RESOLUTION NO. 2014-157

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF ELK GROVE ACCEPTING THE MASTER WATER PLAN, LEVEL II SEWER STUDY, AND DRAINAGE STUDY FOR THE SOUTHEAST POLICY AREA PROJECT NO. PL0016

WHEREAS, on November 19, 2003, the City Council adopted Resolution 2003-217 adopting the General Plan of the City of Elk Grove as required by State law; and

WHEREAS, the General Plan included Policy LU-32 establishing the Southeast Policy Area, as a future growth area of the City; and

WHEREAS, the City Council has directed the preparation of a strategic plan for the Southeast Policy Area as a City project; and

WHEREAS, the Southeast Policy Area Strategic Plan is a "project" under the California Environmental Quality Act (CEQA); and

WHEREAS, on June 19, 2014, the Planning Commission held a duly-noticed public hearing as required by law to consider all of the information presented by staff and public testimony presented in writing and at the meeting; and

WHEREAS, on July 9, 2014, the City Council held a duly-noticed public hearing as required by law to consider all of the information presented by staff and public testimony presented in writing and at the meeting; and

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Elk Grove hereby accepts the following for the Southeast Policy Area:

1) The Master Water Plan, as provided in Exhibit A and incorporated herein by this reference;
2) The Level II Sewer Study, as provided in Exhibit B and incorporated herein by this reference; and
3) The Drainage Study, as provided in Exhibit C and incorporated herein by this reference.

PASSED AND ADOPTED by the City Council of the City of Elk Grove this 9th day of July 2014.

James Cooper

JAMES COOPER, VICE MAYOR of the CITY OF ELK GROVE

ATTEST:

JASON LINDGREN, CITY CLERK

APPROVED AS TO FORM:

JONATHAN P. HOBBS, CITY ATTORNEY

CERTIFICATION
ELK GROVE CITY COUNCIL RESOLUTION NO. 2014-157

STATE OF CALIFORNIA)
COUNTY OF SACRAMENTO) ss
CITY OF ELK GROVE)

I, Jason Lindgren, City Clerk of the City of Elk Grove, California, do hereby certify that the foregoing resolution was duly introduced, approved, and adopted by the City Council of the City of Elk Grove at a regular meeting of said Council held on July 9, 2014 by the following vote:

AYES :	***COUNCILMEMBERS:***	***Cooper, Detrick, Hume, Trigg***
NOES:	***COUNCILMEMBERS:***	***None***
ABSTAIN :	***COUNCILMEMBERS:***	***None***
ABSENT:	***COUNCILMEMBERS:***	***Davis***

Jason Lindgren, City Clerk
City of Elk Grove, California

EXHIBIT A

Elk Grove Southeast Policy Area Master Water Plan

February 19, 2014

Prepared for

CITY OF ELK GROVE
PROUD HERITAGE. BRIGHT FUTURE.

Prepared by

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

Department of Water Resources
Michael L. Peterson, Director

SACRAMENTO COUNTY
WATER AGENCY

Including service to the Cities of
Elk Grove and Rancho Cordova

March 18, 2014

Mike Motroni
Wood Rodgers
3301 C Street, Bldg. 100-B
Sacramento, CA 95816

Re: Elk Grove South East Policy Area Water Study

Mr. Motroni,

Sacramento County Water Agency (SCWA) staff has reviewed the water study prepared by Wood Rodgers for the South East Policy Area (SEPA) in the City of Elk Grove (City). SCWA staff determines that the identified major water supply facilities in the SEPA at build-out are consistent with the current Zone 40 Water Supply Infrastructure Plan (WSIP) and ongoing WSIP update efforts.

SCWA staff also recognizes that this water study is prepared to assist the City's CEQA reviewing process for the SEPA. Therefore, individual water studies may still be required by SCWA for each subdivision by the project applicant based on the latest WSIP during the plan check process in the future.

If you have any questions, please contact me at 874-5039.

Sincerely,

Darrell Eck
Senior Civil Engineer, SCWA

cc: Ping Chen, SCWA

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TABLES

FIGURES

APPENDICES

1.0 Introduction

The purpose of this water study is to identify domestic water needs for the Elk Grove Southeast Policy Area (SEPA) plan area. The report is part of an overall high-level infrastructure analysis. This study will demonstrate it is possible to provide domestic water service for the project and technical compliance with the water purveyor's requirements for water conveyance. The project falls within the jurisdiction of the Sacramento County Water Agency (SCWA).

Existing and planned domestic water facilities border the project area to the north, west and east. It is anticipated that these existing facilities will be extended to provide domestic water service to the plan area. This study has been prepared to present the project build-out domestic water conveyance facilities for the plan area. The study includes transmission main pipe sizes and distribution system sizes of 12-inch where serving multiple land uses. These conveyance facilities will serve as part of the backbone infrastructure to serve SEPA. This study includes a discussion on proposed water demands, point of connection assumptions, and modeling results.

1.1 Southeast Policy Area

Located at the southern end of the City, the Southeast Policy Area is the last large-scale development area within the urbanized portion of Elk Grove. It lies directly south of the Laguna Ridge Specific Plan area and west of Lent Ranch/Elk Grove Promenade and the approved Sterling Meadows development.[1]

Location

The SEPA project encompasses approximately 1,200 acres and is located in the southeast portion of the City of Elk Grove. In general the project area is located east of Bruceville Road, north of Kammerer Road, east of Big Horn Boulevard, and south of Poppy Ridge Road. The Laguna Ridge Specific Plan borders the project on the north and west. Proposed Sterling Meadows project borders the project directly to the east.

See **Figure 1-1: Vicinity Map** for a vicinity map of the project site.

Topography and Vegetation

The site currently consists of a mix of farm and ranch land with a number of residential structures on large lots spread throughout the plan area. The existing topography varies from elevation 39-feet to 22-feet and falls from the northeast to the southwest. Bisecting the project is a drainage canal flowing from east to west.

Land Use

The project area is currently zoned in the City's general plan as a special planning area. Therefore, specific polices are required to guide development within this area. The proposed land use will consist of residential (very low, low, medium and high density), mixed use, commercial, office, light industrial / flex space, schools, parks, and open space. The proposed land use for SEPA includes a total of 4,790 dwelling units from residential and mixed use land uses. See **Table 1-1: Proposed Project Land Use** for detailed project land uses and **Figure 1-2: Land Use Plan** for an exhibit showing the proposed land use, within the project area.

[1] Project description per City of Elk Grove, planning department website, 1 October 2013.

Table 1-1: Proposed Project Land Use
Source: Land use spreadsheet provided by City of Elk Grove, September 10, 2013

Land Use		Area[2] (acres)	Estimated Dwelling Units (DU)
ER	Estate Residential	62.6	288
LDR	Low Density Residential	212.0	1341
MDR	Medium Density Residential	95.2	1324
HDR	High Density Residential	60.7	1511
MUR	Mixed Use Residential	14.0	267
COM	Commercial	14.2	-
MUV	Mixed Use Commercial	27.3	58
ES	Elementary School	27.6	-
OFF	Office	279.9	-
LI/FS	Light Industrial / Flex Space	108.2	-
P/OS	Park / Open Space	56.8	-
Greenway	Greenway	35.5	-
Basin	Basin	49.4	-
Drainage	Drainage Channel	1.7	-
Channel	Channel	65.3	-
	Right of Way[3]	84.4	-
Total		**1,195**	**4,790**

1.2 Existing & Future Water Studies

Sacramento County Water Agency

The project area falls within the jurisdiction of the Sacramento County Water Agency (SCWA). The project area is located in SCWA's south service area. The SCWA Zone 40 Water System Infrastructure Plan (WSIP), dated April 2006 was utilized as the basis for SCWA conveyance facilities discussed in this study. The April 2006 WSIP identified transmission conveyance facilities to serve SEPA. These transmission mains are included as part of this study.

At time of this study SCWA is preparing an update to the WSIP. It is anticipated that the design as presented in this study will be consistent with the WSIP update.

Existing Water Studies

There were a number of existing studies completed to date that were reviewed as part of this report. These studies are referenced below and discussed further within the study.

[2] Acreage values are approximate and reflect high-level master planning. Acreages are subject to change through subsequent development processing in keeping with the policies and procedures provided in the City's Special Planning Area document.

[3] Assumed to be internal roadways per the land use plan, plus fifty feet of right of way adjacent to SEPA boundary except 100 feet along future Lotz Parkway.

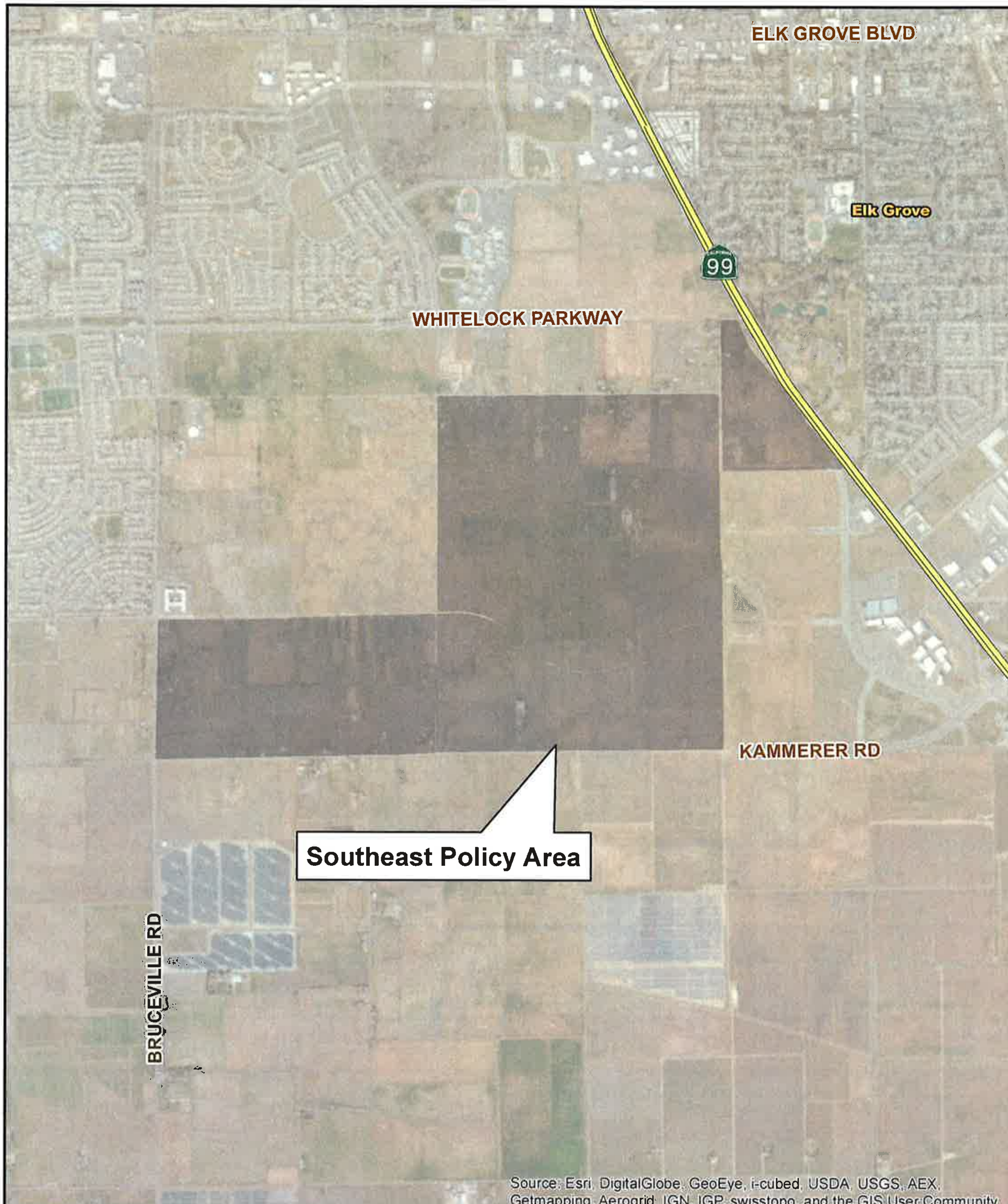
- Laguna Ridge Specific Plan, Water Study, by Wood Rodgers, Inc., dated January 30, 2003, hereon referred as "LRSP plan".
- Elk Grove Promenade, Master Water Study, by Wood Rodgers, Inc., dated January 2006, heron refereed as "EGP plan".
- Zone 40 Water System Infrastructure Plan, by Sacramento County Water Agency, dated April 2006, heron referred as "WSIP".

Future Water Studies

This study has been prepared to identify the backbone conveyance facilities required to convey domestic water to serve the project area. It does not identify sources of domestic water supply. There is an opportunity to within the plan area provide recycled water to parks, landscaping, and greenways. This study assumes that all land uses will be supplied by domestic water and does not take into account recycled water use. Future studies will be required as subsequent planning and phasing is solidified and prior to improvement plan approval.

Recycled Water

Recycled water was not evaluated as part of this master plan. The 2003 Zone 40 Recycled Water Master Plan dated 2003 and revised in 2006 did not consider recycled water for the Southeast Policy Area. The existing and planned recycled water use is limited to Laguna West, Lakeside, Laguna Stonelake, East Franklin, and Laguna Ridge.



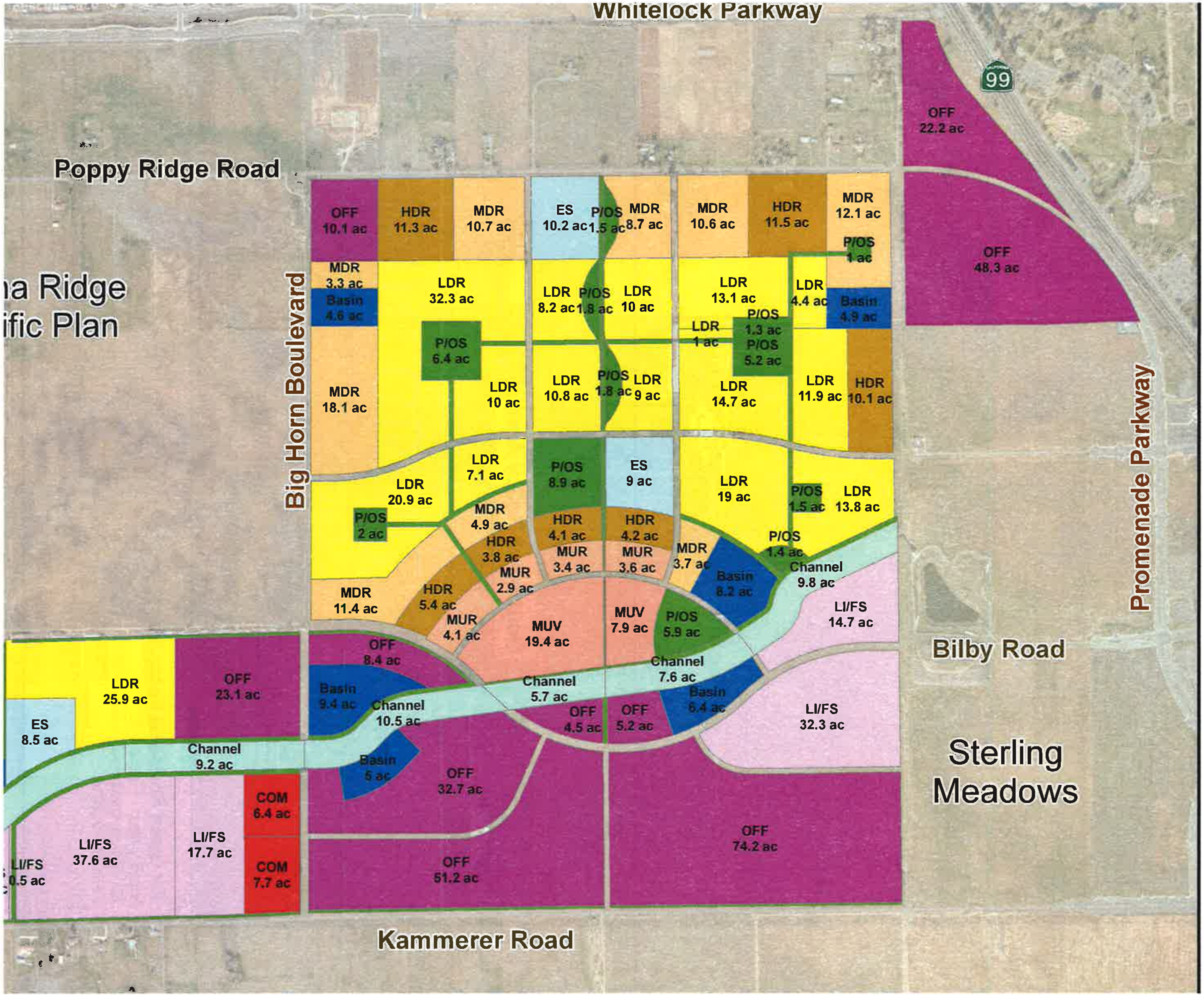
Elk Grove Southeast Policy Area
Vicinity Map - Figure 1-1
Elk Grove, California
February 19, 2014

NORTH

0 1,250 2,500
FEET

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS

3301 C Street, Bldg. 100-B Tel: 916.341.7760
Sacramento, CA 95816 Fax: 916.341.7767



Whitelock Parkway
Poppy Ridge Road
a Ridge
ific Plan
Big Horn Boulevard
Promenade Parkway
Bilby Road
Sterling Meadows
Kammerer Road
99
OFF 22.2 ac
OFF 48.3 ac
OFF 10.1 ac
HDR 11.3 ac
MDR 10.7 ac
ES 10.2 ac
P/OS 1.5 ac
MDR 8.7 ac
MDR 10.6 ac
HDR 11.5 ac
MDR 12.1 ac
P/OS 1 ac
MDR 3.3 ac
Basin 4.6 ac
LDR 32.3 ac
LDR 8.2 ac
P/OS 1.8 ac
LDR 10 ac
LDR 13.1 ac
LDR 4.4 ac
Basin 4.9 ac
P/OS 1.3 ac
LDR 1 ac
P/OS 5.2 ac
P/OS 6.4 ac
MDR 18.1 ac
LDR 10 ac
LDR 10.8 ac
P/OS 1.8 ac
LDR 9 ac
LDR 14.7 ac
LDR 11.9 ac
HDR 10.1 ac
LDR 7.1 ac
P/OS 8.9 ac
ES 9 ac
LDR 19 ac
P/OS 1.5 ac
LDR 13.8 ac
LDR 20.9 ac
P/OS 2 ac
MDR 4.9 ac
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HDR 3.8 ac
MUR 3.4 ac
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MDR 3.7 ac
P/OS 1.4 ac
Basin 8.2 ac
Channel 9.8 ac
MUR 2.9 ac
MDR 11.4 ac
HDR 5.4 ac
MUR 4.1 ac
MUV 19.4 ac
MUV 7.9 ac
P/OS 5.9 ac
LI/FS 14.7 ac
OFF 8.4 ac
Channel 7.6 ac
Basin 9.4 ac
Channel 5.7 ac
Channel 10.5 ac
Basin 6.4 ac
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LI/FS 32.3 ac
LDR 25.9 ac
OFF 23.1 ac
ES 8.5 ac
Channel 9.2 ac
Basin 5 ac
OFF 32.7 ac
COM 6.4 ac
COM 7.7 ac
LI/FS 37.6 ac
LI/FS 17.7 ac
LI/FS 0.5 ac
OFF 51.2 ac
OFF 74.2 ac

2.0 Project Water Demands

Project water demands were determined based on land use area. The project water demands were determined by multiplying an annual demand factor by the land use area. Annual demand factors utilized in this study are shown in **Table 2-1: Land Use Demand Factors and Annual Water Demand**. The WSIP demand factors were utilized as the basis of determining annual demand. Some land uses as proposed are not explicitly referenced in the WSIP. To maintain consistency and in general conformance, assumptions for annual demand were consistent with the WSIP.

Table 2-1: Land Use Demand Factors and Annual Water Demand
Source: Sacramento County Water Agency, WSIP, dated April 2006.

Land Use		Annual Demand Factor per WSIP (acre/feet)	Annual Demand Factor [4] (acre/feet)	Annual Demand [4] (acre/feet)
ER	Estate Residential	1.33	1.43	89.5
LDR	Low Density Residential	2.89	3.11	658.5
MDR	Medium Density Residential	3.70	3.98	378.5
HDR	High Density Residential	4.12	4.43	268.8
MUR	Mixed Use Residential	4.12[5]	4.43	62.0
COM	Commercial	2.75	2.96	41.9
MUV	Mixed Use Commercial	2.75[6]	2.96	80.8
ES	Elementary School	3.46	3.72	102.8
OFF	Office	2.75[6]	2.96	827.4
LI/FS	Light Industrial / Flex Space	2.71	2.91	315.2
P/OS	Park / Open Space	3.46	3.72	211.4
Greenway	Greenway	3.46[7]	3.72	132.0
Basin	Basin	-[8]	-	-
Drainage	Drainage Channel	-[8]	-	-
Channel	Channel	-[8]	-	-
	Right of Way		0.23	19.1
Total				**3,188**

[4] Includes 7.5% system losses.

[5] WSIP does not contain a unit demand factor for mixed use residential. This study assumes the same demand factor as high density residential land use.

[6] WSIP does not contain a unit demand factor for mixed use commercial or office. This study assumes the same demand factor as commercial land use.

[7] WSIP does not contain a unit demand factor for greenways. This study assumes the same demand factor as public recreation land use.

[8] Per City of Elk Grove some water demand via drip irrigation may be required to establish plantings. Ultimate water demand will be zero.

It is important to note that the City is pursuing recycled water for non-domestic uses relating to landscaping. There may be opportunities for several land uses to take advantages of this availability. For planning purposes, this study does not take into account recycled water demand.

2.1 Hydraulic Water Demands

The hydraulic water demands utilized for modeling are shown in below **Table 2-2: Proposed Water Demands**. The average annual demand was determined by multiplying the land use area by the demand factor as indicated in **Table 2-1**. The average day demand is calculated by taking the average annual demand and converting it into gallons per minute. Average day demand is representative of the average daily demand based on 365 days in a year.

Per the WSIP, the maximum day demand is the highest demand expected on any given day throughout the year. Typically this demand occurs in July where temperatures are excessively warm. The maximum day demand is assumed to be twice the average day demand. Maximum day demand is also utilized for fire flow scenarios and analysis.

Peak hour demand is the highest expected demand for any given hour throughout the year. This demand is four times the average day demand

Table 2-2: Proposed Water Demands

Land Use		Area (acres)	Average Annual Demand (acre/feet)	Average Day Demand (gpm)	Maximum Day Demand (gpm)	Peak Hour Demand (gpm)
ER	Estate Residential	62.6	89.5	55	111	222
LDR	Low Density Residential	212.0	658.5	408	817	1633
MDR	Medium Density Residential	95.2	378.5	235	469	939
HDR	High Density Residential	60.7	268.8	167	333	667
MUR	Mixed Use Residential	14.0	62.0	38	77	154
COM	Commercial	14.2	41.9	26	52	104
MUV	Mixed Use Commercial	27.3	80.8	50	100	200
ES	Elementary School	27.6	102.8	64	128	255
OFF	Office	279.9	827.4	513	1026	2052
LI/FS	Light Industrial / Flex Space	108.2	315.2	195	391	782
P/OS	Park / Open Space	56.8	211.4	131	262	524
Greenway	Greenway	35.5	132.0	82	164	327
Basin	Basin	49.4	-	-	-	-
Drainage	Drainage Channel	1.7	-	-	-	-
Channel	Channel	65.3	-	-	-	-
	Right of Way	84.4	19.1	12	24	47
Total		**1,195**	**3,188**	**1,976**	**3,953**	**7,906**

3.0 Service Description and System Criteria

Proposed water distribution mains are to be designed to provide required flow deliveries while maintaining acceptable service pressures to all customers within the plan area. Description of the proposed water system, operating goals, and facility sizing requirements are discussed in this section.

3.1 Service Description

Figure 3-1: Water System Layout and **Appendix C** show the proposed water conveyance facilities for the plan area. The proposed water system layout is representative of both transmission mains and 12-inch distributions mains that will serve as the plan area's backbone infrastructure. The basis of the proposed domestic water backbone infrastructure layout through the plan area is in general conformance with the 2006 WSIP. Included in this study are copies of the 2006 WSIP maps relating to the SEPA plan area. See **Figure 3-2** and **Figure 3-3**. Further discussion regarding connection and extension into the project area is included below.

<u>Bruceville Road Extension</u>

There is an existing 20-inch transmission main in Bruceville Road conveying water from the Poppy Ridge Water Treatment Plant south where it turns west in Bilby Road. The WSIP and this study assume an extension of the 20-inch transmission main within Bruceville Road to Kammerer Road. Eventually the WSIP identifies this water main extending to the Rio Consumnes Correctional Center.

<u>Bilby Road Extension</u>

Currently an existing 20-inch transmission main runs from west to east in Bilby Road adjacent to the East Franklin Specific Plan. This existing transmission main terminates in Bilby Road approximately 750 feet east of the Bilby Road and Bruceville Road intersection. From the current termination point, per the WSIP and this study, the 20-inch main is to extend along the future Bilby Road alignment within the plan area boundary at future Lotz Parkway.

The EGP plan and subsequent construction of the "Elk Grove Promenade – Major Roads" improvement provided a 20-inch transmission main from Promenade Parkway to the project boundary of Sterling Meadows. The Sterling Meadows project will complete the 20-inch transmission main within Bilby Road between SEPA and the existing stub where the transmission main terminates in Bilby Road.

<u>Big Horn Boulevard Extension</u>

In the LRSP plan, a 16-inch transmission main is proposed to extend along the LRSP boundary to Bilby Road. However, in the WSIP this transmission main is shown as 20-inch. This study proposes a 20-inch transmission main extending from Whitelock Parkway to Kammerer Road as shown in the WSIP and this study.

<u>Kammerer Road Extension</u>

Existing in Kammerer road, constructed as part of the "Elk Grove Promenade – Major Roads" is a 20-inch transmission main. This study proposes extending, a 16-inch transmission main within Kammerer Road between Bruceville Road and Lotz Parkway per the ongoing WSIP update. From Lotz Parkway to the 20-inch stub, adjacent to Sterling Meadows, a 20-inch transmission main is proposed.

<u>Lotz Parkway Extension</u>

Per the ongoing WSIP update, a 24-inch transmission main in future Lotz Parkway will be extended south from Whitelock Parkway to Kammerer Road.

3.2 System Criteria

The WSIP outlines system criteria for both distribution and transmission main design. Included in **Table 3-1: Design Criteria** are each design criteria and operating goal for design of domestic water conveyance systems.

Water Main Design System Criteria

The responsibility for operation and maintenance of the water supply facilities within SEPA is by SCWA Zone 41, the retail zone of SCWA. SCWA has developed minimum operating goals to be used in the planning of new water distribution systems. These goals apply to water studies that analyze subdivision level developments. The goals help ensure adequate pressure and flow are available to serve customers on a daily basis and also during emergency fire flow situations. The goals used in this study for the water distribution lines are listed in **Table 3-1: Design Criteria**.

Table 3-1: Design Criteria

Source: Sacramento County Water Agency, Zone 40 Water System Infrastructure Plan, April 2006

Criteria	Goal
Maximum System Pressure	75 psi
Minimum pressure in transmission main	40 psi
Minimum pressure in domestic main	35 psi
Minimum pressure at fire flow	25 psi
Maximum pipe flow velocity at MDD	5 fps
Maximum pipe flow velocity at PHD	7 fps
Maximum pipe velocity at fire flow	10 fps

Fire Flow System Criteria

Fire flow is assumed to occur during maximum day demand conditions. Fire flow is assumed at 4,000 gpm for all new industrial land uses[9]. Smaller fire flows are typical for single family residential. Greater fire flows may be required for larger buildings as defined by the California Fire Code and the local fire authority. This study utilizes 4,000 gpm fire flow as a conservative approach for the entire plan area.

System Assumptions

The following assumptions were utilized in the hydraulic models:

- Model demands do not take into account demands outside the boundary of the project area.
- The system must be able to accommodate the delivery of domestic water through the transmission facilities as identified in WSIP.
- Pipe losses are reflected with a Hazen-William "C" value of 125 to represent all pipe material, included ductile iron, welded steel, concrete cylinder, and polyvinyl chloride mains.

[9] Sacramento County Water Agency, Zone 40 Water System Infrastructure Plan, April 2006.

