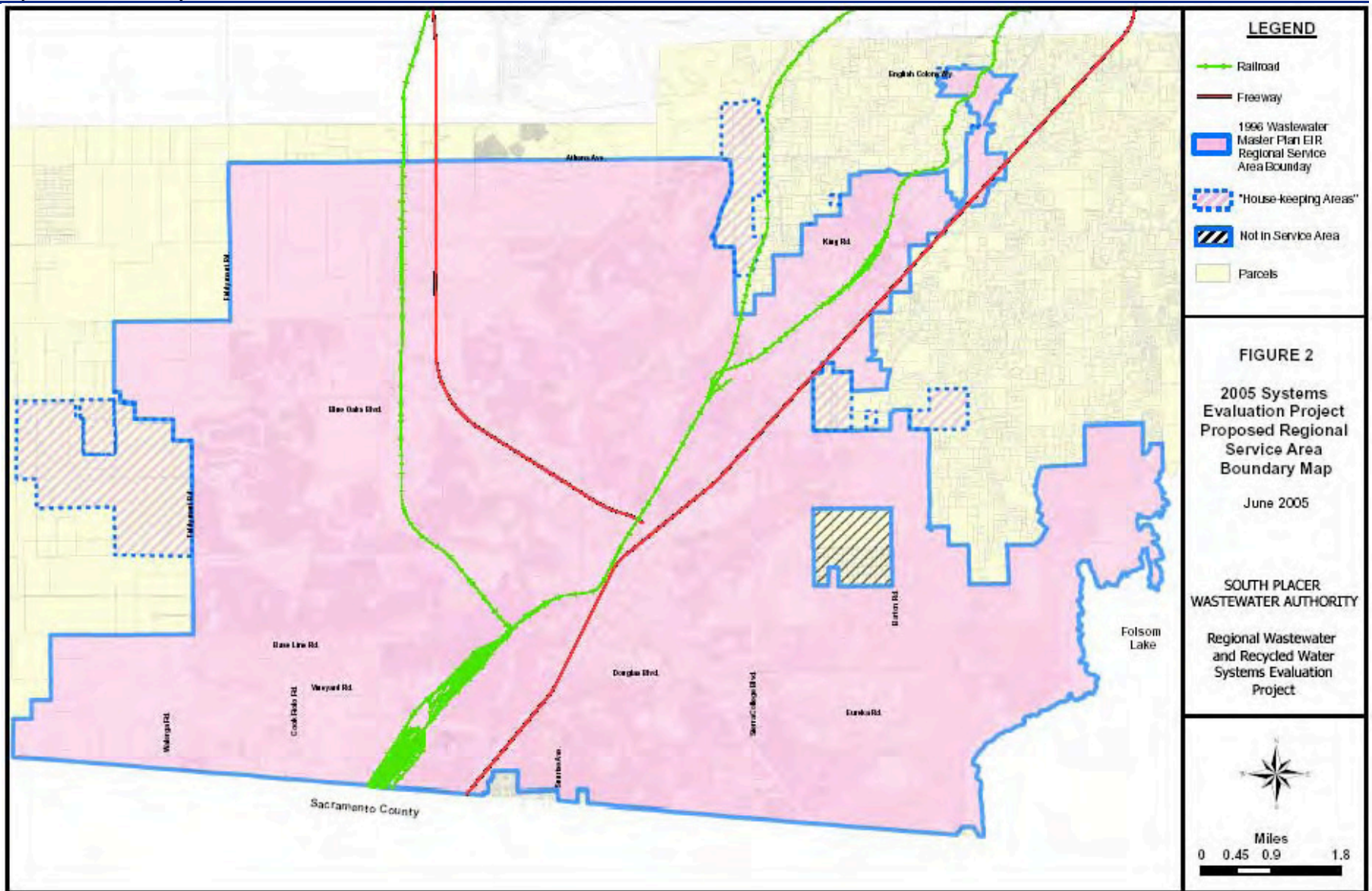
For this project, ADWF is projected on a parcel-by-parcel basis using unit BSF and GWI factors. Land use information is summarized in the *Current and Buildout Land Use TM* (TM No. 1b). Development of unit BSF and GWI factors is discussed below. Individual large or atypical dischargers (customers) were identified and their BSF was projected individually based on historical data.

3 Land Use

A parcel-based land use map of the 2005 SPWA Regional Service Area was developed for this project from specific plan and county assessor’s data provided by the City of Roseville and Placer County. The 1996 Wastewater Master Plan Environmental Impact Report service area boundary (Regional Service Area) was revised and June 2004 land use information was assigned to each parcel within the revised Regional Service Area. The process used to revise the Regional Service Area is documented in the January 2005 TM (TM No. 1a) entitled “*Proposed 2005 Regional Service Area Boundary.*” A map of the 2005 Regional Service Area is included as **Figure 2**. Development of the land use map (June 2004 and buildout), land use code designations, and connected land use is documented in TM No. 1b.

The land use map and associated database was developed for this project solely to project wastewater flows. This information should not be used for other purposes without consulting the City of Roseville and SPWA.

South Placer Regional Wastewater and Recycled Water Systems Evaluation
 Dry Weather Flow Projection



3.1 Land Use Designations

The team consolidated approximately 114 land use codes previously used by the City of Roseville and Placer County into 17 new land use codes. Those 17 land use codes were further consolidated into 11 land use codes to simplify the process of projecting June 2004 and buildout wastewater flows in the model. Part 2 of the consolidation process aggregated the non-flow producing land use types into one “Open Space” category and introduced three new land use codes (Mixed Use, Schools, and Parks > 10 Acres). Parks were consolidated into the Open Space category with the exception of those parks greater than 10 acres in size. This was done so that these larger parks (typically with restroom facilities) could be accounted for in the flow projections.

3.2 June 2004 Land Use and Connected Parcels

Parcels that are currently connected to the SPWA collection system were identified to project June 2004 wastewater flow and calibrate the sewer model for the June 2004 system. Further discussion on the identification of connected parcels is presented in TM No. 1b.

3.3 Buildout Land Use

The buildout land use is based on buildout within the 2005 Regional Service Area as shown on **Figure 2**. For the buildout condition, all parcels are considered to be connected to the wastewater collection system even though some land uses in the “Open Space” category do not generate wastewater.

June 2004 and buildout land use acreages for connected parcels within the 2005 Regional Service Area are summarized by land use designation in **Table 1** and **Table 2**.

As of June 2004, there were 22,159 connected acres within the 2005 Regional Service Area. Approximately 67 percent of the developed land is classified as single or multi-family residential. Approximately 10 percent of the developed land is classified as open space.

Table 1 - June 2004 Land Use Summary within the 2005 Regional Service Area

Land Use Designation	June 2004 Connected Area (Acres)		Total June 2004 Connected Area (Acres)
	Pleasant Grove Watershed	Dry Creek Watershed	
Commercial	495	1,622	2,117
Heavy Industrial	364	111	475
Light Industrial	616	316	932
Mixed Use	0	7	7
Open Space	1,398	737	2,135
Parks > 10 Acres	247	263	510
Public/Quasi-Public	154	467	621
Residential 1 DU	4,186	9,343	13,529
Residential 2 DU	0	280	280
Residential 3 DU	0	37	37
Residential Multiple DU	380	547	927
Schools	171	418	589
Total Acreage	8,011	14,148	22,159

Table 2 – Buildout Land Use Summary within the 2005 Regional Service Area

Land Use Designation	Buildout Connected Area (Acres)		Total Buildout Connected Area (Acres ^{1,2})
	Pleasant Grove Watershed ¹	Dry Creek Watershed ²	
Commercial	2,151	2,915	5,066
Heavy Industrial	1,715	263	1,978
Light Industrial	1,599	637	2,236
Mixed Use	13	12	25
Open Space	7,318	3,502	10,820
Parks > 10 Acres	303	361	664
Public/Quasi-Public	327	878	1,205
Residential 1 DU	7,629	18,859	26,488
Residential 2 DU	0	839	839
Residential 3 DU	9	366	375
Residential Multiple DU	789	635	1,424
Schools	377	540	917
Total Acreage	22,231	29,808	52,039

1 Includes portion of Placer Ranch UGA within the 2005 service area.

2 Includes portion of Placer Vineyards UGA within the 2005 service area.

The 2005 Regional Service Area includes portions of two Urban Growth Areas (UGAs), the remainder of which are outside both the 1996 Service Area and the 2005 Regional Service Area. Projected flows from UGAs will be the subject of a future TM, *Dry Weather Flow Projection for the Ultimate SPWA Service Area (Including UGAs)* (TM No. 2b).

The 2005 Regional Service Area also includes “Housekeeping Areas,” areas discussed in TM No. 1a. The largest of those “housekeeping areas” is the West Roseville Specific Plan. Information about proposed development within the Placer Vineyards and Placer Ranch UGAs and West Roseville was obtained from Specific Plans and discussions with developers. The UGAs and West Roseville are comprised, as of June 2004, of several large parcels that have not been subdivided to reflect the proposed future developments. Flow projections from these areas are based on the proposed number of dwelling units, land use acreages, and unit BSF and GWI factors discussed below.

In 2009, an update to the West Roseville Specific Plan (WRSP) was proposed and the impacts to the SPWA Systems were evaluated. The update proposed additional densification which would result in an increase of ADWF from 1.70 mgd to 2.07 mgd from the WRSP. Although this update has not been approved, buildout land uses have been updated to reflect the findings of this evaluation as the update may occur at a later date and it is considered to be more conservative.

4 Point Sources

Eight point sources were identified for the sewer evaluation based on discussions with SPWA member agencies. Information about point sources is summarized in **Table 3**. Point sources were identified from flow monitoring and water billing information. A landfill in Placer County was also identified as a point source because it generates very little wastewater flow in comparison to its land area. Buildout flow

projections from NEC and HP were provided by the City of Roseville and are based on buildout conditions for each development.

Table 3 - June 2004 and Projected ADWF from Point Sources in the 2005 Service Area

Point Source	Location	June 2004 Flow Data Source	June 2004 ADWF (gpd)	Projected Buildout ADWF (gpd)
Union Pacific Railroad	Roseville	City of Roseville	85,000	85,000
Landfill	Placer County	City of Roseville	5,000	5,000
NEC	Roseville	Flow Monitor Data	700,000	2,000,000
HP	Roseville	City of Roseville	150,000	484,000
Kaiser Hospital	Roseville	Water Use Data	50,000	50,000
Formica	Placer County	Placer County	60,000	60,000
Rio Bravo Power Plant	Placer County	Placer County	15,000	15,000

Notes: Flow projections are based upon existing land use and existing land use designations current as of June, 2004, and provide the estimated flows for baseline modeling scenario for SPWA. Rezoning of HP and Kaiser Hospital properties are now better known than in June 2004, and are documented in TM No. 9b, and are included in a “Land Use intensification Scenario”.

5 Base Sanitary Unit Flow Factors

Unit BSF factors were developed using the following sources of data:

- City of Roseville Water Billing Data
- Temporary Dry Weather Flow Monitoring Data from selected locations in the SPWA Service Area
- Permanent Flow Monitoring Data from Pleasant Grove and Dry Creek WWTPs
- Permanent Flow Monitoring Data from collection system meters serving SPMUD and Placer County

The basic approach utilized to develop the unit flow factors included gathering and analyzing land use-specific water billing and flow monitoring data and then testing the resulting unit factors for the June 2004 system in a mass balance.

5.1 Roseville Water Billing Data

Unit flow factors were developed from City of Roseville water billing information from December 2003 – March 2004. Water billing data was available for approximately 50 percent of the parcels in Roseville. Water billing information was joined to the parcels in the land use database by Assessor Parcel Number (APN). The parcel database includes land use information that allowed water usage information to be grouped by land use designation. Winter water usage information was primarily evaluated since landscape irrigation is minimal during winter months and water usage is more closely related to wastewater flows. These water demand factors can be correlated to BSF unit flow factors. Historically, BSF is typically 80-90 percent of water demand. This process yielded the following results, presented in **Table 4**.

Table 4 - Water Demand Factors Derived from the Roseville Water Billing Data

Land Use Designation	Water Demand Factor		Typical Base Sanitary Flow	
			Factor Range ¹	
Commercial	1,000	gpd per acre	800-900	gpd per acre
Heavy Industrial	310	gpd per acre	250-280	gpd per acre
Light Industrial	1,000	gpd per acre	800-900	gpd per acre
Mixed Use	2,700	gpd per acre	2,160-2,430	gpd per acre
Public/Quasi-Public	780	gpd per acre	620-700	gpd per acre
Schools	200	gpd per acre	160-180	gpd per acre
Single Family Residential	220	gpd per du	180-200	gpd per du
Residential Multiple DU	1,500	gpd per acre	1,200-1,350	gpd per acre

¹ 80 to 90 percent of the Water Demand Factor

5.2 Temporary Dry Weather Flow Monitoring

Temporary dry weather flow monitoring was conducted at 16 sites for 24 days in September and October 2004. These sites were located in Roseville, Placer County and SPMUD sewer service areas. The intent of this flow monitoring was to isolate single land use types so that unit flow factors could be determined for each monitored land use.

As would be expected in a collection system with diverse development ages and types, the unit flow factors varied widely within each land use category. The reason for this variation is due to the fact that the data is only representative of a very small sample of parcels within the service area. For example, the monitored residential parcels represent approximately 5 percent of the total residential parcels within the study area. These results were used in conjunction with the water use data presented in the previous section. Specific details and information about the temporary dry weather flow monitoring is presented in the October 2005 Flow Monitoring TM (No. 2d).

5.3 Permanent Dry Weather Flow Monitoring

Dry weather flow monitoring data from seven permanent flow monitoring sites in Roseville, SPMUD and Placer County were reviewed to establish “target” flows for the unit flow factor mass balance. Flow data from September and October 2004 was provided by Roseville, SPMUD and Placer County. A flow data summary is presented in **Table 5**. The two sites in Roseville were located at each wastewater treatment plant (WWTP). The five remaining sites were located at flumes where SPMUD and Placer County trunk sewers enter Roseville. The flow monitors in the Dry Creek watershed are tributary to the Dry Creek WWTP. The flow monitors in the Pleasant Grove watershed are tributary to the Pleasant Grove WWTP. Hydrographs for the Springview, Strap Ravine and Old Auburn flow monitoring sites exhibited signs of GWI. This was confirmed during the unit flow factor mass balance procedure and a review of temporary wet weather flow monitoring data from Winter 2005.

6 Groundwater Infiltration (GWI)

GWI occurs when groundwater levels are above the inverts of the collection system pipes and manholes and the pipes and manholes have leaky joints or other defects that allow groundwater to enter the collection system. Groundwater levels vary seasonally and are highest at the end of the wet season and lowest at the end of the dry season, which is typically in September. Higher GWI levels that may occur during wet weather will be addressed in the *Wet Weather Flow Projection TM* (TM No. 2c).

South Placer Regional Wastewater and Recycled Water Systems Evaluation

Dry Weather Flow Projection

Total GWI is estimated by subtracting total BSF projections from total ADWF as measured at each WWTP flow monitoring site. The total calculated GWI rate for the service area is approximately 1.70 million gallons per day (mgd). For purposes of WWTP expansion planning, the GWI will be distributed evenly across the entire service area. For purposes of collection system modeling, the GWI will be distributed spatially based on the results of the flow monitoring data analysis.

Table 5 - Measured Flow at 2004 Permanent Dry Weather Flow Monitoring Sites, and Estimated GWI from Watershed Lands Upstream of Meter

Site Name	Location	Watershed	BSF (mgd)	GWI (mgd)	ADWF (mgd)
Old Auburn	Placer County	Dry Creek	0.75	0.50	1.25
Strap Ravine	Placer County	Dry Creek	0.73	0.30	1.03
Highlands	SPMUD	Dry Creek	0.08	0.00	0.08
Springview	SPMUD	Dry Creek	2.19	0.80	2.99
Dry Creek WWTP	Roseville	Dry Creek	12.70	1.70	14.40
North Roseville	SPMUD	Pleasant Grove	1.84	0.00	1.84
Pleasant Grove WWTP	Roseville	Pleasant Grove	2.55	0.00	2.55

7 Unit Flow Factor Mass Balance

Unit flow factors from the water data and temporary flow data analysis were used as a starting point to balance the wastewater flows with the permanent flow meter sites. Flow projections for the WWTP analysis are based on unit ADWF factors which include BSF and GWI. This provides a uniform methodology for projecting flows throughout the service area.

Utilizing the total ADWF observed at the Roseville WWTPs (without subtracting GWI), the most representative ADWF unit flow factor set was approximately 85 percent of the winter water use, with the exception of Residential Multiple DU and Heavy Industrial, which are explained below.

The Residential Multiple DU unit flow rate of 2,040 gpd/acre is based on an estimated unit flow factor of 130 gpd per multi-family dwelling unit (which is approximately 70 percent of the wastewater flow of single-family dwelling units) with a development density of 16 units per acre. Multi-family dwelling units typically have fewer occupants than single-family dwelling units and therefore generate less wastewater. The development density of 16 units per acre is the average number of Residential Multiple DU dwelling units/acre in Roseville and SPMUD.

The Heavy Industrial unit flow factor of 250 gpd/acre appeared to be extremely low compared to the Light Industrial unit flow factor and typical Heavy Industrial unit flow factors seen in other cities. Because of this difference, the Heavy Industrial unit flow rate was modified to match the Light Industrial unit flow factor. In the future, any proposed Heavy Industrial land use will be evaluated on the basis of the type of proposed use (e.g., Wet industry, or Dry Industry) and the site specific flow associated with any development or planning proposal.

The June 2004 ADWF mass balance (including GWI) for the 2005 SPWA Regional Service Area is presented in **Table 6**. This projection is within 2 percent of the average total flow of 16.99 mgd measured at Dry Creek and Pleasant Grove WWTPs in September and October 2004.

Table 6 – June 2004 Dry Weather Flow Mass Balance

Land Use	Unit Flow Factor		June 2004 Units (Acres or DU)	June 2004 ADWF (mgd)
Commercial	850	gpd per acre	2,117	1.79
Heavy Industrial ¹	850	gpd per acre	475	0.40
Light Industrial ¹	850	gpd per acre	932	0.79
Mixed Use	2,300	gpd per acre	7	0.02
Public/Quasi-Public ¹	660	gpd per acre	621	0.41
Schools	170	gpd per acre	589	0.10
Residential 1 DU	190	gpd per du	51,285	9.74
Residential 2 DU	190	gpd per du	1,537	0.30
Residential 3 DU	190	gpd per du	306	0.06
Residential Multiple DU	2,040	gpd per acre	927	1.89
Open Space	0	gpd per acre	2,135	0.00
Parks > 10 Acres	10	gpd per acre	510	0.005
Point Sources		varies	1,139	1.16
Total				16.67

¹ Land use category does not include area of parcels associated with point sources identified in Table 1.

7.1 Unit Flow Factors

The unit flow factors for WWTP expansion analysis are presented in **Table 7**. Unit flow factors for single family residential are applied on a per dwelling unit (du) basis while unit flow factors for other land uses are on an acreage basis.

As explained previously, the temporary flow monitoring data identified wide variations in the unit flow factors for various land use types and was not representative of the entire service area. Water billing data from the City of Roseville and the permanent flow monitoring data from Roseville, SPMUD and Placer County presented a much broader picture which ultimately proved to be more representative of the entire service area.

Table 7 – 2005 Average Dry Weather Flow (ADWF) Factors

Land Use Designation	Units	2005 Unit Flow Factors WWTP Analysis ¹	1996 Master Plan Unit Flow Factor
Commercial	gpd per acre	850	1,040
Heavy Industrial	gpd per acre	850	1,560
Light Industrial	gpd per acre	850	1,040
Mixed Use	gpd per acre	2,300	N/A
Public/Quasi-Public	gpd per acre	660	1,040
Schools	gpd per acre	170	N/A
Residential 1 DU	gpd per du	190	260
Residential 2 DU	gpd per du	190	260
Residential 3 DU	gpd per du	190	260
Residential Mult. DU ²	gpd per acre	2,040	4,160
Open Space	gpd per acre	0	0
Parks > 10 Acres	gpd per acre	10	N/A
Vacant	gpd per acre	0	0

¹ Includes allowance for dry season GWI.

² The 2005 Residential Multiple DU unit flow factor can also be represented as 130 gpd per du

8 ADWF Unit Flow Factors and Future (Buildout) Flow Projections

Buildout ADWF projections within the 2005 Regional Service Area are based on the unit ADWF factors developed for the WWTP analysis above (includes dry season GWI). These flow projections do not include the results of proposed redevelopment/intensification within Roseville and Rocklin which have been analyzed as a separate scenario and are presented in the *Impact on Regional Trunk Sewer System and WWTPs of Land Use Intensification for Parcels within Redevelopment Areas in Roseville and Rocklin TM* (No 9d). Buildout dry weather flow projections within the 2005 Regional Service Area are presented in **Table 8**.

Table 8 - Buildout ADWF Projections within the 2005 Regional Service Area

Land Use	Unit Flow Factor	PG WWTP ³		DC WWTP ⁴		2005 Regional Service Area	
		Buildout Units (ac or du)	Buildout ADWF (mgd)	Buildout Units (ac or du)	Buildout ADWF (mgd)	Buildout Units (ac or du)	Buildout ADWF (mgd)
Commercial	850 gpd/ac	1,728	1.47	2,890	2.46	4,618	3.92
Heavy Industrial ¹	850 gpd/ac	1,680	1.43	263	0.22	1,943	1.65
Light Industrial ¹	850 gpd/ac	1,221	1.04	637	0.54	1,858	1.58
Mixed Use	2,300 gpd/ac	-	-	7	0.02	7	0.02
Public/Quasi-Public ¹	660 gpd/ac	282	0.19	851	0.56	1,133	0.75
Schools	170 gpd/ac	258	0.04	540	0.09	798	0.14
Residential 1 DU	190 gpd/du	26,893	5.11	42,866	8.14	69,759	13.25
Residential 2 DU	190 gpd/du	2	0.0004	2,122	0.40	2,124	0.40
Residential 3 DU	190 gpd/du	12	0.002	720	0.14	732	0.14
Residential Multiple DU	2,040 gpd/ac	594	1.21	606	1.24	1,200	2.45
Open Space	0 gpd/ac	6,034	-	3,171	-	9,205	-
Parks > 10 Acres	10 gpd/ac	270	0.003	361	0.004	631	0.01
Point Sources	Varies gpd/ac	1,043	2.56	91	0.14	1,134	2.70
Placer Ranch ²	Varies gpd/ac	1,027	0.90	-	-	1,027	0.90
West Roseville ²	Varies gpd/ac	2,968	2.07	-	-	3,162	2.07
Placer Vineyards ²	Varies gpd/ac	-	-	1,062	0.58	1,062	0.58
Rezones	Varies gpd/ac		0.50		0.17		0.67
Intensification	Varies gpd/ac		-		1.64		1.64
	Totals (mgd)		16.52		16.34		32.86

¹ Land use category does not include area of parcels associated with point sources identified in Table 1.

² Includes portion of development located within the 2005 Regional Service Area.

³ Pleasant Grove WWTP Service Area

⁴ Dry Creek WWTP Service Area

9 1996 Service Area ADWF Projection Comparison

A review of the flow projections for the 1996 Master Plan EIR Service Area boundary was completed. This review compares 1996 and 2005 flow projections within the 1996 Service Area boundary. The flow projection for the 1996 Service Area as calculated in the 1996 Master Plan is 45.6 mgd. This 1996 flow projection utilized the 1996 Master Plan unit flow factors (shown in **Table 7**) to project flows in the service area and different land use assumptions. Since 1996, land use within the service area has changed and the unit flow factors established in this Master Plan have caused the 2005 flow projection within the 1996 Service Area to decrease to 28.7 mgd (shown in **Table 9**). This decrease can be attributed to reductions in the residential unit flow factor and an approximately 20 percent reduction in the development densities. Note that the 28.7 mgd flow projection is less than the 32.5 mgd presented in **Table 8** for the 2005 Regional Service Area. The 2005 Regional Service Area is inclusive of the 1996 Master Plan EIR Service Area, and also includes the “housekeeping areas” (West Roseville, Clover Valley Lakes, and others) documented in TM No. 1a.

Table 9 – Average Dry Weather Flow for the 1996 Service Area with 2005 Unit Flow Factors

Land Use	Unit Flow Factor	PG WWTP ³		DC WWTP ⁴		2005 Regional Service Area	
		Buildout Units (ac or du)	Buildout ADFW (mgd)	Buildout Units (ac or du)	Buildout ADFW (mgd)	Buildout Units (ac or du)	Buildout ADFW (mgd)
Commercial	850 gpd/ac	1,728	1.47	2,864	2.43	4,592	3.90
Heavy Industrial ¹	850 gpd/ac	1,680	1.43	263	0.22	1,943	1.65
Light Industrial ¹	850 gpd/ac	1,221	1.04	637	0.54	1,858	1.58
Mixed Use	2,300 gpd/ac	-	-	7	0.02	7	0.02
Public/Quasi-Public ¹	660 gpd/ac	282	0.19	829	0.55	1,111	0.73
Schools	170 gpd/ac	258	0.04	394	0.07	652	0.11
Residential 1 DU	190 gpd/du	26,671	5.07	40,956	7.78	67,627	12.85
Residential 2 DU	190 gpd/du	2	0.0004	2,122	0.40	2,124	0.40
Residential 3 DU	190 gpd/du	12	0.002	720	0.14	732	0.14
Residential Multiple DU	2,040 gpd/ac	594	1.21	606	1.24	1,200	2.45
Open Space	0 gpd/ac	4,004	-	3,290	-	7,294	-
Parks > 10 Acres	10 gpd/ac	270	0.003	360	0.004	630	0.01
Point Sources	Varies gpd/ac	1,043	2.56	91	0.14	1,134	2.70
Placer Ranch ²	Varies gpd/ac	1,027	0.90	-	-	1,027	0.90
West Roseville ²	Varies gpd/ac	1,316	0.67	-	-	1,316	0.67
Placer Vineyards ²	Varies gpd/ac	-	-	1,062	0.58	1,062	0.58
Totals (mgd)			14.58		14.11		28.69

¹ Land use category does not include area of parcels associated with point sources identified in Table 1.

² Includes portion of development located within the 2005 Regional Service Area.

³ Pleasant Grove WWTP Service Area

⁴ Dry Creek WWTP Service Area

Attachment A
2009 Update Sheet

Update Sheet



South Placer Regional Wastewater and Recycled Water Systems Evaluation

Subject: 2009 Update Sheet for TM 2a
Prepared For: Art O'Brien, City of Roseville
Prepared by: Chris van Lienden, RMC
Reviewed by: Dave Richardson, RMC
Date: September 3, 2009
Reference: 0091-04

The TM has been modified since it was originally developed in 2005 based on the following updates.

1 2006 Updates

The TM was updated in 2006 to reflect changes in the SPMUD UGA boundary and land use, and to add Brookfield as an additional UGA.

2 2008 Updates

The TM was further updated in 2008 to reflect changes in the land uses and flow projections of the UGAs.

3 2009 Updates

An additional update was prepared in 2009 to reflect the following changes.

3.1 Updates to the H2Omap Sewer Model

Since the 2008 update, the H2Omap Sewer software has been updated which resulted changes to the build-out flow estimates. The flow estimates in the TM has been updated to reflect the most recent model results.

3.2 Changes to the Development Timeline

Flow projections have been updated to reflect reduced rates of residential development due to the economic slowdown beginning in 2008.

3.3 West Roseville Specific Plan Rezone

Buildout flow estimates have been updated to reflect additional inflow from a proposed rezone in the West Roseville Specific Plan (May, 2009). The new land uses and associated average dry weather flow (ADWF) are summarized in Table 1.

Table 1 – West Roseville Specific Plan Rezone Comparison

Connected Land Use Description	Original Developer Agreements		2009 Proposed Update	
	DU or Area (DU or ac)	Flow (mgd)	DU or Area (DU or ac)	Flow (mgd)
1 Residential				
1.1 Low Density Residential	4842 DU	0.92	5963 DU	1.13
1.2 LDR (age restricted)	710 DU	0.13	0 DU	0.00
1.3 Medium Density Residential	1064 DU	0.20	1746 DU	0.33
1.4 High Density Residential	1774 DU	0.23	3229 DU	0.42
2 Open Space	670 ac		696 ac	0.00
2.1 Paseo	15 ac		0 ac	0.00
2.2 Park	251 ac		284 ac	0.00
2.3 Pocket Parks	19 ac		0 ac	0.00
3. Public/Quasi-Public				
3.1 Schools	108 ac	0.02	109 ac	0.02
3.2 Public/Quasi-Public	41 ac	0.02	15 ac	0.01
4 Community Commercial				
4.1 Commercial	34 ac	0.03	56 ac	0.05
4.2 Mixed Use	14 ac	0.03	0 ac	0.00
4.3 Church	0 ac	0.01	0 ac	0.00
5. Business Professional				
5.1 Commercial	20 ac	0.02	18 ac	0.02
6. Light Industrial	74 ac	0.06	75 ac	0.06
7. Industrial	34 ac	0.03	35 ac	0.03
Total		1.71		2.07

Appendix E: *TM 2c – Wet Weather Flow Projection
for Ultimate Service Area (w/ UGAs)*

Technical Memorandum



South Placer Regional Wastewater and Recycled Water Systems Evaluation

Subject: Wet Weather Flow Projection for the Ultimate SPWA Service Area (Including Urban Growth Areas) (TM No. 2c)

Prepared For: Art O'Brien – City of Roseville

Prepared by: Pete Bellows/Chris Peters – Brown and Caldwell
Andy Smith – RMC

Reviewed by: Dave Richardson/Gisa Ju – RMC

Date: January 17, 2006; updated January 24, 2008 & September 3, 2009

Reference: 0091-004 Task 2

O Previous TM Publication and Updates

Since the initial publication of technical memorandum (TM) 2c on January 17, 2006, changes in information available for the South Placer Wastewater and Recycled Water Systems Evaluation (Systems Evaluation), as well as changes in the data, have resulted in the need to identify and update out-of-date information. The newest version of the TM is consistent with the updates summarized in the 2009 Update Sheet which is included in Attachment B.

1 Introduction

This TM summarizes the wet weather wastewater flow projections for buildout conditions within the Ultimate SPWA service area. This includes flows generated within the proposed 2005 Service Area boundary and flows generated within the Urban Growth Areas (UGAs) located outside the proposed 2005 Service Area boundary. Wet weather flow projections are used with the hydraulic model to perform the hydraulic assessment of the collection system and for the analysis of the SPWA wastewater treatment plants. Wet weather flows are based on flow monitoring data which are presented in the *Flow Monitoring TM* (TM No. 2d).

2 Wastewater Flow Components

Typically, wastewater consists of three components: base sanitary flow (BSF), groundwater infiltration (GWI), and rainfall dependent infiltration and inflow (RDI/I). These components are shown on Figure 1: . BSF and GWI during dry weather constitute ADWF. ADWF components were previously discussed in the *Dry Weather Flow Projection TM* (TM No. 2a). GWI can vary seasonally as rainfall causes localized groundwater levels to rise during the winter. This phenomenon occurs within the SPWA service area and results in increased GWI in some areas during the wet season. RDI/I occurs during rainfall conditions and causes the wastewater flow to increase. Together, BSF, GWI, wet season GWI, and RDI/I constitute wet weather flow.