WATER SYSTEM LAYOUT

ELK GROVE **CALIFORNIA**

FEBRUARY 26, 2014

HEAST POLICY AREA BORDER

NODE

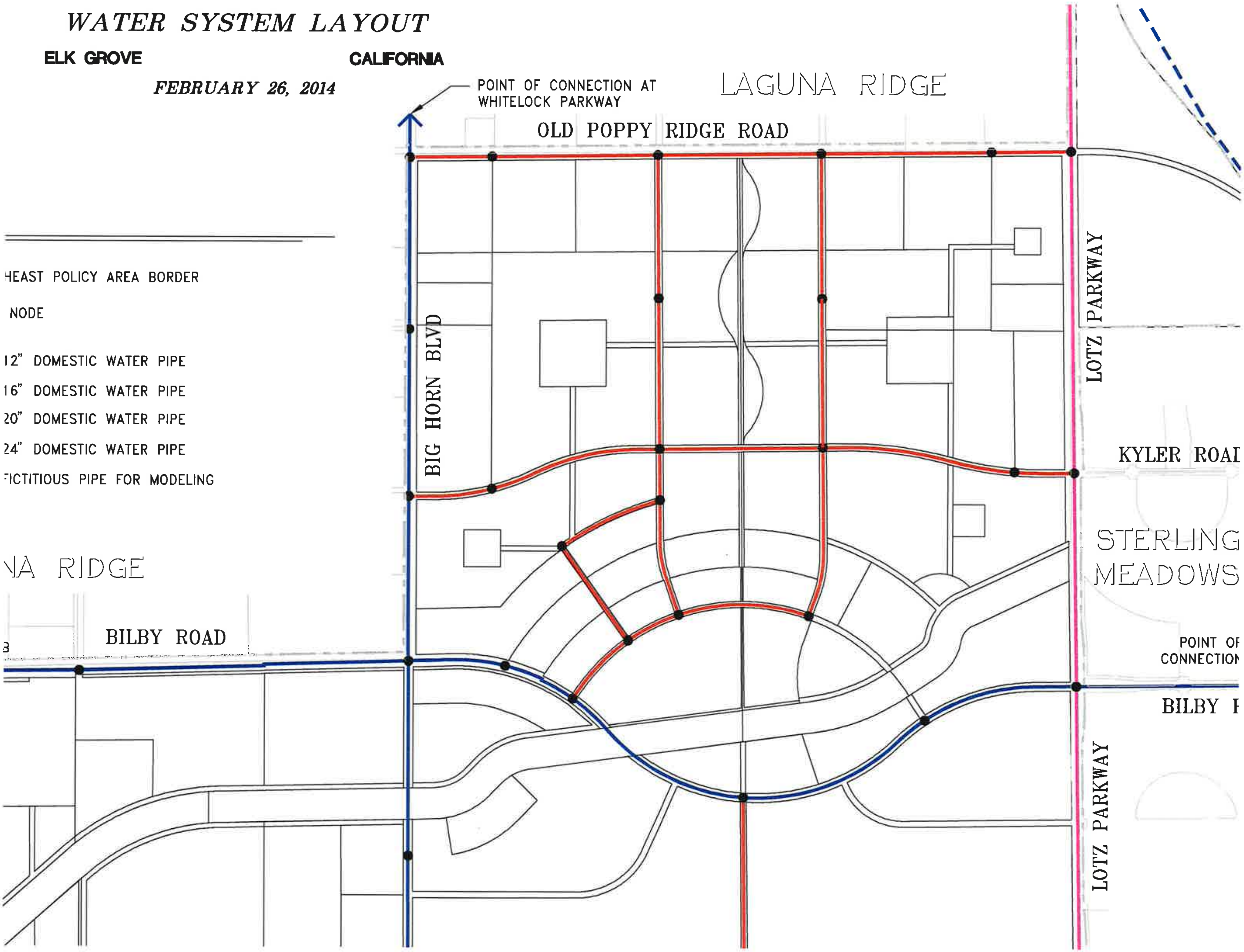
12" DOMESTIC WATER PIPE

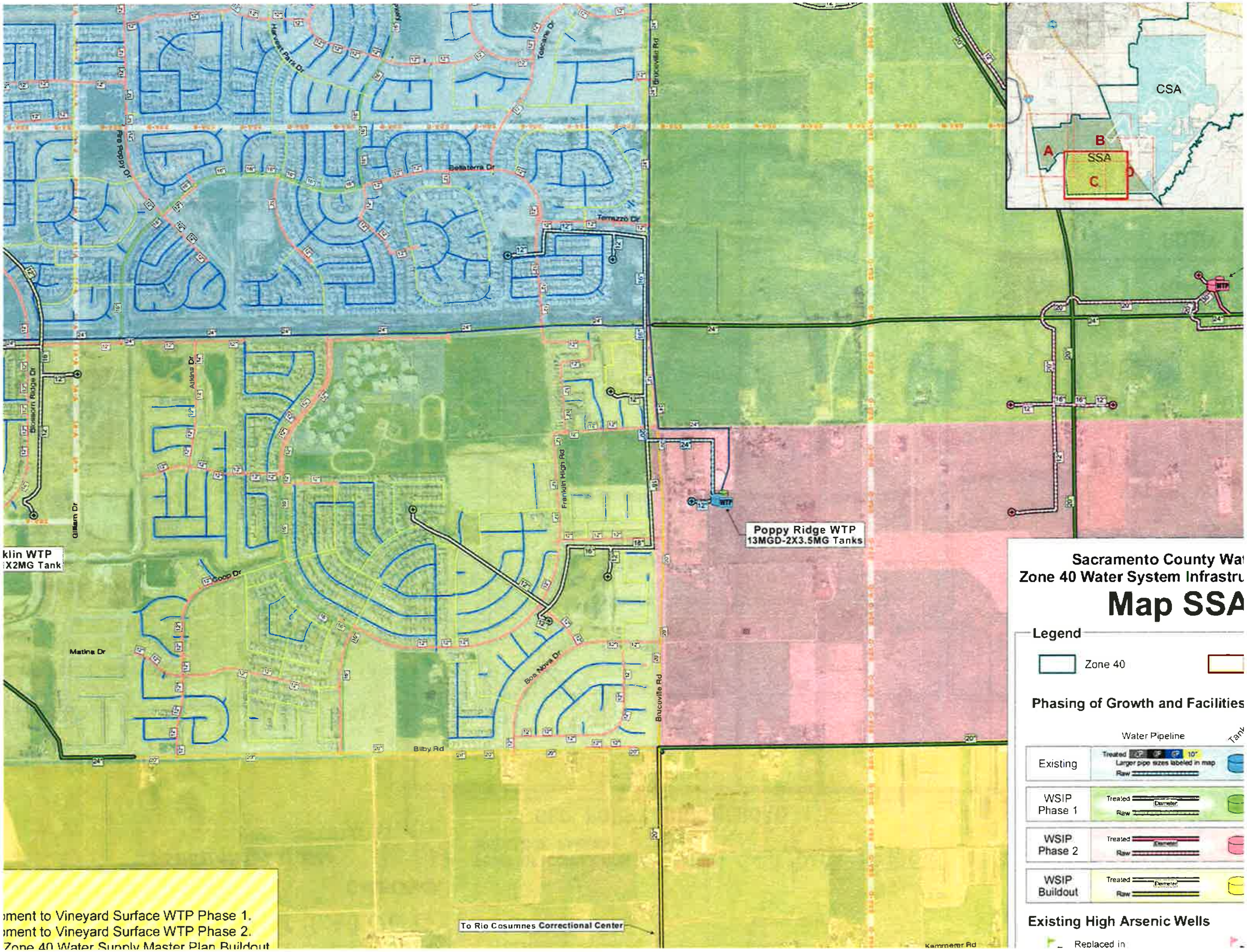
16" DOMESTIC WATER PIPE

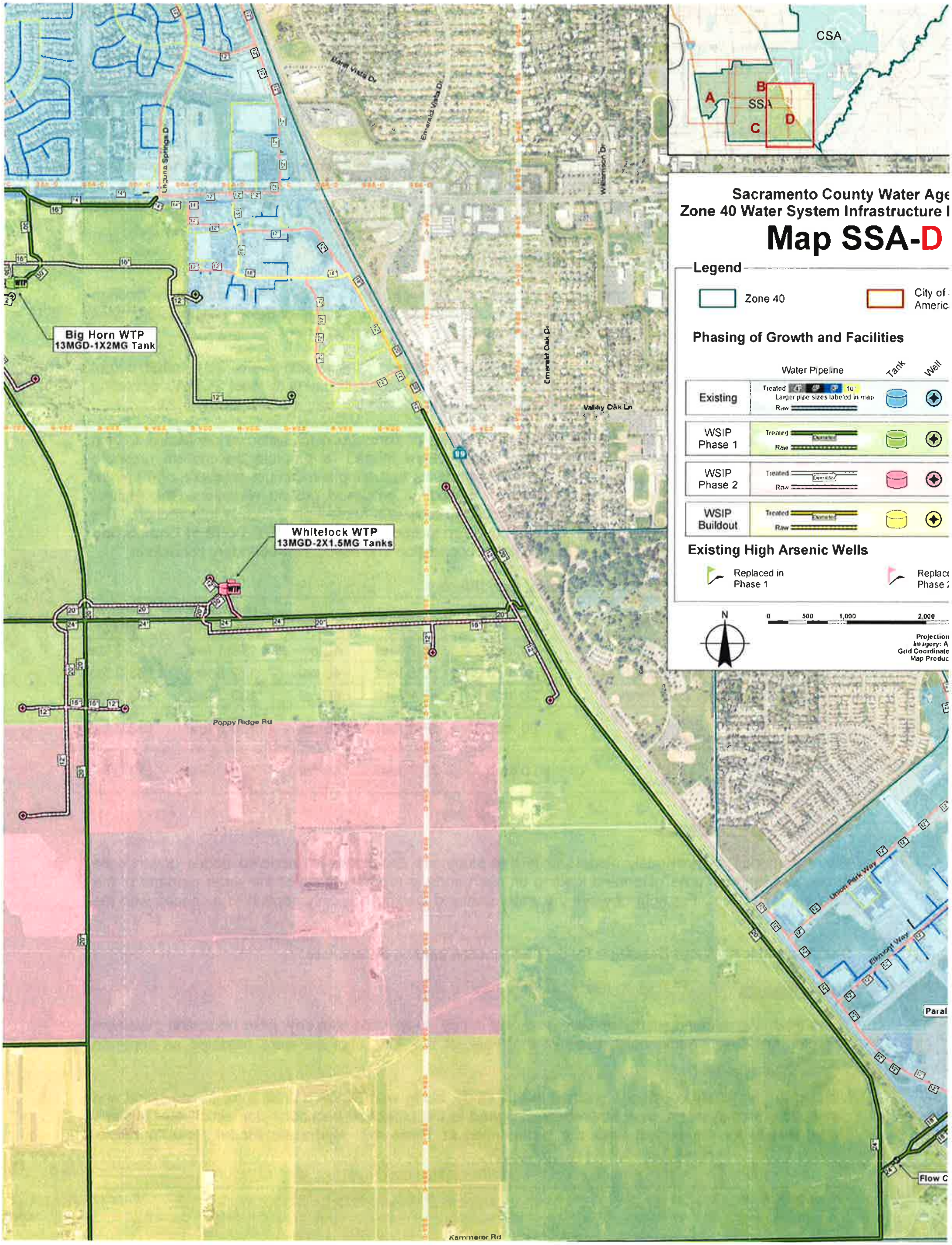
20" DOMESTIC WATER PIPE

24" DOMESTIC WATER PIPE

FICTITIOUS PIPE FOR MODELING




Sacramento County Wat
Zone 40 Water System Infrastru
Map SSA
Legend
Zone 40
Phasing of Growth and Facilities
Water Pipeline
Existing
Larger pipe sizes labeled in map
WSIP Phase 1
WSIP Phase 2
WSIP Buildout
Treated
Raw
Diameter
Existing High Arsenic Wells
Replaced in
Poppy Ridge WTP
13MGD-2X3.5MG Tanks
klin WTP
X2MG Tank
CSA
SSA
A
B
C
D
Bruceville Rd
Harvest Park Dr
Toscana Dr
Fire Poppy Dr
Bellaterra Dr
Terrazzo Dr
Blossom Ridge Dr
Atkins Dr
Franklin High Rd
Gilliam Dr
Goop Dr
Matina Dr
Bos Nova Dr
Bilby Rd
Kammerer Rd
To Rio Cosumnes Correctional Center
ment to Vineyard Surface WTP Phase 1.
ment to Vineyard Surface WTP Phase 2.
Zone 40 Water Supply Master Plan Buildout



Sacramento County Water Age
Zone 40 Water System Infrastructure I
Map SSA-D
Legend
Zone 40
City of
Americ
Phasing of Growth and Facilities
Water Pipeline
Tank
Well
Existing
Treated
Larger pipe sizes labeled in map
Raw
WSIP Phase 1
WSIP Phase 2
WSIP Buildout
Existing High Arsenic Wells
Replaced in Phase 1
Replace Phase
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500
1,000
2,000
N
CSA
A
B
C
D
SSA
Big Horn WTP
13MGD-1X2MG Tank
Whitelock WTP
13MGD-2X1.5MG Tanks
Laguna Springs Dr
Bond Vista Dr
Emerald Vista Dr
Williamson Dr
Emerald Oak Dr
Valley Oak Ln
Poppy Ridge Rd
Union Park Way
Elmont Way
Kammerer Rd
Paral
Flow C

4.0 Hydraulic Model Results

Wood Rodgers developed a hydraulic model of the SEPA plan area to size facilities within the plan area as shown in **Figure 3-1: Water System Layout** and **Appendix C**. The model was developed utilizing the hydraulic model program H2ONet (version 8.5) developed by Innovyze. Upon request, an electronic copy of the water model is available.

Point of Connection and Boundary Conditions

To serve the project area, domestic water will be conveyed from SCWA treatment plants through proposed transmission mains as outlined in the WSIP and this study. Some of these transmission mains are currently in service while others will be built to partially serve the plan area.

SCWA guarantees that a pressure of 40 psi is available in system transmission mains. As a result, output pressure at SCWA operated transmission main facilities may require boosting to meet SCWA's operating goals. Further analysis of SCWA operational procedures is outside the scope of this study.

The model developed for this project utilizes five points of connection to transmission facilities, both existing and proposed per the WSIP. These stubs where utilized to simulate the system pressure boundary conditions. The modeled HGL was calculated by assuming a minimum pressure of 40 psi at the connection point with the highest elevation. Based on proposed ground elevations, the highest connection point is in the northeast at the Whitelock Parkway and future Lotz Parkway intersection. The resulting HGL was then applied to all boundary condition locations. See **Table 4-1: Point of Connection Boundary Conditions** for locations of each point of connection and associated boundary conditions.

Table 4-1: Point of Connection Boundary Conditions

Point of Connection	Transmission Main Size	Elev.	Pressure	Hydraulic Grade Line	Modeled HGL
Bruceville Road & Bilby Road	20 inch	26.8 feet	40 psi	119.1 feet	133.2 feet
Big Horn Blvd. & Whitelock Pkwy.	24 inch	30.5 feet	40 psi	122.8 feet	133.2 feet
Whitelock Pkwy. & Lotz Pkwy	20 inch	40.9 feet	40 psi	133.2 feet	133.2 feet
Bilby Road (West of Promenade Pkwy)	20 inch	37.3 feet	40 psi	129.6 feet	133.2 feet
Kammerer Road (West of Promenade Pkwy)	20 inch	40.7 feet	40 psi	133.0 feet	133.2 feet

Applied Water Demands

Water demands as previously discussed in this study are distributed to modeled nodes or junctions throughout the plan area. Demand loading on each node is representative of the water demand of the adjacent land uses. For right of ways the water demand loading is evenly applied to all nodes with the SEPA plan area.

See **Appendix A: Water Demands** for detailed junction loading by land use.

Model Results

Three modeling demand scenarios were analyzed in this study: maximum day, peak hour, and maximum day plus fire flow. Additionally, three of the weakest fire flow junctions were modeled as separate scenarios.

Utilizing the boundary conditions outlined in this study, along with SCWA's criteria for transmission and distribution main systems, pipe sizes were assigned to the proposed backbone domestic water system. Model results for the project area are summarized in **Table 4-2: Hydraulic Model Results** below.

Detailed model results for each scenario are included in **Appendix B**. The results indicate that the proposed system, as previously discussed, is adequate to meet SCWA's operating goals.

Table 4-2: Hydraulic Model Results

Demand Scenario	Minimum Pressure	Maximum Velocity
Maximum Day Demand	39.3 psi	1.8 fps
Peak Hour Demand	37.5 psi	3.5 fps
MDD + 4,000gpm Fire Flow @ EGJ680	31.6 psi	6.4 fps
MDD + 4,000gpm Fire Flow @ EGJ390	31.3 psi	6.3 fps
MDD + 4,000gpm Fire Flow @ EGJ330	26.9 psi	6.5 fps

5.0 Conclusion

This study has been prepared with the intent of providing supporting documentation for specific plan level planning for domestic water conveyance facilities within the Elk Grove Southeast Policy Area. The study indicates that the proposed water conveyance facilities as shown in **Appendix C: Proposed Water System Layout** are sufficiently sized to hydraulically convey domestic water within the project area to serve the proposed land use.

The hydraulic model developed as part of this study is based on a number of assumptions that may change as new and updated information becomes available. Information that may considerably change the assumptions and hydraulic modeling results found in this study include SCWA's WSIP update and ability to provide water supply to the project area. It is important to note that the proposed conveyance facilities only assume conveyance to and within the proposed plan area. It is anticipated that the WSIP will account for conveyance through the plan area to serve adjacent planning areas. Subsequent studies should update assumptions and boundary conditions as development proposals progress within the plan area.

Appendix A
Water Demands

Appendix Attachments

1. Annual Demand Factors
2. Demands by Land Use
3. Demands by Model Junction

ELK GROVE SOUTHEAST POLICY AREA
Annual Unit Demand Factors

Updated: 10/31/2013

Land Use Designation	Project Land Use	Land Use Category	Annual Demand (acre/feet)	System Losses	Annual Demand[5] (acre/feet)	Footnote
Basin	Basin	Public Recreation	---	---	---	6.
COM	Commercial	Commercial	2.75	7.50%	2.96	1.
	Drainage Channel	Public Recreation	---	---	---	6.
ER	Estate Residential	Rural Estates	1.33	7.50%	1.43	1.
ES	Elementary School	Public Recreation	3.46	7.50%	3.72	1.
	Greenway	Public Recreation	3.46	7.50%	3.72	4.
HDR	High Density Residential	MF (High Density)	4.12	7.50%	4.43	1.
LDR	Low Density Residential	Single Family	2.89	7.50%	3.11	1.
LI/FS	Light Industrial / Flex Space	Industrial	2.71	7.50%	2.91	1.
MDR	Medium Density Residential	MF (Low Density)	3.70	7.50%	3.98	1.
OFF	Office		2.75	7.50%	2.96	2.
P/OS	Park / Open Space	Public Recreation	3.46	7.50%	3.72	1.
MUR	Mixed Use Residential		4.12	7.50%	4.43	3.
MUC	Mixed Use Commercial		2.75	7.50%	2.96	2.
Channel	Channel		---	---	---	6.
ROW	Right of Way		0.21	7.50%	0.23	1.

Footnotes:

1. Source: Sacramento County Water Agency, Zone 40 Water System Infrastructure Plan, April 2006.
2. For mixed use commercial land use annual demand assumes the same demand factor as commercial land use
3. Assumes mixed use residential demand is equal to high density residential land use
4. For Basins, drainage channels, and greenways public recreation is assumed for annual demand.
5. Includes 7.5% system losses.
6. Per City of Elk Grove (email dated 10/17/2013) these land uses will ultimatly have zero water demand

Wood Rodgers, Inc.
M. Motroni
2/26/2014

ELK GROVE SOUTHEAST POLICY AREA
Annual and Hydraulic Water Demand

Updated: 10/31/2013

City Designation	Land Use	Area[3] (acres)	Demand Factor[2] (AFY/acre)	Annual Demand (AFY)	ADD (gpm)	MDD (gpm)	PHD (gpm)
Basin	Basin	49.4	---	---	---	---	---
COM	Commercial	14.2	2.96	41.9	26.0	52.0	104.0
Drainage Channel	Drainage Channel	1.7	---	---	---	---	---
ER	Estate Residential	62.6	1.43	89.5	55.5	111.0	222.0
ES	Elementary School	27.6	3.72	102.8	63.8	127.5	255.0
Greenway	Greenway	35.5	3.72	132.0	81.8	163.6	327.3
HDR	High Density Residential	60.7	4.43	268.8	166.7	333.3	666.7
LDR	Low Density Residential	212.0	3.11	658.5	408.3	816.5	1,633.0
LI/FS	Light Industrial / Flex Space	108.2	2.91	315.2	195.4	390.9	781.7
MDR	Medium Density Residential	95.2	3.98	378.5	234.6	469.3	938.6
OFF	Office	279.9	2.96	827.4	513.0	1,025.9	2,051.8
P/OS	Park / Open Space	56.8	3.72	211.4	131.0	262.1	524.2
MUR	Mixed Use Residential	14.0	4.43	62.0	38.4	76.9	153.8
MUV	Mixed Use Commercial	27.3	2.96	80.8	50.1	100.2	200.3
Channel	Channel	65.3	---	---	---	---	---
	Right of Way[1]	84.4	0.23	19.1	11.8	23.6	47.2
Total		**1,195**		**3,188**	**1,976**	**3,953**	**7,906**

Footnotes:

1. Internal roadways + 50' of R/W along perimeter of SEPA boundary but 100' along Sterling Meadows.
2. See demand factor spreadsheet for source of demand and assumptions. (Includes 7.5% system losses)
3. Based on GIS shape file received from City of Elk Grove on9/10/2013.

Elk Grove, dated 9/10/2013.

						Land Uses									Elevation
ercial (res)	Drainage Channel (acres)	Estate Residential (acres)	Elementary School (acres)	Greenway (acres)	High Density Residential (acres)	Low Density Residential (acres)	Light Industrial / Flex Space (acres)	Medium Density Residential (acres)	Office (acres)	Park / Open Space (acres)	Mixed Use Residential (acres)	Mixed Use Commercial (acres)	Channel (acres)	Right of Way[1] (acres)	Average Elevation (ft)
		55.77		1.58	10.31			11.73						4.69	27
	1.66	6.84	8.48	5.42		25.87				17.94				4.69	28
									23.08					4.69	31
														4.69	35
						20.89		18.05		2.00					35
								3.31						4.69	33
									10.07					4.69	36
					11.29									4.69	36
			10.19					10.66						4.69	39
				1.95		40.47				1.83					36
				0.50		27.90				6.45					36
				0.96	4.10					8.94					38
				0.68							3.37	19.44			35
								19.34		1.50				4.69	41
				2.04		24.03				6.45					38
			9.00			42.69				1.84					40
				3.67	4.19			3.65		7.37	3.58	7.88			36
				0.97	11.53	4.40		12.09		1.01				4.69	40
									70.54					4.69	38
														4.69	38
				1.35	10.12	25.73				1.49					38
														4.69	37
														4.69	39
				3.00					125.42					4.69	35
														4.69	32
.18				1.66			17.65		32.7						30
				3.26			43.56							4.69	26
				3.14									65.31	4.69	24
				0.38					9.71						33
							47.00								33
															32
											7.05				34
				2.57	9.16			16.32							35
				2.36					8.37						32
4.2	1.7	62.6	27.7	35.5	60.7	212.0	108.2	95.2	279.9	56.8	14.0	27.3	65.3	84.4	

r of SEPA boundary but 100' along Sterling Meadows. Acreage is equally distributed along demands around perimeter of SEPA boundary.

Appendix B
System Hydraulic Model Results

Appendix Attachments

1. Maximum Day Demand
2. Peak Hour Demand
3. Maximum Day Demand plus Fire Flow
4. Fire Flow at Junction EGJ330
5. Fire Flow at Junction EGJ390
6. Fire Flow at Junction EGJ640

ELK GROVE - SOUTHEAST POLICY AREA
MAXIMUM DAY DEMAND MODEL OUTPUT

Updated: February 19, 2014

JUNCTION REPORT				
JUNCTION NODE ID	DEMAND (gpm)	ELEVATION (feet)	HEAD (feet)	PRESSURE (psi)
EGJ100	222	27	133.2	46.0
EGJ150	260	28	133.0	45.5
EGJ200	86	31	132.9	44.1
EGJ230	1	35	132.9	42.4
EGJ235	179	35	132.5	42.3
EGJ270	16	33	133.0	43.3
EGJ300	38	36	133.1	42.1
EGJ310	63	36	133.1	42.1
EGJ330	101	39	132.3	40.4
EGJ335	173	36	132.2	41.7
EGJ340	140	36	132.3	41.7
EGJ345	68	38	132.3	40.9
EGJ350	93	35	132.3	42.2
EGJ370	104	41	132.4	39.6
EGJ375	132	38	132.3	40.9
EGJ380	214	40	132.3	40.0
EGJ390	140	36	132.3	41.7
EGJ395	161	40	132.5	40.1
EGJ400	260	38	133.1	41.2
EGJ450	1	38	133.0	41.2
EGJ460	168	38	132.7	41.1
EGJ500	1	37	133.1	41.6
EGJ600	1	39	133.1	40.8
EGJ620	475	35	132.8	42.4
EGJ640	1	32	132.9	43.7
EGJ660	243	30	132.9	44.6
EGJ680	174	26	132.9	46.3
EGJ700	16	24	133.1	47.3
EGJ800	37	33	132.9	43.3
EGJ825	170	33	133.0	43.3
EGJ840	0	32	132.9	43.7
EGJ850	39	34	132.4	42.6
EGJ860	143	35	132.3	42.2
EGJ880	42	32	132.9	43.7

PIPE REPORT									
PIPE ID	FROM NODE	TO NODE	LENGTH (ft)	DIAMETER (in)	ROUGHNESS (C-value)	FLOW (gpm)	VELOCITY (ft/s)	HEADLOSS (ft)	HL/1000 (ft/kft)
EGP01	EGJ700	EGJ100	2637	20	125	-335.63	0.34	0.08	0.03
EGP03	EGJ100	EGJ150	2538	20	125	620.27	0.63	0.24	0.09
EGP05	EGJ150	EGJ200	2650	20	125	360.27	0.37	0.09	0.03
EGP07	EGJ200	EGJ230	1316	20	125	-116.88	0.12	0.01	0.00
EGP09	EGJ230	EGJ270	1334	20	125	-516.97	0.53	0.09	0.07
EGP11	EGJ270	EGJ300	1366	20	125	-534.97	0.55	0.10	0.07
EGP13	EGJ300	EGJ310	659	12	125	63.00	0.18	0.01	0.02
EGP15	EGJ330	EGJ370	1304	12	125	-151.98	0.43	0.11	0.08
EGP17	EGJ370	EGJ395	1357	12	125	-184.79	0.52	0.16	0.12
EGP19	EGJ400	EGJ450	2559	24	125	233.73	0.17	0.02	0.01
EGP21	EGJ450	EGJ500	1703	24	125	-226.32	0.16	0.01	0.01
EGP23	EGJ500	EGJ600	2347	24	125	-224.73	0.16	0.01	0.01
EGP25	EGJ600	EGJ620	2668	16	125	325.19	0.52	0.22	0.08
EGP27	EGJ620	EGJ640	2692	16	125	-66.56	0.11	0.01	0.00
EGP29	EGJ640	EGJ680	2640	16	125	-145.63	0.23	0.05	0.02
EGP31	EGJ680	EGJ700	2577	16	125	-319.63	0.51	0.21	0.08
EGP33	EGJ200	EGJ660	1561	20	125	164.93	0.17	0.01	0.01
EGP35	EGJ660	EGJ640	1049	20	125	-78.07	0.08	0.00	0.00
EGP37	EGJ200	EGJ880	778	20	125	226.23	0.23	0.01	0.01
EGP39	EGJ880	EGJ840	616	20	125	184.23	0.19	0.01	0.01
EGP41	EGJ840	EGJ800	1620	20	125	-282.06	0.29	0.04	0.02
EGP43	EGJ800	EGJ825	1627	20	125	-402.30	0.41	0.07	0.04
EGP45	EGJ825	EGJ500	1259	20	125	-572.30	0.58	0.10	0.08
EGP47	EGJ840	EGJ850	645	12	125	466.29	1.32	0.43	0.66
EGP49	EGJ850	EGJ860	920	12	125	179.87	0.51	0.10	0.11
EGP51	EGJ860	EGJ345	868	12	125	36.87	0.10	0.01	0.01
EGP53	EGJ850	EGJ350	456	12	125	247.42	0.70	0.09	0.21
EGP55	EGJ350	EGJ345	937	12	125	65.21	0.19	0.02	0.02
EGP57	EGJ345	EGJ340	408	12	125	34.08	0.10	0.00	0.01
EGP59	EGJ230	EGJ235	669	12	125	399.08	1.13	0.33	0.50
EGP61	EGJ235	EGJ340	1393	12	125	220.08	0.62	0.23	0.17
EGP63	EGJ340	EGJ380	1304	12	125	-7.86	0.02	0.00	0.00
EGP65	EGJ350	EGJ390	1058	12	125	89.21	0.25	0.03	0.03
EGP67	EGJ390	EGJ380	1361	12	125	-50.79	0.14	0.01	0.01
EGP69	EGJ380	EGJ460	1544	12	125	-291.05	0.83	0.43	0.28
EGP71	EGJ460	EGJ450	475	12	125	-459.05	1.30	0.31	0.64
EGP73	EGJ380	EGJ375	1184	12	125	18.40	0.05	0.00	0.00
EGP75	EGJ375	EGJ370	1157	12	125	-113.60	0.32	0.06	0.05
EGP77	EGJ340	EGJ335	1199	12	125	122.02	0.35	0.07	0.06
EGP79	EGJ335	EGJ330	1142	12	125	-50.98	0.14	0.01	0.01
EGP81	EGJ800	EGJ620	1476	12	125	83.24	0.24	0.04	0.03
EGP83	EJRES01	EGJ100	286	99	125	1177.91	0.05	0.00	0.00
EGP87	EJRES03	EGJ300	1391	20	125	635.97	0.65	0.14	0.10
EGP89	EJRES04	EGJ400	1379	24	125	1024.56	0.73	0.13	0.10
EGP91	EGJ500	EJRES05	1729	20	125	-574.90	0.59	0.14	0.08
EGP93	EJRES06	EGJ600	1687	20	125	550.92	0.56	0.13	0.08
EGP95	EGJ370	EGJ395	1357	12	125	-184.79	0.52	0.16	0.12
EGP97	EGJ395	EGJ400	633	12	125	-530.82	1.51	0.53	0.84

ELK GROVE - SOUTHEAST POLICY AREA
PEAK HOUR DEMAND MODEL OUTPUT

Updated: February 19, 2014

JUNCTION REPORT				
JUNCTION NODE ID	DEMAND (gpm)	ELEVATION (feet)	HEAD (feet)	PRESSURE (psi)
EGJ100	444	27	133.2	46.0
EGJ150	520	28	132.3	45.2
EGJ200	172	31	132.0	43.8
EGJ230	3	35	132.0	42.0
EGJ235	357	35	130.8	41.5
EGJ270	35	33	132.4	43.1
EGJ300	76	36	132.7	41.9
EGJ310	127	36	132.7	41.9
EGJ330	202	39	129.8	39.4
EGJ335	347	36	129.8	40.6
EGJ340	279	36	130.0	40.7
EGJ345	136	38	130.0	39.9
EGJ350	186	35	130.1	41.2
EGJ370	207	41	130.2	38.7
EGJ375	263	38	130.0	39.9
EGJ380	429	40	130.0	39.0
EGJ390	281	36	130.0	40.7
EGJ395	301	40	130.8	39.4
EGJ400	520	38	132.7	41.0
EGJ450	3	38	132.7	41.0
EGJ460	336	38	131.6	40.5
EGJ500	3	37	132.7	41.5
EGJ600	3	39	132.7	40.6
EGJ620	950	35	131.9	42.0
EGJ640	3	32	132.0	43.3
EGJ660	487	30	132.0	44.2
EGJ680	347	26	132.2	46.0
EGJ700	32	24	132.9	47.2
EGJ800	75	33	132.1	42.9
EGJ825	340	33	132.3	43.0
EGJ840	0	32	132.0	43.3
EGJ850	77	34	130.4	41.8
EGJ860	285	35	130.1	41.2
EGJ880	89	32	132.0	43.3