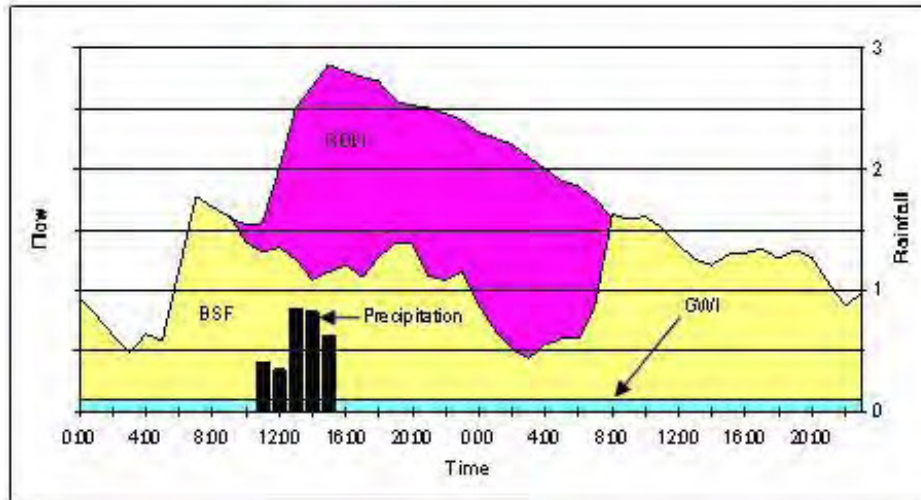


Figure 1: Wastewater Components

3 Wet Weather Flow and Precipitation Data

Wet weather flow data was collected at 43 locations during the winter of 2005. The monitor network consisted of 37 temporary flow monitors and 6 permanent flow monitors. Twenty-seven of the flow monitor sites (including the WWTP monitors) were within the City of Roseville and were utilized for the Roseville Hydraulic Modeling Project. The rest of the monitors were located in Placer County and SPMUD. Some of the temporary monitors located outside of Roseville were located to verify the data from several permanent meter sites. For the wet weather analysis, flow data from the network were evaluated from late January through March 2005. The flow monitor locations utilized for the SPWA wet weather flow projections are listed in Table 1 and are shown on Figure 2

Precipitation information during the wet weather flow monitoring period was collected at 17 permanent rain gauge sites in the City of Roseville and Placer County and one temporary rain gauge sites in SPMUD. The rain gauge network provided comprehensive coverage over the entire SPWA service area.

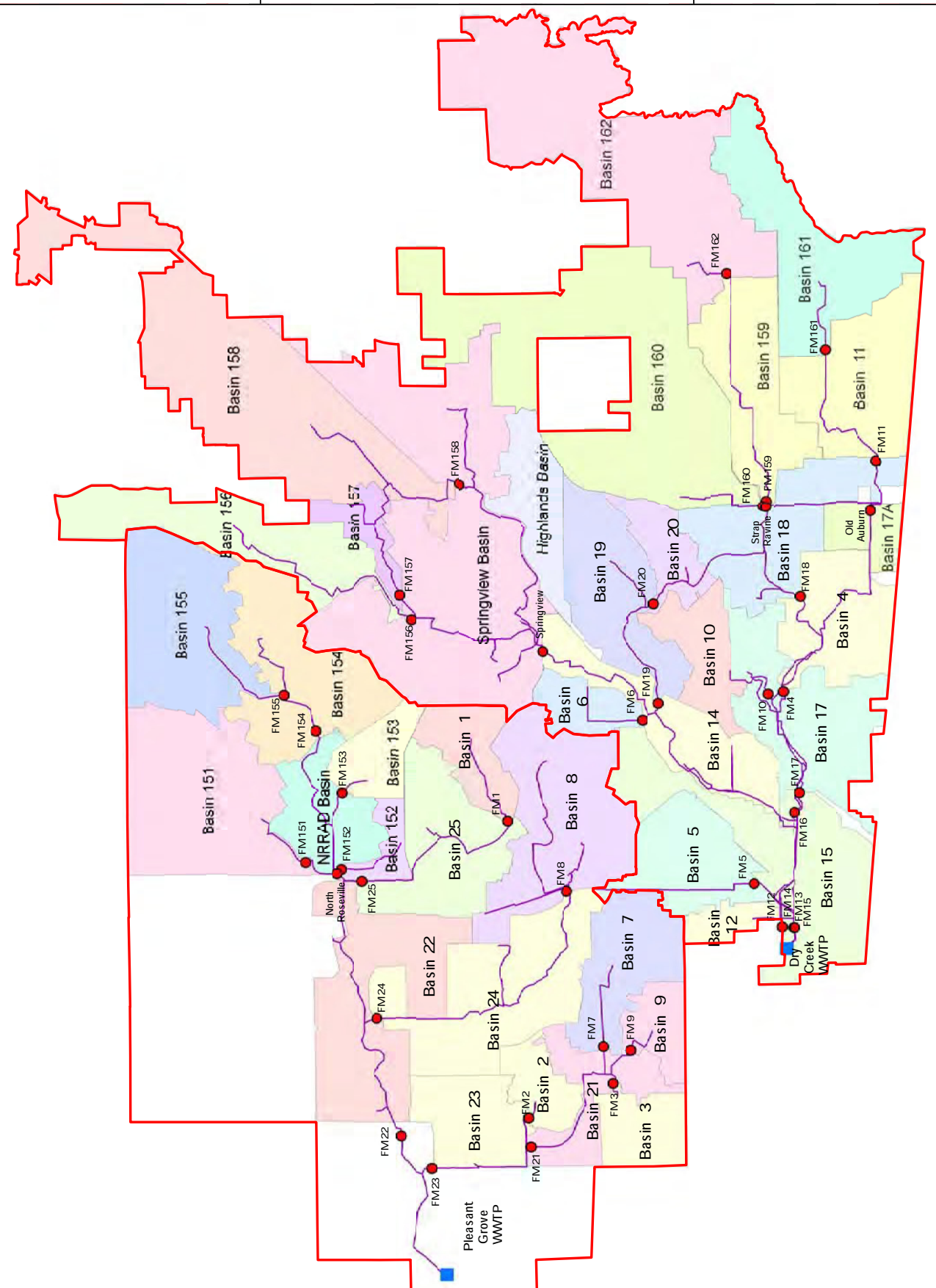
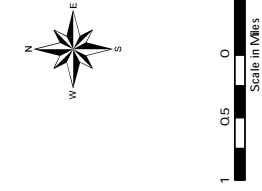
Further discussion and analysis of the wet weather flow and rainfall monitoring data is presented in the *Flow Monitoring TM* (TM No. 2d).

Table 1: Temporary and Permanent Wet Weather Flow Monitors – Winter 2005

Number	Meter Type	Location	Pipe Diameter (in)
1	Temporary	Roseville	18
2	Temporary	Roseville	15
3	Temporary	Roseville	15
4	Temporary	Roseville	15
5	Temporary	Roseville	21
6	Temporary	Roseville	18
7	Temporary	Roseville	24
8	Temporary	Roseville	30
9	Temporary	Roseville	18
10	Temporary	Roseville	18
11	Temporary	Roseville	15
12	Temporary	Roseville	21
13	Temporary	Roseville	42
14	Temporary	Roseville	66
15	Temporary	Roseville	33
17	Temporary	Roseville	21
18	Temporary	Roseville	24
19	Temporary	Roseville	36
20	Temporary	Roseville	24
21	Temporary	Roseville	33
22	Temporary	Roseville	72
23	Temporary	Roseville	36
24	Temporary	Roseville	42
25	Temporary	Roseville	21
151	Temporary	SPMJD	20
152	Temporary	SPMJD	18
153	Temporary	SPMJD	18
154	Temporary	SPMJD	24
155	Temporary	SPMJD	21
156	Temporary	SPMJD	15
157	Temporary	SPMJD	18
158	Temporary	SPMJD	18
161	Temporary	Placer County	15
162	Temporary	Placer County	15
North Roseville	Permanent	SPMJD	36
Springview	Permanent	SPMJD	42
Strap Ravine	Permanent	Placer County	15
Old Auburn	Permanent	Placer County	18

- Legend**
- Flow Meter Location
 - WWTP
 - Collection System Pipe
 - Flow Monitor Basin
 - WWTP Service Area Boundary

FIGURE 2
Wet Weather Flow Monitor Basins
 November 2005
 SOUTH PLACER
 WASTEWATER AUTHORITY
 Regional Wastewater
 and Recycled Water
 Sewer Evaluation
 Project



4 RDI/I Modeling with H₂OMAP Sewer Pro

The hydraulic analysis of the SPWA collection system is being performed using H₂OMAP Sewer Pro, a commercially available modeling program. The program has several modules that can be used to simulate RDI/I. The modules are calibrated using flow monitor and precipitation data described above. Once the model is calibrated, a design storm is applied to develop design RDI/I flow projections. Design RDI/I and wet weather GWI are combined with design base flows to compute predicted design peak wet weather flows and identify collection system deficiencies.

RDI/I is modeled within H₂OMAP Sewer Pro using the modules to simulate storm water runoff. H₂OMAP Sewer Pro has a unit hydrograph module with four different unit hydrograph methods for projecting runoff. The tri-triangle method was utilized to simulate RDI/I because it is widely used for projecting RDI/I, it is very flexible and it can be readily used to simulate RDI/I. The module simulates how much of and how quickly RDI/I enters the collection system from the contributing basins and subbasins.

The parameters needed to simulate RDI/I with the tri-triangle module are illustrated in Figure 3. Up to three synthetic hydrographs and three corresponding sets of parameters are defined for each basin, representing the fast, medium, and slow response components of the total RDI/I hydrograph. Each synthetic hydrograph has an associated time to peak (T) and recession constant (K) that defines the shape of its respective hydrograph and a rainfall volume factor (R) percentage that determines the volume of RDI/I. These parameters are adjusted during wet weather calibration to vary how much and how quickly rainfall enters the collection system and how long it takes the flow to recede, until a reasonable match is obtained between the actual monitored wet weather hydrograph and the RDI/I projection. In some cases, only one or two synthetic hydrographs are needed to calibrate the RDI/I.

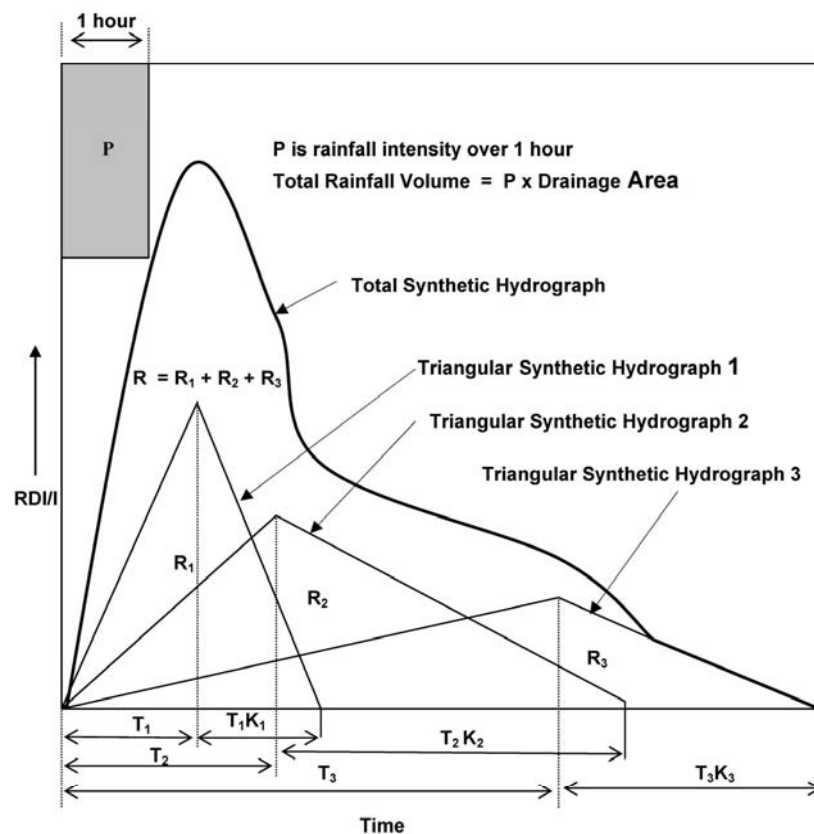


Figure 3: Tri-Triangle Synthetic Hydrograph Method

5 RDI/I Calibration

RDI/I calibration was performed by adjusting the parameters in H₂OMAP Sewer Pro until the modeled flow at the wet weather flow monitor sites reasonably simulates flow monitor data for an actual storm event. Once the model is calibrated, the design storm rainfall profile can be applied to predict design RDI/I responses. A key assumption is that the design storm response will be similar to that of the calibrated storm event. Therefore it is important that the conditions of the calibration event (e.g., antecedent soil and groundwater conditions, magnitude and intensity of rainfall) be as close as possible to the desired design storm condition. The storm on March 1-2, 2005 was chosen as the calibration event because it was the largest storm during the flow monitoring period and there was a reasonable flow response at most of the flow monitoring locations.

The goal for calibration is to match the peak measured flow with the peak modeled flow and the general shape of the flow response (e.g., time to peak and duration and slope of hydrograph recession). However, as with any model, some flow monitor sites calibrate better than others. This was observed previously during the dry weather model calibration. For this model, calibration at critical locations on the trunk sewers entering Roseville from Placer County and SPMUD and trunk sewers within Roseville was successful. Flow data anomalies at some flow meter sites prevented better calibration at those locations.

The calibration constants for the March 1-2 storm for each flow monitor basin are listed in Table 2. The plots of the model flow and flow monitor data are provided at the end of this TM in Attachment A. Figure 4 shows the wet weather flow monitor basins that were used to calibrate the model and their relative R factors.

Relatively low R factors ($\leq 1.5\%$) generally indicate a “tight” system with low rates of RDI/I. Some of the higher R factors ($\geq 3\%$) were found in the older areas of Roseville where pipes and laterals may have a higher level of deterioration, thus allowing more I/I into the system.

Table 2: RDI Calibration Parameters for March 1-2, 2005 Storm Event

Flow Monitor Basin	Total R ^a (%)	Hydrograph 1 ^b			Hydrograph 2 ^b			Hydrograph 3 ^b		
		R ₁ (% of R)	T ₁	K ₁	R ₂ (% of R)	T ₂	K ₂	R ₃ (% of R)	T ₃	K ₃
1	0.5	60	1	2	40	8	3	0	24	2
2	0.5	60	2	0.5	40	6	3	0	24	2
3	1.0	75	1	1	25	8	3	0	24	2
4	1.0	60	1.5	1	40	8	3	0	24	2
5	3.5	65	2	2	35	6	3	0	24	2
6	0.5	60	1	2	40	8	3	0	24	2
7	3.0	70	1.5	1	30	6	3	0	24	2
8	1.0	50	2	0.75	50	8	3	0	24	2
9	0.75	75	1	1	25	8	3	0	24	2
10	0.75	70	2	1	30	8	3	0	24	2
11 ^d	1.0	30	1	2	60	8	3	10	24	0.5
12	3.0	65	2	2	35	6	3	0	24	2
14	1.5	80	2	2	20	8	3	0	24	2
15N	3.0	65	2	2	35	6	3	0	24	2
15S	1.0	65	2	1	35	6	3	0	24	2
17/17A ^c	1.0	70	2	1	30	6	3	0	24	2
18	1.0	80	2	2	20	8	3	0	24	2
19	1.0	80	2	2	20	8	3	0	24	2
20	1.0	80	2	2	20	8	3	0	24	2
21	0.5	60	2	0.5	40	6	3	0	24	2
22	0.5	75	2	2	25	8	3	0	24	2
23	0.5	65	2	0.5	35	6	3	0	24	2
24	0.75	75	5.5	2	25	8	3	0	24	2
25	0.5	50	1	2	50	8	3	0	24	2
151	0.2	0	1	0.5	100	6	0.5	0	24	2
152	0.1	5	1	2	70	8	1	25	24	2
153	2.75	0	0.5	0.5	50	8	0.5	50	24	0.5
154	2.25	10	1	2	10	8	1	80	24	1
155	3.0	10	0.5	2	90	8	3	0	24	2
156	0.5	40	2	2	40	8	3	20	24	2
157	5.0	0	1	0.5	80	6	0	20	24	2
158	0.5	40	2	2	40	8	3	20	24	2
161	1.5	7	1	2	50	7	1	43	24	0.5
162	0.5	20	2	2	40	8	3	40	24	2
North Roseville	0.1	0	0.5	1	80	6	0.5	20	24	2
Springview	2.0	5	2	2	30	8	3	65	24	2
Strap Ravine ^e	0.5	40	1	1	45	8	1	15	24	2

^a Total percent of rainfall volume that enters the collection system as RDI/I

^b Refer to Figure 2 for R, T, and K coefficient definitions. R₁, R₂, and R₃ are a percentage of Total R (total 100%)

^c Flow from Monitor Basin 17A flows through the area representing Basin 4 but is tributary to flow monitor 17.

^d Data from Flow Monitor Basin 11 represents the majority of the area tributary to the Old Auburn flow monitor.

^e Data from the Strap Ravine Flow Monitor Basin represents the area tributary to the flow monitors 159 and 160.

Legend

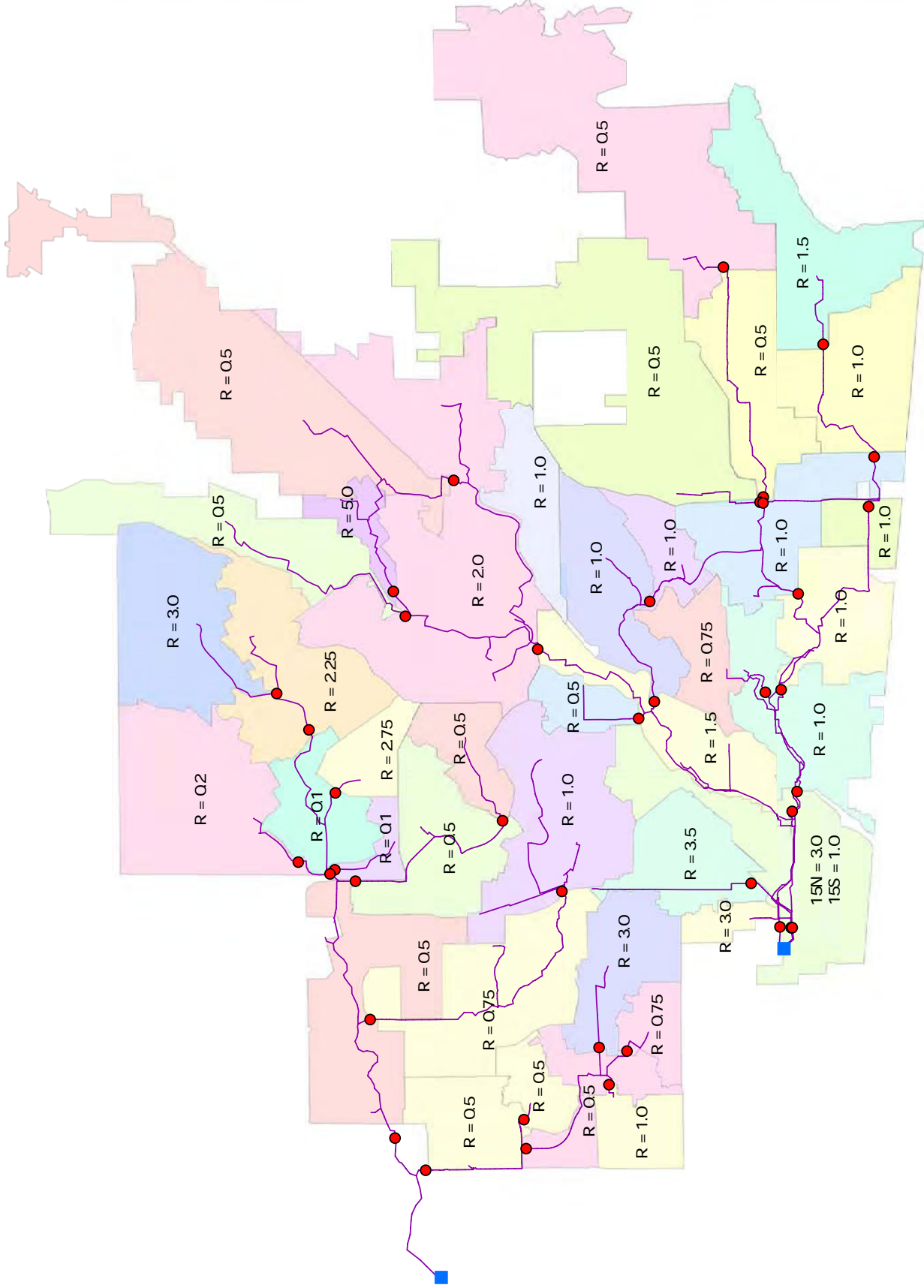
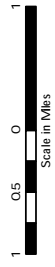
- Flow Meter Location
- WWTP
- Collection System Pipe
- Flow Monitor Basin
- % of rainfall volume that enters system as RDI/I

FIGURE 4
Wet Weather Flow Monitor Basins with Calibration R Factors

November 2005

SOUTH PLACER
 WASTEWATER AUTHORITY

Regional Wastewater
 and Recycled Water
 Sewer Evaluation
 Project



6 Wet Season GW

Wet season GWI occurs in addition to the dry season GWI that was defined in the *Dry Weather Flow Projection TM* (TM No. 2a). Wet season GWI was determined by comparing average daily flows at the permanent flow monitor sites in Roseville, SPMUD and Placer County during the 2004 dry season and 2005 wet season. Wet weather GWI was calculated for each area tributary to the permanent flow monitoring sites and was applied to each parcel in the model according the area of the parcel. Wet weather GWI is summarized in Table 3 and Table 4. Based on the results of this analysis, a wet season GWI rate of 200 gpd/acre was applied to currently developed parcels in the Dry Creek watershed. A wet season GWI rate of 100 gpd/acre was applied to currently developed parcels in the Pleasant Grove watershed. Wet season GWI was not applied to parks, open space, or Union Pacific Railroad property.

Table 3: Estimated Wet Season GW in the Dry Creek Watershed

Permanent Monitor Location	Tributary Area (acres)	2005 Wet Season ADWF (mgd)	2004 Dry Season ADWF (mgd)	Wet Season GW (mgd)	Wet Season GW Rate (gpd/acre)
Roseville ^a	5,076	6.32	5.09	1.23	242
SPMUD (Springview)	3,791	3.65	2.99	0.66	174
Placer County (Strap Ravine)	2,533	1.47	1.03	0.44	174
Placer County (Old Auburn)	1,555	1.46	1.25	0.21	135
Dry Creek WWTP	12,955	12.90	10.36 ^b	2.54	196

^a Calculated flow rates. Includes the following areas outside of Roseville: Highlands and West Dry Creek

^b 2004 dry season ADWF estimated based on 2005 dry season ADWF data at Dry Creek and Pleasant Grove WWTP

Table 4: Estimated Wet Season GW in the Pleasant Grove Watershed

Permanent Monitor Location	Tributary Area (acres)	2005 Wet Season ADWF (mgd)	2004 Dry Season ADWF (mgd)	Wet Season GW (mgd)	Wet Season GW Rate (gpd/acre)
Roseville ^a	4,064	5.27	4.79	0.48	118
SPMUD (North Roseville)	1,841	1.96	1.84	0.12	65
Pleasant Grove WWTP	5,905	7.23	6.63 ^b	0.60	102

^a Calculated flow rates. Includes the following areas outside of Roseville: Sunset Industrial Park

^b 2004 dry season ADWF estimated based on 2005 dry season ADWF data at Dry Creek and Pleasant Grove WWTP

Appendix F: Placer Ranch Modeling Assumptions

Phil Tabor

From: Chris van Lienden [cvanlienden@rmcwater.com]
Sent: Wednesday, April 14, 2010 11:40 AM
To: Phil Tabor; Hanson, George
Subject: RE: Fiddymment Farm

I've attached the Hydraulic Modeling TM which describes how land uses were assigned (in section 2). Table 1 shows that all residential land use categories were assigned to the residential multiple DU SPWA category. You are correct that the BSF factor is 120 rather than 130. An updated table is below. Hope that helps.

SPWA_LU	Acres	Acres or Dwelling Units	BSF Unit Factor (gpd/unit)	Base Sanitary Flow (gpd)	ADWF Unit Factor (gpd/unit)	ADWF (gpd)
Commercial	402	402	800	321,288	850	341,369
Light Industrial	2,159	2,159	800	1,727,493	850	1,835,461
Mixed Use	34	34	2160	73,802	2300	78,585
Open Space	329	329	0	0	0	0
Parks > 10 Acres	36	36	10	364	10	364
Public/Quasi-Public	48	222	620	137,372	660	146,235
Residential Mult. DU	502	6,652	120	798,240	130	864,700
Schools	40	40	160	6,427	170	6,828
Point Sources						
University	173			500,000		500,000
Toad Hill Estates	-			25,000		25,000
Total	3,725	acres		3,589,986		3,798,542
GWI (100 gpd/acre)	372,487	gpd				

Chris van Lienden, P.E.
 Project Engineer

RMC Water and Environment
 980 9th St, 16th Floor
 Sacramento, CA 95814
 916-449-9979 ph
 916-449-9959 dd
cvanlienden@rmcwater.com

4/19/2010

www.rmewater.com

From: Phil Tabor [mailto:ptabor@WoodRodgers.com]
Sent: Wednesday, April 14, 2010 11:24 AM
To: Hanson, George
Cc: Chris van Lienden
Subject: RE: Fiddyment Farm

George,

Thank you for forwarding this information. I will be attaching this email chain as an appendix and referencing it as the basis for our evaluation of the Placer Ranch Flow as it relates the Pleasant Grove Creek East Crossing.

I have one item on the list below that I would like to clarify however, as the format shown differs from what was previously provided in the December 2009 System Report - Appendix L

(I have highlighted this in RED below).

With regard to the Residential Units listed below, it appears that single family residential and multifamily residential dwelling units have been lumped together in the total 6,652 number shown. It does not seem consistent with the Systems report to apply the same BSF factor to all of residential units. Can you confirm that this is the intent of the revised table shown below?

I also see that the BSF flow factor listed for the multiple family residential is 130 gpd/ac – should this value be 120 consistent with the Systems report Chapter 3?

Thanks for your help.

-Phil

Phil Tabor, PE

Wood Rodgers, Inc
3301 C Street, Bldg. 100-B
Sacramento, CA 95816
ptabor@woodrodgers.com
office 916-341-7760
direct 916 341-7711
fax 916 341-7767

From: Hanson, George [mailto:GHanson@roseville.ca.us]
Sent: Tuesday, April 13, 2010 5:19 PM
To: Chris van Lienden
Cc: Phil Tabor

4/19/2010

Subject: RE: Fiddymment Farm

Chris,
No it's not necessary to get me the RDII info. This should work for now

Thanks

Phil, see info below

From: Chris van Lienden [mailto:cvanlienden@rmcwater.com]
Sent: Tuesday, April 13, 2010 9:32 AM
To: Hanson, George
Subject: RE: Fiddymment Farm

Hi George,
Below is a table of land uses showing the flow contribution in both BSF and ADWF (including offsite flows). PWWF from the model is 7.0 mgd. Pipe diameter is 27 ".
Breaking out the RDII contribution of PWWF would take a little bit of additional modeling to provide, so let me know if that 's necessary. It uses the same RDII factors as all the other UGAs (R = 0.5). Hope this helps, let me know if you have any questions.

SPWA_LU	Acres	Acres or Dwelling Units	BSF Unit Factor (gpd/unit)	Base Sanitary Flow (gpd)	ADWF Unit Factor (gpd/unit)	ADWF (gpd)
Commercial	402	402	800	321,288	850	341,369
Light Industrial	2,159	2,159	800	1,727,493	850	1,835,461
Mixed Use	34	34	2160	73,802	2300	78,585
Open Space	329	329	0	0	0	0
Parks > 10 Acres	36	36	10	364	10	364
Public/Quasi-Public	48	222	620	137,372	660	146,235
Residential Mult. DU	502	6,652	130	864,700	130	864,700
Schools	40	40	160	6,427	170	6,828
Point Sources						
University	173			500,000		500,000
Toad Hill Estates	-			25,000		25,000
Total	3,725	acres		3,656,446		3,798,542
GW (100 gpd/acre)	372,487	gpd				

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Project Engineer

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980 9th St, 16th Floor
Sacramento, CA 95814
916-449-9979 ph
916-449-9959 dd
cvanlienden@rmcwater.com
www.rmcwater.com

From: Hanson, George [mailto:GHanson@roseville.ca.us]
Sent: Thursday, April 08, 2010 5:25 PM
To: Chris van Lienden
Subject: RE: Fiddymment Farm

ok

From: Chris van Lienden [mailto:cvanlienden@rmcwater.com]
Sent: Thursday, April 08, 2010 5:06 PM
To: Hanson, George
Subject: RE: Fiddymment Farm

Hi George. I should be able to look into that and get back to you by early next week if that 's alright with you

Chris van Lienden, P.E.
Project Engineer

RMC Water and Environment
980 9th St, 16th Floor
Sacramento, CA 95814
916-449-9979 ph
916-449-9959 dd
cvanlienden@rmcwater.com
www.rmcwater.com

From: Hanson, George [mailto:GHanson@roseville.ca.us]
Sent: Thursday, April 08, 2010 4:03 PM
To: Chris van Lienden
Subject: Fiddymment Farm

4/19/2010

Chris,

Wood Rodgers contacted me regarding the subject project. They are doing some hydraulic modeling of the sewer and they need to confirm information on the flows from Placer Ranch.

Below is the information Wood Rodgers has:

n Info from GC Wallace via Email to Wood Rodgers (they quote the source of this email info to be RMC)

- i Placer Ranch line conveying flow to the City (20 inch)
- i Flow from Placer Ranch to city: 7.14 MGD

n Older information from previous years that Wood Rodgers also has

- i Flow from Placer Ranch: 1.74 MGD.