PIPE REPORT									
PIPE ID	FROM NODE	TO NODE	LENGTH (ft)	DIAMETER (in)	ROUGHNESS (C-value)	FLOW (gpm)	VELOCITY (ft/s)	HEADLOSS (ft)	HL/1000 (ft/kft)
EGP01	EGJ700	EGJ100	2637	20	125	-670.83	0.69	0.29	0.11
EGP03	EGJ100	EGJ150	2538	20	125	1240.10	1.27	0.86	0.34
EGP05	EGJ150	EGJ200	2650	20	125	720.10	0.74	0.33	0.12
EGP07	EGJ200	EGJ230	1316	20	125	-236.13	0.24	0.02	0.02
EGP09	EGJ230	EGJ270	1334	20	125	-1033.56	1.06	0.32	0.24
EGP11	EGJ270	EGJ300	1366	20	125	-1068.56	1.09	0.35	0.26
EGP13	EGJ300	EGJ310	659	12	125	127.00	0.36	0.04	0.06
EGP15	EGJ330	EGJ370	1304	12	125	-307.00	0.87	0.40	0.31
EGP17	EGJ370	EGJ395	1357	12	125	-373.80	1.06	0.60	0.44
EGP19	EGJ400	EGJ450	2559	24	125	472.07	0.33	0.06	0.02
EGP21	EGJ450	EGJ500	1703	24	125	-446.37	0.32	0.04	0.02
EGP23	EGJ500	EGJ600	2347	24	125	-446.81	0.32	0.05	0.02
EGP25	EGJ600	EGJ620	2668	16	125	650.53	1.04	0.81	0.30
EGP27	EGJ620	EGJ640	2692	16	125	-132.84	0.21	0.04	0.02
EGP29	EGJ640	EGJ680	2640	16	125	-291.83	0.47	0.18	0.07
EGP31	EGJ680	EGJ700	2577	16	125	-638.83	1.02	0.75	0.29
EGP33	EGJ200	EGJ660	1561	20	125	331.00	0.34	0.05	0.03
EGP35	EGJ660	EGJ640	1049	20	125	-156.00	0.16	0.01	0.01
EGP37	EGJ200	EGJ880	778	20	125	453.23	0.46	0.04	0.05
EGP39	EGJ880	EGJ840	616	20	125	364.01	0.37	0.02	0.03
EGP41	EGJ840	EGJ800	1620	20	125	-563.53	0.58	0.13	0.08
EGP43	EGJ800	EGJ825	1627	20	125	-805.16	0.82	0.25	0.15
EGP45	EGJ825	EGJ500	1259	20	125	-1145.16	1.17	0.37	0.29
EGP47	EGJ840	EGJ850	645	12	125	927.54	2.63	1.53	2.37
EGP49	EGJ850	EGJ860	920	12	125	357.87	1.02	0.37	0.41
EGP51	EGJ860	EGJ345	868	12	125	72.87	0.21	0.02	0.02
EGP53	EGJ850	EGJ350	456	12	125	492.67	1.40	0.34	0.73
EGP55	EGJ350	EGJ345	937	12	125	128.83	0.37	0.06	0.06
EGP57	EGJ345	EGJ340	408	12	125	65.69	0.19	0.01	0.02
EGP59	EGJ230	EGJ235	669	12	125	794.42	2.25	1.19	1.78
EGP61	EGJ235	EGJ340	1393	12	125	437.42	1.24	0.82	0.59
EGP63	EGJ340	EGJ380	1304	12	125	-17.88	0.05	0.00	0.00
EGP65	EGJ350	EGJ390	1058	12	125	177.85	0.50	0.12	0.11
EGP67	EGJ390	EGJ380	1361	12	125	-103.15	0.29	0.06	0.04
EGP69	EGJ380	EGJ460	1544	12	125	-579.43	1.64	1.53	0.99
EGP71	EGJ460	EGJ450	475	12	125	-915.43	2.60	1.10	2.31
EGP73	EGJ380	EGJ375	1184	12	125	29.40	0.08	0.00	0.00
EGP75	EGJ375	EGJ370	1157	12	125	-233.60	0.66	0.21	0.18
EGP77	EGJ340	EGJ335	1199	12	125	242.00	0.69	0.24	0.20
EGP79	EGJ335	EGJ330	1142	12	125	-105.00	0.30	0.05	0.04
EGP81	EGJ800	EGJ620	1476	12	125	166.63	0.47	0.15	0.10
EGP83	EJRES01	EGJ100	286	99	125	2354.94	0.10	0.00	0.00
EGP87	EJRES03	EGJ300	1391	20	125	1271.56	1.30	0.49	0.35
EGP89	EJRES04	EGJ400	1379	24	125	2040.67	1.45	0.48	0.35
EGP91	EGJ500	EJRES05	1729	20	125	-1147.72	1.17	0.51	0.29
EGP93	EJRES06	EGJ600	1687	20	125	1100.34	1.12	0.46	0.27
EGP95	EGJ370	EGJ395	1357	12	125	-373.80	1.06	0.60	0.44
EGP97	EGJ395	EGJ400	633	12	125	-1048.60	2.97	1.88	2.98

ELK GROVE - SOUTHEAST POLICY AREA
MAXIMUM DAY DEMAND + FIRE FLOW MODEL OUTPUT

Updated: February 19, 2014

JUNCTION ID	STATIC DEMAND (gpm)	STATIC PRESSURE (psi)	STATIC HEAD (feet)	FIRE FLOW DEMAND (gpm)	RESIDUAL PRESSURE (psi)	AVAILABLE FLOW AT HYDRANT (gpm)	AVAILABLE FLOW PRESSURE (psi)
EGJ100	222.00	46.00	133.2	4,000	46.00	2,106,439	29.50
EGJ150	260.00	45.50	133.0	4,000	44.20	22,434	20.00
EGJ200	86.00	44.10	132.9	4,000	43.30	30,934	20.00
EGJ230	1.00	42.40	132.9	4,000	41.30	23,149	20.00
EGJ235	179.00	42.30	132.5	4,000	36.70	9,071	20.00
EGJ270	18.00	43.30	133.0	4,000	42.10	21,602	20.00
EGJ300	38.00	42.10	133.1	4,000	41.10	23,816	20.00
EGJ310	63.00	42.10	133.1	4,000	30.60	5,816	20.00
EGJ330	101.00	40.40	132.3	4,000	29.00	5,723	20.00
EGJ335	173.00	41.70	132.2	4,000	30.70	6,129	20.00
EGJ340	140.00	41.70	132.3	4,000	37.50	10,896	20.00
EGJ345	68.00	40.90	132.3	4,000	35.90	9,487	20.00
EGJ350	93.00	42.20	132.3	4,000	36.90	9,454	20.00
EGJ370	104.00	39.60	132.4	4,000	33.80	8,381	20.00
EGJ375	132.00	40.90	132.3	4,000	32.10	6,764	20.00
EGJ380	214.00	40.00	132.3	4,000	35.30	9,813	20.00
EGJ390	140.00	41.70	132.3	4,000	32.70	6,831	20.00
EGJ395	161.30	40.10	132.5	4,000	35.10	9,172	20.00
EGJ400	260.00	41.20	133.1	4,000	40.70	38,819	20.00
EGJ450	1.00	41.20	133.0	4,000	40.60	33,023	20.00
EGJ460	168.00	41.10	132.7	4,000	36.50	9,836	20.00
EGJ500	1.00	41.60	133.1	4,000	41.20	43,622	20.00
EGJ600	1.00	40.80	133.1	4,000	40.20	32,512	20.00
EGJ620	475.00	42.40	132.8	4,000	39.90	14,809	20.00
EGJ640	1.00	43.70	132.9	4,000	42.00	18,495	20.00
EGJ660	243.00	44.60	132.9	4,000	43.00	20,321	20.00
EGJ680	174.00	46.30	132.9	4,000	42.40	11,834	20.00
EGJ700	16.00	47.30	133.1	4,000	45.20	16,731	20.00
EGJ800	37.00	43.30	132.9	4,000	42.10	22,887	20.00
EGJ825	170.00	43.30	133.0	4,000	42.20	23,985	20.00
EGJ840	0.00	43.70	132.9	4,000	42.50	24,321	20.00
EGJ850	39.00	42.60	132.4	4,000	38.30	10,776	20.00
EGJ860	143.00	42.20	132.3	4,000	34.30	7,457	20.00
EGJ880	42.00	43.70	132.9	4,000	42.60	24,988	20.00

ELK GROVE - SOUTHEAST POLICY AREA

MAXIMUM DAY DEMAND + FIRE FLOW AT NODE EGJ390 MODEL OUTPUT

Updated: February 19, 2014

JUNCTION REPORT				
JUNCTION NODE ID	DEMAND (gpm)	ELEVATION (feet)	HEAD (feet)	PRESSURE (psi)
EGJ100	222.0	27.0	133.20	46.02
EGJ150	260.0	28.0	132.44	45.25
EGJ200	86.0	31.0	131.94	43.74
EGJ230	1.0	35.0	131.93	42.00
EGJ235	179.0	35.0	129.47	40.93
EGJ270	18.0	33.0	132.32	43.03
EGJ300	38.0	36.0	132.72	41.91
EGJ310	63.0	36.0	132.71	41.90
EGJ330	101.0	39.0	126.49	37.91
EGJ335	173.0	36.0	125.91	38.96
EGJ340	140.0	36.0	125.69	38.86
EGJ345	68.0	38.0	125.25	37.80
EGJ350	93.0	35.0	123.51	38.35
EGJ370	104.0	41.0	127.49	37.48
EGJ375	132.0	38.0	125.89	38.08
EGJ380	214.0	40.0	124.78	36.74
EGJ390	4140.0	36.0	111.57	32.74
EGJ395	150.0	40.0	129.16	38.63
EGJ400	260.0	38.0	132.60	40.99
EGJ450	1.0	38.0	132.52	40.95
EGJ460	168.0	38.0	130.33	40.00
EGJ500	1.0	37.0	132.61	41.43
EGJ600	1.0	39.0	132.69	40.60
EGJ620	475.0	35.0	132.01	42.03
EGJ640	1.0	32.0	132.01	43.33
EGJ660	243.0	30.0	131.95	44.18
EGJ680	174.0	26.0	132.34	46.08
EGJ700	16.0	24.0	132.97	47.22
EGJ800	37.0	33.0	131.97	42.89
EGJ825	170.0	33.0	132.28	43.02
EGJ840	0.0	32.0	131.64	43.17
EGJ850	39.0	34.0	125.94	39.84
EGJ860	143.0	35.0	125.46	39.19
EGJ880	42.0	32.0	131.77	43.23

PIPE REPORT									
PIPE ID	FROM NODE	TO NODE	LENGTH (ft)	DIAMETER (in)	ROUGHNESS (C-value)	FLOW (gpm)	VELOCITY (ft/s)	HEADLOSS (ft)	HL/1000 (ft/kft)
EGP01	EGJ700	EGJ100	2637.00	20	125	-596.16	0.61	0.23	0.09
EGP03	EGJ100	EGJ150	2538.00	20	125	1166.76	1.19	0.76	0.30
EGP05	EGJ150	EGJ200	2650.00	20	125	906.76	0.93	0.50	0.19
EGP07	EGJ200	EGJ230	1316.00	20	125	41.12	0.04	0.00	0.00
EGP09	EGJ230	EGJ270	1334.00	20	125	-1136.35	1.16	0.38	0.29
EGP11	EGJ270	EGJ300	1366.00	20	125	-1154.35	1.18	0.40	0.30
EGP13	EGJ300	EGJ310	659.00	12	125	63.00	0.18	0.01	0.02
EGP15	EGJ330	EGJ370	1304.00	12	125	-504.85	1.43	1.00	0.77
EGP17	EGJ370	EGJ395	1357.00	12	125	-651.00	1.85	1.67	1.23
EGP19	EGJ400	EGJ450	2559.00	24	125	580.19	0.41	0.09	0.03
EGP21	EGJ450	EGJ500	1703.00	24	125	-749.06	0.53	0.09	0.05
EGP23	EGJ500	EGJ600	2347.00	24	125	-578.22	0.41	0.08	0.03
EGP25	EGJ600	EGJ620	2668.00	16	125	591.96	0.94	0.68	0.25
EGP27	EGJ620	EGJ640	2692.00	16	125	38.55	0.06	0.00	0.00
EGP29	EGJ640	EGJ680	2640.00	16	125	-406.16	0.65	0.33	0.13
EGP31	EGJ680	EGJ700	2577.00	16	125	-580.16	0.93	0.63	0.24
EGP33	EGJ200	EGJ660	1561.00	20	125	-200.71	0.21	0.02	0.01
EGP35	EGJ660	EGJ640	1049.00	20	125	-443.71	0.45	0.05	0.05
EGP37	EGJ200	EGJ880	778.00	20	125	980.36	1.00	0.17	0.22
EGP39	EGJ880	EGJ840	616.00	20	125	938.36	0.96	0.12	0.20
EGP41	EGJ840	EGJ800	1620.00	20	125	-948.92	0.97	0.33	0.21
EGP43	EGJ800	EGJ825	1627.00	20	125	-907.51	0.93	0.31	0.19
EGP45	EGJ825	EGJ500	1259.00	20	125	-1077.51	1.10	0.33	0.26
EGP47	EGJ840	EGJ850	645.00	12	125	1887.28	5.35	5.70	8.84
EGP49	EGJ850	EGJ860	920.00	12	125	412.44	1.17	0.49	0.53
EGP51	EGJ860	EGJ345	868.00	12	125	269.45	0.76	0.21	0.24
EGP53	EGJ850	EGJ350	456.00	12	125	1435.84	4.07	2.43	5.33
EGP55	EGJ350	EGJ345	937.00	12	125	-811.32	2.30	1.73	1.85
EGP57	EGJ345	EGJ340	408.00	12	125	-609.88	1.73	0.45	1.09
EGP59	EGJ230	EGJ235	669.00	12	125	1176.46	3.34	2.46	3.68
EGP61	EGJ235	EGJ340	1393.00	12	125	997.46	2.83	3.78	2.71
EGP63	EGJ340	EGJ380	1304.00	12	125	478.43	1.36	0.91	0.70
EGP65	EGJ350	EGJ390	1058.00	12	125	2154.16	6.11	11.94	11.29
EGP67	EGJ390	EGJ380	1361.00	12	125	-1985.84	5.63	13.22	9.71
EGP69	EGJ380	EGJ460	1544.00	12	125	-1160.25	3.29	5.54	3.59
EGP71	EGJ460	EGJ450	475.00	12	125	-1328.25	3.77	2.19	4.61
EGP73	EGJ380	EGJ375	1184.00	12	125	-561.16	1.59	1.11	0.93
EGP75	EGJ375	EGJ370	1157.00	12	125	-693.16	1.97	1.60	1.38
EGP77	EGJ340	EGJ335	1199.00	12	125	-230.85	0.65	0.22	0.18
EGP79	EGJ335	EGJ330	1142.00	12	125	-403.85	1.15	0.58	0.51
EGP81	EGJ800	EGJ620	1476.00	12	125	-78.41	0.22	0.04	0.02
EGP83	EJRES01	EGJ100	286.00	99	125	1984.92	0.08	0.00	0.00
EGP87	EJRES03	EGJ300	1391.00	20	125	1255.35	1.28	0.48	0.34
EGP89	EJRES04	EGJ400	1379.00	24	125	2292.20	1.63	0.60	0.43
EGP91	EGJ500	EJRES05	1728.50	20	125	-1249.35	1.28	0.59	0.34
EGP93	EJRES06	EGJ600	1686.92	20	125	1171.18	1.20	0.51	0.30
EGP95	EGJ370	EGJ395	1357.00	12	125	-651.00	1.85	1.67	1.23
EGP97	EGJ395	EGJ400	633.00	12	125	-1452.00	4.12	3.44	5.44

ELK GROVE - SOUTHEAST POLICY AREA

MAXIMUM DAY DEMAND + FIRE FLOW AT NODE EGJ680 MODEL OUTPUT

Updated: February 19, 2014

JUNCTION REPORT				
JUNCTION NODE ID	DEMAND (gpm)	ELEVATION (feet)	HEAD (feet)	PRESSURE (psi)
EGJ100	222.0	27.0	133.20	46.02
EGJ150	260.0	28.0	132.49	45.27
EGJ200	86.0	31.0	132.03	43.78
EGJ230	1.0	35.0	132.17	42.10
EGJ235	179.0	35.0	131.91	41.99
EGJ270	18.0	33.0	132.48	43.10
EGJ300	38.0	36.0	132.80	41.95
EGJ310	63.0	36.0	132.79	41.94
EGJ330	101.0	39.0	131.77	40.20
EGJ335	173.0	36.0	131.73	41.48
EGJ340	140.0	36.0	131.76	41.49
EGJ345	68.0	38.0	131.76	40.63
EGJ350	93.0	35.0	131.77	41.93
EGJ370	104.0	41.0	131.95	39.41
EGJ375	132.0	38.0	131.82	40.65
EGJ380	214.0	40.0	131.81	39.78
EGJ390	140.0	36.0	131.76	41.49
EGJ395	150.0	40.0	132.21	39.95
EGJ400	260.0	38.0	132.94	41.14
EGJ450	1.0	38.0	132.85	41.10
EGJ460	168.0	38.0	132.45	40.93
EGJ500	1.0	37.0	132.85	41.53
EGJ600	1.0	39.0	132.86	40.67
EGJ620	475.0	35.0	131.62	41.87
EGJ640	1.0	32.0	130.73	42.78
EGJ660	243.0	30.0	131.16	43.83
EGJ680	4174.0	26.0	123.92	42.43
EGJ700	16.0	24.0	130.79	46.27
EGJ800	37.0	33.0	132.17	42.97
EGJ825	170.0	33.0	132.50	43.11
EGJ840	0.0	32.0	132.05	43.35
EGJ850	39.0	34.0	131.81	42.38
EGJ860	143.0	35.0	131.76	41.93
EGJ880	42.0	32.0	132.04	43.35

PIPE REPORT									
PIPE ID	FROM NODE	TO NODE	LENGTH (ft)	DIAMETER (in)	ROUGHNESS (C-value)	FLOW (gpm)	VELOCITY (ft/s)	HEADLOSS (ft)	HL/1000 (ft/kft)
EGP01	EGJ700	EGJ100	2637.00	20	125	-2122.31	2.17	2.41	0.91
EGP03	EGJ100	EGJ150	2538.00	20	125	1124.00	1.15	0.71	0.28
EGP05	EGJ150	EGJ200	2650.00	20	125	864.00	0.88	0.46	0.17
EGP07	EGJ200	EGJ230	1316.00	20	125	-662.24	0.68	0.14	0.11
EGP09	EGJ230	EGJ270	1334.00	20	125	-1012.86	1.03	0.31	0.23
EGP11	EGJ270	EGJ300	1366.00	20	125	-1030.86	1.05	0.33	0.24
EGP13	EGJ300	EGJ310	659.00	12	125	63.00	0.18	0.01	0.02
EGP15	EGJ330	EGJ370	1304.00	12	125	-196.14	0.56	0.17	0.13
EGP17	EGJ370	EGJ395	1357.00	12	125	-238.99	0.68	0.26	0.19
EGP19	EGJ400	EGJ450	2559.00	24	125	579.72	0.41	0.09	0.03
EGP21	EGJ450	EGJ500	1703.00	24	125	48.25	0.03	0.00	0.00
EGP23	EGJ500	EGJ600	2347.00	24	125	-126.31	0.09	0.00	0.00
EGP25	EGJ600	EGJ620	2668.00	16	125	817.97	1.31	1.23	0.46
EGP27	EGJ620	EGJ640	2692.00	16	125	684.88	1.09	0.90	0.33
EGP29	EGJ640	EGJ680	2640.00	16	125	2067.69	3.30	6.80	2.58
EGP31	EGJ680	EGJ700	2577.00	16	125	-2106.31	3.36	6.87	2.67
EGP33	EGJ200	EGJ660	1561.00	20	125	1626.80	1.66	0.87	0.56
EGP35	EGJ660	EGJ640	1049.00	20	125	1383.80	1.41	0.43	0.41
EGP37	EGJ200	EGJ880	778.00	20	125	-186.56	0.19	0.01	0.01
EGP39	EGJ880	EGJ840	616.00	20	125	-228.56	0.23	0.01	0.01
EGP41	EGJ840	EGJ800	1620.00	20	125	-564.48	0.58	0.13	0.08
EGP43	EGJ800	EGJ825	1627.00	20	125	-943.40	0.96	0.33	0.20
EGP45	EGJ825	EGJ500	1259.00	20	125	-1113.40	1.14	0.35	0.28
EGP47	EGJ840	EGJ850	645.00	12	125	335.92	0.95	0.23	0.36
EGP49	EGJ850	EGJ860	920.00	12	125	126.04	0.36	0.05	0.06
EGP51	EGJ860	EGJ345	868.00	12	125	-16.96	0.05	0.00	0.00
EGP53	EGJ850	EGJ350	456.00	12	125	170.89	0.48	0.05	0.10
EGP55	EGJ350	EGJ345	937.00	12	125	37.14	0.11	0.01	0.01
EGP57	EGJ345	EGJ340	408.00	12	125	-47.82	0.14	0.00	0.01
EGP59	EGJ230	EGJ235	669.00	12	125	349.62	0.99	0.26	0.39
EGP61	EGJ235	EGJ340	1393.00	12	125	170.62	0.48	0.14	0.10
EGP63	EGJ340	EGJ380	1304.00	12	125	-95.07	0.27	0.05	0.03
EGP65	EGJ350	EGJ390	1058.00	12	125	40.74	0.12	0.01	0.01
EGP67	EGJ390	EGJ380	1361.00	12	125	-99.26	0.28	0.05	0.04
EGP69	EGJ380	EGJ460	1544.00	12	125	-362.47	1.03	0.64	0.42
EGP71	EGJ460	EGJ450	475.00	12	125	-530.47	1.50	0.40	0.84
EGP73	EGJ380	EGJ375	1184.00	12	125	-45.85	0.13	0.01	0.01
EGP75	EGJ375	EGJ370	1157.00	12	125	-177.85	0.50	0.13	0.11
EGP77	EGJ340	EGJ335	1199.00	12	125	77.86	0.22	0.03	0.02
EGP79	EGJ335	EGJ330	1142.00	12	125	-95.14	0.27	0.04	0.03
EGP81	EGJ800	EGJ620	1476.00	12	125	341.92	0.97	0.55	0.37
EGP83	EJRES01	EGJ100	286.00	99	125	3468.31	0.14	0.00	0.00
EGP87	EJRES03	EGJ300	1391.00	20	125	1131.86	1.16	0.40	0.28
EGP89	EJRES04	EGJ400	1379.00	24	125	1467.71	1.04	0.26	0.19
EGP91	EGJ500	EJRES05	1728.50	20	125	-939.85	0.96	0.35	0.20
EGP93	EJRES06	EGJ600	1686.92	20	125	945.28	0.97	0.34	0.20
EGP95	EGJ370	EGJ395	1357.00	12	125	-238.99	0.68	0.26	0.19
EGP97	EGJ395	EGJ400	633.00	12	125	-627.99	1.78	0.73	1.15

ELK GROVE - SOUTHEAST POLICY AREA

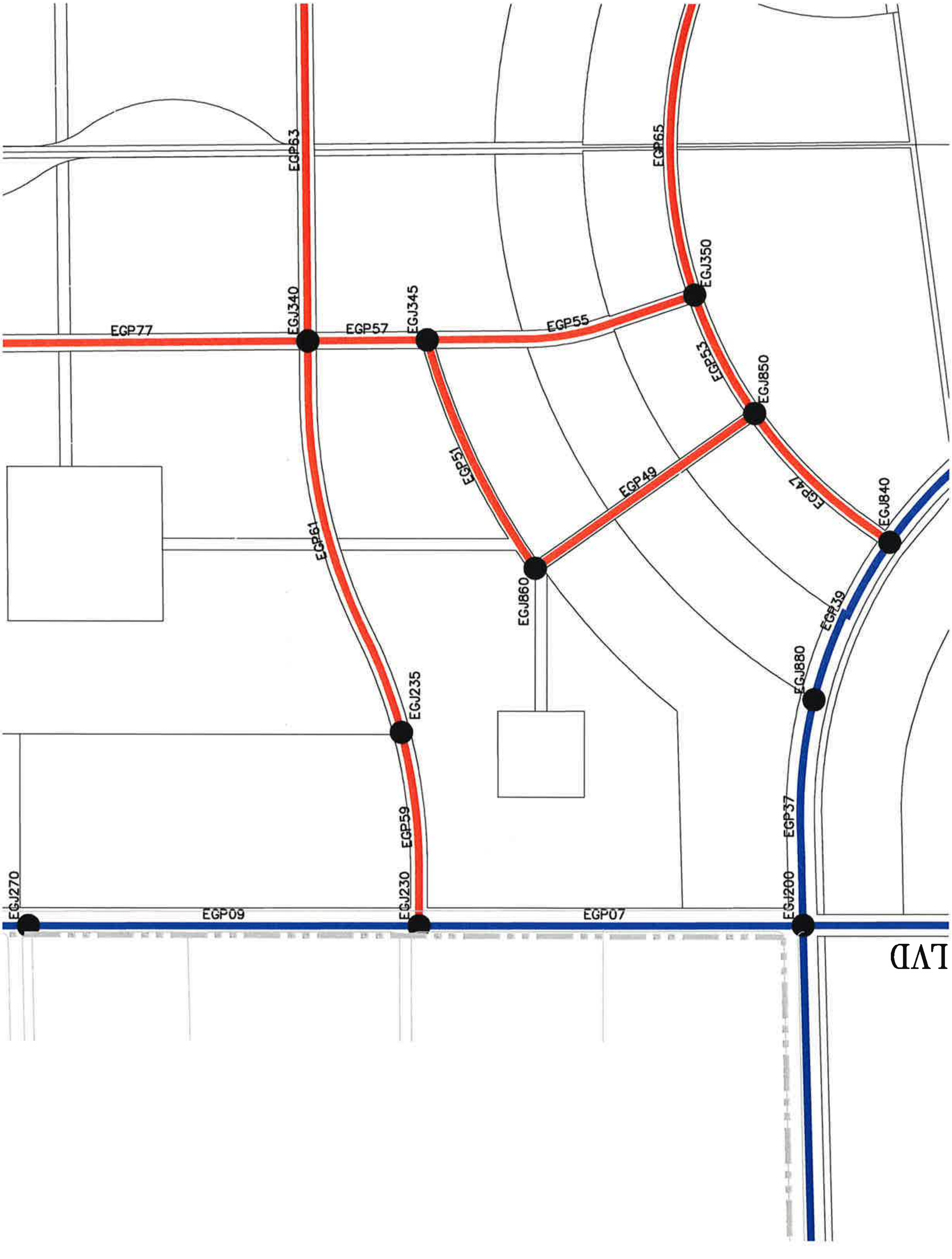
MAXIMUM DAY DEMAND + FIRE FLOW AT NODE EGJ330 MODEL OUTPUT

Updated: February 19, 2014

JUNCTION REPORT				
JUNCTION NODE ID	DEMAND (gpm)	ELEVATION (feet)	HEAD (feet)	PRESSURE (psi)
EGJ100	222.0	27.0	133.20	46.02
EGJ150	260.0	28.0	132.52	45.29
EGJ200	86.0	31.0	132.10	43.80
EGJ230	1.0	35.0	132.09	42.07
EGJ235	179.0	35.0	129.67	41.02
EGJ270	18.0	33.0	132.42	43.08
EGJ300	38.0	36.0	132.78	41.93
EGJ310	63.0	36.0	132.77	41.93
EGJ330	4101.0	39.0	106.04	29.05
EGJ335	173.0	36.0	114.90	34.19
EGJ340	140.0	36.0	125.97	38.98
EGJ345	68.0	38.0	126.67	38.42
EGJ350	93.0	35.0	127.14	39.93
EGJ370	104.0	41.0	123.22	35.63
EGJ375	132.0	38.0	124.49	37.48
EGJ380	214.0	40.0	126.36	37.42
EGJ390	140.0	36.0	126.64	39.28
EGJ395	150.0	40.0	126.37	37.42
EGJ400	260.0	38.0	132.50	40.95
EGJ450	1.0	38.0	132.48	40.94
EGJ460	168.0	38.0	130.70	40.17
EGJ500	1.0	37.0	132.61	41.43
EGJ600	1.0	39.0	132.70	40.60
EGJ620	475.0	35.0	132.15	42.09
EGJ640	1.0	32.0	132.15	43.39
EGJ660	243.0	30.0	132.10	44.24
EGJ680	174.0	26.0	132.43	46.12
EGJ700	16.0	24.0	132.99	47.23
EGJ800	37.0	33.0	132.13	42.95
EGJ825	170.0	33.0	132.36	43.05
EGJ840	0.0	32.0	131.91	43.29
EGJ850	39.0	34.0	128.13	40.79
EGJ860	143.0	35.0	127.19	39.95
EGJ880	42.0	32.0	131.98	43.32

PIPE REPORT									
PIPE ID	FROM NODE	TO NODE	LENGTH (ft)	DIAMETER (in)	ROUGHNESS (C-value)	FLOW (gpm)	VELOCITY (ft/s)	HEADLOSS (ft)	HL/1000 (ft/kft)
EGP01	EGJ700	EGJ100	2637.00	20	125	-562.34	0.57	0.21	0.08
EGP03	EGJ100	EGJ150	2538.00	20	125	1092.84	1.12	0.68	0.27
EGP05	EGJ150	EGJ200	2650.00	20	125	832.84	0.85	0.43	0.16
EGP07	EGJ200	EGJ230	1316.00	20	125	111.36	0.11	0.01	0.00
EGP09	EGJ230	EGJ270	1334.00	20	125	-1055.17	1.08	0.33	0.25
EGP11	EGJ270	EGJ300	1366.00	20	125	-1073.17	1.10	0.35	0.26
EGP13	EGJ300	EGJ310	659.00	12	125	63.00	0.18	0.01	0.02
EGP15	EGJ330	EGJ370	1304.00	12	125	-2341.70	6.64	17.18	13.18
EGP17	EGJ370	EGJ395	1357.00	12	125	-916.45	2.60	3.15	2.32
EGP19	EGJ400	EGJ450	2559.00	24	125	262.07	0.19	0.02	0.01
EGP21	EGJ450	EGJ500	1703.00	24	125	-923.86	0.66	0.14	0.08
EGP23	EGJ500	EGJ600	2347.00	24	125	-618.96	0.44	0.09	0.04
EGP25	EGJ600	EGJ620	2668.00	16	125	532.44	0.85	0.56	0.21
EGP27	EGJ620	EGJ640	2692.00	16	125	14.15	0.02	0.00	0.00
EGP29	EGJ640	EGJ680	2640.00	16	125	-372.34	0.59	0.28	0.11
EGP31	EGJ680	EGJ700	2577.00	16	125	-546.34	0.87	0.56	0.22
EGP33	EGJ200	EGJ660	1561.00	20	125	-142.48	0.15	0.01	0.01
EGP35	EGJ660	EGJ640	1049.00	20	125	-385.48	0.39	0.04	0.04
EGP37	EGJ200	EGJ880	778.00	20	125	777.97	0.79	0.11	0.14
EGP39	EGJ880	EGJ840	616.00	20	125	735.97	0.75	0.08	0.13
EGP41	EGJ840	EGJ800	1620.00	20	125	-774.66	0.79	0.23	0.14
EGP43	EGJ800	EGJ825	1627.00	20	125	-768.37	0.78	0.23	0.14
EGP45	EGJ825	EGJ500	1259.00	20	125	-938.37	0.96	0.25	0.20
EGP47	EGJ840	EGJ850	645.00	12	125	1510.63	4.29	3.77	5.85
EGP49	EGJ850	EGJ860	920.00	12	125	587.60	1.67	0.94	1.02
EGP51	EGJ860	EGJ345	868.00	12	125	444.60	1.26	0.53	0.61
EGP53	EGJ850	EGJ350	456.00	12	125	884.03	2.51	0.99	2.17
EGP55	EGJ350	EGJ345	937.00	12	125	403.11	1.14	0.47	0.51
EGP57	EGJ345	EGJ340	408.00	12	125	779.72	2.21	0.70	1.72
EGP59	EGJ230	EGJ235	669.00	12	125	1165.53	3.31	2.42	3.62
EGP61	EGJ235	EGJ340	1393.00	12	125	986.53	2.80	3.70	2.66
EGP63	EGJ340	EGJ380	1304.00	12	125	-306.06	0.87	0.40	0.30
EGP65	EGJ350	EGJ390	1058.00	12	125	387.92	1.10	0.50	0.47
EGP67	EGJ390	EGJ380	1361.00	12	125	247.92	0.70	0.28	0.21
EGP69	EGJ380	EGJ460	1544.00	12	125	-1016.93	2.88	4.34	2.81
EGP71	EGJ460	EGJ450	475.00	12	125	-1184.93	3.36	1.77	3.73
EGP73	EGJ380	EGJ375	1184.00	12	125	744.79	2.11	1.87	1.58
EGP75	EGJ375	EGJ370	1157.00	12	125	612.79	1.74	1.27	1.10
EGP77	EGJ340	EGJ335	1199.00	12	125	1932.30	5.48	11.07	9.23
EGP79	EGJ335	EGJ330	1142.00	12	125	1759.30	4.99	8.86	7.76
EGP81	EGJ800	EGJ620	1476.00	12	125	-43.29	0.12	0.01	0.01
EGP83	EJRES01	EGJ100	286.00	99	125	1877.18	0.08	0.00	0.00
EGP87	EJRES03	EGJ300	1391.00	20	125	1174.17	1.20	0.42	0.30
EGP89	EJRES04	EGJ400	1379.00	24	125	2504.98	1.78	0.70	0.51
EGP91	EGJ500	EJRES05	1728.50	20	125	-1244.27	1.27	0.59	0.34
EGP93	EJRES06	EGJ600	1686.92	20	125	1152.40	1.18	0.50	0.29
EGP95	EGJ370	EGJ395	1357.00	12	125	-916.45	2.60	3.15	2.32
EGP97	EGJ395	EGJ400	633.00	12	125	-1982.91	5.63	6.13	9.68

Appendix C
Proposed Water System Layout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EGP77
EGJ340
EGP57
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EGP55
EGP53
EGJ850
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EGP47
EGJ840
EGP61
EGJ860
EGP39
EGJ880
EGJ235
EGP59
EGP37
EGJ270
EGP09
EGJ230
EGP07
EGJ200
LVD

EXHIBIT B

Elk Grove Southeast Policy Area
Level II Sewer Study

March 5, 2014

Prepared for

CITY OF
ELK GROVE
PROUD HERITAGE, BRIGHT FUTURE

Prepared by

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

SACRAMENTO AREA
SEWER DISTRICT
SERVING YOU 24/7

March 5, 2014

Mike Motroni
Wood Rodgers
3301 C Street, Suite 100-B
Sacramento, CA 95816

Subject: **Elk Grove Southeast Policy Area – Level 2 Sewer Study Approval**

Dear Mr. Motroni:

Sacramento Area Sewer District staff reviewed the subject submittal and finds it sufficiently addresses District requirements and is considered approved. Any significant change in the proposed and/or assumed land use presented in this document, which impacts the sewer design, may require a revision to this study.