You will notice that the two sources of info have significantly conflicting flows. Let me know what the latest and greatest info is (and include)

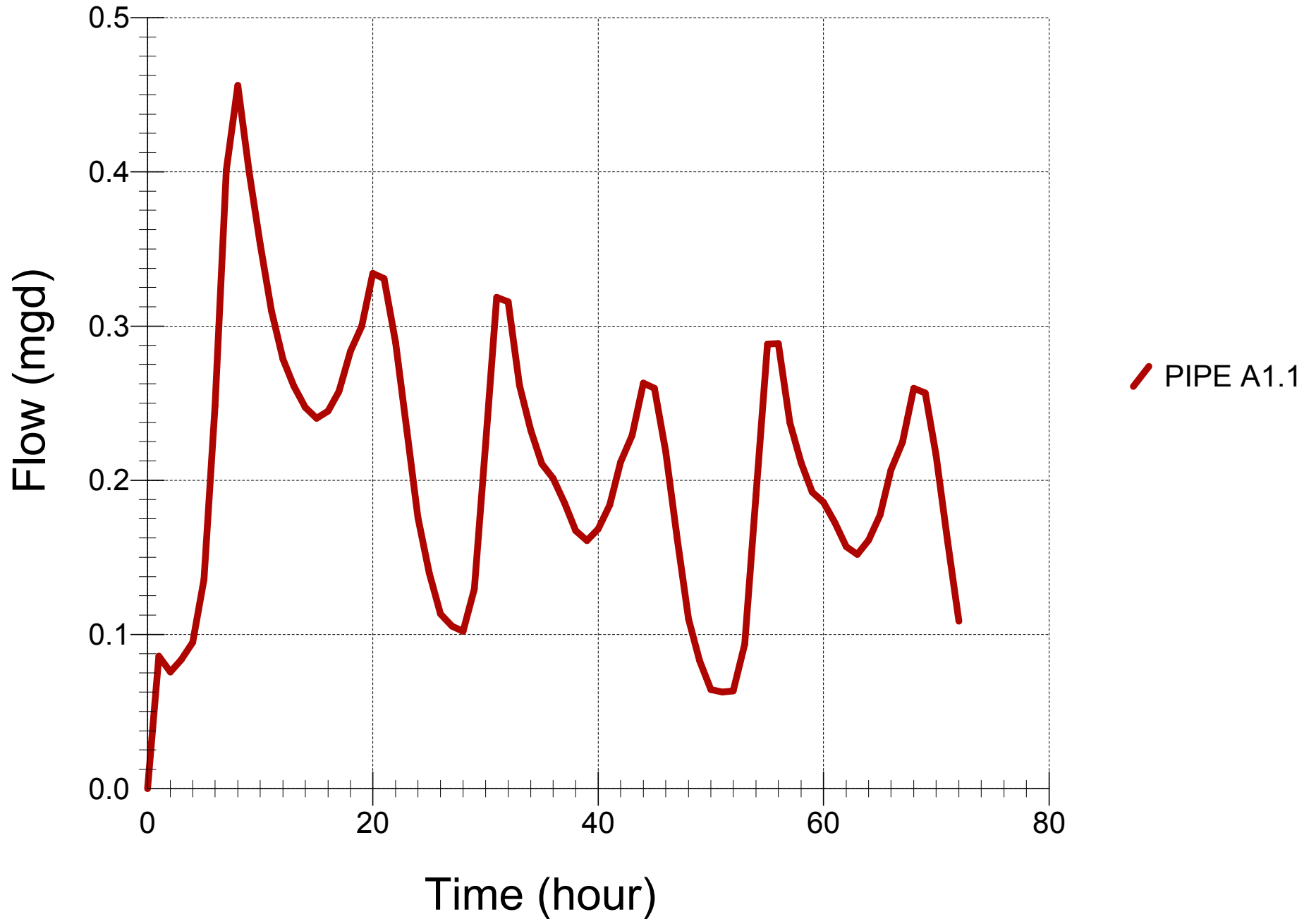
- n Total flow from Placer Ranch to City
- n Size of Line conveying flow to City from Placer Ranch (see map attached – just for clarification: map is from 2006 SPWA regional work by RMC, just included because don't have anything current)
- n Break down of flow as follows
 - i Commercial
 - i Residential
 - i Industrial
 - i Also corresponding acreage
- n Specify the information for both BSF and ADWF, and include what accounts for GWI, RDII if any

Thank you

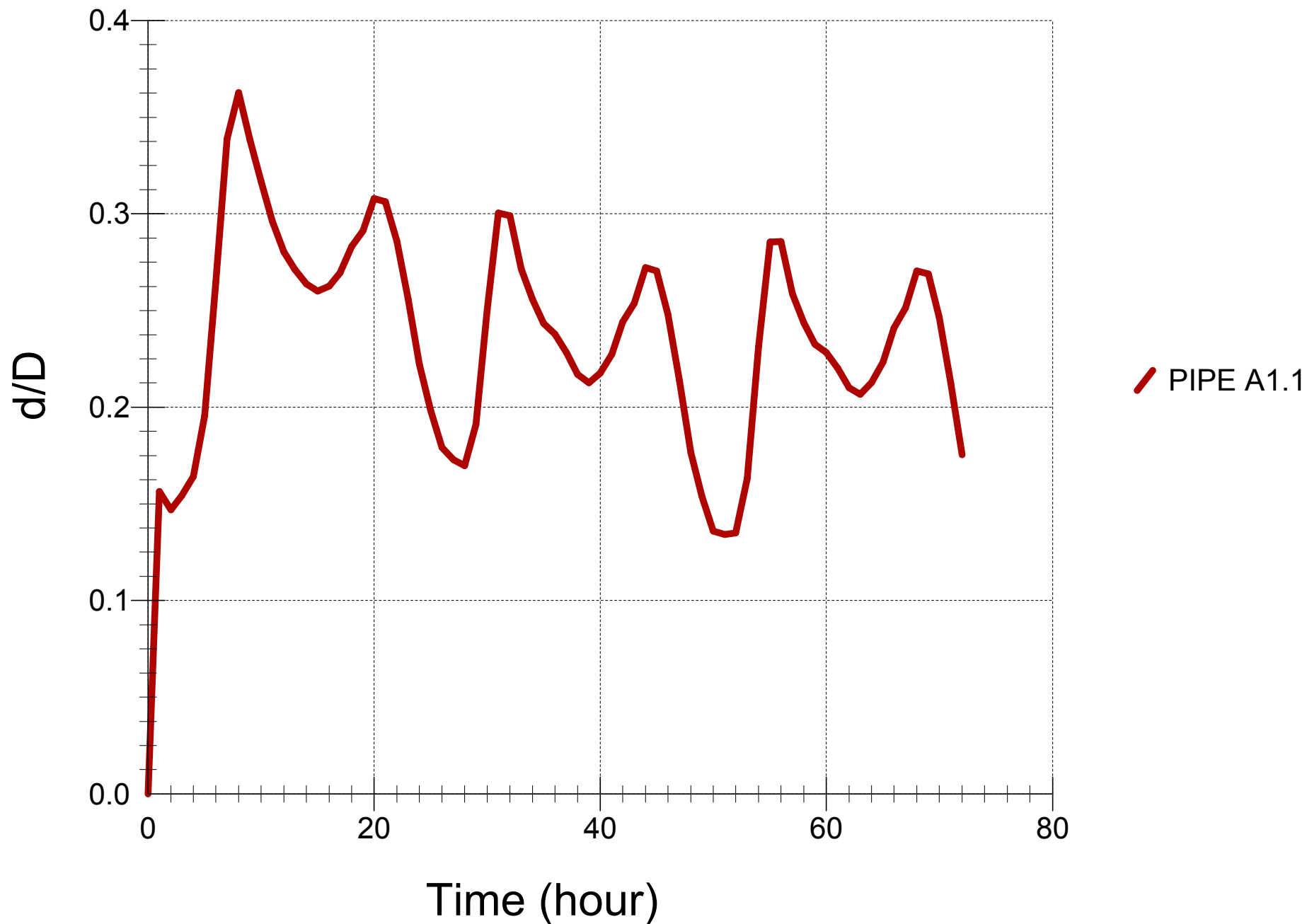
Appendix G: H₂O Map Sewer - Trunk Main Layout