If you have any questions regarding these comments, please call me at 916-876-6278, or call Amandeep Singh at 916-876-6296.

Sincerely,

Stephen Moore

Stephen Moore, P.E., M.B.A.
Development Services

10060 Goethe Road
Sacramento, CA 95827-3553
Tel 916.876.6000
Fax 916.876.6160
www.sacsewer.com

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1.0 Executive Summary

Purpose

The purpose of this sewer study is to identify the backbone sewer conveyance facilities for the Elk Grove Southeast Policy Area (SEPA). This report is part of an overall high-level infrastructure analysis for the plan area. This study will demonstrate it is possible to provide sewer service for the project and technical compliance with the sewer district's requirements for sewer conveyance. The project falls within the jurisdiction of the Sacramento Area Sewer District (SASD).

Existing and planned sewer conveyance facilities border the project area to the north, west, and east. It is anticipated that these facilities will be extended to provide sewer service to the project area. This study has been prepared to present the project's ultimate build out sewer conveyance facilities for the plan area. The study includes backbone trunk and collector mains to serve each proposed land use. This study includes a discussion on the proposed project, sewer flows, alignments, and sewer facilities.

Project and Study Characteristics

The plan area encompasses approximately 1,200 acres and will convey 7,904 ESD's. The plan area is located in the south portion of Elk Grove between the Laguna Ridge Specific Plan and Elk Grove Promenade / Lent Ranch Specific Plan. The project proposes a mix of land use including residential, commercial, office, and industrial. The full plan area build out will convey a total of 2.5 mgd and 5.4 mgd during average dry weather flow and peak wet weather flow, respectively.

Findings

This study identifies onsite facilities required to serve the plan area. Design of the Laguna Ridge south lift station will need to provide consideration for planned flows from SEPA during development of level three studies. The existing Elk Grove Promenade lift station and force main will also require analysis at time of level three sewer study to show that these facilities are capable of conveying sewer flow from the plan area, as proposed in this study. These findings are discussed in detail within this study.

2.0 Introduction

Level of Study

This study is a level two study for a community plan level sewer assessment. The focus of this study is on backbone or trunk infrastructure required to serve the plan area. This level of study is not sufficient for design and it is anticipated that a level three study or series of studies will be required prior to improvement plan approval for backbone facilities.

Location

The SEPA project encompasses approximately 1,200 acres and is located in the southeast portion of the City of Elk Grove. In general the project area is located east of Bruceville Road, north of Kammerer Road, east of Big Horn Boulevard, and south of Poppy Ridge Road. The Laguna Ridge Specific Plan borders the project on the north and west. Proposed Sterling Meadows project borders the project directly to the east.

See **Figure 2-1: Vicinity Map** for a vicinity map of the project site.

Topography

The site currently consists of a mix of farm and ranch land with a number of residential structures on large lots spread throughout the plan area. The existing topography varies from elevation 39-feet to 22-feet and falls from the northeast to the southwest. Bisecting the project is a drainage canal flowing from east to west.

Detail Description

SEPA is the last large-scale development area within the urbanized portion of Elk Grove. It lies directly south of the Laguna Ridge Specific Plan area and west of Lent Ranch/Elk Grove Promenade and the approved Sterling Meadows development.[1]

Land Use and Zoning

The project area is currently zoned in the City's general plan as a special planning area. Therefore, specific polices are required to guide development within this area. The proposed land use will consist of residential (very low, low, medium and high density), mixed use, commercial, office, light industrial / flex space, schools, parks, and open space. The proposed land use for SEPA includes a total of 4,790 dwelling units from residential and mixed use land areas. See **Table 2-1: Proposed Project Land Use** for detailed project land uses and **Figure 2-2: Land Use Plan** for an exhibit showing the proposed land use, within the project area.

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[1] Project description per City of Elk Grove, planning department website, 1 October 2013.

Table 2-1: Proposed Project Land Use
Source: Land use spreadsheet provided by City of Elk Grove, September 10, 2013

	Land Use	Area[2] (acres)	Estimated Dwelling Units (DU)
ER	Estate Residential	62.6	288
LDR	Low Density Residential	212.0	1,341
MDR	Medium Density Residential	95.2	1,324
HDR	High Density Residential	60.7	1,511
MUR	Mixed Use Residential	14.0	267
COM	Commercial	14.2	-
MUV	Mixed Use Commercial	27.3	58
ES	Elementary School	27.7	-
OFF	Office	279.9	-
LI/FS	Light Industrial / Flex Space	108.2	-
P/OS	Park / Open Space	56.8	-
Greenway	Greenway	35.5	-
Basin	Basin	49.4	-
Drainage	Drainage Channel	1.7	-
Channel	Channel	65.3	-
	Right of Way[3]	84.4	-
Total		**1,195**	**4,790**

Existing Studies

The following studies were reviewed and referenced within this study.

- Laguna Ridge Specific Plan, Sewer Master Plan, Technical Addendum #2, by Wood Rodgers, Inc., dated May 2005.
- Laguna Ridge Specific Plan, Sewer Master Plan, Figure 5 Exhibit, by Wood Rodgers, Inc., revised November 2012.
- Elk Grove Promenade, Maser Sewer Study, by Wood Rodgers, Inc., dated October 2006.
- Elk Grove Promenade, Interim Sewer Lift Station (S-142) & Force Main Project, by Wood Rodgers Inc., dated February 16, 2007.
- SASD 2010 System Capacity Plan Expansion Trunk Sheds, by Sacramento Area Sewer District, dated 2010.

---

[2] Acreage values are approximate and reflect high-level master planning. Acreages are subject to change through subsequent development processing in keeping with the policies and procedures provided in the City's Special Planning Area document.

[3] Assumed to be internal roadways per the land use plan plus fifty feet of right of way adjacent to SEPA boundary except 100 feet along future Lotz Parkway.

Elk Grove Southeast Policy Area
Vicinity Map - Figure 2-1
Elk Grove, California
March 5, 2014

NORTH

0 1,250 2,500

FEET

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

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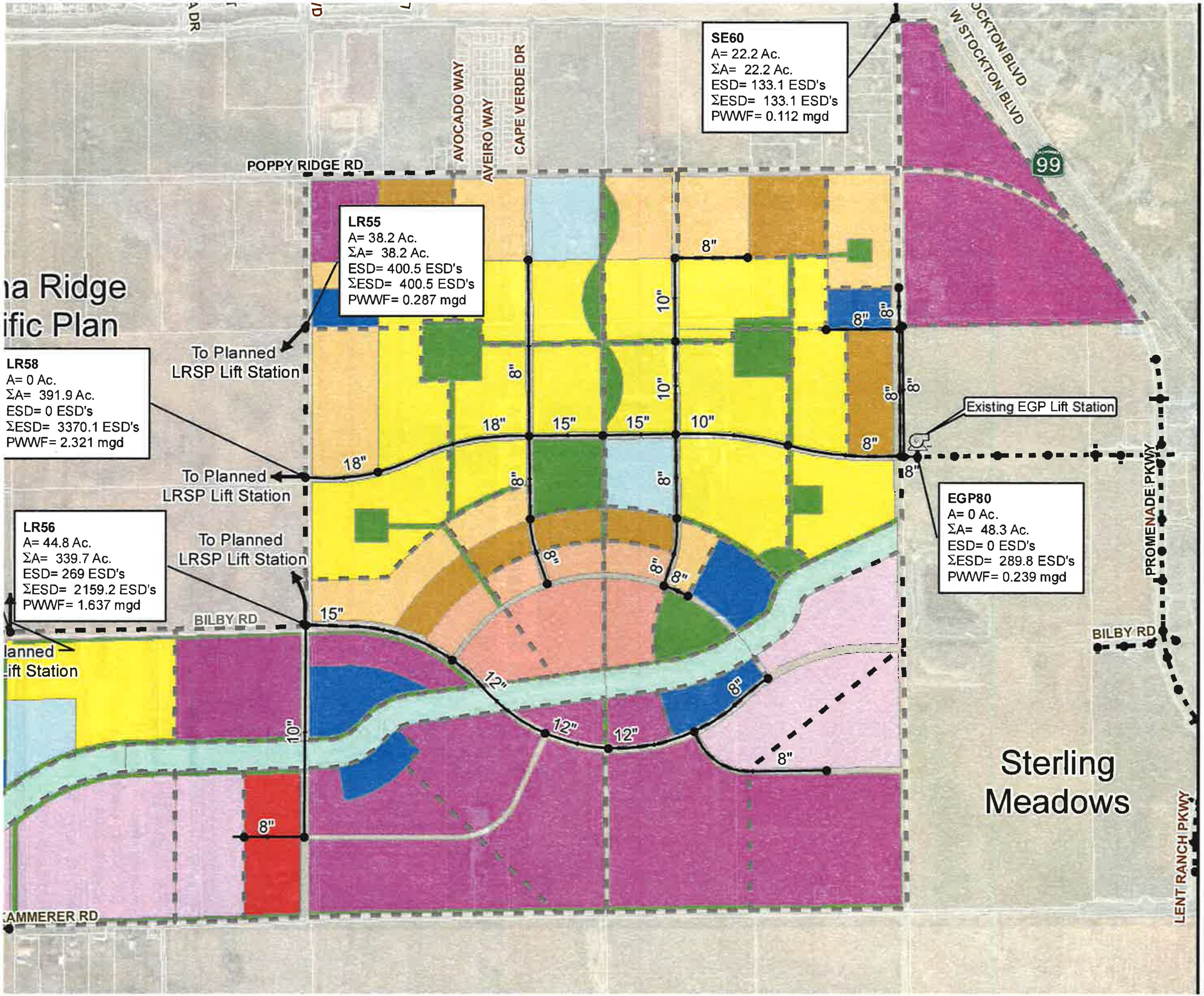


SE60
A= 22.2 Ac.
ΣA= 22.2 Ac.
ESD= 133.1 ESD's
ΣESD= 133.1 ESD's
PWWF= 0.112 mgd
LR55
A= 38.2 Ac.
ΣA= 38.2 Ac.
ESD= 400.5 ESD's
ΣESD= 400.5 ESD's
PWWF= 0.287 mgd
LR58
A= 0 Ac.
ΣA= 391.9 Ac.
ESD= 0 ESD's
ΣESD= 3370.1 ESD's
PWWF= 2.321 mgd
LR56
A= 44.8 Ac.
ΣA= 339.7 Ac.
ESD= 269 ESD's
ΣESD= 2159.2 ESD's
PWWF= 1.637 mgd
EGP80
A= 0 Ac.
ΣA= 48.3 Ac.
ESD= 0 ESD's
ΣESD= 289.8 ESD's
PWWF= 0.239 mgd
Existing EGP Lift Station
To Planned LRSP Lift Station
To Planned LRSP Lift Station
To Planned LRSP Lift Station
Sterling Meadows
POPPY RIDGE RD
AVOCADO WAY
AVEIRO WAY
CAPE VERDE DR
BILBY RD
KAMMERER RD
PROMENADE PKWY
LENT RANCH PKWY
W STOCKTON BLVD
99
18"
15"
10"
12"
8"

3.0 Design & Sewer Flow Information

The proposed design is included in **Appendix B: Level II Sewer Study** with a reduced copy included as **Figure 3-1: Level II Sewer Study**. The design illustrated in the above referenced exhibits is based upon the subsequent discussion in this section.

3.1 Elk Grove Promenade Trunk Sewer Shed

Preceding the date of this sewer study significant discussions have occurred regarding the Elk Grove Promenade (EGP) lift station and force main (designated as S-142) and available capacity. Development interests within the Elk Grove Promenade / Lent Ranch Specific Plan are working to ensure sufficient capacity for build out of their respective plan areas. The following discusses the different variations and assumptions regarding the Elk Grove Promenade sewer shed and how it relates to SEPA.

<u>2006 Elk Grove Promenade Study</u>

The 2006 Elk Grove Promenade Master Sewer Study and Interim Lift Station and Force Main design report identified the facilities to serve a portion of the Elk Grove Promenade sewer shed. The originally designed shed that would convey via the interim lift station and force main included the mall site, adjacent commercial properties, and proposed Sterling Meadows subdivision. The lift station conveys sewer via an existing force main under Highway 99 to a trunk sewer main in East Stockton Boulevard.

At the time of the 2006 studies the ultimate conveyance of sewer flows from this shed would be conveyed through SEPA and LRSP to the Laguna Ridge South Interceptor. The EGP lift station and force main would then be abandoned, once sufficient gravity infrastructure was in service.

<u>2010 Sewer Capacity Plan</u>

As part of the 2010 Sewer Capacity Plan, SRCSD had determined that the Laguna Ridge South Interceptor would not be constructed as originally planned. As a result SASD staff revised their sewer capacity plans, which resulted in significant changes to the size of the EGP sewer shed. The revised plan makes permanent the EGP lift station and force main. However, the shed area conveying to this lift station was significantly increased to include eastern portions of SEPA immediately to the west and north of the original EGP sewer shed. Copies of shed maps showing both the Elk Grove and Laguna Ridge trunk sheds from the 2010 System Capacity Plan are included as **Figure 3-2** and **Figure 3-3**, respectively.

<u>2013 Proposed Trunk Sheds</u>

Concern among Elk Grove Promenade / Lent Ranch Specific Plan developers and the City of Elk Grove led to further discussion regarding the size and extent of the ultimate shed that would convey via the EGP lift station and force main. The discussions resulted in a reversion back to the EGP sewer shed just slightly larger than originally proposed in 2006. This slightly modified sewer shed adds about 48 acres of office land use for 290 ESD's of SEPA (NE corner) that SASD now plans on serving through the EGP lift station and force main.

Further analysis of the existing capacity of the EGP lift station and force main will be required as a subsequent part of level three sewer studies. This study only looks at, and supports, most flows conveying to the west via SEPA's backbone facilities to the LRSP south lift station as shown in **Figure 3-4: Proposed Trunk Sewer Sheds**. This approach results in the most conservative design for the onsite SEPA trunk and backbone facilities.

3.2 Laguna Ridge South Trunk Sewer Shed

To date, multiple interests have discussed sewer conveyance for the Laguna Ridge South Trunk Sewer Shed. Since SEPA in large part will convey via the LRSP south sewer lift station, this study further discusses conveyance alternatives. Similar to the conversion of a permanent facility for the Elk Grove Promenade sewer lift station (S-142) the two interim sewer lift stations that were planned to serve the Laguna Ridge Specific Plan and surrounding areas are now or will be considered permanent facilities.

Laguna Ridge Specific Plan Sewer Studies

Wood Rodgers prepared the initial sewer study to serve the Laguna Ridge Specific Plan (LRSP) in a study dated May 2005 and revised November 2012. Since then other developers have prepared supplemental level three sewer studies to serve individual projects within LRSP. The study envisioned two lift stations would serve LRSP before regional interceptor facilities would be constructed to serve LRSP and SEPA. To date, only the LRSP north lift station (S-136), as known as the Whitelock Pump Station, is built and operational.

Additionally, SASD has received a number of requests for shed shifts for developments to convey flow from the future south lift station to the operational north lift station. This in large part is because parcels that would otherwise be served by the south lift station are moving ahead with development in advance of the south lift station being operational. SASD provided Wood Rodgers with revised sewer shed boundaries that reflect the current shed boundaries for the south lift station.[4] These flows are discussed in more detail later in this report.

Most SEPA sewer flows will flow directly into the Laguna Ridge development. Approximately 22.2 acres or 133.1 ESD's of office land use will flow to the existing Laguna Ridge north lift station via planned collector mains in Lotz Parkway as part of the Madeira East project. With the exception of those land uses previously discussed as they relate to the Elk Grove Promenade lift station, the remainder of the project will convey flows via the Laguna Ridge south lift station.

3.3 Design

The project sewer study consisted of calculating the sewer flows and designing the sewer system to serve the plan area. The SASD Design Standards, dated June 24, 2013 and Minimum Sewer Study Requirements, dated February 25, 2009 were utilized as the basis for this study.

Assumptions

There were a number of assumptions that are included in the design approach for this level two study. It is understood that as this plan area develops level three sewer studies, these assumptions may require further refinement. These assumptions are stated below:

- Per the sewer study for the Laguna Ridge Specific Plan (LRSP), by Wood Rodgers, dated May 2005 and revised November 2012, proposed sewer mains within LRSP are to provide for sewer service to SEPA. The LRSP study, consistent with trunk sewer sheds at the time, assumed that the EGP sewer shed, served by EGP lift station S142, would convey sewer through SEPA and LRSP to then proposed Laguna Ridge South Interceptor. As previously discussed district staff have indicated the EGP sewer shed will permanently convey flows to the east via force main as it does today. The future LRSP south lift station and associated force main will have to be designed to provide sufficient wet well depth to serve SEPA.

[4] Provided to Wood Rodgers via email from SASD on February 21, 2014.

- There will be no upstream development or significant increase in on-site densities that will affect the planned on-site or off-site sewer facilities.

- Only major nodal manholes are shown in this study. Additional manholes, per SASD Design Guidelines, will be included along the proposed sewer alignments. To allow for the additional manholes, a one-tenth drop is accounted for in the inverts shown in the study, for every 200-feet of pipe length. The slope published on the plans is representative of sewer pipe slope and is irrespective of the additional one-tenth drops. Further study will incorporate additional manholes per SASD Design Guidelines.

- Pipes were sized and flow lines calculated based on the SASD design standards and adhere to SASD "Minimum Sewer Study Requirements" Criteria. Actual alignments will be determined with subsequent level three study design scope.

- At time of this report a grading study of the plan area has not been developed. The existing topographic contours have been utilized as part of this study to determine invert depth.

- The land use plan has designated a number of parcels in the northeast part of the plan area with a sports and entertainment overlay. Flows from an entertainment overlay have not be analyzed and it is assumed that any flows from a stadium or other high peak flow venue would require attenuation onsite before discharging via collector pipes.

Approach

The following general procedure was used in the development of this study.

1. Gross areas based on the proposed Elk Grove Southeast Policy Area land use dated September 10, 2013 were used to calculate sewer flows.
2. Sub sheds areas were defined by topographic elevations, proposed service lines, and land use.
3. Equivalent dwelling units (ESD's) were calculated for each shed based on the underlying land use and shed area.
4. 310 gallons per day is assumed to be the average dry weather flow or a single equivalent single family dwelling unit (ESD).
5. This study does not include lateral mains as onsite street patterns are not defined.
6. Due to the flat terrain, minimum slopes were utilized to calculate inverts and run sewer lines to the upstream portions of the plan area.
7. Minimum sewer depth was set between five to six feet from existing elevation at street centerline.
8. Flows were determined based on the SASD, County Improvement Standards, and on the design criteria and assumptions identified in this study.
9. A schematic backbone trunk and collector system was established.
10. Major sheds were divided into sub-sheds in order to define the areas, which contribute flows to certain points (nodes) on the collection system.
11. To estimate sewage flows, land use boundaries were overlaid on the sub-sheds creating sub-areas of single land use within each sub-shed. The acreages of these sub-areas were determined and multiplied by the average number of equivalent single family dwellings (ESDs) per acre for their particular land use in order to determine the total number of ESDs entering each

pipe system. Pipes were sized and inverts calculated using an iterative process. For hydraulic calculations refer to **Appendix A: Demand & Hydraulic Calculation Table**.

Design Criteria

SASD Standards and Specifications, dated July 24, 2013 were used as the basis for this design. The flows were generated using the information found in Chapter 201 (Capacity Design) of the standards and specifications. The flow criteria used for this report is presented in **Table 3-1: Design Flow Criteria**.

Table 3-1: Design Flow Criteria
Source: Sacramento Area Sewer District

Criteria		Modifier
Flow Generation		
Estate Residential	6 ESD/acre	Not less than 6 ESD/acre for any land use.
Low Density Residential	6 ESD/acre	
Medium Density Residential	10 ESD/acre	
High Density Residential	20 ESD/acre	
Office	6 ESD/acre	
Commercial	6 ESD/acre	
School	6 ESD/acre	
Light Industrial / Flex Space	6 ESD/acre	
Mixed Use	6 ESD/acre	
Open Space / Public Recreation	6 ESD/acre	
Detention Basins	6 ESD/acre	
Peaking Factor	$PF = 3.5 - 1.8 * Q_{ADWF}^{0.05}$ (Minimum PF = 1.2)	
Minimum Velocity	Minimum 2 fps at Peak Dry Weather Flow	
Rainfall Infiltration Factor	Existing Areas: 1,600 gpd per acre New areas: 1,400 gpd per acre	
Hydraulic Grade Line	Maximum HGL at crown of pipe at Peak Wet Weather Flow	
Friction Factor (Manning's n-value)	0.01300	

3.4 Sewer Flow Information

Onsite Sewer Flows

Onsite sewer flows were generated based on design flow criteria identified in **Table 3-1** overlaid with the proposed land use. The project area consists of nearly 1,200 acres with about 1,043 acres generating sewer flow. The balance of the acreage that does not produce sewer flow are drain channels and backbone roadways. These flows, by land use, are shown in **Table 3-3: Sewer Flows by Land Use**. Detailed calculations for flow generation are included in **Appendix A: Demand & Hydraulic Calculation Table**.

For school facilities the SASD standards require an additional analysis to determine the maximum sewer flow to utilize for sewer calculations. This analysis is shown in **Table 3-2: School Sewer Flows**. Method A calculates the sewer flow at 6 ESD's per acre. Method B utilizes the flow rates identified in Table 201-1 and Table 201-2 of the SASD standards and converts the flow to ESD's. The flow rate for middle / junior high schools was utilized. These sites are not anticipated to be high schools.

Table 3-2: School Sewer Flows

School Site	Upstream Node	Method A		Method B		Maximum ESD's Utilized
		Area (acres)	Flow (ESD)	Flow (mgd)	Flow (ESD)	
1	SE70	10.2	61.1	0.06	193.5	193.5
2	SE43	9.0	54.0	0.06	193.5	193.5
3	SE61	8.5	50.8	0.06	193.5	193.5

Table 3-3: Sewer Flows by Land Use

	Land Use	Area (acres)	Sewer Flow per Acre (ESD/acre)	Sewer Flow (ESD's)
ER	Estate Residential	62.6	6	375
LDR	Low Density Residential	212.0	6	1,272
MDR	Medium Density Residential	95.2	10	952
HDR	High Density Residential	60.7	20	1,214
MU	Mixed Use	41.3	6	248
COM	Commercial	14.2	6	85
ES	Elementary School	27.7	See footnote 5	581
OFF	Office	279.9	6	1,679
LI/FS	Light Industrial / Flex Space	108.2	6	649
P/OS	Park / Open Space	56.8	6	341
Greenway	Greenway	35.4	6	212
Basin	Basin	49.4	6	296
Drainage	Drainage Channel	1.7	-	-
Channel	Drainage Channel	65.3	-	-
	Right of Way[6]	84.4	-	-
Total		**1,195**		**7,904**

Offsite Sewer Flow

No upstream flows are anticipated to pass through the plan area. Flows generated by SEPA will connect to existing or planned facilities that serve adjacent projects. This study proposes to convey flows through six different points of connection to sewer facilities planned with the Laguna Ridge Specific Plan. One additional connection to the Elk Grove Promenade lift station will also be required to serve the plan area. Onsite sewer flows produced by SEPA will convey via offsite sheds / lift stations identified in **Table 3-4: Onsite Sewer Flows by Conveyance Shed** and shown in **Figure 3-4: Proposed Trunk Sewer Sheds**.

[5] Flow rate for schools determined on a flow rate per school type basis. See **Table 3-2: School Sewer Flows** for additional information.

[6] Assumed to be internal roadways per the land use plan plus fifty feet of right of way adjacent to SEPA boundary except 100 feet along future Lotz Parkway.

Table 3-4: Onsite Sewer Flows by Conveyance Shed

Sewer Shed	Area (acres)	Sewer Flow (ESD's)
To Elk Grove Promenade Lift Station	48.3	289.8
To Laguna Ridge North Lift Station	22.2	133.1
Via Laguna Ridge South Sewer Shed	972.7	7,481.5
Total SEPA Sewer Flows	**1,043.2**	**7,904**

Subsequent level three sewer studies they will provide more detailed analysis and updating of the LRSP sewer study based on known conveyance from SEPA. These updates are not a part of this study and will be required for the LRSP south lift station. Part of the LRSP master sewer plan update should include the permanent location of a planned LRSP lift station that will serve the south portion of Laguna Ridge and SEPA. At time of this study SASD has indicated that an engineering firm is coordinating with them on the level 3 sewer study for the LRSP south area and the permanent Lift Station. It is anticipated that this study will locate the LRSP south lift station and provide conveyance facilities for SEPA flows entering through LRSP.

However, this study does address the total anticipated flows that are to be conveyed via the Laguna Ridge south lift station. As part of this task, SASD provided Wood Rodgers with the shed areas for the Laguna Ridge south sewer shed. The shed as envisioned today by SASD encompasses 355 acres. These flows as provided by SASD are shown in **Table 3-5** below.

Table 3-5: Laguna Ridge South Sewer Flows

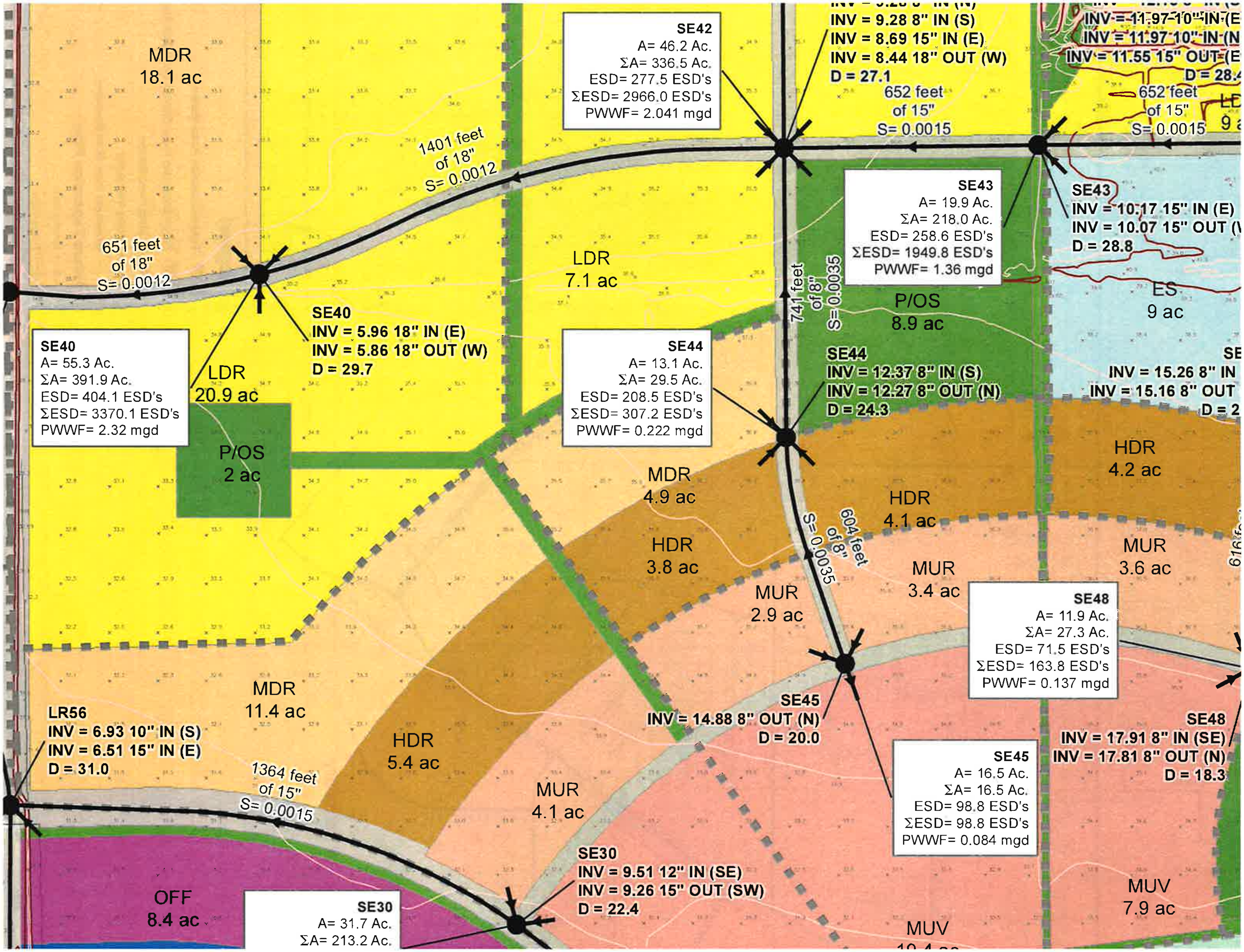
Source: Sacramento Area Sewer District email dated February 7 and February 21, 2014

Planning Area	Land Use	Area (acres)	Sewer Flow per Acre (ESD/acre)	Sewer Flow (ESD's)
LRSP	High Density Residential #1	11.6	20.4	236.6
LRSP	High Density Residential #2	7.9	21.0	165.9
LRSP	All other land uses	315.1	6.0	1,890.6
SEPA	From **Table 3-4**	972.7	varies	7,481.5
Total		**1,307.4**	-	**9,775**

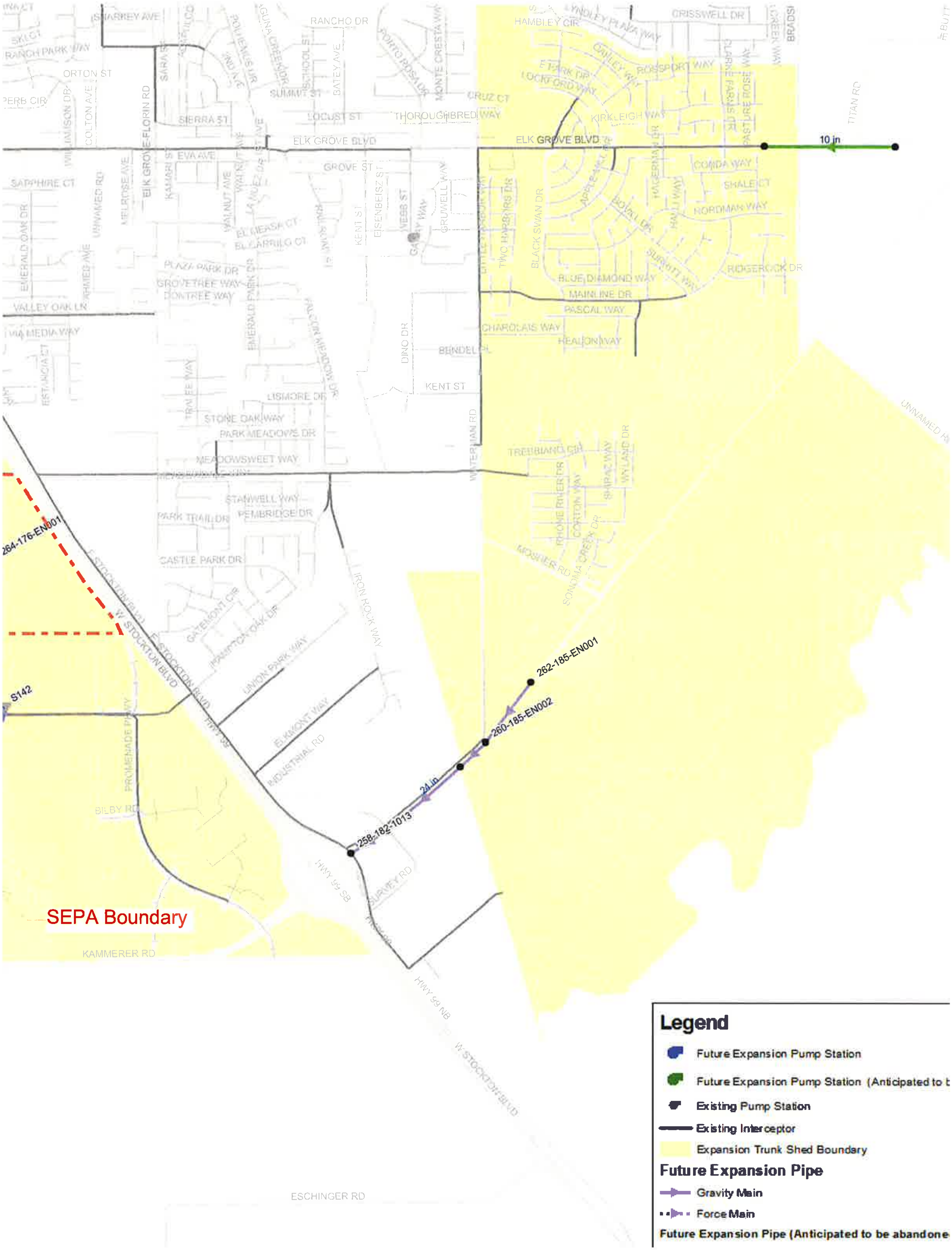
The peak wet weather flows from these areas total 6.7 mgd. The LRSP south sewer lift station should be designed to accommodate these flows either now or in the future with expansion projects. The LRSP south sewer lift station was originally planned to utilize one of the five force mains within Bruceville Road. These force mains convey sewer flows north to Laguna Blvd where they discharge into the Laguna Interceptor and where it will convey to the regional treatment plant. SASD has indicated that these gravity sewer facilities have sufficient capacity to serve LRSP South and SEPA as defined in this study.

Per SASD the existing force mains in Bruceville Road have a current available capacity of 6.5 mgd. There is a dry 12-inch force main that that was installed by the Laguna Ridge Owners Group that was to serve the LRSP south lift station. This existing force main runs from just south of Poppy Ridge Road to the Laguna Interceptor gravity sewer connection in Laguna Boulevard to the north.

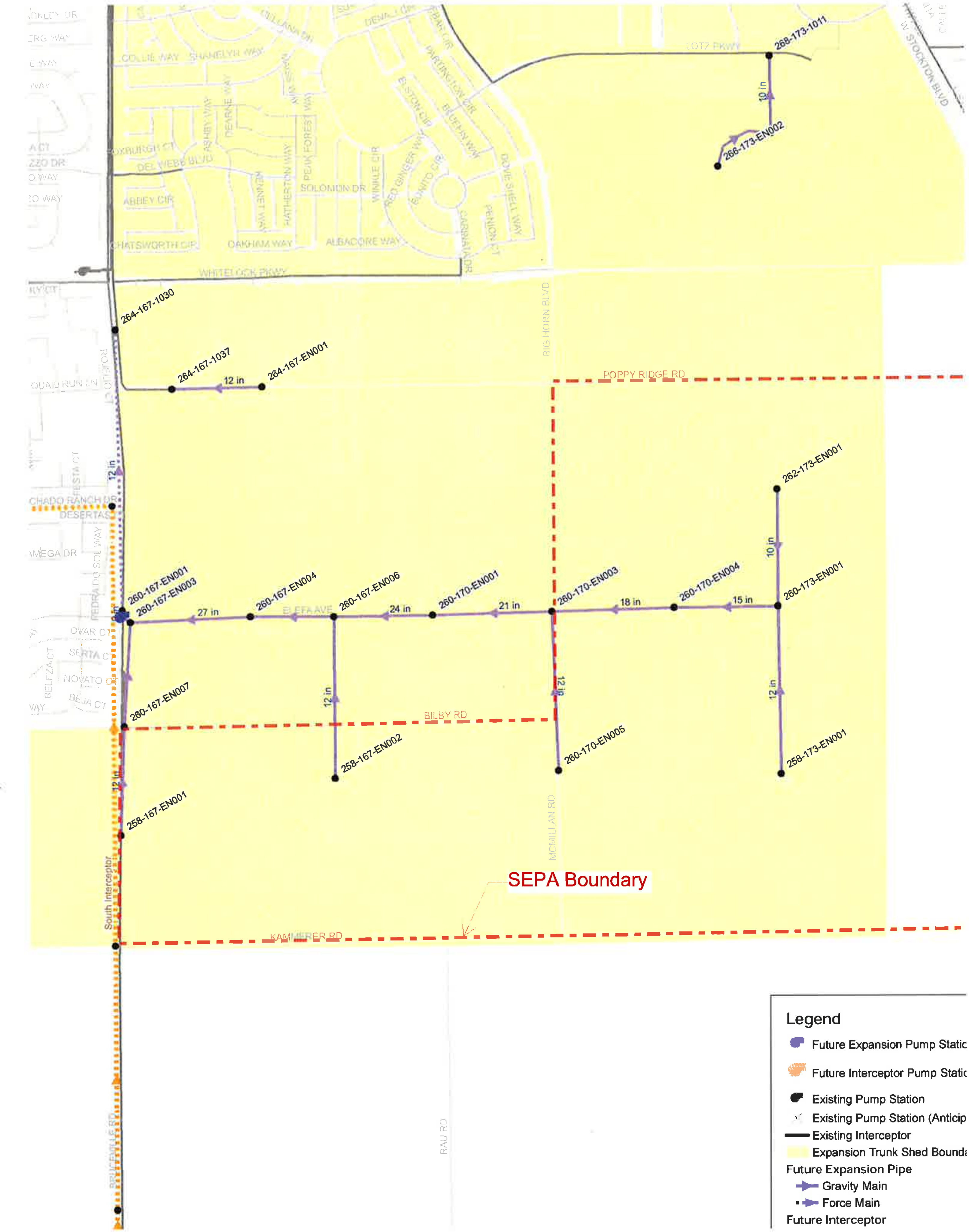
The undeveloped areas will generate 6.7 mgd resulting in a need for additional 0.2 mgd in conveyance capacity. This will require an additional 4-inch force main to be installed in Bruceville Rd from the proposed LRSP south sewer lift station to the Laguna Interceptor sewer to accommodate the plan area build out.



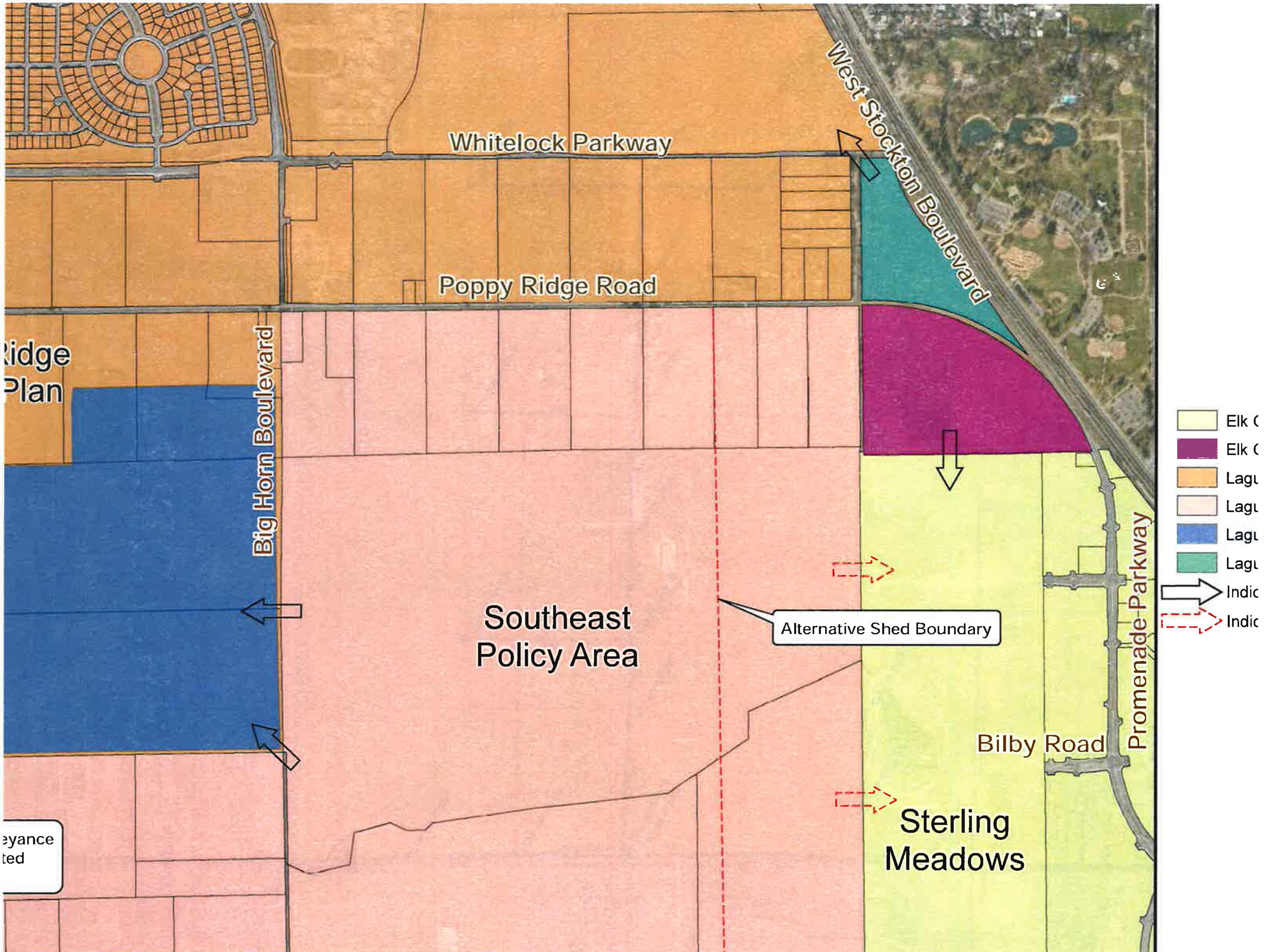
MDR
18.1 ac
SE42
A= 46.2 Ac.
ΣA= 336.5 Ac.
ESD= 277.5 ESD's
ΣESD= 2966.0 ESD's
PWWF= 2.041 mgd
INV = 9.28 8" IN (S)
INV = 8.69 15" IN (E)
INV = 8.44 18" OUT (W)
D = 27.1
652 feet
of 15"
S= 0.0015
INV = 11.97 10" IN (E
INV = 11.97 10" IN (N
INV = 11.55 15" OUT (E
652 feet
of 15"
S= 0.0015
1401 feet
of 18"
S= 0.0012
SE43
A= 19.9 Ac.
ΣA= 218.0 Ac.
ESD= 258.6 ESD's
ΣESD= 1949.8 ESD's
PWWF= 1.36 mgd
SE43
INV = 10.17 15" IN (E)
INV = 10.07 15" OUT (
D = 28.8
651 feet
of 18"
S= 0.0012
LDR
7.1 ac
741 feet
of 8"
S= 0.0035
P/OS
8.9 ac
ES
9 ac
SE40
INV = 5.96 18" IN (E)
INV = 5.86 18" OUT (W)
D = 29.7
SE40
A= 55.3 Ac.
ΣA= 391.9 Ac.
ESD= 404.1 ESD's
ΣESD= 3370.1 ESD's
PWWF= 2.32 mgd
LDR
20.9 ac
SE44
A= 13.1 Ac.
ΣA= 29.5 Ac.
ESD= 208.5 ESD's
ΣESD= 307.2 ESD's
PWWF= 0.222 mgd
SE44
INV = 12.37 8" IN (S)
INV = 12.27 8" OUT (N)
D = 24.3
INV = 15.26 8" IN
INV = 15.16 8" OUT
P/OS
2 ac
MDR
4.9 ac
HDR
4.1 ac
HDR
4.2 ac
HDR
3.8 ac
604 feet
of 8"
S= 0.0035
MUR
3.6 ac
MUR
3.4 ac
MUR
2.9 ac
SE48
A= 11.9 Ac.
ΣA= 27.3 Ac.
ESD= 71.5 ESD's
ΣESD= 163.8 ESD's
PWWF= 0.137 mgd
MDR
11.4 ac
SE45
INV = 14.88 8" OUT (N)
D = 20.0
SE48
INV = 17.91 8" IN (SE)
INV = 17.81 8" OUT (N)
D = 18.3
LR56
INV = 6.93 10" IN (S)
INV = 6.51 15" IN (E)
D = 31.0
HDR
5.4 ac
1364 feet
of 15"
S= 0.0015
MUR
4.1 ac
SE45
A= 16.5 Ac.
ΣA= 16.5 Ac.
ESD= 98.8 ESD's
ΣESD= 98.8 ESD's
PWWF= 0.084 mgd
SE30
INV = 9.51 12" IN (SE)
INV = 9.26 15" OUT (SW)
D = 22.4
MUV
7.9 ac
OFF
8.4 ac
SE30
A= 31.7 Ac.
ΣA= 213.2 Ac.
MUV



ELK GROVE BLVD
ELK GROVE-FLORIN RD
WATERMAN RD
E STOCKTON BLVD
W STOCKTON BLVD
HWY 99 SB
HWY 99 NB
KAMMERER RD
ESCHINGER RD
BILBY RD
PROMENADE PKWY
IRON ROCK WAY
ELKMONT WAY
INDUSTRIAL RD
UNION PARK WAY
SURVEY RD
MOSHER RD
UNNAMED R
TITAN RD
10 in
24 in
264-176-EN001
262-185-EN001
260-185-EN002
258-182-1013
S142
SEPA Boundary
Legend
Future Expansion Pump Station
Future Expansion Pump Station (Anticipated to b
Existing Pump Station
Existing Interceptor
Expansion Trunk Shed Boundary
Future Expansion Pipe
Gravity Main
Force Main
Future Expansion Pipe (Anticipated to be abandone



LOTZ PKWY
268-173-1011
10 in
266-173-EN002
W. STOCKTON BLVD
COLLIE WAY
SHANELYN WAY
DENALI CIR
OXBURGH CT
DEL WEBB BLVD
ABBEY CIR
CHATSWORTH CIR
OAKHAM WAY
ALBACORE WAY
SOLOMON DR
WHITELOCK PKWY
BIG HORN BLVD
264-167-1030
264-167-1037
12 in
264-167-EN001
POPPY RIDGE RD
12 in
262-173-EN001
10 in
260-167-EN001
260-167-EN003
27 in
260-167-EN004
260-167-EN006
24 in
260-170-EN001
21 in
260-170-EN003
18 in
260-170-EN004
15 in
260-173-EN001
260-167-EN007
12 in
12 in
12 in
BILBY RD
258-167-EN002
260-170-EN005
258-173-EN001
12 in
258-167-EN001
MCMILLAN RD
South Interceptor
SEPA Boundary
KAMMERER RD
BRUCEVILLE RD
RAU RD
Legend
Future Expansion Pump Static
Future Interceptor Pump Static
Existing Pump Station
Existing Pump Station (Anticip
Existing Interceptor
Expansion Trunk Shed Bounda
Future Expansion Pipe
Gravity Main
Force Main
Future Interceptor



West Stockton Boulevard
Whitelock Parkway
Poppy Ridge Road
Big Horn Boulevard
Ridge
Plan
Southeast
Policy Area
Alternative Shed Boundary
Promenade Parkway
Bilby Road
Sterling
Meadows
eyance
ted
Elk
Elk
Lagu
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Lagu
Lagu
Indic
Indic

4.0 Sewer Alignments and Facilities

Interim Facilities

There are currently no interim facilities proposed with this project. As individual developments move forward with proposals, interim facilities maybe considered and should be evaluated at time of level three sewer study development.

Ultimate Facilities

This level two study schematically shows the proposed trunk and backbone sewer alignments. Ultimately, further refinement of the land use plan, determination of roadway alignments, and additional level three studies will further define position and depth of sewer conveyance facilities.

Offsite Conveyance Alternatives

Currently there are five force mains located in Bruceville Road that convey flows from south to north. As previously discussed, SASD has indicated, based on their internal modeling, that there is 6.5 mgd of capacity within the existing force mains. Two conveyance alternatives have been identified to convey the balance of sewer flows and are briefly discussed below:

- Construct the south lift station to convey 6.7 mgd, as discussed in this study, and convey flows via existing and proposed force mains to the north. These force main would terminate at the Laguna Interceptor where the flows are conveyed to the regional treatment plant.
- Construct the south lift station to convey 6.5 mgd of flows and fully utilize capacity within the Bruceville Road force mains. The balance of flows within SEPA to be conveyed via the Elk Grove Promenade Lift Station with approval of a shed shift through SASD. SASD anticipates the pumps at the existing lift station could be upsized to provide additional capacity. This option would require further study and analysis.

As previously discussed SASD staff has determined that the Elk Grove Promenade lift station and force main are considered permanent SASD facilities and will convey sewer from a larger sewer shed than originally planned. This additional shed area includes office land use identified in SEPA.[7] Development of this area will require a level 3 sewer study. The level 3 study will include the required analysis of the existing EGP lift station and force main and design of conveyance facilities in Lotz Parkway to serve the land use tributary to the EGP lift station.

Dedicated SEPA Lift Station

While this study anticipates connection to the LRSP south lift station, currently in design, as an alternative, the SEPA flows could be directed to a SEPA lift station, located near the future intersection of Bilby Road and Big Horn Boulevard. Flows from this lift station would then run through a force main along Bilby Road west of Bruceville Road. This alternative requires further analysis and support from SASD prior to design, as it would result in additional SASD infrastructure. The intent of this alternative is to allow development of SEPA independent of outside constraints, should the LRSP south lift station not move forward consistent with the development goals of the City.

[7] This shed area does not include areas that would be conveyed via the EGP lift station in order to reduce flows from the south lift station to within existing capacity of the Bruceville Road force mains.

5.0 Conclusion

This study has been prepared in accordance with SASD design guidelines to identify backbone conveyance facilities to serve the Elk Grove Southeast Policy Area. The study has been prepared as a level two study. **Appendix B: Level II Sewer Study** identifies the required backbone infrastructure through the plan area.

Interim facilities are not proposed with this study. Subsequent level three sewer studies may identify interim facilities as necessary for the conveyance of flow from specific developments.

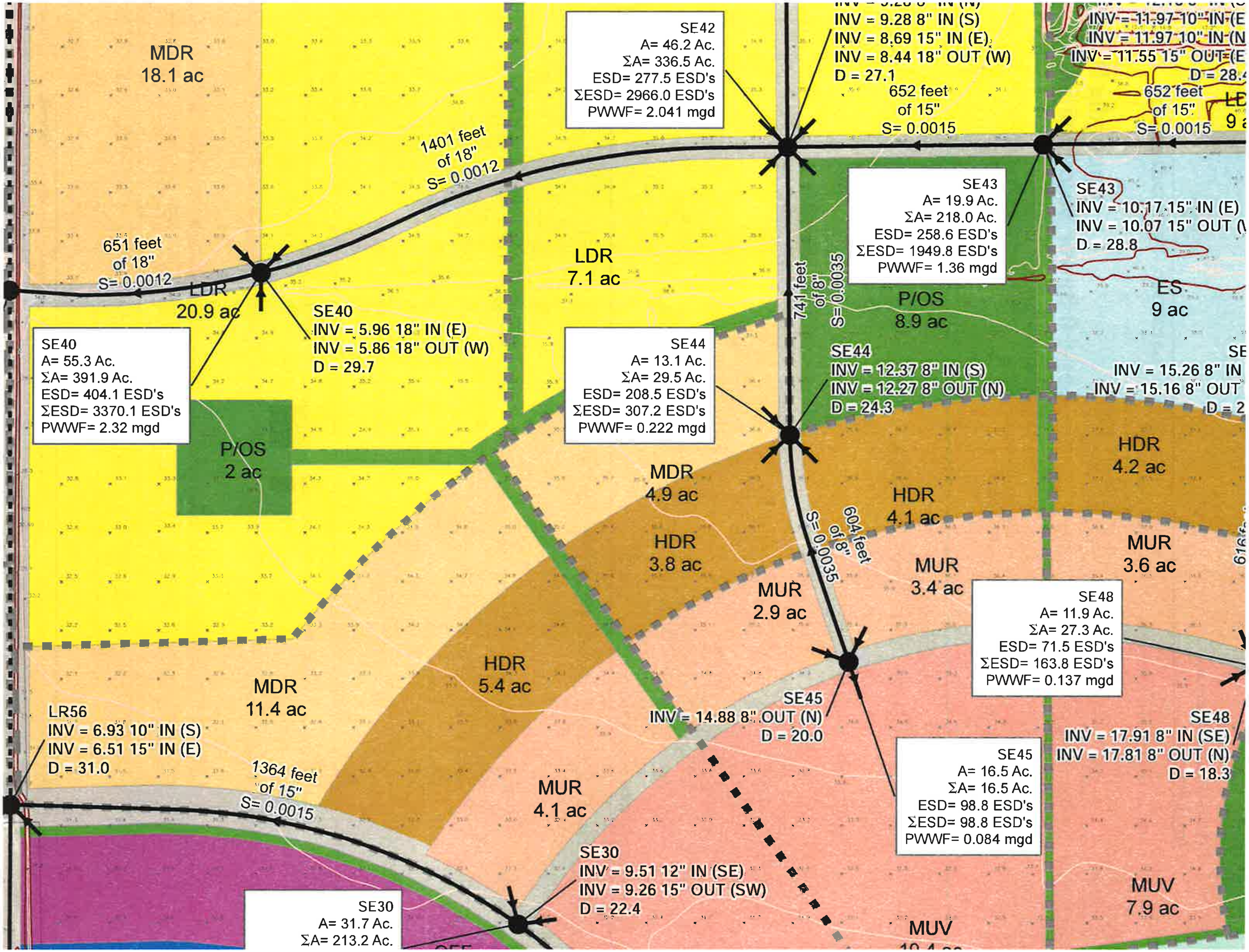
The total acreage of the project is 1,195 acres and conveys 7,904 ESD's. This equates to a total of 2.5 mgd and 5.4 mgd during average dry weather flow and peak wet weather flow, respectively.

Appendix A
Demand & Hydraulic Calculation Table

	Medium Density Residential		High Density Residential		Office		Commerical		Light Industrial / Flex Space		Mixed Use		Elementary School		Public / Open Space / Rec		Greenway		Basin		Total Shed		Culmulative Sheds		Average Flows, Q Q_{AVG}	Peaking Factor	Infiltration $Q_{I/I}$
	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(acres)	(ESD)	(mgd)		(mgd)
0		0.0		0.0	22.2	133.1		0.0		0.0		0.0		0.0		0.0		0.0		0.0	22.2	133.1	**22.2**	**133.1**	0.041	1.965	0.031
6	3.3	33.1	11.3	225.8	10.1	60.4		0.0		0.0		0.0		0.0		0.0		0.0	4.6	27.5	38.2	400.5	**38.2**	**400.5**	0.124	1.878	0.053
0		0.0		0.0	31.5	188.7		0.0		0.0		0.0		0.0		0.0	4.0	24.2	9.4	56.2	44.8	269.0	**339.7**	**2159.2**	0.669	1.736	0.476
0		0.0		0.0	42.0	251.8		0.0		0.0		0.0		0.0		0.0	2.0	11.9	5.0	30.2	49.0	293.9	**81.7**	**490.4**	0.152	1.862	0.114
0		0.0		0.0		0.0	14.2	85.1	17.7	105.9		0.0		0.0		0.0	0.9	5.5		0.0	32.7	196.5	**32.7**	**196.5**	0.061	1.935	0.046
0	11.4	114.0	5.4	107.6		0.0		0.0		0.0	13.9	83.2		0.0		0.0	1.1	6.5		0.0	31.7	311.2	**213.2**	**1399.9**	0.434	1.774	0.298
0		0.0		0.0	46.5	278.8		0.0		0.0		0.0		0.0		0.0	0.5	2.7		0.0	46.9	281.5	**181.4**	**1088.6**	0.337	1.795	0.254
0		0.0		0.0	5.2	31.2		0.0		0.0		0.0		0.0		0.0	0.2	1.2		0.0	5.4	32.4	**134.5**	**807.1**	0.250	1.820	0.188
0		0.0		0.0	37.1	222.6		0.0		0.0		0.0		0.0		0.0	0.7	4.3	6.4	38.6	44.3	265.5	**129.1**	**774.7**	0.240	1.824	0.181
0		0.0		0.0		0.0		0.0	30.8	185.0		0.0		0.0		0.0		0.0		0.0	30.8	185.0	**30.8**	**185.0**	0.057	1.940	0.043
0		0.0		0.0	37.1	222.6		0.0	16.2	97.0		0.0		0.0		0.0	0.8	4.6		0.0	54.0	324.2	**54.0**	**324.2**	0.101	1.895	0.076
0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	0.0	0.0	**391.9**	**3370.1**	1.045	1.696	0.549
4	18.1	180.5		0.0		0.0		0.0		0.0		0.0		0.0	2.0	12.0	0.5	3.2		0.0	55.3	404.1	**391.9**	**3370.1**	1.045	1.696	0.549
4		0.0		0.0		0.0		0.0		0.0		0.0		0.0	15.4	92.3	3.0	17.7		0.0	46.2	277.5	**336.5**	**2966.0**	0.919	1.708	0.471
1	10.7	106.8		0.0		0.0		0.0		0.0		0.0	10.2	193.5	1.8	11.0	2.3	14.1		0.0	42.7	431.5	**42.7**	**431.5**	0.134	1.872	0.060
1		0.0		0.0		0.0		0.0		0.0		0.0	9.0	193.5	1.8	11.0		0.0		0.0	19.9	258.6	**218.0**	**1949.8**	0.604	1.745	0.305
0	4.9	49.2	7.9	157.6		0.0		0.0		0.0		0.0		0.0		0.0	0.3	1.7		0.0	13.1	208.5	**29.5**	**307.2**	0.095	1.900	0.041
0		0.0		0.0		0.0		0.0		0.0	16.0	96.0		0.0		0.0	0.5	2.8		0.0	16.5	98.8	**16.5**	**98.8**	0.031	1.988	0.023
1		0.0		0.0		0.0		0.0		0.0		0.0		0.0	6.6	39.8	1.3	7.6		0.0	41.6	249.4	**198.2**	**1691.2**	0.524	1.757	0.277
0	3.7	36.5	4.2	83.8		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	7.8	120.3	**35.1**	**284.1**	0.088	1.906	0.049
0		0.0		0.0		0.0		0.0		0.0	11.5	68.8		0.0		0.0	0.5	2.7		0.0	11.9	71.5	**27.3**	**163.8**	0.051	1.949	0.038
0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	5.9	35.6	1.2	7.3	8.2	49.4	15.4	92.3	**15.4**	**92.3**	0.029	1.993	0.022
0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	0.0	0.0	**59.4**	**595.4**	0.185	1.846	0.083
2	8.7	87.2		0.0		0.0		0.0		0.0		0.0		0.0	2.8	16.6	1.5	8.8		0.0	37.0	256.8	**59.4**	**595.4**	0.185	1.846	0.083
0	10.6	106.2	11.5	230.6		0.0		0.0		0.0		0.0		0.0		0.0	0.3	1.9		0.0	22.5	338.7	**22.5**	**338.7**	0.105	1.892	0.031
4		0.0		0.0		0.0		0.0		0.0		0.0		0.0	1.5	8.9	2.1	12.8		0.0	29.4	176.1	**62.0**	**562.2**	0.174	1.851	0.087
0		0.0	10.1	202.4		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	10.1	202.4	**32.7**	**386.1**	0.120	1.881	0.046
0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	4.9	29.3	4.9	29.3	**22.5**	**183.7**	0.057	1.940	0.032
0	12.1	120.9		0.0		0.0		0.0		0.0		0.0		0.0	1.0	6.1	0.2	1.0		0.0	13.3	128.0	**17.7**	**154.4**	0.048	1.954	0.025
4		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	4.4	26.4	**4.4**	**26.4**	0.008	2.084	0.006
2		0.0		0.0		0.0		0.0		0.0		0.0	8.5	193.5	17.9	107.6	3.7	22.5	2.9	17.3	65.7	537.2	**65.7**	**537.2**	0.167	1.854	0.092
0		0.0	10.3	206.2		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	22.0	276.4	**137.2**	**1014.4**	0.314	1.801	0.192
0	11.7	117.3		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	18.7	159.3	**18.7**	**159.3**	0.049	1.951	0.026
0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	1.6	9.4	3.6	21.3	42.1	252.7	**96.5**	**578.7**	0.179	1.848	0.135
0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	0.0	0.0	**54.3**	**326.0**	0.101	1.895	0.076
0		0.0		0.0		0.0		0.0	43.6	261.4		0.0		0.0		0.0	6.4	38.2	4.4	26.5	54.3	326.0	**54.3**	**326.0**	0.101	1.895	0.076
																				0.0	0.0	0.0	**48.3**	**289.8**	0.090	1.904	0.068
																				0.0	0.0	0.0	**48.3**	**289.8**	0.090	1.904	0.068
0		0.0			48.3	289.8		0.0		0.0		0.0		0.0		0.0		0.0		0.0	48.3	289.8	**48.3**	**289.8**	0.090	1.904	0.068
	95.2		**60.7**		**279.8**		**14.2**		**108.2**		**41.3**		**27.7**		**56.8**		**35.4**		**49.4**		**1043.2**						
2		**952**		**1214**		**1679**		**85**		**649**		**248**		**581**		**341**		**212**		**296**		**7904.4**	**1043.2**	**7904.4**	**2.450**	**1.618**	**1.460**

ıvided by the City of Elk Grove 9/10/2013.
ıstream of subject node.
type of school not ESD's/acre. Assumed to be Middle Schools.