Appendix H: H₂O Map Sewer – Peak Flow Results

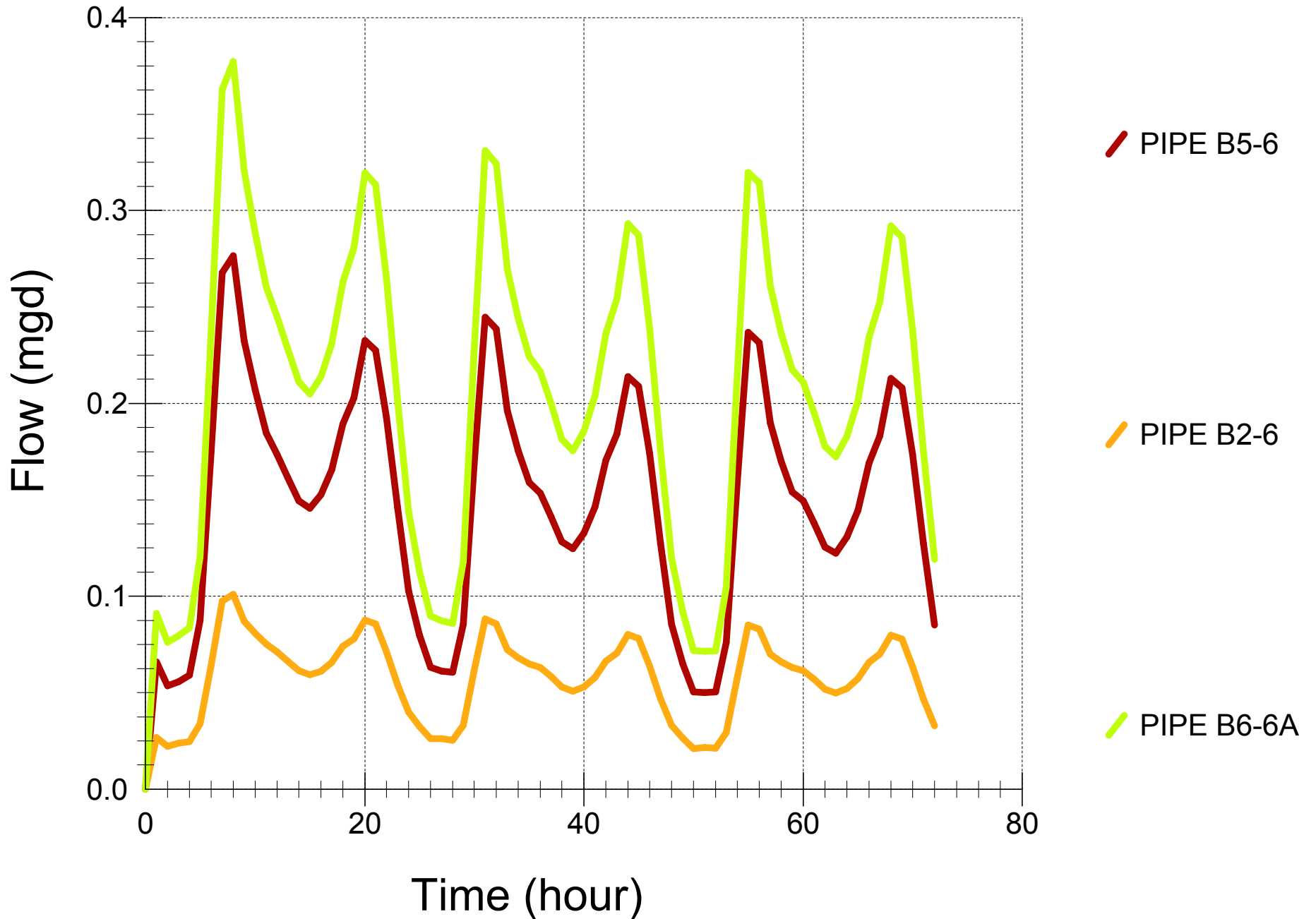
Fiddymment Phase 1a



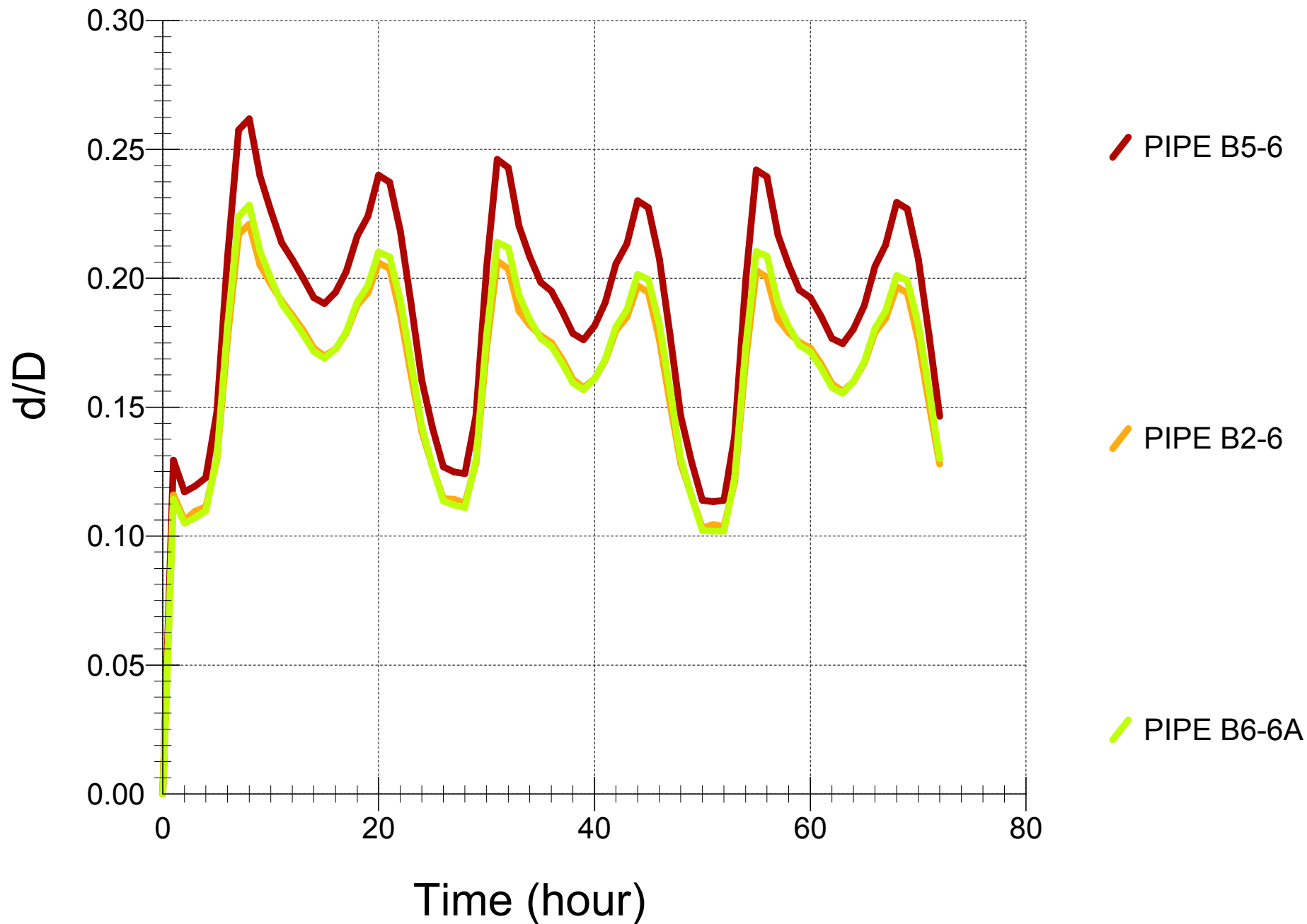
Fiddymment Phase 1a



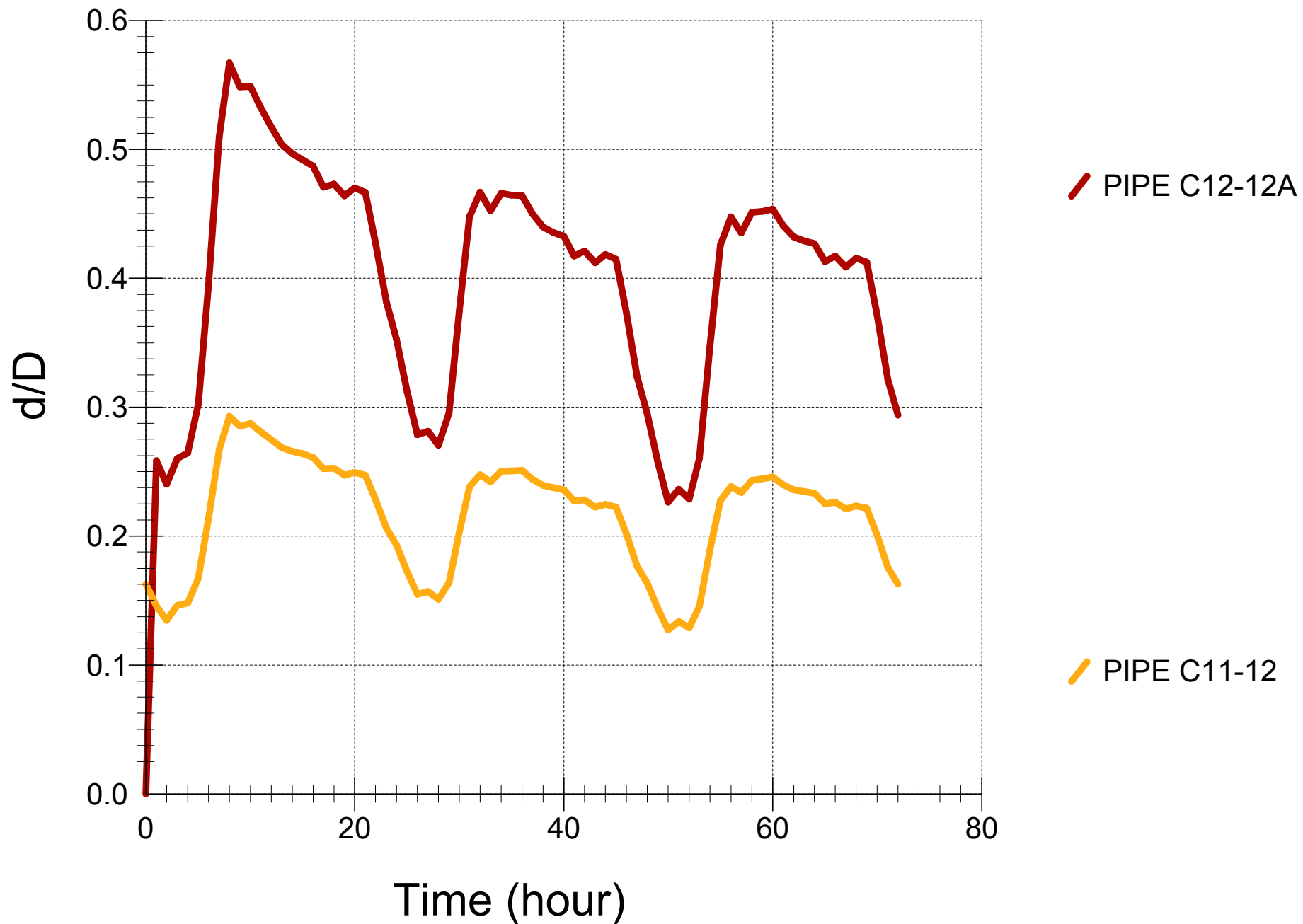
Fiddymment Phase 1b



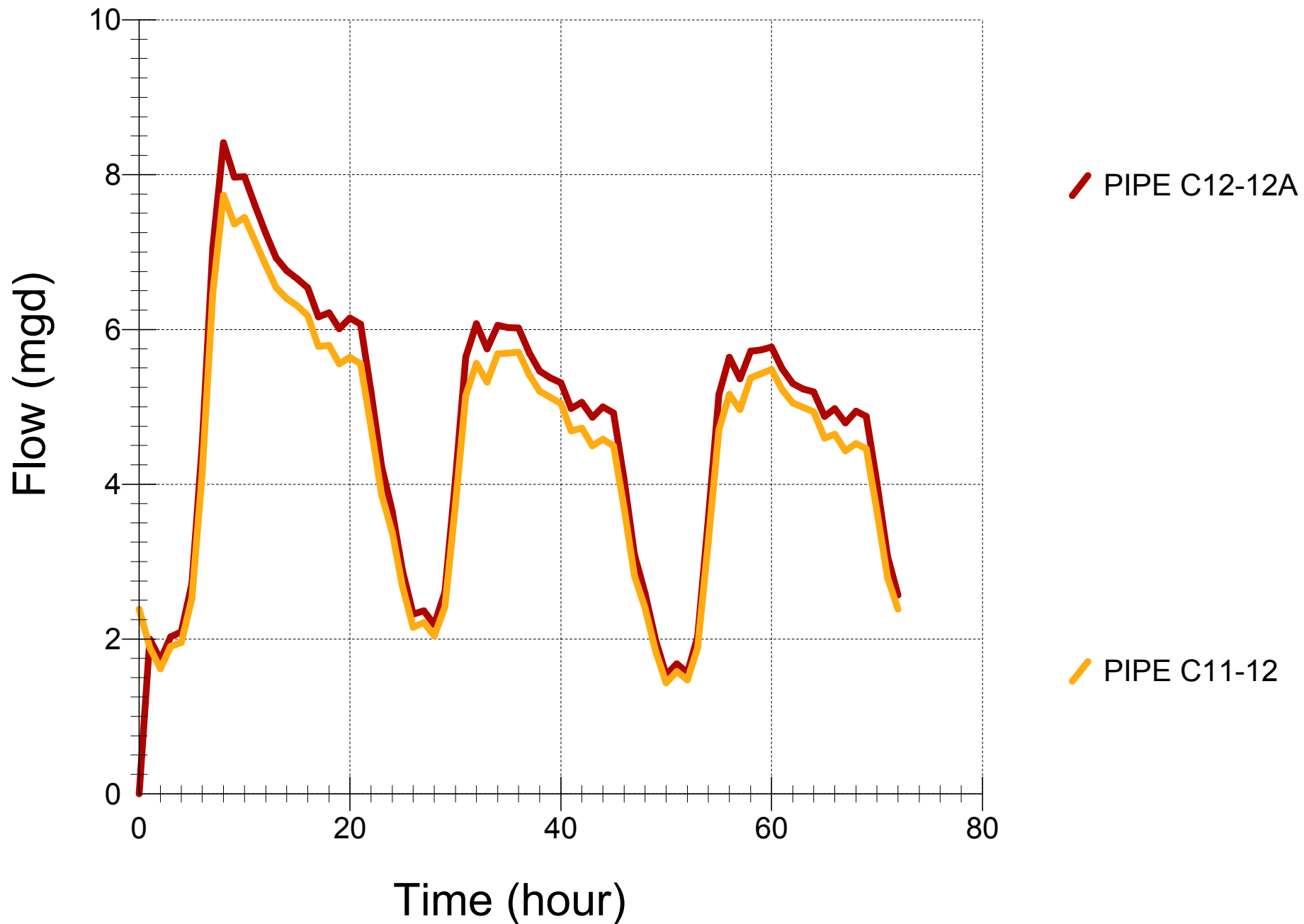
Fiddymment Phase 1b



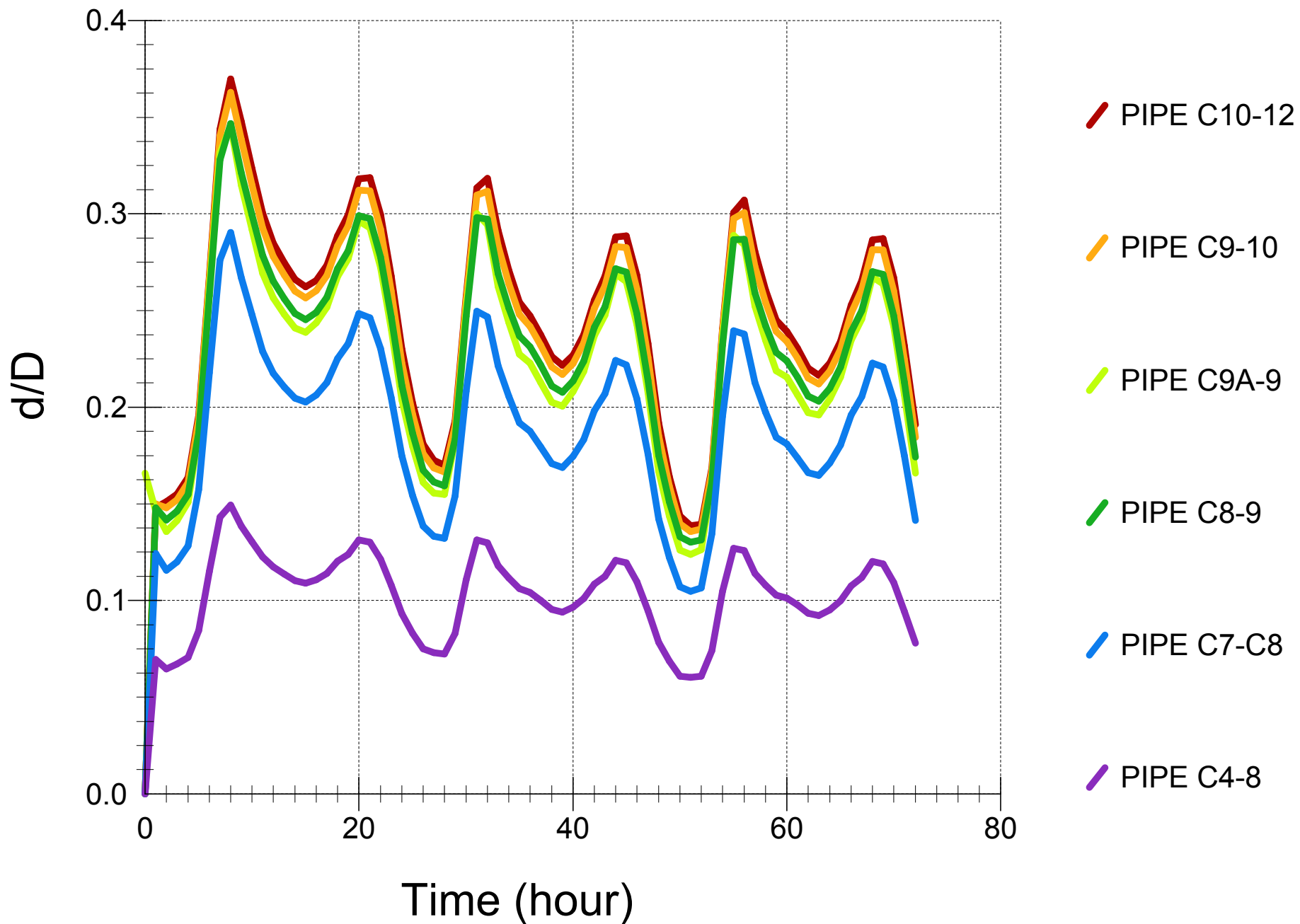
Fiddymment Phase 2



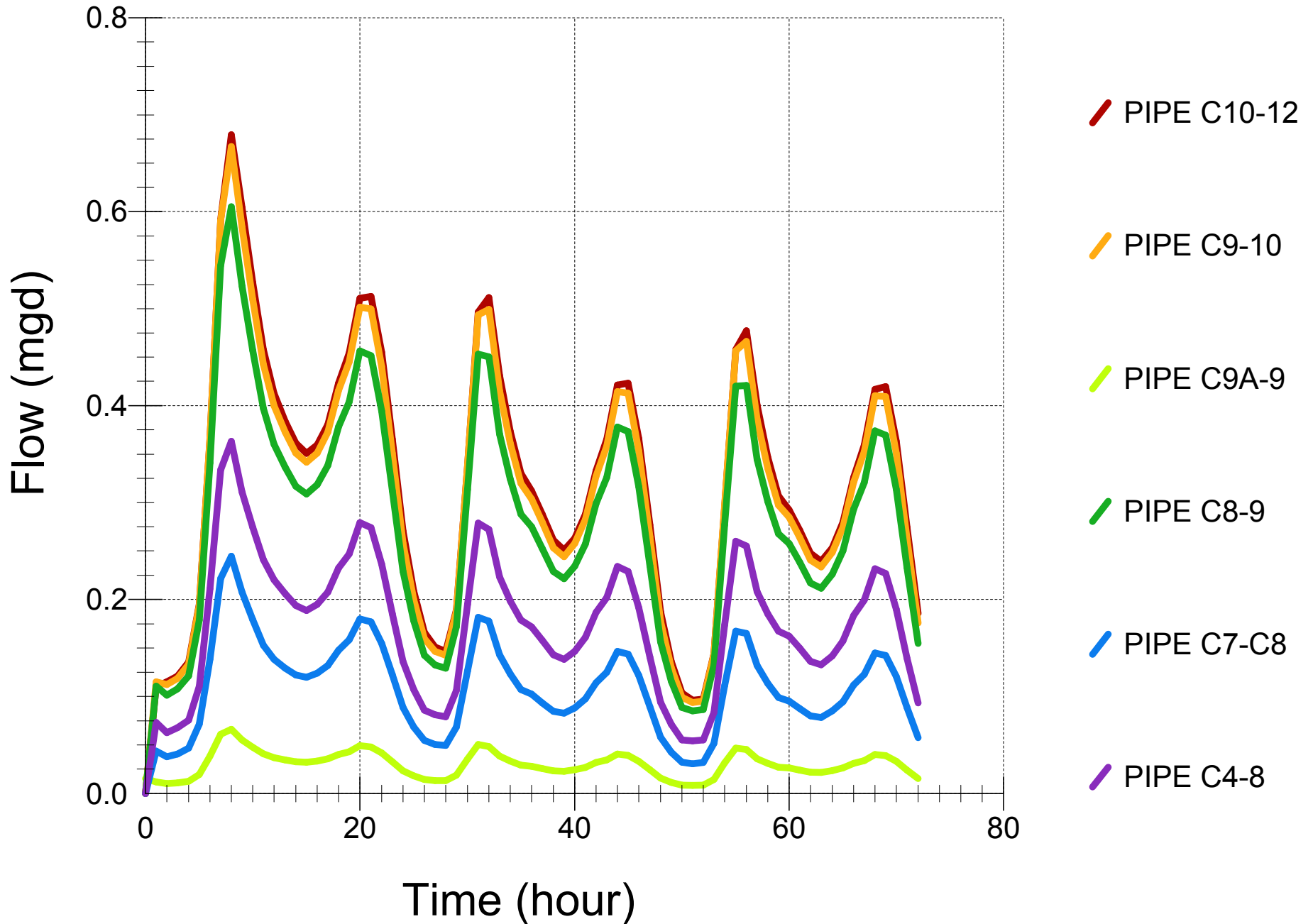
Fiddymment Phase 2



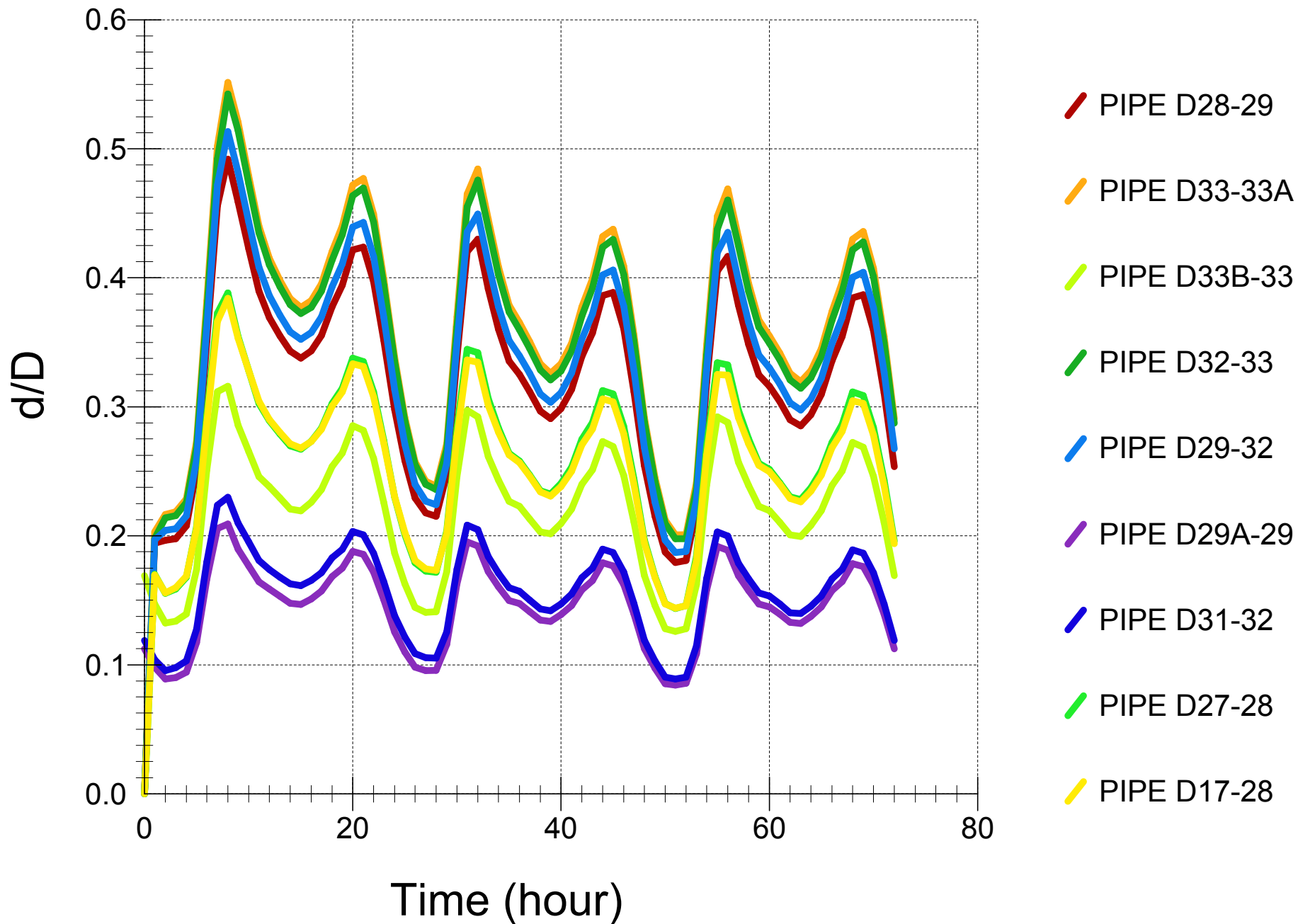
Fiddymment Phase 2



Fiddymment Phase 2



Fiddymment Phase 3



Appendix I: H₂O Map Sewer – Software Set-up Details

H2OMAP Sewer GIS Professional - [\\Sacfile01\Jobs\1000-s\1027-Fiddymnt Ranch\Phase 3\Fiddymnt Ranch-PH3-0A\Civil\Studies\Sewer\FEB-2010-UPDATE\Sewer Model\Map]

File Create Edit View Exchange Scenario Tools Utilities Window Help

BASE, Base Data Scenario

Control Center - Operation Data

- Curve
 - DESIGNSTORM, 10-yr Design
 - DESIGNSTORMREV, 10-yr D
- DB Query
- Output Relate
- Pattern
 - COMMERCIAL, Commercial D
 - INDUSTRIAL, Industrial Diurn
 - RESIDENTIAL, Residential Di
 - RESIDENTIAL_ADJUSTED, I
- Query Set
- Selection Set
- Simulation Options
 - BASE, Base Simulation Optior
 - CURRENTWWF, Current We
- Simulation Report
 - BASE, Base Simulation Repor
 - CURRENTWWF2, Current W
- Simulation Time
 - BASE, Base Simulation Time
 - CURRENTDESIGN, Current \
 - CURRENTWWF, Current We
 - DESIGN72, Current Wet Wea
- Unit Hydrograph
 - FM23, FLOW MONITOR 23
 - UGA, UGA values

Run Manager

Output Source

Name: *Active*:EPS

Reference: BASE, Extended Period Simulation

Steady-State Design EPS / Dynamic

Report Options: CURRENTWWF2, Current WWeather-seasonalGWI @200

Simulation Options: CURRENTWWF, Current Wet Weather Flow

Time Setting: DESIGN72, Current Wet Weather Run using Design Storm

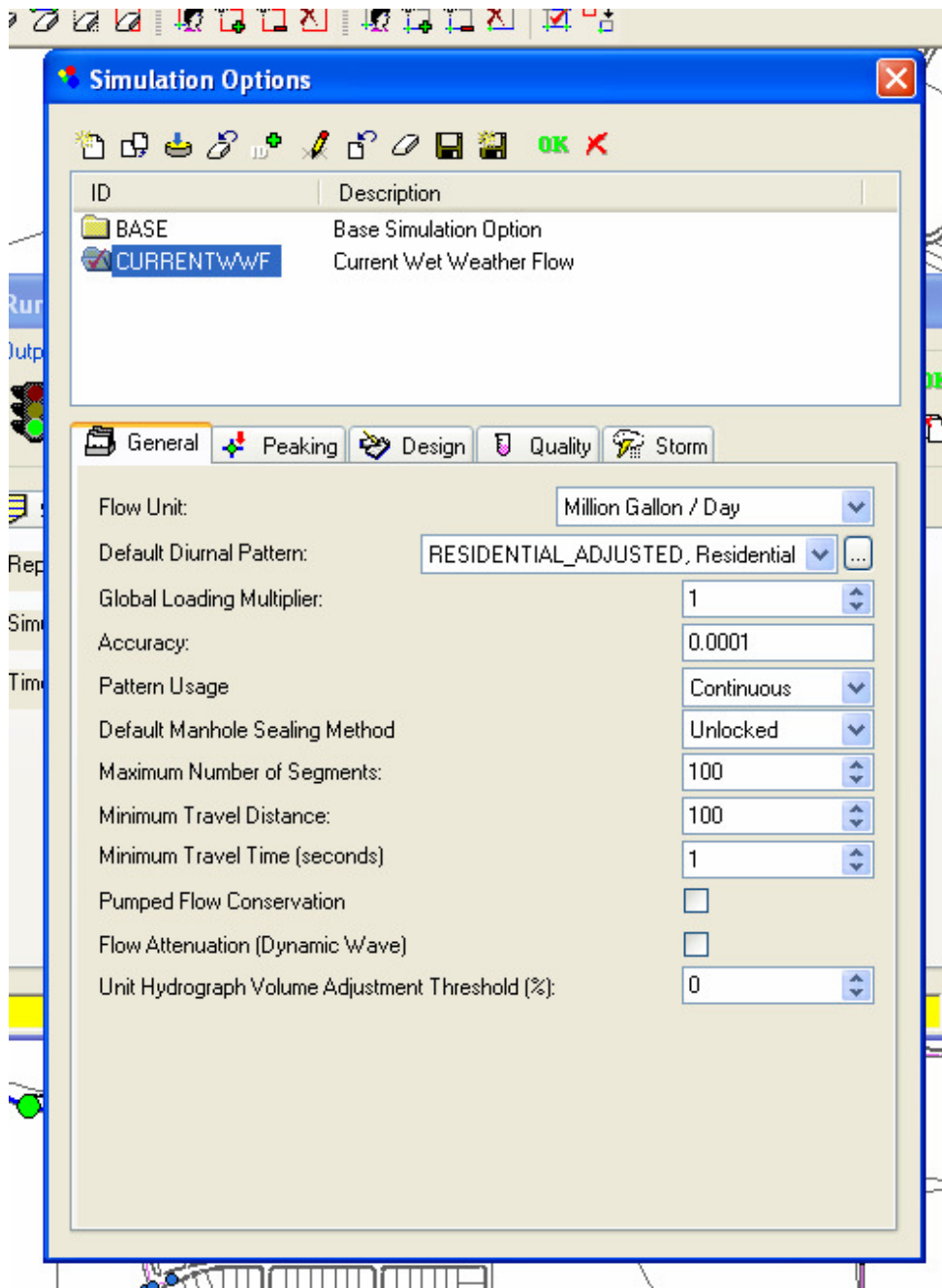
Attribute Browser --- Node

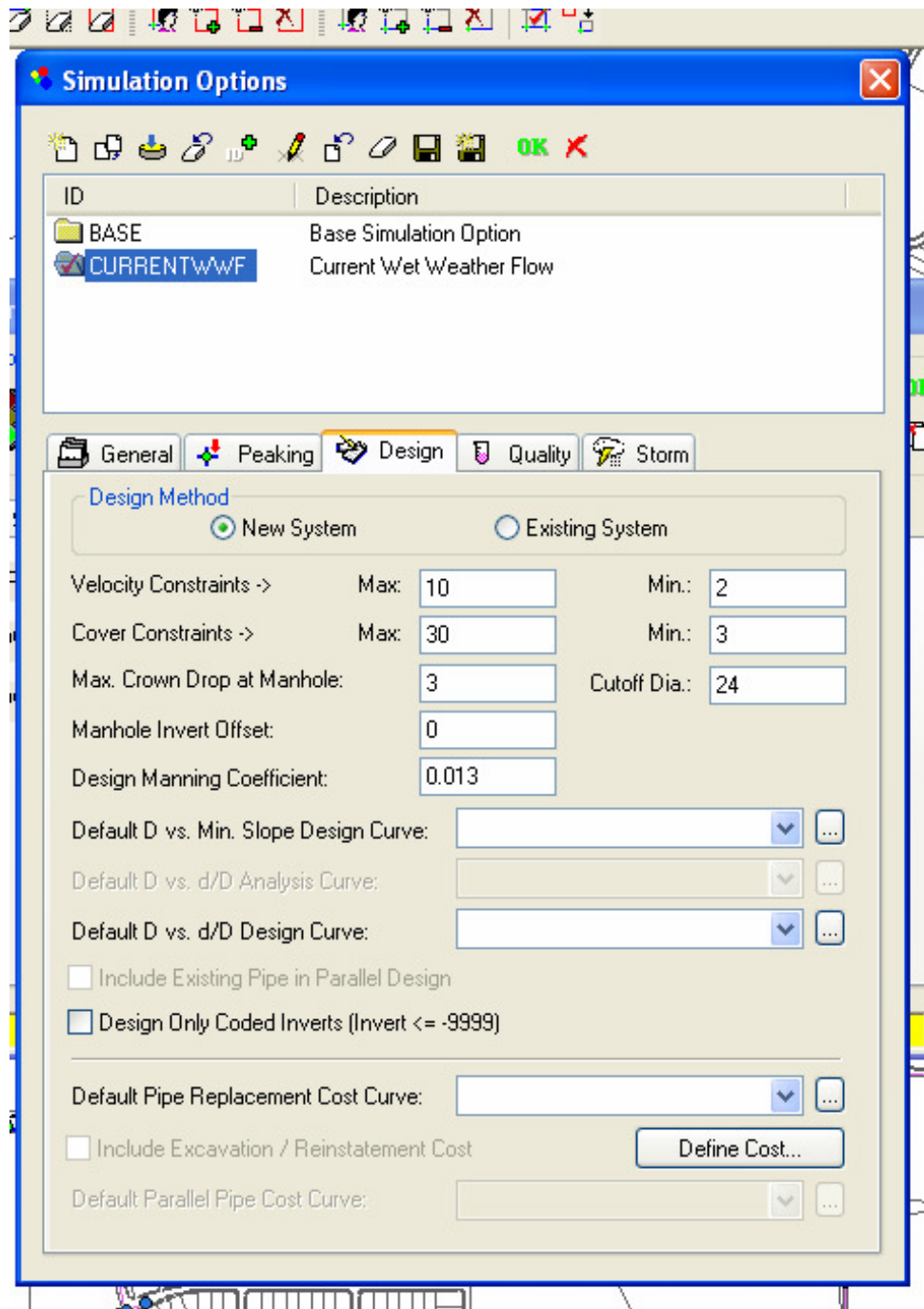
MANHOLE: C12

(ID)	C12
Description	
<input checked="" type="checkbox"/> Geometry	
X	6747556.710000000
Y	2053454.050000000