Appendix B
Level II Sewer Study Exhibit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ΣA= 336.5 Ac.
ESD= 277.5 ESD's
ΣESD= 2966.0 ESD's
PWWF= 2.041 mgd
INV = 9.28 8" IN (S)
INV = 8.69 15" IN (E)
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652 feet
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INV = 12.37 8" IN (S)
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2 ac
HDR
4.2 ac
MDR
4.9 ac
HDR
4.1 ac
HDR
3.8 ac
604 feet
of 8"
S= 0.0035
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3.4 ac
MUR
3.6 ac
MUR
2.9 ac
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1364 feet
of 15"
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INV = 9.26 15" OUT (SW)
D = 22.4
MUV
7.9 ac
SE30
A= 31.7 Ac.
ΣA= 213.2 Ac.
MUV

Appendix C
Electronic GIS Files

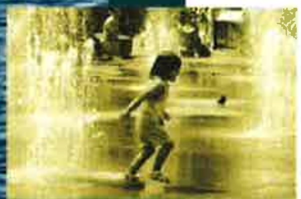

EXHIBIT C

Southeast Policy Area Drainage Study

Prepared for

City of Elk Grove

January 2014

WEST YOST ASSOCIATES

Consulting Engineers

448-00-12-03

WEST YOST ASSOCIATES

consulting engineers

Southeast Policy Area Drainage Study

Prepared for

City of Elk Grove

January 2014

WEST YOST ASSOCIATES
Consulting Engineers

REGISTERED PROFESSIONAL ENGINEER
MARK O. KUBIK
No. 50963
Exp. 9-30-15
CIVIL
STATE OF CALIFORNIA

448-00-12-03

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ELK GROVE

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1.0 INTRODUCTION

The Southeast Policy Area (SEPA) in the City of Elk Grove (City) covers approximately 1,200 acres at the southwest corner of the City and is the largest remaining new development area in the City (see Figure 1). The SEPA is also referred to as the Meridian Community Plan Area. Previous drainage planning for this area is described in Chapter 15 of the City of Elk Grove Storm Drainage Master Plan (SDMP) Volume II (June 2011), which was prepared by West Yost Associates (West Yost). The SDMP envisions that a multi-functional drainage corridor will be created to serve the SEPA at buildout. The corridor will provide multiple benefits including flood control, wildlife habitat, wetlands, recreation, and stormwater quality treatment.

The drainage concept plan in the SDMP defines an approximate configuration, alignment, and size for the future drainage channel that will serve the area, and defines approximate locations and sizes of required detention basins to mitigate for increased runoff due to development. The sizing of these facilities was based on runoff rates generated from assumed future land use data based on the available information at that time. Since then, a more comprehensive planning effort has been completed and a new land-use plan has been developed for the SEPA. Using the latest land-use planning information, West Yost has prepared this updated drainage study for the SEPA and this report provides a description of the updated analysis.

2.0 WATERSHED DESCRIPTION

The SEPA lies within Drainage Shed C, which covers nearly 7,900 acres in southern Sacramento County (see Figure 1). Of that total, approximately 2,100 acres lie within the City. The watershed generally slopes from east to west with an average slope of about 0.10 percent. The existing land use within the watershed is agricultural with the exception of the Elk Grove Promenade site, which covers 525 acres in the upstream (eastern) portion of the watershed. Although the Promenade project stalled before completion, many of the site improvements were constructed including roads, parking lots, buildings, and underground utilities including a storm drainage pipe system. The pipe system that collects runoff from the Promenade site delivers it to a detention basin that was constructed on the west side of the future Sterling Meadows project.

Downstream of the existing detention basin, runoff is conveyed through the SEPA in an agricultural drainage channel, which is referred to as the Shed C Channel in this report. The Shed C Channel begins near the western boundary of the future Sterling Meadows project and conveys runoff to the southwest for approximately 12,600 feet until it reaches Bruceville Road. At that point, the channel exits the City and continues west for approximately 22,000 feet where it crosses under Interstate 5 and enters the Stone Lakes National Wildlife Refuge.

3.0 DRAINAGE PLAN CONCEPT

As development occurs in Shed C, drainage system improvements will be required to provide flood protection and mitigation, stormwater quality treatment, and hydromodification mitigation. The preliminary drainage plan included in the SDMP for Shed C was developed with input from the Expert Advisory Committee (EAC) that was formed by the City to help guide the development of the SDMP. The drainage concept for Shed C was developed with consideration of the guiding principles that were developed by the EAC for the drainage SDMP:

1. Stormwater management systems shall be designed to take maximum advantage of the natural hydrological processes of the existing landscape.
2. Alternative stormwater management approaches shall be adopted, wherever and whenever feasible, to complement approaches to traditional stormwater management systems. Alternative approaches may include distributed systems (e.g. low impact development systems), flow duration control basins, and/or instream rehabilitation.
3. Design of stormwater management projects shall balance considerations related to environmental effects, capital and operating costs, property rights, economic development impacts, and recreational opportunities without compromising public safety and/or property protection.
4. Stormwater management systems shall be designed so that the volume, quality, and timing of downstream discharges will minimize impacts to downstream resources, such as the Stone Lakes National Wildlife Refuge.
5. The SDMP shall comply with applicable local, state, and federal laws and regulations.

With these guiding principles in mind, the drainage concept for Shed C includes a multi-functional drainage corridor that will create and enhance the natural stream and habitat values. The multi-functional corridor will include a low flow channel that is stable and self-sustaining and will be designed based on natural processes. The low flow channel will meander within a larger floodplain corridor that will provide flood storage and conveyance as well as an opportunity for the creation of wetlands habitat. Although not specifically defined in this plan, it is anticipated that the corridor will also include an access path that will provide recreational and educational opportunities for the City's residents.

Additional key components of the drainage concept are detention basins that will be included at major inflow points to the drainage corridor. These detention basins will provide flood storage and flow duration control to mitigate for potential flood flow increases and hydromodification effects due to the proposed urban development in the watershed. They will also provide stormwater quality treatment and will provide an opportunity for wetlands creation.

4.0 ANALYSIS APPROACH

As shown on Figure 1, the SEPA lies within the Shed C watershed. The drainage plan for the SEPA must reflect the needs of the entire Shed C watershed. Therefore, the drainage analysis for the SEPA included an analysis of the entire Shed C watershed with a focus on the area located within the City. The Shed C analysis consisted of two major components: 1) a continuous hydrologic analysis; and 2) an event based analysis as described below.

4.1 Continuous Hydrologic Analysis

An important consideration in the Shed C analysis is the potential hydromodification effects of development in the watershed. Hydromodification is the change in runoff characteristics within a watershed caused by land use changes. These altered runoff characteristics can result in increased erosion and sedimentation, degradation of stream habitat, increased flood flows, and other negative impacts. Research has shown that a large percentage of the sediment transport and erosion in a stream system occurs at flow rates less than generated by the 2-year storm (Geosyntec, 2007).

Because of this, traditional hydrologic analyses that focus on individual design storms (e.g. 2-year, 10-year, etc.) are not suitable for hydromodification analyses. To insure that the cumulative effects of all potentially erosive flows are considered, a continuous hydrologic model is required. For the SDMP, a continuous hydrologic simulation was performed using the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) software. The model was used to evaluate the long-term rainfall-runoff response for the Shed C watershed for two land-use conditions:

- Base Conditions – this represents existing land-use conditions within the watershed plus proposed projects that already have approved tentative maps. Projects with approved tentative maps will not be required to include hydromodification mitigation. Therefore, these projects were included in the base conditions modeling to provide a reasonable starting point that could be used to assess the potential impacts of development of the SEPA.
- Buildout Conditions – this represents full buildout of City land within Shed C. The results from buildout conditions were compared against those for base conditions to assess the performance of the drainage facilities proposed for hydromodification mitigation.

4.2 Event Based Analysis

A traditional event based analysis was also performed to assess the flood control performance of the proposed system. Single event hydrologic and hydraulic models were prepared for the 10-year and 100-year storms for both pre-development conditions and for mitigated buildout conditions. The results were used to confirm that the ultimate improvements will adequately mitigate for potential impacts to flood flows and to confirm the required size of the flood control channel.

5.0 CONTINUOUS SIMULATION MODEL – BASE CONDITIONS

A continuous simulation model was developed for base conditions using HEC-HMS. The model input data is described below.

5.1 Watershed Boundaries

For the hydrologic modeling, Shed C was divided into the subsheds shown on Figure 2. Watershed areas and other model parameters are listed in Table 1, which can be found at the end of the report text along with the other tables and figures. Note that for the continuous simulation modeling, not all of the subsheds shown on Figure 2 and listed in Table 1 were included in the model. Because of the long model run times and large output files, only the subsheds within, and immediately downstream (west), of the City limits at Bruceville Road were included in the continuous simulation model. This was reasonable because the proposed facilities for the SEPA will be designed to mitigate for potential drainage impacts at the City boundary at Bruceville Road.

5.2 Land Use

For base conditions, the majority of the watershed was assumed to be undeveloped agricultural land. However, there are some exceptions including the Elk Grove Promenade and Sterling Meadows properties at the upstream end of Shed C (Subsheds A1 and A2 on Figure 2). The Promenade project was previously approved by the City and the site improvements were largely completed prior to the project being stalled due to the recent economic recession. The project construction included a large detention basin to serve both the Promenade and Sterling Meadows sites. The Sterling Meadows project has an approved tentative map. Therefore, for the base condition model, full buildout was assumed for the Promenade and Sterling Meadows projects and the existing detention basin that serves these sites was also included.

The other exception is the Laguna Ridge Specific Plan (LRSP) area. Tentative maps and drainage studies have already been approved for the projects within that specific plan. The development of that area will include construction of a detention basin for stormwater quality treatment and flood control and will also include a constructed channel that will convey flows from the project area to the Shed C Channel. Because the proposed drainage approach has already been approved, buildout conditions were assumed for the LRSP area.

5.3 Unit Hydrographs

Unit hydrographs for the continuous simulation model were developed by creating SacCalc models based on the Sacramento City/County Drainage Manual, which has been adopted for use in Elk Grove. These unit hydrographs created with SacCalc were imported into HEC-HMS. The input parameters for the calculation of unit hydrographs in SacCalc are presented in Table 1.

5.4 Precipitation Data

For the continuous simulation analysis, 53 years of hourly precipitation for water years 1957 through 2009 was obtained from various gages in the area as summarized in Table 2. To better represent precipitation in Elk Grove, the rainfall data from the Sacramento Post Office gage was adjusted using a ratio of the average annual rainfall between the Post Office and Elk Grove rain gages. Based on this approach, a factor of 0.94 was applied to the Sacramento Post Office hourly rainfall values.

5.5 Soil Moisture Accounting Parameters

The rainfall loss method was used for this study was the Soil Moisture Accounting method, which was incorporated into HEC-HMS specifically for continuous simulations. This method allows for a continuous accounting of rainfall losses including evapotranspiration, surface storage, infiltration, and interflow. Ideally, the model parameters assigned to represent the various processes would be determined from a calibration analysis based on measured stream flow data. Unfortunately, stream flow records for the Shed C watershed are not available. Therefore, the model input from a calibrated HEC-HMS model for Laguna Creek was used to guide the input choices for this study. The Laguna Creek model was prepared by Geosyntec (Geosyntec, 2007) and the information developed for that study was applied to this one. The soils types within the Shed C watershed were determined using the latest soil survey data from the Natural Resources Conservation Service. Subsheds in the Laguna Creek model with the same soil types as those within Shed C were identified and the Soil Moisture Accounting parameters those subsheds were applied to the Shed C model. Table 3 presents the values used for this study.

6.0 CONTINUOUS SIMULATION MODEL – BUILDOUT CONDITIONS

For buildout conditions, the continuous simulation model parameters were updated to represent full buildout within the City limits. The specific buildout assumptions for the continuous simulation model are discussed below.

6.1 Watershed Boundaries

Subshed boundaries within the City for buildout conditions are shown on Figure 3. The SEPA was divided into nine subsheds (S1a through S8), each of which will drain directly into a detention basin. Watershed boundaries outside of the SEPA were unchanged from base conditions.

6.2 Land Use

For the buildout conditions model, the base conditions model was updated to include full buildout within the SEPA based on the land use plan shown on Figure 4. The other areas within the City were already assumed to be developed for base conditions. Subsheds outside of the City limits were assumed to be unchanged from existing conditions. Table 1 presents the land-use assumed for each subshed for both base and buildout conditions. The assumed imperviousness associated with each land-use type is listed in the table.

6.3 Unit Hydrographs

Unit hydrographs were calculated using a SacCalc model representing buildout conditions. The input parameters for the calculation of unit hydrographs in SacCalc for buildout conditions are presented in Table 1.

6.4 Detention Basins

Detention basins are proposed at inflow points to the drainage corridor. These nine detention basins will provide runoff storage volume that will mitigate for potential increases in peak flood flows and will provide flow duration control to mitigate for the potential hydromodification effects. The basins will also provide stormwater quality treatment and the opportunity to create wetlands to mitigate for potential impacts to existing wetland features in the watershed. The general locations of the detention basins are shown in Figure 4.

For stormwater quality treatment purposes, the detention basins were assumed to be configured as Constructed Wetland Basins per the Sacramento Stormwater Quality Manual (Sacramento Stormwater Quality Partnership, 2007). This configuration assumes that each basin will include a permanent pool of water and will include four zones: a forebay, an open water zone, a wetland zone with aquatic plants, and an outlet zone. An area above the permanent pool will be provided to detain the stormwater quality treatment volume and slowly release it after a storm. Additional storage volume is provided above what is required for stormwater quality treatment to mitigate hydromodification and flood control impacts. A typical detention basin layout is presented on Figure 5.

Wetland detention basins can be community amenities that provide multiple benefits including wildlife habitat, stormwater quality treatment, flood control, and flow duration control. Along with these benefits comes a higher level of maintenance to insure proper function and also the need to provide a supplemental water supply to maintain the permanent pool. It may not be necessary, or desirable, to configure each detention basin as a constructed wetland area. The wetland area required to mitigate for impacts will be determined after a more detailed biological study is performed that defines the existing habitat in the watershed and after discussions with the appropriate permitting agencies are held and the mitigation requirements are determined. At that time, a more informed decision can be made on the exact configuration of each of the proposed detention basins.

The storage volumes required for flood and hydromodification control were determined through a series of model runs using the continuous simulation hydrologic model. Combinations of detention basin volumes and outlet configurations were iteratively tested with the model until the desired results were achieved. The outlets were assumed to consist of a riser pipe with a round orifice at the bottom for low flows and a notch at the top of the riser for larger flows. During large storm events that exceed the design event (100-year) excess flow can spill over the top of the riser. An emergency outlet weir will also be provided in the embankment between the basin and the channel in case the riser becomes plugged. The configuration of the outlet is shown on Figure 5. Tables 4 through 12 provide summaries of the detention basin volumes and outlet sizes. More discussion of the results from the modeling and the effectiveness of the detention basins in providing mitigation is presented later in this report.

For this study, it is assumed that all runoff from developed areas will be directed into a detention basin. As refined drainage and grading studies are prepared with proposed projects in the watersheds, if it is found that runoff from some small, isolated areas cannot be feasibly directed to a detention basin, some direct discharge of runoff into the channel may be allowed. In such cases, separate stormwater quality treatment facilities will be necessary and a detailed study will be required that demonstrates the overall flood control and hydromodification goals for the watershed are still met.

6.5 Stable Channel Design

The existing Shed C Channel is essentially a man-made agricultural ditch that has been highly altered from its natural form. Its original alignment has been straightened and it has numerous 90 degree bends. The channel side slopes are uniform and steep and vegetation has been removed from many reaches. It is desired to create a more naturalized multi-functional channel corridor that will include a low flow channel designed to be stable based on the anticipated flow regime and natural processes. The low flow channel will meander within a larger floodplain corridor that will provide flood storage and conveyance, wetlands habitat, and passive recreation opportunities. The sizing of the channel involved the following steps:

- Develop an alignment for the channel.
- Determine the channel forming discharge and low flow geometry.
- Determine the channel meander dimensions.
- Check to insure that the geometry provides adequate flood conveyance capacity.

6.5.1 Channel Alignment

A channel alignment was developed in consultation with the City during development of the land plan by the City. The proposed channel alignment generally follows the existing channel alignment but provides a more natural, meandering path that eliminates the sharp bends. The channel ties into the fixed points at the upstream end near the existing detention basin and at the downstream end at Bruceville Road. The proposed alignment is shown on Figure 4.

6.5.2 Channel Forming Discharge

The channel forming discharge is the flow rate that is most effective in shaping a stream channel. The channel forming discharge was estimated using the effective work method, which provides a way to estimate the flow magnitude associated with the maximum potential erosion over a long period. First, a histogram was used to create a flow frequency distribution of hourly peak flows (in 10 cfs intervals) from the continuous simulation model results. The potential erosion was determined using the Andrew Simon's effective work equation for consolidated materials:

$$W = \sum_{i=1}^{n} k(\tau_i - \tau_c)^{1.5} \Delta t$$

Where:

W = the total work performed in dimensionless units

k = erodibility coefficient

τ_i = the applied hydraulic shear stress, lbs/sf

τ_c = the critical shear stress that initiates erosion, lbs/sf

The value k was ignored (or assumed to be 1.0) because it is the same for base conditions and buildout conditions and does not affect the results. The applied shear stress was based on the following equation:

$$\tau_i = \gamma DS$$

Where:

γ = the unit weight of water (62.4 lbs/sf)

D = the depth of flow, ft

S = the slope of the channel, ft/ft

The critical shear stress was determined based on Figure 3-1 from Guidance Manual for Design of Multi-Functional Drainage Corridors, County of Sacramento, 2003. That figure is provided as Figure 6. Based on that information, the critical shear stress was estimated to be 0.10 lbs/sf, which is an appropriate value for fairly compact to loose clay soil.

To perform the work calculations, it was necessary to make an initial estimate of the channel forming flow and channel geometry. The channel forming flow was first estimated by determining the flow-frequency relationship in the channel for mitigated buildout conditions. Channel forming discharges typically vary between a 1-year to 2-year event, with a 1.5-year event being a reasonable average (Leopold, 1964). Therefore, the 1.5-year event was used as a starting point to estimate the channel forming discharge.

Using the estimated channel forming discharge, the average width and depth of the low flow channel was determined using the Manning's Equation:

$$d = \left[\frac{Q \times n}{1.49(W / D)\sqrt{S}} \right]^{3/8}$$

Where:

d = the average depth of the low flow channel, ft

Q = the channel forming discharge, cfs

n = Manning's roughness coefficient

W/D = the width the depth ratio of the low flow channel

S = the slope of the channel, ft/ft

To use the equation it is necessary to estimate the width to depth ratio (W/D) for the channel. This ratio is dependent on the ability of the channel to resist erosion, which is a function of soil characteristics and vegetation. Measurements of width to depth ratios for existing creeks in the Sacramento area were performed by Zentner and Zentner and are published in the Guidance Manual for Design of Multi-Functional Drainage Corridors, County of Sacramento, 2003. Laguna Creek near Bradshaw Road, which has the same soil type as those along the Shed C Channel, had a measured W/D ratio between 12 and 14. Therefore, a W/D ratio of 12 was selected for the Shed C Channel.

Using the initial channel dimensions, the effective work method was applied and the channel forming discharge was calculated. If the calculated discharge was different than the original estimate, the new value was used to re-size the channel and the process continued iteratively until the flow value used to size the channel matched the channel forming flow calculated by the effective work method. The reasonableness of the channel forming flow was then checked against the flood frequency curve.

Using the process described above, the preliminary channel forming discharge and low flow channel geometry was determined for four reaches along the channel. The reaches are shown on Figure 4 and are described below.

- Reach 1 – From Lotz Parkway to the outfall from Detention Basin S1a.
- Reach 2 – From the outfall from Detention Basin S1a to extension of Big Horn Boulevard.

- Reach 3 – From the extension of Big Horn Boulevard. to the confluence with the channel from the LRSP area.
- Reach 4 – From the confluence with the LRSP channel to Bruceville Road.

Figures 7 through 10 present the results from the effective work method for the four reaches. As shown on Figure 7, in Reach 1 the large majority of peak flows over the 53 year period of record are 55 cfs or less. However, flows in that range are too small to produce shear stresses above the critical shear stress and therefore those flows do not perform work (i.e. cause erosion) on the channel. It appears the flow rate that produces the most work over the modeled period is approximately 85 cfs. Therefore 85 cfs is selected as the channel forming discharge for Reach 1. The results for Reaches 2, 3, and 4 are shown on Figures 8, 9, and 10, respectively. As shown on those figures, the channel forming discharge is approximately 125 cfs for Reach 2, 115 cfs for Reach 3, and 265 cfs for Reach 4. Figure 11 presents the flow frequency curves for the four reaches. As can be seen on that figure, the return periods of the channel forming flows for the four reaches vary between 0.9 and 2.2 years, which is very close to the 1 to 2 year range that is considered typical.

Using these flows along with Manning's equation and the assumed width to depth ratio as discussed above, the average dimensions of the low flow channel were calculated using a Manning's n of 0.04 and a slope of 0.0001 feet per foot for Reaches 1, 2, and 3 and 0.0006 feet per foot for Reach 4. Because the equation provides the average dimensions based on a rectangular channel, the resultant dimensions were converted to an equivalent trapezoidal shape based on a side slope of 3 to 1 (horizontal to vertical). Table 13 presents an initial estimate of the low flow channel dimensions for each reach.

6.5.3 Channel Meander Dimensions

After determining average low flow channel sizes, the meander dimensions can be estimated. The meander dimensions are based on equations developed from empirical observations. The meander dimensions were estimated using the equations presented in the Stream Corridor Restoration, Principles, Processes, and Practices, Federal Interagency Stream Restoration Group, USDA, 2001. These equations are as follows:

$$B = 3.7w^{1.12}$$

$$M_L = 4.4w^{1.12}$$

$$L = 6.5w^{1.12}$$

$$r_c = 1.3w^{1.12}$$

The variables in the above equations are shown in Figure 12. For this study, because detailed channel design was not performed, the main variable of interest was the meander amplitude (B) also called the belt width. This variable provides an estimate of the required minimum width of the floodway corridor (i.e. the bottom width of the flood control channel). The estimated meander dimensions for the low flow channel are presented in Table 13.

6.6 Effectiveness of Mitigation Measures for Hydromodification

The City, as a member of the Sacramento Stormwater Quality Partnership, has prepared a Hydromodification Management Plan (HMP) that establishes the criteria for assessing the effectiveness of hydromodification mitigation measures. Although, the plan has yet to be approved by State regulators, the plan contains the best available information at this time for compliance criteria. According to the HMP, satisfactory hydromodification mitigation is achieved by meeting specific flow duration control as follows:

- For flow rates ranging from either 25 percent or 45 percent of the pre-project 2-year recurrence interval event ($0.25Q_2$ to $0.45Q_2$) up to the pre-project 10-year runoff event (Q_{10}), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10 percent over more than 10 percent of the length of the flow duration curve.

The specific low flow threshold to be used is dependent on the erosion susceptibility of the subject waterway. No susceptibility testing has been performed for the Shed C Channel. According to results from the susceptibility tests that were conducted during preparation of the HMP, most tested waterways in Sacramento County are categorized with medium to very high susceptibility to vertical erosion and high to very high susceptibility to lateral erosion. Based on that, it is assumed for this study that the Shed C Channel would fall in the high susceptibility category and, therefore, the low end of the flow duration assessment of $0.25Q_2$ should be used.

The effectiveness of the proposed mitigation measures for hydromodification were assessed by comparing the flow durations results for base conditions and buildout conditions at the downstream boundary of the City (Bruceville Road). Figure 13 presents a comparison of the flow duration results. As indicated on the figure, the proposed drainage plan provides adequate flow duration control within the critical flow range between $0.25Q_2$ (61 cfs) and Q_{10} (425 cfs). The flow duration curve for buildout conditions is lower than the curve for base conditions for all but the low end of the relevant flow range. Because the increases at the low end of the flow range occur for less than 10 percent of the length of the flow duration curve, the mitigation measures are considered acceptable.

As an additional check on the effectiveness of the hydromodification mitigation, a comparison was made of the cumulative effective work performed in the channel at Bruceville Road. The cumulative effective work was based on Simon's effective work equation presented earlier in this study. For the comparison, the change in erosion potential due to buildout was measured as the ratio of the cumulative effective work for buildout conditions versus base conditions as follows:

$E_p = W_{post}/W_{base}$, where:

E_p = the erosion potential

W_{post} = the cumulative work performed for post project conditions (buildout conditions)

W_{base} = the cumulative work performed for base conditions

As shown on Figure 14, it is estimated that the proposed facilities would decrease the erosion potential at the downstream boundary by approximately 13 percent. This verifies that the proposed facilities provide reasonable mitigation of potential hydromodification effects.

7.0 EVENT BASED ANALYSIS

A traditional event based analysis was performed to assess the flood control performance of the proposed facilities. For flood control purposes, the proposed drainage facilities must accomplish two key objectives:

- Mitigate for potential increases in flood flows downstream from the City (Bruceville Road)
- Safely convey flood flows through the project area

For the event based analysis, hydrologic models were prepared to estimate flood flows into the Shed C Channel (or detention basins) for the 10-year and 100-year storm events. Hydraulic models were used to route the flood flows through the Shed C Channel and to calculate water surface elevations along the channel. These analyses were performed for both pre-development conditions and buildout conditions within the City limits.

7.1 Event Based Analysis – Pre-Development Conditions

7.1.1 Hydrologic Analysis – Pre-Development

Hydrologic models were prepared with SacCalc to determine the 10-year and 100-year flows entering the Shed C Channel for pre-development conditions. These models very similar to the SacCalc models that were used as the starting point for development of base conditions continuous simulation model. The main difference is that the Promenade, Sterling Meadows, and LRSP areas were modeled as undeveloped. Shed C was divided into the 29 subsheds as shown on Figure 2. Table 1 presents the key hydrologic parameters for each subshed for existing conditions. Note that the SacCalc models were used only to calculate the flows from each subshed before they enter collector channels or the Shed C Channel. The flows were then combined and routed through the channel system using a hydraulic model as discussed below.

7.1.2 Hydraulic Analysis – Pre-Development

A hydraulic analysis was performed using HEC-RAS to determine the flows and water surface elevations within the Shed C Channel for the 10-year and 100-year storm events. Descriptions of the various features of the HEC-RAS model are provided below.

7.1.2.1 Channel Geometry and Manning's Roughness Coefficients

The hydraulic model of the Shed C Channel begins just downstream of the existing Promenade detention basin at the west boundary of Subshed A2 (near Lotz Parkway). The model extends downstream to the west side of Interstate 5. The channel geometry was defined using approximately 150 cross sections. The cross section locations within the City limits are shown on Figure 15. For pre-development conditions, the cross sections from the upstream end of the model to approximately 1,000 feet downstream of the future extension of

Big Horn Boulevard (currently McMillan Road at the Shed C Channel crossing) are based on a field survey performed by West Yost in 2009. The remaining cross sections are based on a combination of field survey data collected by Murray Smith & Associates (Murray Smith) in the late 1990's and LIDAR generated topographic mapping. All elevations in this report are based on the National Geodetic Vertical Datum of 1929. The original Murray Smith survey data was unavailable for review, but it is considered adequate for estimating pre-development flood flows and water surface elevations. Manning's roughness coefficients range from 0.04 to 0.06 within the main channel and 0.04 to 0.05 in the overbank areas.

7.1.2.2 Bridges and Culverts

There are nine existing bridge or culvert crossings included in the model. Within the City limits, there are six culvert crossings. Five of these culverts are small pipe culverts used for farm roads that cross the channel. The other set of culverts within the City is located at Bruceville Road, where two 48-inch concrete pipelines cross under the roadway. Downstream of the City there are bridge structures at the Union Pacific Railroad and Interstate 5. At Franklin Boulevard, there are four 15 feet x 4.5 feet concrete box culverts.

7.1.2.3 Downstream Boundary Condition

For the 10-year and 100-year water surface calculations, the water surface elevations at the downstream end of the hydraulic model (near Interstate 5) were set at constant elevations of 7.3 feet and 8.6 feet, respectively. These are the estimated water surface elevations in the Beach Stone Lakes area at the time of peak flows in the local Shed C Channel as determined from hydraulic modeling prepared by for Sacramento County for the Beach Stone Lakes area. Although the values are lower than the peak water surface elevations in the Beach Stone Lakes area, they are considered reasonable for this study because the peak flows from Shed C are expected to occur well before the peak stage occurs in the Beach Stone Lakes area west of Interstate 5. Peak stages in the Beach Stone Lakes area are controlled by flows from the Cosumnes River and Mokelumne River watersheds that back up into the Beach Stone Lakes area. Due to the large size of the Cosumnes and Mokelumne River watersheds, the peak flows from these rivers occur well after the peak flows from Shed C. As a sensitivity test, the downstream stage for the 100-year storm event was increased from 8.6 feet to 12.0 feet. Even with the large increase in the starting downstream water surface elevation, the water surface elevations from the original model and the test model merge at Franklin Boulevard, which is well downstream of the study area. Therefore, the results of this study are not sensitive to variations in the starting water surface elevation at the downstream end of the hydraulic model.

7.2 Event Based Analysis – Buildout Conditions

7.2.1 Hydrologic Analysis – Buildout

For buildout conditions, it was assumed that the entire area within the City limits was developed. The buildout land-use conditions for the event based analysis are exactly the same as those used for the continuous simulation modeling. The subshed boundaries for areas within the City are shown on Figure 3. Subshed limits for areas outside of the City are the same as for pre-development conditions, as shown on Figure 2. Table 1 presents the key hydrologic parameters for each subshed for buildout conditions. The calculated flow hydrographs were input into

HEC-RAS to determine the resultant flows and water surface elevations in the Shed C Channel and detention basins for buildout conditions.

7.2.2 Hydraulic Analysis – Buildout

A hydraulic analysis was performed using HEC-RAS to evaluate the flood control performance of the proposed detention basin and channel improvements proposed for the SEPA and to determine the adequacy of the flood flow mitigation at the downstream limits of the City at Bruceville Road.