<input checked="" type="checkbox"/> Modeling	
Diameter	4.000
Rim Elevation	88.000
Headloss Coef.	
<input checked="" type="checkbox"/> Load1	0.000
<input checked="" type="checkbox"/> Load2	0.000
<input checked="" type="checkbox"/> Load3	0.000
<input checked="" type="checkbox"/> Load4	0.000
<input checked="" type="checkbox"/> Load5	
<input checked="" type="checkbox"/> Load6	
<input checked="" type="checkbox"/> Load7	
<input checked="" type="checkbox"/> Load8	
<input checked="" type="checkbox"/> Load9	
<input checked="" type="checkbox"/> Load10	
<input checked="" type="checkbox"/> Subbasin Area	0.000
Runoff Coefficient	0.000
Channel Slope	
Channel Length	
Hyetograph	DESIGNSTORMREV, 10-yr Des
Hydrograph	UGA, UGA values
% Imperv.	
Perv. Retention	
Imperv. Retention	
Ini. Infiltration	
Final Infiltration	
Decay Constant	
Regen. Constant	
Time of Concentration	
<input checked="" type="checkbox"/> Information	
Type	0: Loading
Elevation	
Installation Year	
Retirement Year	
Zone	
RIM_INV	0

00:00

Launch Run Manager Run Manager 6746231.19, 2056916.31 Snap Grid





Simulation Options

ID	Description
BASE	Base Simulation Option
CURRENTWWF	Current Wet Weather Flow

Enable Storm Runoff Computation

Steady-State

Minimum Time of Concentration (min.):

Intensity-Duration-Frequency (IDF) Curve:

IDF Curve Duration Unit:

IDF Curve Intensity Unit:

San Diego (Rational/Modified Rational) Method

6-hr Precipitation:

EPS / Dynamic

Default Hyetograph:

Default Unit Hydrograph:

Duration of Unit Hydrograph (min.):

Appendix J: LNMO Software – Inverted Siphon
Calculations

Inverted Siphon (Depressed Sewer) Design Calculation

LMNO Engineering, Research, and Software, Ltd.

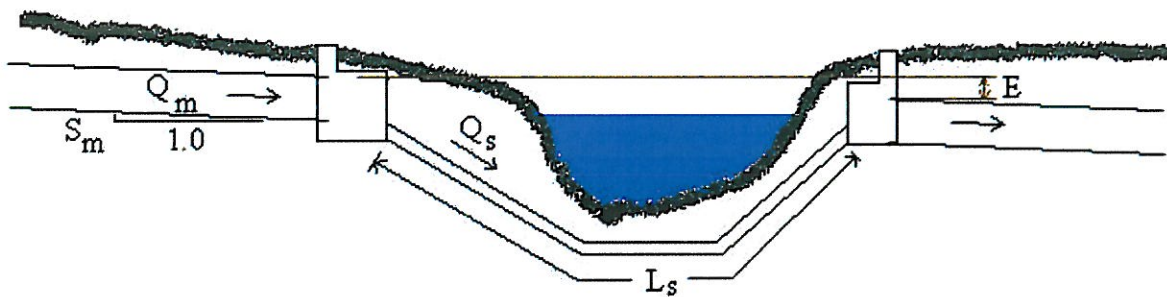
7860 Angel Ridge Rd. Athens, Ohio 45701 USA

+1 (740) 592-1890 LMNO@LMNOeng.com <http://www.LMNOeng.com>

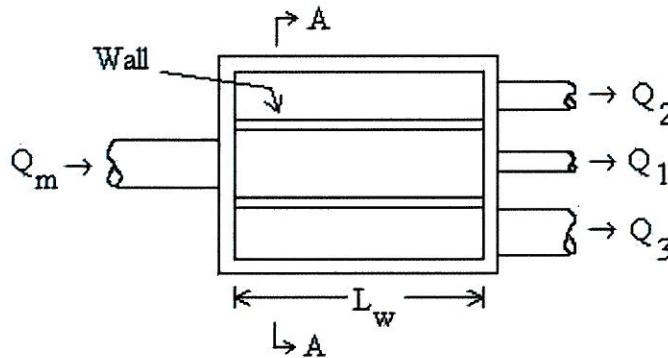
This calculation has been purchased for use as a stand-alone program. User does not need to be connected to the internet. It is illegal to load this program on a publicly-accessible internet server.