7.2.2.1 Channel Geometry and Manning's Roughness Coefficients

For buildout conditions, the cross sections within the City limits were configured to represent the proposed buildout channel geometry. Cross section locations within the City limits for buildout conditions are shown on Figure 16. The general channel configuration is the same for all channel reaches within the City. A typical cross section is shown on Figure 17. The average side slopes of the low flow and flood control channel were set at 3:1 and 4:1, respectively. These are average values and the expectation is that the side slopes will be varied to provide a more natural appearance.

The specific channel dimensions adopted for each reach of the Shed C Channel are listed in Table 14. The limits of each reach can be seen on Figure 16. The low flow channel dimensions are primarily based on the results from the continuous simulation analysis as summarized in Table 13. Some adjustments to the low flow channel dimensions were made in Reaches 2 and 4. For Reach 2, the channel forming flow was estimated to be 125 cfs. Just downstream in Reach 3, the channel forming flow was estimated to be 115 cfs, which is counter-intuitive given that the watershed draining to Reach 3 is larger than that for Reach 2. This result demonstrates the approximate nature of the method for estimating the channel forming flow rate. For consistency, the same low flow channel dimensions were adopted for Reaches 2 and 3 based on a channel forming flow rate of 115 cfs. For Reach 4, the depth of the low flow channel was reduced to allow the flood control bench to be lowered to provide more flood conveyance capacity for this reach.

The channel floodway widths were initially set equal to the belt width (meander amplitude) values in Table 13. An initial model run was made and the floodway bottom width was adjusted where needed based on the flood control requirements. In the lower reaches of the channel (Reaches 3b and 4), which will be relatively shallow, it was necessary to increase the floodway width to 207 feet, which is larger that calculated the belt width value, to provide adequate flood conveyance. Even with the extra width, it is anticipated that fill will be required along the channel banks between cross section 6625 and Bruceville Road to provide adequate freeboard (1 foot minimum) for the 100-year event. The channel is relatively shallow along this reach compared to the upper reaches of the channel due to the need to tie into the existing channel downstream of Bruceville Road. To provide as much depth as possible in this reach, it is proposed that some excavation be performed to deepen the existing channel downstream of Bruceville Road. The excavation will be limited to construction of a small pilot channel to eliminate existing high points in the existing channel. This will allow the proposed SEPA channel to be constructed deeper. The off-site excavation is only intended to provide some extra depth in the on-site channel and is not intended to provide a significant increase in capacity downstream of Bruceville Road. It is estimated that the pilot channel will extend approximately

3,200 feet downstream of Bruceville Road and the average depth of excavation will be approximately 1.8 feet. The limits of the offsite channel deepening are shown on Figure 18.

In the upper reaches, the channel will be deeper and the initial model results showed a significant amount of freeboard during the 100-year storm. Based on that, it was determined that the floodway width in the upper reaches could be reduced from the belt width that was determined from the natural channel design described previously. The belt width value represents the theoretical width of the corridor that the low flow channel can be expected to meander within (see Figure 12). There is a desire to not design a channel that is conservatively large from the flood control and short-term economic perspective. However, there is also a desire not to excessively constrain the channel, which could produce long-term maintenance problems.

To find an appropriate balance between the two competing perspectives, the natural channel design elements were re-evaluated. The belt width value is based on theoretical equations related to the channel forming flow. A larger channel forming flow produces a larger predicted belt width. The channel forming flow typically ranges between the 1-year and 2-year flow event. For the upper reaches of the channel between the Promenade detention basin and Big Horn Boulevard, the channel forming flow for this study ranged between a 1.7-year to 2-year event, which are at the high end of the typical range. Therefore, a smaller predicted belt width for the 1-year storm was used to establish a minimum channel floodway width. This reduced the floodway width of the channel between 11 feet and 17 feet. These reduced widths still provided adequate flood capacity and, therefore, were adopted for this study.

For buildout conditions, the roughness coefficients for the proposed Shed C Channel were set at 0.04 within the low flow channel and 0.08 within the overbank areas. The relatively large value used in the overbank area for buildout conditions is intended to allow for the establishment of significant riparian vegetation which would help reduce maintenance requirements.

A channel will be constructed through the SEPA to convey runoff from a portion of the LRSP area to the Shed C Channel. The general configuration of the channel was established during planning for the LRSP and carried forward to this study. The dimensions of the channel are presented on Table 14. The channel alignment, which is shown on Figure 16, has been modified from that originally conceived during the planning for the LRSP due to land use planning requirements for the SEPA.

7.2.2.2 Bridges and Culverts

There are five road crossings proposed within the SEPA. Box culverts were sized for each of the crossings using the HEC-RAS model. The sizes of the proposed box culverts are shown on Figure 16. During the design of the road crossings, alternative bridge designs may be proposed as long as they do not produce significantly larger head losses than the culverts proposed with this study.

7.2.2.3 Detention Basins

The proposed detention basins that are to be located adjacent to the Shed C Channel were included in the HEC-RAS model. The elevation-storage volume information and outlet configurations assumed for the modeling are presented in Tables 4 through 12. These tables provide the assumed dimensions of each detention basin. The general shape of the detention basins was generally based on the shape of the basins included on the SEPA land use plan. When the basins are designed, they will likely differ from the shapes assumed for this study and this is acceptable as long as the elevation-storage volume relationship is reasonably close. Significant deviations may need to be tested with modeling.

Two detention basins, DETS1a and DET2, are not located adjacent to the channel and backwater from the channel is not expected to affect the outflow characteristics from them. Therefore, these detention basins were not included in the HEC-RAS model. Outflow from these detention basins was calculated with the SacCalc hydrologic model and the resulting hydrographs were input directly into the channel in the HEC-RAS model.

7.3 Results from the Hydrologic and Hydraulic Analyses

7.3.1 Results for Pre-development Conditions

The HEC-RAS model was used to route the inflows from the tributary subsheds through the Shed C Channel and to calculate water surface elevations in the channel using an unsteady-state analysis. For pre-development conditions, the channel and culvert capacities are insufficient to pass the 10-year flows or the 100-year flows and significant overbank flooding is predicted as shown on Figure 15. Figure 19 presents the calculated water surface profiles for pre-development conditions within the City limits. Figure 15 shows the approximate pre-development floodplain limits for the 100-year event. It appears that structure flooding may occur during a 100-year storm near cross sections 5685, 7040, and 9730. The pre-development modeling and floodplain mapping was previously prepared for the City's SDMP and was not revised during this study. The floodplain mapping is considered approximate. Detailed output tables from the HEC-RAS model for pre-development conditions are provided in Attachment A.

7.3.2 Results for Buildout Conditions

For buildout conditions, the proposed detention basins and channel improvements will provide adequate storage and conveyance to protect the SEPA form flooding and mitigate for potential flood flow increases downstream. Figure 20 presents the calculated water surface profiles in the Shed C Channel for buildout conditions within the City limits. Figure 21 presents the same information for the channel from the LRSP area. Detailed output tables from the HEC-RAS model for buildout conditions are provided in Attachment B. Table 15 lists the calculated peak flood flows at the downstream end of the City (Bruceville Road). As shown in the table, the peak flood flows for the 10-year and 100-year storms are predicted to be reduced slightly at that location.

8.0 SUMMARY OF RECOMMENDED FACILITIES

It is recommended that a multi-functional drainage system be constructed in the SEPA to accommodate future development in the watershed and to create and enhance the natural stream and habitat values. The multi-functional corridor should include a low flow channel that is stable and self-sustaining, and meanders within a larger floodway corridor that will provide flood conveyance as well as wetlands habitat. At key points along the corridor, detention basins should be constructed as defined by this study to provide storage volume to mitigate for potential flood flow and hydromodification impacts. The channel and detention basins will also provide the opportunity to establish riparian habitat. Specific drainage facilities that are proposed with the plan are summarized below.

8.1 Channel Improvements

8.1.1 On-Site Channel and Culvert Improvements

A new channel will be constructed between Lotz Parkway and Bruceville Road. The approximate alignment of the channel is shown on Figure 16. The channel includes five reaches, which are also shown on Figure 16. Within each reach, the channel cross section will have the same general configuration, but with different dimensions. The specific dimensions of each channel reach are presented in Table 14.

Based on discussions with engineers representing future development projects, there is a desire to use the channel corridor to create water features that would be an amenity to the surrounding area. These features may include creation of permanent water features within the stream corridor or within widened areas along the corridor. The permanent pools would be created by either excavating a deeper area within the channel corridor or by constructing a berm to back up flow. These types of features are acceptable and even desirable in that they provide variation along the corridor and utilize the stream corridor as a public amenity, which is a goal of this drainage plan. Specific proposals will be reviewed on a case by case basis to insure that they do not compromise flood protection or the natural channel features within the corridor.

Box culverts are proposed at the five road crossings within the SEPA. The specific sizes of the culverts are shown on Figure 16. Different culvert or bridge configurations are acceptable as long as the capacities are similar to those proposed by the study.

8.1.2 Off-site Channel Improvements

The downstream end of the proposed channel, especially Reach 4 (see Figure 16), is relatively shallow. To provide as much depth as possible in this reach of the channel, it is proposed that some excavation be performed to deepen the existing channel downstream of Bruceville Road. The excavation will be limited to construction of a small pilot channel to eliminate existing high points in the existing channel. This will allow the proposed SEPA channel to be constructed deeper. The off-site excavation is only intended to provide some extra depth in the on-site channel and is not intended to provide a significant increase in capacity downstream of Bruceville Road. It is estimated that the pilot channel will extend approximately 3,200 feet downstream of Bruceville Road and the average depth of excavation will be approximately 1.8 feet.

8.2 Detention Basins

Runoff from the SEPA will be directed into one of nine detention basins proposed with the drainage plan. The general locations and approximate areas of the basins are shown on Figure 16. Tables 4 through 12 present the assumed dimensions, elevations, and storage volumes for the detention basin. When the basins are designed, they will likely differ from the shapes assumed for this study and this is acceptable as long as the elevation-storage volume relationship is reasonably close. Significant deviations may need to be tested with modeling. Figure 22 shows a typical outlet configuration for a basin.

Underground pipe systems will convey runoff from small to moderate storms to the detention basins. During large events that exceed the capacity of the pipe systems, excess flow will be conveyed overland through streets and open space. It will be important to ensure that the grading plans for the proposed projects in the SEPA are designed in such a way to direct all overland flow into the detention basins. During the design of individual projects, if it is found that runoff from some small, isolated areas cannot be feasibly directed to a detention basin, some direct discharge of runoff into the channel may be allowed. In such cases, separate stormwater quality treatment facilities will be necessary and a detailed study will be required that demonstrates the overall flood control and hydromodification goals for the watershed are still met.

9.0 REFERENCES

County of Sacramento, 2003. Guidance Manual for Design of Multi-Functional Drainage Corridors.

Geosyntec, 2007. A Technical Study of Hydrology, Geomorphology, and Water Quality in the Laguna Creek Watershed.

Leopold, 1964. Fluvial Processes in Geomorphology.

Sacramento Stormwater Quality Partnership, 2007. Stormwater Quality Design Manual for the Sacramento and South Placer Regions.

USDA, 2001. Stream Corridor Restoration, Principles, Processes, and Practices, Federal Interagency Stream Restoration Group.

Wood Rodgers, 2005. Drainage Document for Laguna Ridge Specific Plan, Supplemental Master Drainage Plan for Local Drainage Area Shed C.

ed	Area, acres	Mean Elevation, ft, NGVD29	Basin Length, ft	Basin Centroid Length, ft	Basin Slope, ft/ft	Ag. 2%	Park, Open Space, Rec 5%	Estate Res. 30%	LDR 40%	School, Res. 6-8 du/ac 50%	Res. 8-10 du/ac 60%	MDR 70%	Light Industrial/ Flex 75%	HDR 80%	Mixed Use 85%	Office, Comm. 90%	Wate Impe Pe
Pre-Development Conditions																	
	319.2	42	5,547	1,324	0.0008	319.2	0	0	0	0	0	0	0	0	0	0	2
	202.4	40	5,800	1,600	0.0008	202.4	0	0	0	0	0	0	0	0	0	0	2
	118.0	39	3,720	2550	0.0013	118	0	0	0	0	0	0	0	0	0	0	2
	290.7	39	4,700	1,500	0.0008	290.7	0	0	0	0	0	0	0	0	0	0	2
	215.5	39	4,800	1,400	0.0008	215.5	0	0	0	0	0	0	0	0	0	0	2
	93.6	39	2,200	1,100	0.0008	93.6	0	0	0	0	0	0	0	0	0	0	2
	247.7	36	4,800	2,000	0.0012	247.7	0	0	0	0	0	0	0	0	0	0	2
	222.5	32	4,880	2,446	0.0015	222.5	0	0	0	0	0	0	0	0	0	0	2
	91.6	30	4,000	1,700	0.0008	91.6	0	0	0	0	0	0	0	0	0	0	2
	184.3	30	3,700	1,840	0.0012	184.3	0	0	0	0	0	0	0	0	0	0	2
	40.5	28	1,200	500	0.0017	40.5	0	0	0	0	0	0	0	0	0	0	2
	95	27	3,500	1,700	0.0008	95	0	0	0	0	0	0	0	0	0	0	2
	216.4	27	5,200	2,600	0.0008	216.4	0	0	0	0	0	0	0	0	0	0	2
	557	20	6,400	1,900	0.0008	557	0	0	0	0	0	0	0	0	0	0	2
	213.2	19	5,300	1,000	0.0008	213.2	0	0	0	0	0	0	0	0	0	0	2
	470.8	42	7,400	3,500	0.0008	470.8	0	0	0	0	0	0	0	0	0	0	2
	257.9	38	5,400	2,700	0.0008	257.9	0	0	0	0	0	0	0	0	0	0	2
	481.7	38	7,500	1,400	0.0008	481.7	0	0	0	0	0	0	0	0	0	0	2
	487.3	35	6,900	1,400	0.0008	487.3	0	0	0	0	0	0	0	0	0	0	2
	723.2	32	10,000	1,300	0.0008	723.2	0	0	0	0	0	0	0	0	0	0	2
	722.6	28	9,000	1,200	0.0008	722.6	0	0	0	0	0	0	0	0	0	0	2
	699.3	20	12,000	6,300	0.0008	699.3	0	0	0	0	0	0	0	0	0	0	2
	223.6	18	5,300	1,200	0.0008	223.6	0	0	0	0	0	0	0	0	0	0	2
	80.9	16	2,800	600	0.0008	80.9	0	0	0	0	0	0	0	0	0	0	2
	156.4	14	5,000	2,600	0.0008	156.4	0	0	0	0	0	0	0	0	0	0	2
	96.7	18	3,600	900	0.0008	96.7	0	0	0	0	0	0	0	0	0	0	2
	66.6	16	2,900	600	0.0008	66.6	0	0	0	0	0	0	0	0	0	0	2
	88.5	13	3,700	2,000	0.0008	88.5	0	0	0	0	0	0	0	0	0	0	2
	219.5	12	5,000	1,900	0.0008	219.5	0	0	0	0	0	0	0	0	0	0	2
Base Conditions (These subsheds are assumed to be developed and replace A1, A2, A5A, and A5C from existing conditions, all other subsheds the same as existing conditions)																	
	319.2	42	5,547	1,324	0.0008	0	0	0	0	0	0	0	0	0	0	319.2	9
	202.4	40	5,800	1,600	0.0008	0	0	0	202.4	0	0	0	0	0	0	0	4
	217.1	31	5,940	3,130	0.0014	0	5.3	0	103.2	95.2	0	13.1	0	0	0	0	4
	178.7	29	4,450	2,130	0.0019	0.0	24.4	0.0	131.8	0.0	0.0	22.5	0.0	0.0	0.0	0.0	3
Buildout Conditions (These subsheds represent the buildout subsheds within the SEPA, all other subsheds are the same as base conditions)																	
	154.4	39	3,000	1100	0.0016	0.0	8.2	0.0	18.5	0.0	0.0	24.7	0.0	11.5	0.0	91.5	7
	103.3	38	2,930	1500	0.0010	0.0	19.8	0.0	67.0	0.0	0.0	4.7	0.0	11.8	0.0	0.0	3
	102.0	36	3,400	1550	0.0021	0.0	10.7	0.0	34.8	11.2	0.0	23.1	0.0	11.3	0.0	10.9	5
	241.0	36	4,750	1,700	0.0013	0.0	41.1	0.0	77.4	9.8	0.0	39.2	0.0	18.5	45.0	10.0	5
	147.2	36	2,970	1,310	0.0010	0.0	7.9	0.0	0.0	0.0	0.0	0.0	51.1	0.0	0.0	88.2	8
	104.5	34	3,000	1,390	0.0019	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.0	8
	89.7	27	3,630	1,700	0.0013	0.0	23.3	6.8	27.1	8.5	0.0	0.0	0.0	0.0	0.0	24.0	4
	87.4	25	3,200	1,600	0.0013	0.0	3.5	58.1	0.0	0.0	0.0	13.4	0.0	12.3	0.0	0.0	4
	86.6	28	3,550	2,120	0.0013	0.0	7.2	0.0	0.0	0.0	0.0	0.0	64.6	0.0	0.0	14.7	7

Table 2. Summary of Precipitation Data Sources		
Gage ID	Gage Description	Date Range
HPD047630	Sacramento Post Office National Weather Service (Adjusted)	10/1/1956 to 12/3/1962 and 05/9/1974 to 8/4/1974
ElkGroveFD	The Elk Grove Fire Station on Elk Grove Boulevard	12/04/1962 to 5/8/1974
ElkGroveFH	The Elk Grove Fish Hatchery on Bond Road	8/5/1975 to 6/5/1985
ElkGroveFH ALERT	ALERT gage at the Elk Grove Fish Hatchery on Bond Road	6/6/1985 to 11/6/2002
0270td3240	ALERT gage Laguna Creek at Waterman Road	11/7/2002 to 9/30/2009

Table 3. Soil Moisture Accounting Parameters

Subshed	Canopy Storage, in	Surface Storage, in	Maximum Infiltration, in/hr	Imp., %	Soil Storage, in	Tension Storage, in	Soil Percolation, in/hr	Gw 1 Storage, in	Gw 1 Percolation, in	Gw 1 Storage Coeff.
A01	0.08	0.3	0.07	90	6	4.8	0.07	10	0.07	200
A02	0.08	0.3	0.07	40	6	4.8	0.07	10	0.07	200
A04	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A04A	0.08	0.3	0.07	2	6	4.8	0.07	10	0.08	200
A04B	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A04C	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A05	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A05B	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
LRSP1	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
LRSP2	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
MA5C	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A06	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A08	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200
A10	0.08	0.3	0.07	2	6	4.8	0.07	10	0.07	200

Table 4. Detention Basin Data for DETS1a

Hydraulic Data		
Tributary Area	154.4	acres
Outlet Orifice Size	12	inches
Outlet Orifice Elevation	32.3	feet
Main Spillway Width (Notch)	4	feet
Main Spillway Elevation (Notch)	34	feet
Top of Riser Elevation	37.3	feet
Emergency Weir Elevation	37.5	feet
10-Year Peak WSEL	35.9	feet
100-Year Peak WSEL	37.0	feet

Elevation-Volume-Flow Data

Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	32.3	0.0	357	571	203918	4.7	0.0	0.0	0.0	0.0
Water Quality Pool (Approx)	33.9	1.6	370	584	215963	5.0	7.7	4.9	0.0	4.9
	34.0	1.7	371	585	216727	5.0	8.2	5.0	0.0	5.0
	35.0	2.7	379	593	224434	5.2	13.3	6.3	11.2	17.5
	36.0	3.7	387	601	232269	5.3	18.5	7.4	31.7	39.1
	37.0	4.7	395	609	240232	5.5	23.9	8.3	58.2	66.5
	38.0	5.7	403	617	248324	5.7	29.5	9.2	89.6	98.8

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 5. Detention Basin Data for DETS1b

Hydraulic Data		
Tributary Area	103.3	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	28.6	feet
Main Spillway Width (Notch)	2.6	feet
Main Spillway Elevation (Notch)	31.0	feet
Top of Riser Elevation	34.5	feet
Emergency Weir Elevation	34.6	feet
10-Year Peak WSEL	32.8	feet
100-Year Peak WSEL	34.1	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	28.6	0.0	304	304	92416	2.1	0.0	0.0	0.0	0.0
Water Quality Pool (Approx)	29.8	1.2	314	314	98345	2.3	2.6	2.9	0.0	2.9
	30.0	1.4	315	315	99351	2.3	3.1	3.2	0.0	3.2
	31.0	2.4	323	323	104458	2.4	5.4	4.1	0.0	4.1
	31.5	2.9	327	327	107060	2.5	6.6	4.5	2.6	7.1
	32.0	3.4	331	331	109482	2.5	7.8	4.9	6.8	11.7
	33.0	4.4	339	339	115057	2.6	10.5	5.6	20.6	26.2
	34.0	5.4	347	347	120548	2.8	13.2	6.2	37.8	44.0
	35.0	6.4	355	355	126167	2.9	16.0	6.8	58.2	65.0

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 6. Detention Basin Data for DETS2

Hydraulic Data		
Tributary Area	102	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	27.7	feet
Main Spillway Width (Notch)	2.7	feet
Main Spillway Elevation (Notch)	29.8	feet
Top of Riser Elevation	33.1	feet
Emergency Weir Elevation	33.2	feet
10-Year Peak WSEL	31.5	feet
100-Year Peak WSEL	32.7	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	27.7	0.0	245	441	108045	2.5	0.0	0.0	0.0	0.0
Water Quality Pool (Approx)	29.0	1.3	255	451	115288	2.6	3.3	3.0	0.0	3.0
	30.0	2.3	263	459	121006	2.8	6.0	4.0	0.7	4.7
	31.0	3.3	271	467	126852	2.9	8.9	4.9	9.9	14.8
	32.0	4.3	279	475	132827	3.0	11.9	5.5	24.7	30.2
	32.7	5.0	285	481	137085	3.1	14.0	6.0	37.3	43.3
	33.7	6.0	293	489	143277	3.3	17.3	6.5	58.2	64.8

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 7. Detention Basin Data for DETS3

Hydraulic Data		
Tributary Area	241	acres
Outlet Orifice Size	15	inches
Outlet Orifice Elevation	24.6	feet
Main Spillway Width (Notch)	5.7	feet
Main Spillway Elevation (Notch)	26.3	feet
Top of Riser Elevation	30.0	feet
Emergency Weir Elevation	30.1	feet
10-Year Peak WSEL	28.4	feet
100-Year Peak WSEL	29.6	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	24.6	0.0	507	507	257049	5.9	0.0	0.0	0.0	0.0
	25.6	1.0	515	515	265225	6.1	6.0	6.0	0.0	6.0
Water Quality Pool (Approx)	25.9	1.3	517	517	267703	6.1	7.8	6.8	0.0	6.8
	26.3	1.7	521	521	271024	6.2	10.3	7.8	0.0	7.8
	28.5	3.9	538	538	289659	6.6	24.3	11.9	52.1	63.9
	29.5	4.9	546	546	298334	6.8	31.1	13.3	91.4	104.7
	30.5	5.9	554	554	307138	7.1	38.0	14.6	137.4	152.0

Notes:
[a] All elevations are based on NGVD29.
[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.
[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 8. Detention Basin Data for DETS4

Hydraulic Data		
Tributary Area	147.2	acres
Outlet Orifice Size	12	inches
Outlet Orifice Elevation	27.7	feet
Main Spillway Width (Notch)	3.7	feet
Main Spillway Elevation (Notch)	30.0	feet
Top of Riser Elevation	33.4	feet
Emergency Weir Elevation	33.6	feet
10-Year Peak WSEL	31.9	feet
100-Year Peak WSEL	33.1	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	27.7	0.0	240	720	172800	4.0	0.0	0.0	0.0	0.0
	28.7	1.0	248	728	180544	4.1	4.1	3.8	0.0	3.8
Water Quality Pool (Approx)	29.7	2.0	256	736	188416	4.3	8.3	5.4	0.0	5.4
	30.0	2.3	258	738	190803	4.4	9.6	5.8	0.0	5.8
	31.0	3.3	266	746	198841	4.6	14.1	7.0	10.4	17.3
	32.0	4.3	274	754	207007	4.8	18.7	8.0	29.3	37.3
	33.0	5.3	282	762	215302	4.9	23.6	8.9	53.8	62.7
	34.0	6.3	290	770	223724	5.1	28.6	9.7	82.9	92.5

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 9. Detention Basin Data for DETS5

Hydraulic Data		
Tributary Area	104.5	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	24.6	feet
Main Spillway Width (Notch)	2.7	feet
Main Spillway Elevation (Notch)	27.5	feet
Top of Riser Elevation	30.9	feet
Emergency Weir Elevation	31.0	feet
10-Year Peak WSEL	29.2	feet
100-Year Peak WSEL	30.5	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	24.6	0.0	215	516	110940	2.5	0.0	0.0	0.0	0.0
	25.0	0.4	218	519	113289	2.6	1.0	1.7	0.0	1.7
Water Quality Pool (Approx)	26.0	1.4	226	527	119253	2.7	3.7	3.2	0.0	3.2
	26.9	2.3	233	534	124729	2.9	6.2	4.0	0.0	4.0
	27.5	2.9	238	539	128437	2.9	8.0	4.5	0.0	4.5
	29.0	4.4	250	551	137910	3.2	12.6	5.6	13.9	19.5
	30.5	5.9	262	563	147671	3.4	17.5	6.5	39.3	45.8
	31.5	6.9	270	571	154338	3.5	21.0	7.0	60.5	67.5

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 10. Detention Basin Data for DETS6

Hydraulic Data		
Tributary Area	89.7	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	20.7	feet
Main Spillway Width (Notch)	10.3	feet
Main Spillway Elevation (Notch)	22.7	feet
Top of Riser Elevation	24.9	feet
Emergency Weir Elevation	25.1	feet
10-Year Peak WSEL	24.0	feet
100-Year Peak WSEL	24.6	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	20.7	0.0	247	296	73211	1.7	0.0	0.0	0.0	0.0
	21.0	0.3	249	299	74521	1.7	0.5	1.5	0.0	1.5
	22.0	1.3	257	307	78970	1.8	2.3	3.0	0.0	3.0
Water Quality Pool (Approx)	22.3	1.6	260	309	80330	1.8	2.8	3.4	0.0	3.4
	22.7	2.0	263	312	82161	1.9	3.6	3.8	0.0	3.8
	24.0	3.3	273	323	88254	2.0	6.1	4.9	42.7	47.6
	24.5	3.8	277	327	90654	2.1	7.1	5.2	69.6	74.9
	25.5	4.8	285	335	95552	2.2	9.3	5.8	135.1	141.0

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 11. Detention Basin Data for DETS7

Hydraulic Data		
Tributary Area	87.4	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	19.4	feet
Main Spillway Width (Notch)	8.6	feet
Main Spillway Elevation (Notch)	21.0	feet
Top of Riser Elevation	23.5	feet
Emergency Weir Elevation	23.7	feet
10-Year Peak WSEL	22.5	feet
100-Year Peak WSEL	23.2	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b](c), cfs	Spill Flow[b](c), cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	19.4	0.0	193	367	70773	1.6	0.0	0.0	0.0	0.0
	20.0	0.6	198	372	73483	1.7	1.0	2.1	0.0	2.1
Water Quality Pool (Approx)	20.8	1.4	204	378	77167	1.8	2.4	3.2	0.0	3.2
	21.0	1.6	206	380	78101	1.8	2.7	3.4	0.0	3.4
	21.5	2.1	210	384	80458	1.8	3.6	3.9	8.5	12.4
	22.5	3.1	218	392	85269	2.0	5.5	4.7	44.2	48.9
	23.0	3.6	222	396	87722	2.0	6.5	5.1	68.1	73.2
	24.2	4.8	231	405	93740	2.2	9.0	5.8	137.8	143.7

Notes:

[a] All elevations are based on NGVD29.

[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

Table 12. Detention Basin Data for DETS8

Hydraulic Data		
Tributary Area	87.4	acres
Outlet Orifice Size	10	inches
Outlet Orifice Elevation	19.4	feet
Main Spillway Width (Notch)	8.6	feet
Main Spillway Elevation (Notch)	21.0	feet
Top of Riser Elevation	24.4	feet
Emergency Weir Elevation	24.6	feet
10-Year Peak WSEL	23.4	feet
100-Year Peak WSEL	24.1	feet

Elevation-Volume-Flow Data										
Description	Elevation, ft	Depth, ft	Width, ft	Length, ft	Area, sf	Area, ac	Volume, ac-ft	Outlet Orifice Flow[b][c], cfs	Spill Flow[b][c], cfs	Total Outflow[b], cfs
Bottom or Permanent Pool	19.7	0.0	180	450	81000	1.9	0.0	0.0	0.0	0.0
	21.0	1.3	190	460	87660	2.0	2.5	3.0	0.0	3.0
Water Quality Pool (Approx)	21.75	2.1	196	466	91601	2.1	4.1	3.8	0.0	3.8
	21.8	2.1	197	467	91866	2.1	4.2	3.9	0.0	3.9
	23.0	3.3	206	476	98329	2.3	6.8	4.9	24.7	29.5
	24.0	4.3	214	484	103855	2.4	9.1	5.5	61.2	66.8
	25.0	5.3	222	492	109510	2.5	11.5	6.1	107.4	113.5

Notes:

[a] All elevations are based on NGVD29.

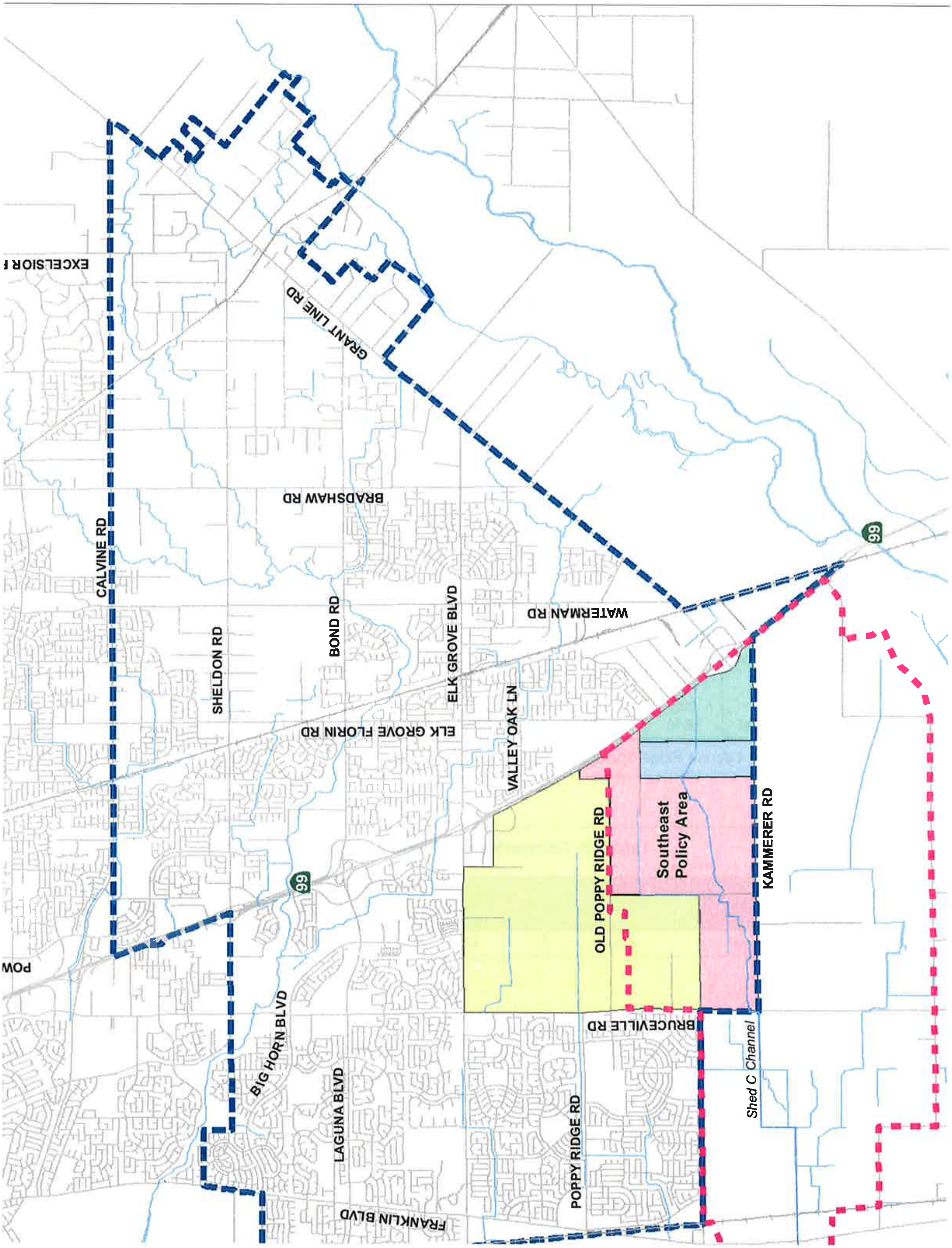
[b] Flow data assumes no backwater effects from the Shed C Channel. This assumption was tested with event modeling using HEC-RAS and found to be reasonable.