Inverted siphons (also called depressed sewers) allow stormwater or wastewater sewers to pass under obstructions such as rivers. Our calculation allows up to five parallel siphons to go under the river. Unlike the main sewer pipe, the siphon pipes flow under pressure and must have flow velocities greater than 3 ft/s (0.9 m/s) to keep material suspended; therefore, several siphons having smaller diameters than the main sewer may be required. Our calculation computes the siphon diameters, velocities, and inlet chamber wall heights and siphon invert elevations.

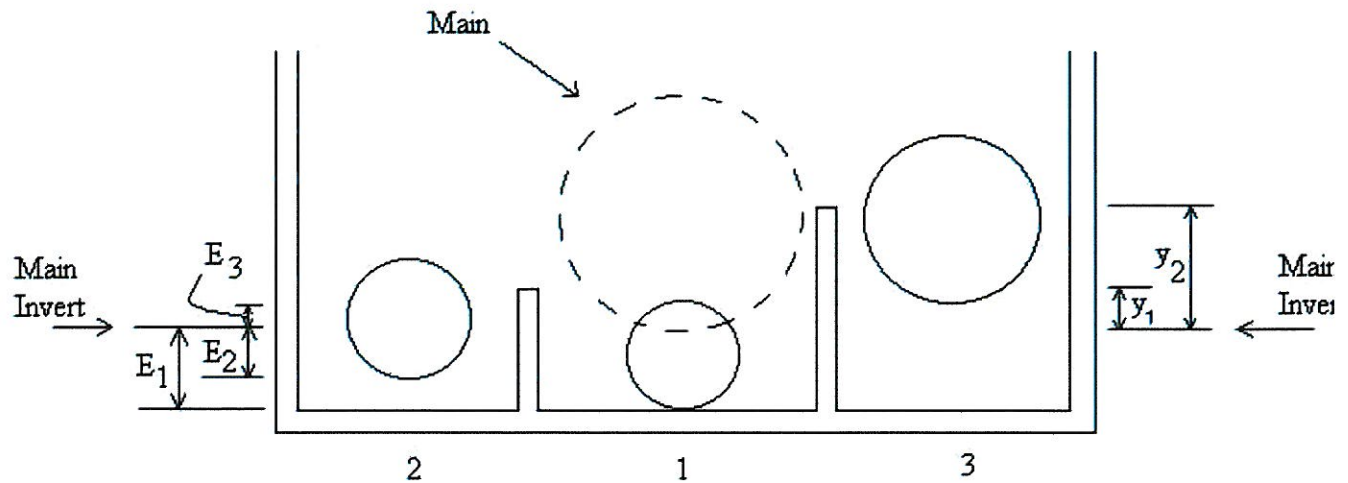
Overall Diagram:



Plan view of inlet chamber (3 siphons):



Section A-A (exploded scale):



For ease of fabrication, all siphon inverts can be located at the elevation of the lowest siphon invert.

Lengths in ft	Inlet box length, L_w (ft):	4	Main flow, Q_m (MGD):	1.446208930
Diameters in inch	Siphon length, L_s (ft):	188	Main diameter, D_m (inch):	15
Flows in MGD	Elevation drop, E (ft):	2.94	Main velocity, V_m (ft/s):	1.823373467
Depths in ft	Siphon HGL, S_s (m/m):	0.015638297872340425	Main slope, S_m (m/m):	0.0012
Velocities in ft/s	Siphon Manning n:	0.013	Main Manning n:	0.013
Siphon capacity, Q_s (MGD):		1.430117655189339	© 2002 LMNO Engineering, Research, and	
Compute Flowrates		Click to Calculate		
Two Siphons	Siphon diameter, D_i (inch)	Siphon flow, Q_i (MGD)	Siphon velocity, V_i (ft/s)	Siphon invert
Siphon 1:	6	0.4534838239847189	3.573439299995174	-0.01923544
Siphon 2:	8	0.9766338312046202	4.328913426171264	0.286489236
Siphon 3:	Not used	Not used	Not used	Not used
Siphon 4:	Not used	Not used	Not used	Not used
Siphon 5:	Not used	Not used	Not used	Not used
It is illegal for this calculation to run on any publicly-accessible website except www.LMNOeng.com .				
Stand-alone version	Wall 1 (rel. to main invert)	Wall 2 (rel. to main invert)	Wall 3 (rel. to main invert)	Wall 4 (rel. to main invert)
Wall height, y_j (ft):	0.48076455621604663	Not used	Not used	Not used

Units: cm=centimeter, cfs=cubic feet per second, ft=feet, gpm=US gallons per minute, gph=US gallons per hour, gpd=US gallons per day, m=meters, MGD=Millions of US gallons per day, s=second

Links on this page: [Introduction](#) [Equations](#) [Variables](#) [Manning n coefficients](#) [Glossary](#) [Error messages and validity](#) [References](#)

Introduction

Stormwater and wastewater sewers often encounter obstructions such as rivers, other pipes, subways, tunnels, or valleys. To pass these obstructions, a common method is for the sewer pipe to drop sharply,

then run horizontal under the obstruction, and finally rise to the desired elevation. The piping going under the obstruction is traditionally called an "inverted siphon", but since the pipe is not actually acting as a siphon, a better term is "depressed sewer" (Metcalf and Eddy, 1981).

Unlike the main sewer pipe, the siphon pipe(s) flow under pressure. Special care must be taken in inverted siphon design since losses are greater for pressurized flow, and the velocity in each siphon pipe must be at least 3 ft/s (0.9 m/s) for sewage or 4 ft/s (1.2 m/s) for storm water (Metcalf and Eddy, 1981). Therefore, even if there is only one main sewer pipe, several siphons may be required.

Equations and Methodology [Back to calculation](#)

Equations are primarily from Metcalf and Eddy (1981) but are supplemented by equations in Chow (1959) and Viessman and Hammer (1998). Note that Manning's equation is empirical, and its form in the following equations requires use of meters and seconds for the units.

Compute the maximum flow in the main sewer pipe using Manning's equation for full pipe flow:

$$Q_m = V_m \left(\frac{\pi D_m^2}{4} \right) \quad V_m = \frac{S_m^{1/2}}{n_m} \left(\frac{D_m}{4} \right)^{2/3}$$

Compute the diameter of each siphon, D_i , or the flow through each siphon, Q_i , using Manning's equation for full pipe flow through each siphon:

$$Q_i = V_i \left(\frac{\pi D_i^2}{4} \right) \quad V_i = \frac{S_s^{1/2}}{n_s} \left(\frac{D_i}{4} \right)^{2/3} \quad S_s = \frac{E}{L_s}$$

Compute the wall heights, y_j (relative to main invert), in the inlet box. The walls separate the siphons from each other. The wall heights are the same height as the water depths, y_j , in the main pipe corresponding to the discharge through the siphons. Here, $Q_{j=1}$ is the discharge through siphon 1, $Q_{j=2}$ is the discharge through siphons 1 and 2, and so on. Manning's equation for a partially full main pipe is used, but is solved backwards (numerically) in order to compute y_j . We allow up to five siphons (four walls).

$$Q_j = V_j A_j \quad V_j = \frac{R_j^{2/3} S_m^{1/2}}{n_m} \quad R_j = \frac{A_j}{P_j} \quad A_j = \frac{D_m^2}{8} [\theta_j - \sin(\theta_j)]$$

$$P_j = \frac{\theta_j D_m}{2} \quad y_j = \frac{D_m}{2} \left[1 - \cos\left(\frac{\theta_j}{2}\right) \right] \quad T_j = 2 \sqrt{y_j (D_m - y_j)}$$

Compute the siphon invert elevations in the inlet chamber. According to Metcalf and Eddy (1981), there is no loss in the inlet box for flow going from the main culvert to the first siphon since the flow travels in a straight path. However, for siphons 2 through n the flow must turn 90° to go over the chamber wall (a head loss of 1.5 velocity heads) and has an additional head loss of one velocity head as the flow enters siphon i. Therefore, for $i=2$ to n siphons and $j=2$ to n-1 walls:

$$E_i = y_j - D_i - H_i \quad H_i = \frac{1.5}{2g} \left[\frac{Q_i}{L_w(y_j - y_{j-1})} \right]^2 + \frac{V_i^2}{2g}$$

where E_i is relative to the invert of the main pipe. Note that for the first siphon, $H_1=0$, and for the last siphon y_j is replaced by D_m . Often, all siphon inverts are located at the same elevation (the elevation of the lowest siphon) for ease of construction.

Variables [Back to calculation](#)

A_j =Flow area in the main pipe for computing height of wall j [m^2].

D_i =Diameter of siphon i [m].

D_m =Diameter of main pipe [m].

E =Main invert's elevation drop from inlet chamber to outlet chamber [m]. Used to compute hydraulic grade line, S_s , for siphon pipes.

E_i =Siphon i inlet invert elevation relative to invert of main culvert [m]. These are maximum elevations. Any siphon can be placed lower than E_i . For ease of fabrication, all siphon inverts are often placed at the elevation of the lowest siphon invert.

H_i =Head loss for flow from main pipe to siphon i [m].

L_s =Total length of one siphon [m]. Assumes all siphons are approximately the same length.

L_w =Wall length inside inlet chamber [m]. Also known as weir length.

n_m =Manning's n coefficient of main pipe.

n_s =Manning's n coefficient for the siphon pipes.

P_j =Wetted perimeter of main pipe for computing height of wall j [m].

Q_i =Flowrate (discharge) through siphon i [m^3/s].

Q_m =Flowrate (discharge) through main pipe when flowing full [m^3/s].

Q_j =Flowrate (discharge) through main pipe where j represents the sum of siphons 1 through j [m^3/s].

For instance, if $j=3$, then $Q_j=Q_1+Q_2+Q_3$. Used to compute height of wall j.

R_j =Hydraulic radius of main pipe for computing height of wall j [m].

S_m =Slope of main pipe [m/m]. Vertical/Horizontal.

S_s =Allowable hydraulic grade line for siphon pipes [m/m]

T_j =Top width of main pipe for computing height of wall j [m].

V_i =Velocity of water flowing through siphon i [m/s].

V_m =Velocity of water flowing through main pipe when flowing full [m/s].

V_j =Velocity of water flowing through main pipe for computing wall heights j [m/s].

y_j =Water depth in main pipe for computing wall heights j [m]. y_j is measured relative to the main invert. Therefore, if the bottom of the inlet chamber is below the main invert, the wall will actually be y_j plus the elevation difference between the main invert and the bottom of the chamber. In the figure titled "Section A-A" at the top of this page, the physical wall heights are y_1+E_1 and y_2+E_1 , since siphon 1 has the lowest invert of the three siphons shown in the figure.

π = Greek letter "pi" = 3.1415926...

θ_j = Greek letter "theta". Angle for computing height of wall j [radians]

Manning n Coefficients

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Manning n values are from Metcalf and Eddy (1981), AISI (1980), and footnoted items in [references](#) for pipes in good condition.

Pipe Material	Manning n	Pipe Material	Manning n
Uncoated cast iron	0.013	Coated cast iron	0.012
Commercial wrought iron - black	0.013	Commercial wrought iron - galvanized	0.014
Smooth brass and glass	0.010	Smooth lockbar and welded "OD"	0.011
Riveted and spiral steel pipe	0.015	Corrugated Metal	0.022*
Common clay drainage tile	0.012	Vitrified sewer pipe	0.013
Brick in cement mortar, brick sewers	0.013	Glazed brickwork	0.012
Cement mortar surfaces	0.012	Neat cement surfaces	0.011
Wood stave pipe	0.011	Concrete pipe	0.013
Corrugated Polyethylene (PE) with smooth inner walls ^{a,b}			0.009-0.015
Corrugated Polyethylene (PE) with corrugated inner walls ^c			0.018-0.025
Polyvinyl Chloride (PVC) with smooth inner walls ^{d,e}			0.009-0.011

* Corrugated metal pipe n value can vary significantly with pipe diameter and type of corrugations (values can range from 0.012 to 0.033) - AISI (1980).

Glossary

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Inlet chamber - usually concrete manhole where main culvert branches into several siphon pipes.

Invert - inside bottom of pipe.

Main - culvert through which flow occurs before and after the siphon.

Siphon - pipe or pipes flowing full and under pressure which go underneath the obstruction. Not siphons by the true definition. True siphons flow uphill then back down. Siphons used here go down then back up.

Error Messages and Validity

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Initial input checks. The following messages are generated from improper input values:

"Need $1e-9 < D_m < 1e9$ m". Main culvert diameter must be between these limits.

"Need $1e-9 < E < 1e9$ m". Elevation drop from the inlet chamber to the outlet chamber must be between these limits.

"Need $1e-9 < L_s < 1e9$ m". The length of each siphon pipe must be between these limits.

"Need $1e-9 < L_w < 1e9$ m". The lengths of the inlet chamber walls must be between these limits.

"Need $1e-9 < Main S < 1e9$ ". The slope of the main culvert must be between these limits.

"Need $1e-9 < Main n < 1e9$ ", "Need $1e-9 < Siphon n < 1e9$ ". The Mannings n values for the main culvert and siphons must be between these limits.

"Need $1e-9 < D_1 < 1e9$ m", "Need $1e-9 < D_2 < 1e9$ m", "Need $1e-9 < D_3 < 1e9$ m", "Need $1e-9 < D_4 < 1e9$ m", "Need $1e-9 < D_5 < 1e9$ m". If siphon diameters are input, they must be between these limits.

"Need $1e-9 < Q_1 < 1e9$ m³/s", "Need $1e-9 < Q_2 < 1e9$ m³/s", "Need $1e-9 < Q_3 < 1e9$ m³/s", "Need $1e-9 < Q_4 < 1e9$ m³/s". If siphon flows are input, the flows must be between these limits.

Run-time errors. The following messages may be generated after performing some calculations:

"Need $1e-9 < Q_m < 1e9$ m³/s". Discharge computed in main culvert must be in this range for calculations to continue.

"Need siphon $Q > 0$ ". If diameters are being computed, the flowrate through the last siphon is automatically computed such that the sum of the flow through all siphons is equal to the discharge through the main culvert. If the siphon flows input by the user exceed the discharge in the main culvert, then the flow in the last siphon will be negative, which will generate the error message. You should reduce the flows in the siphons so that there is positive flow in the last siphon. Or, you could reduce the number of culverts.

"Siphons under-designed". Shown only if siphon flows are being computed and $Q_s/Q_m < 0.95$. You need to increase the siphon diameters. This message will not be generated if diameters are being computed - because diameters are computed so that the total flow through the siphons is exactly equal to the discharge through the main culvert.

"Siphons over-designed". Shown only if siphon flows are being computed and $Q_s/Q_m > 1.05$. Since wall heights cannot be computed for flows grossly exceeding that of the main culvert, the calculation stops. You need to decrease the siphon diameters. This message will not be generated if diameters are being computed - because diameters are computed so that the total flow through the siphons is exactly equal to the discharge through the main culvert.

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Appendix K: Fiddymment SPA#3 Overall Shed map

Appendix L: CD with H2O Map Sewer Dynamic Modeling Software Model for Fiddyment SPA No.3 (Incl. PDF's of all Study documents shown herein)