[c] An emergency high flow weir or similar feature is required in addition to the outlets shown on this table.

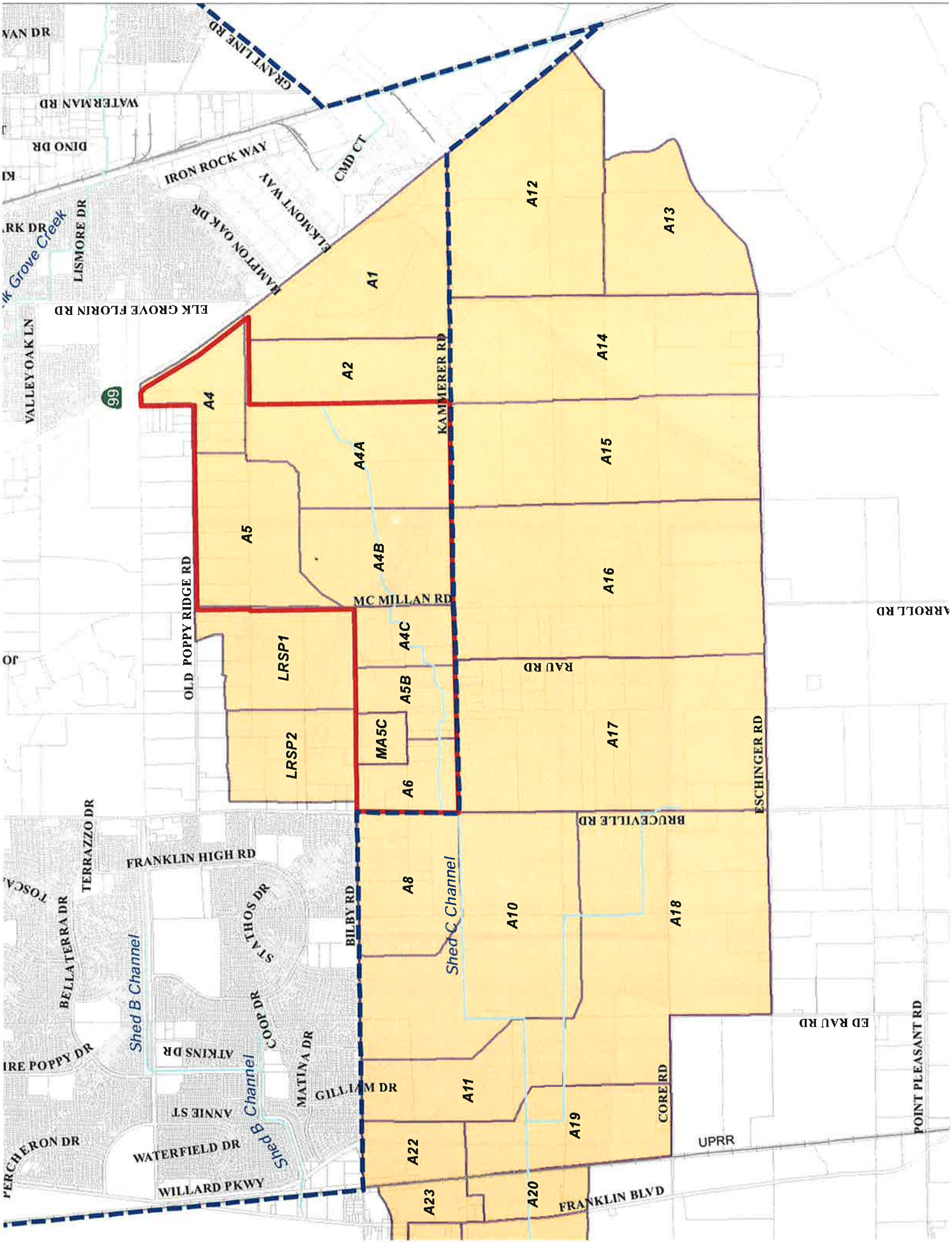
Table 13. Preliminary Estimate of Low Flow Channel Geometry									
Reach	Est. Channel Forming Flow, cfs	Approx. Return Period, years	Depth, ft	Average Width w, ft	Trapezoidal Bottom Width, ft	Trapezoidal Top Width, ft	Wave Length L, ft	Belt Width B, ft	Radius of Curvature rc, ft
1.Lotz Parkway to Road near DETS1b Outfall	85	1.7	1.9	23	18	29	222	126	44
2. Roadway near DETS1b Outfall to Big Horn Blvd.	125	2.0	2.3	27	20	34	261	149	52
3. Big Horn Blvd. to LRSP Channel	115	0.9	2.2	26	20	33	252	143	50
4. LRSP Channel to Bruceville Road	265	2.2	3.0	36	27	45	358	204	72
Note: LRSP = Laguna Ridge Specific Plan									

Table 14. Proposed Channel Dimensions								
Reach	HEC-RAS Cross Section Limits	Approximate Longitudinal Slope	Reach Length, ft	Low Flow Depth, ft	Low Flow Bottom Width, ft	Low Flow Top Width, ft	Flood Control Bottom Width, ft	Approx. Flood Control Top Width, ft
1.Lotz Parkway to Road near DETS1b Outfall	15074 to 13395	0.00102	1,679	1.9	18	29	115	153
2. Road near DETS1b Outfall to Big Horn Blvd.	13341 to 9275	0.00102	4,066	2.2	20	33	126	168
3a. Big Horn Blvd. to Upstream of DETS6	9196 to 6625	0.0010	2,571	2.2	20	33	143	175
3b. Upstream of DETS6 to LRSP Channel	6625 to 5419	0.00102	1,206	2.2	20	33	207	235
4. LRSP Channel to Bruceville Road	5419 to 3696	0.00060	1,723	2.5	27	45	207	237
LRSP Channel	0 to 3510	0.00045	2,446	1.0	8	14	25	55
Note: LRSP = Laguna Ridge Specific Plan								

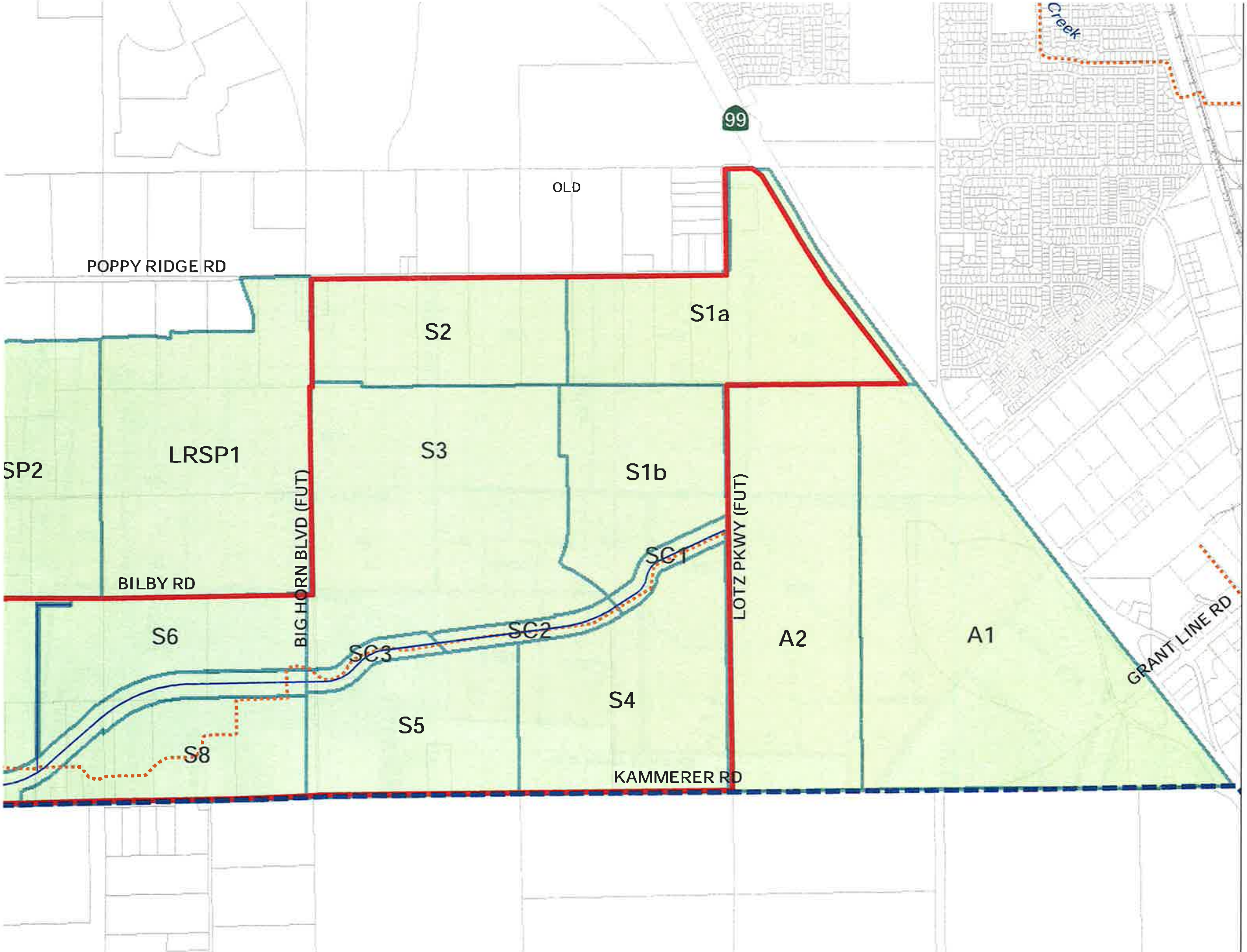
Table 15. Comparison of Flood Flows in cfs				
	10-Year		100-Year	
Location	Pre-Development	Buildout	Pre-Development	Buildout
Bruceville Road	504	409	802	772



EXCELSIOR
GRANT LINE RD
BRADSHAW RD
CALVINE RD
SHELDON RD
BOND RD
ELK GROVE BLVD
WATERMAN RD
VALLEY OAK LN
ELK GROVE FLORIN RD
99
Southeast Policy Area
KAMMERER RD
OLD POPPY RIDGE RD
BIG HORN BLVD
LAGUNA BLVD
BRUCEVILLE RD
Shed C Channel
POPPY RIDGE RD
FRANKLIN BLVD
POW

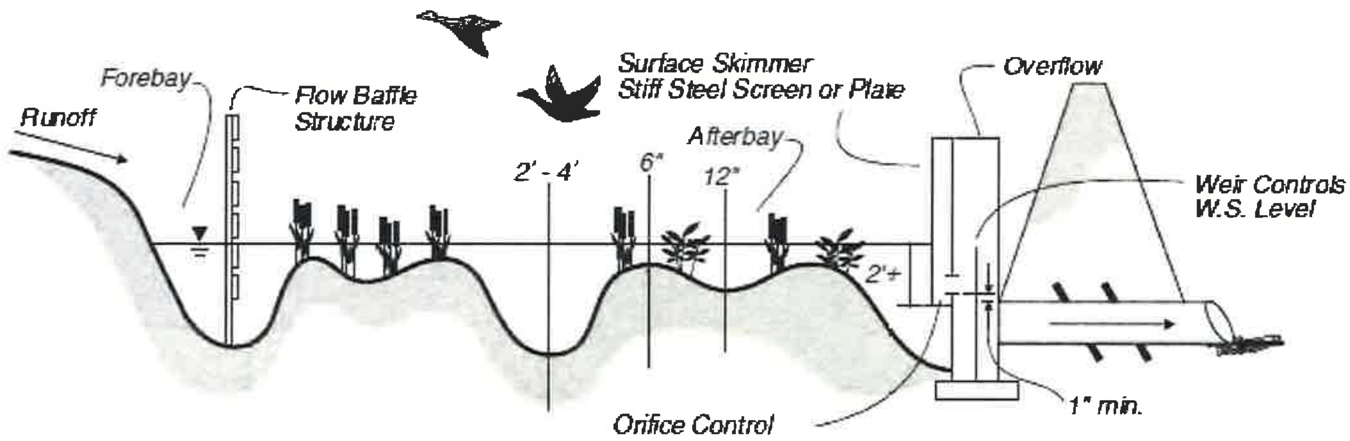


A1
A2
A4
A4A
A4B
A4C
A5
A5B
MA5C
A6
A8
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
A20
A22
A23
LRSP1
LRSP2
GRANT LINE RD
WATERMAN RD
DINO DR
IRON ROCK WAY
CMD CT
ELKMONT WAY
HAMPTON OAK DR
LISMORE DR
Elk Grove Creek
ELK GROVE FLORIN RD
VALLEY OAK LN
99
KAMMERER RD
OLD POPPY RIDGE RD
MC MILLAN RD
RAU RD
ESCHINGER RD
BRUCEVILLE RD
TERRAZZO DR
FRANKLIN HIGH RD
BELLATERRA DR
STATHOS DR
BILBY RD
Shed C Channel
Shed B Channel
COOP DR
MATINA DR
ATKINS DR
GILLIAM DR
ANNIE ST
PERCHERON DR
WATERFIELD DR
WILLARD PKWY
FRANKLIN BLVD
CORE RD
UPRR
ED RAU RD
POINT PLEASANT RD



Creek
99
OLD
POPPY RIDGE RD
S1a
S2
S3
S1b
LRSP1
SP2
BIG HORN BLVD (FUT)
LOTZ PKWY (FUT)
SC1
SC2
SC3
BILBY RD
S6
S4
S5
S8
A2
A1
GRANT LINE RD
KAMMERER RD


99
POPPY RIDGE RD
BILBY RD
BIGHORN BLVD (FUT)
LOTZ PKWY (FUT)
REACH 1
REACH 2
REACH 3
KAMMERER RD



Adapted from UDFCD, 1999

Figure CWB-1. Constructed Wetland Basin

Figure 5. Typical Detention Basin Layout

Note: Adapted from Figure CWB-1 from Stormwater Quality Design Manual for the Sacramento and south Placer Region.

(ASCE Manual No. 77. pg 329)

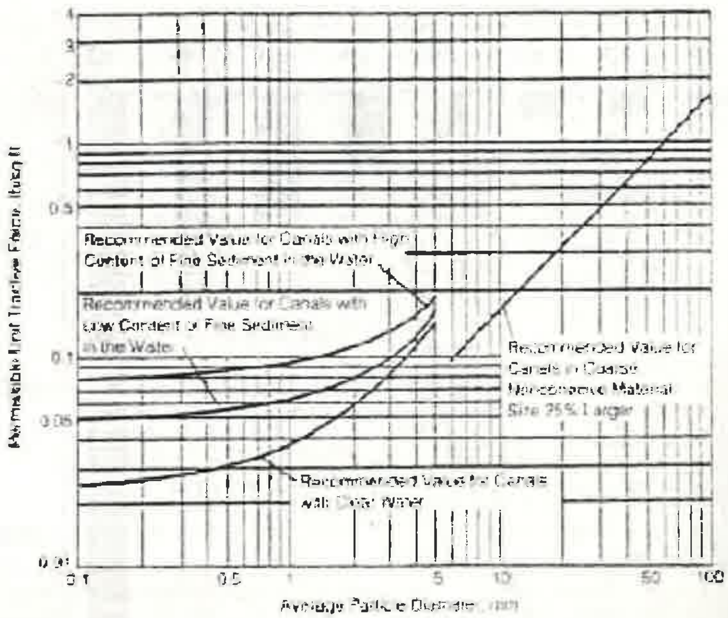


Figure 5.5—Recommended permissible unit tractive forces for canals in noncohesive material (lb/sq ft × 47.88 = Pa) (Chow, 1959).

bridge piers is caused by the vortex resulting from water piling up on the upstream edge and subsequent acceleration of flow around the nose of the pier.

Local scour is a function of a combination of several of the following factors

(a) Slope of the channel

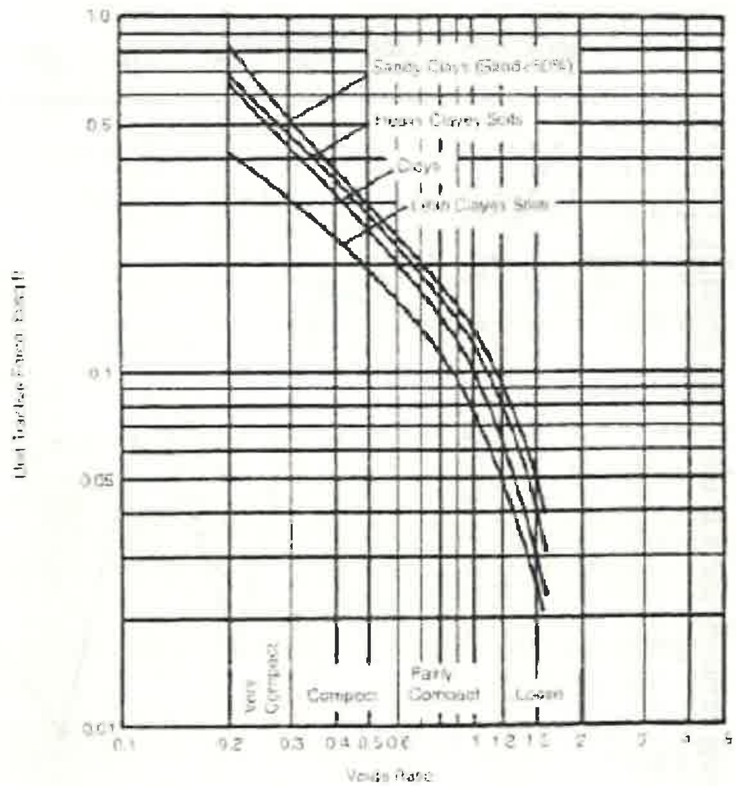


Figure 5.6—Permissible unit tractive forces for canals in cohesive material as converted from data on permissible velocities (lb/sq ft × 47.88 = Pa) (USBR and Hydrotech. Const., 1936).

Figure 6. Determination of Critical Channel Shear Stress

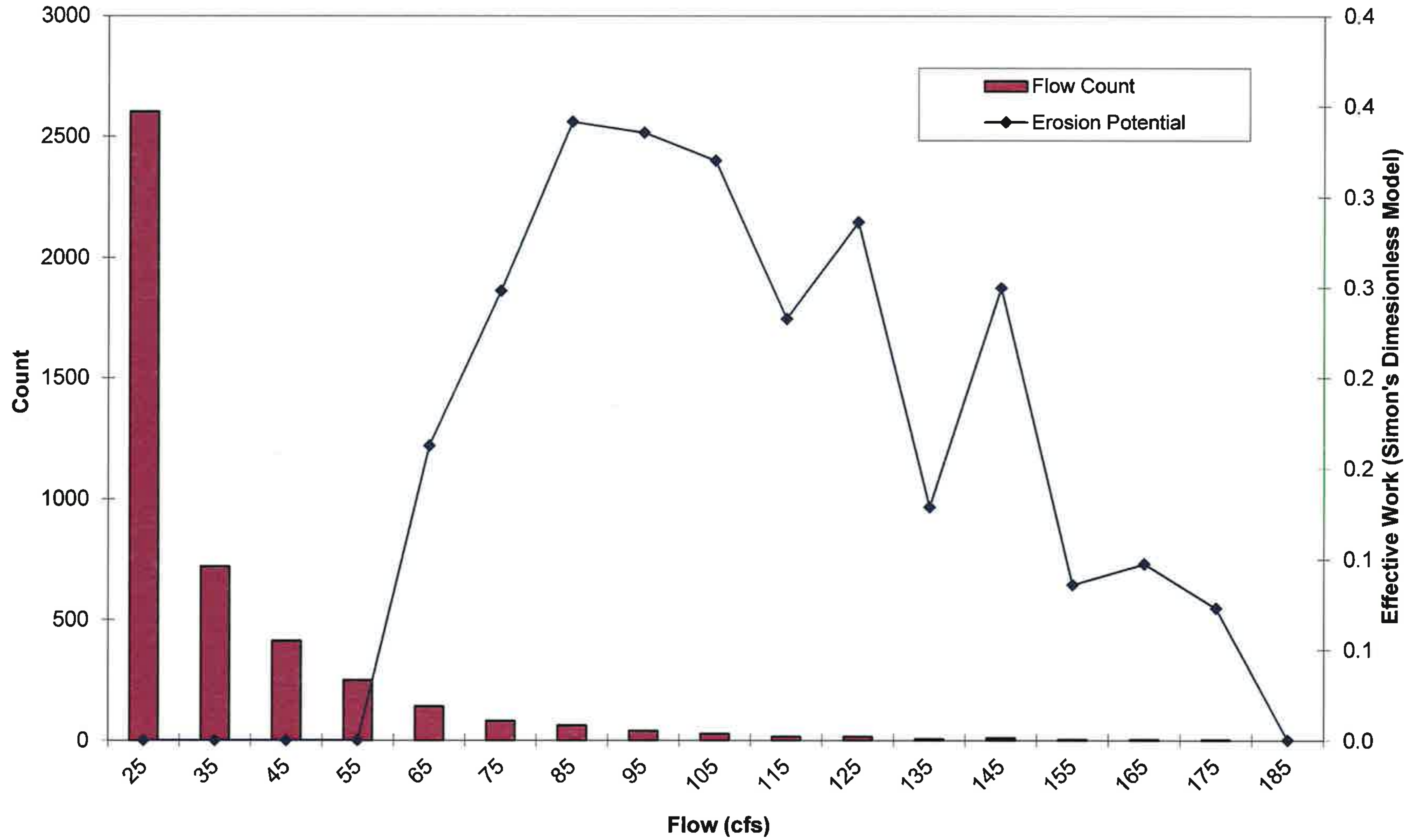


Figure 7

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 1 – CHANNEL FORMING FLOW CALCULATIONS

WEST YOST ASSOCIATES Consulting Engineers

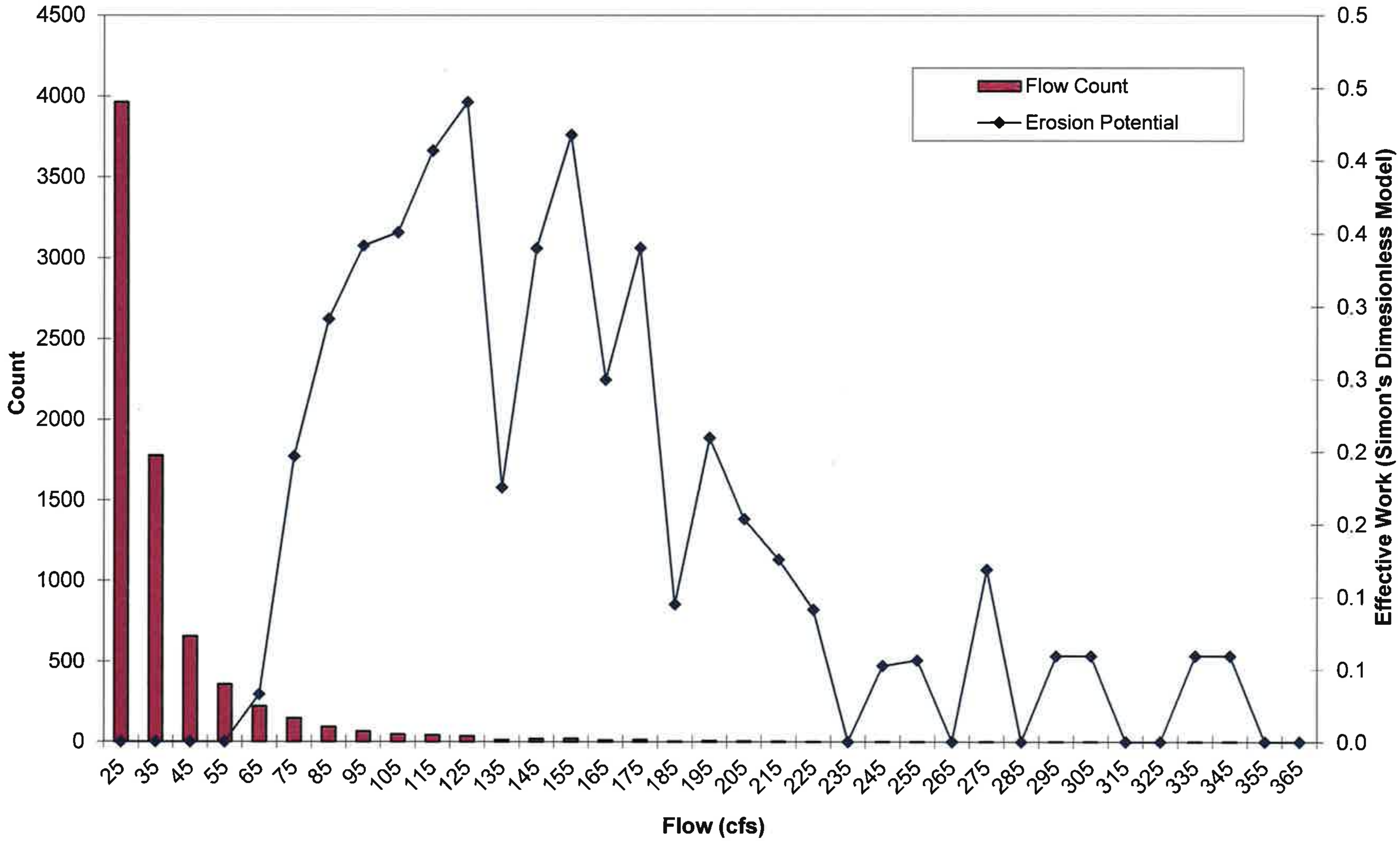


Figure 8

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 2 – CHANNEL FORMING FLOW CALCULATIONS

WEST YOST ASSOCIATES
Consulting Engineers

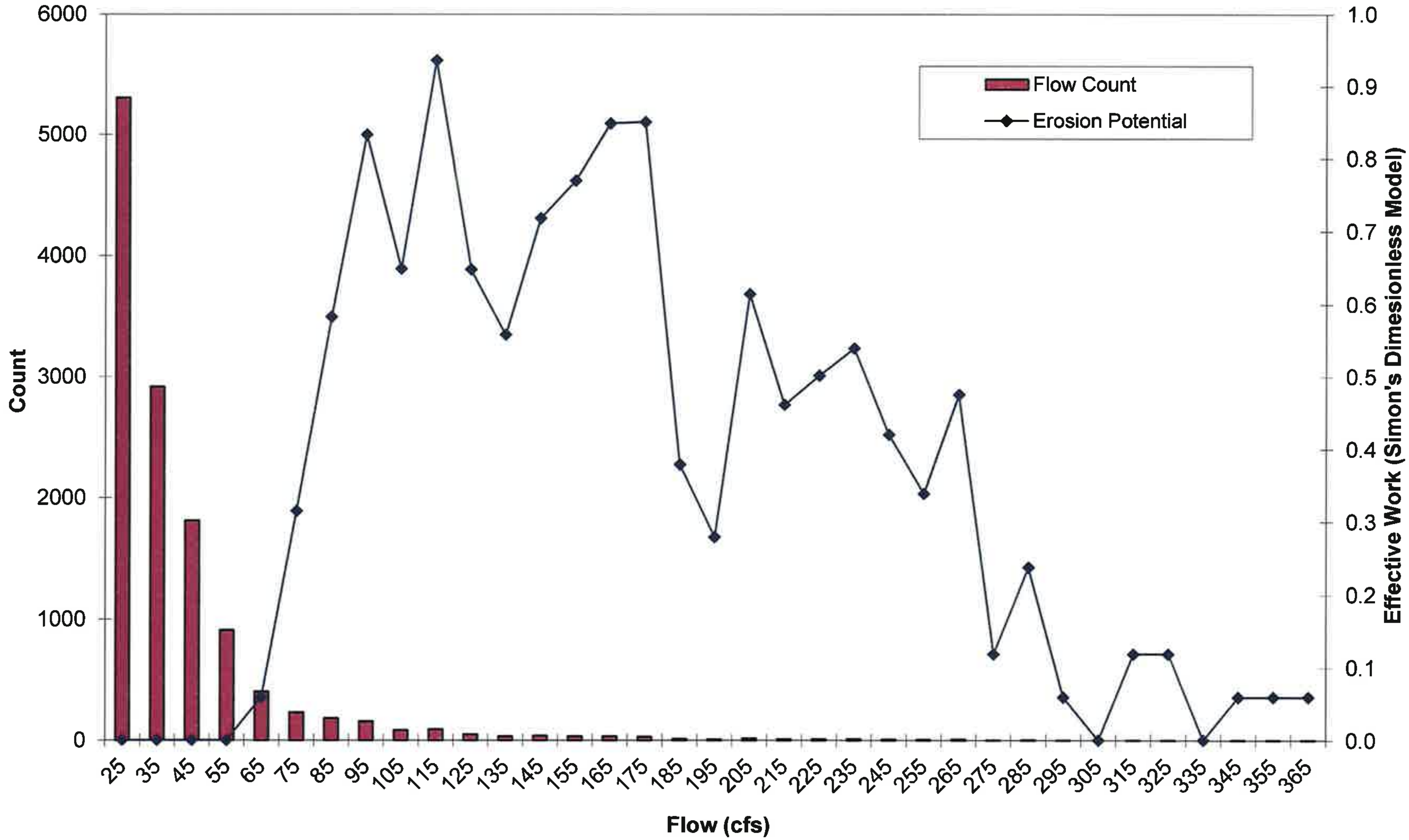


Figure 9

City of Elk Grove

Southeast Policy Area Drainage Study

SHED C CHANNEL REACH 3 – CHANNEL FORMING FLOW CALCULATIONS

WEST YOST ASSOCIATES Consulting Engineers

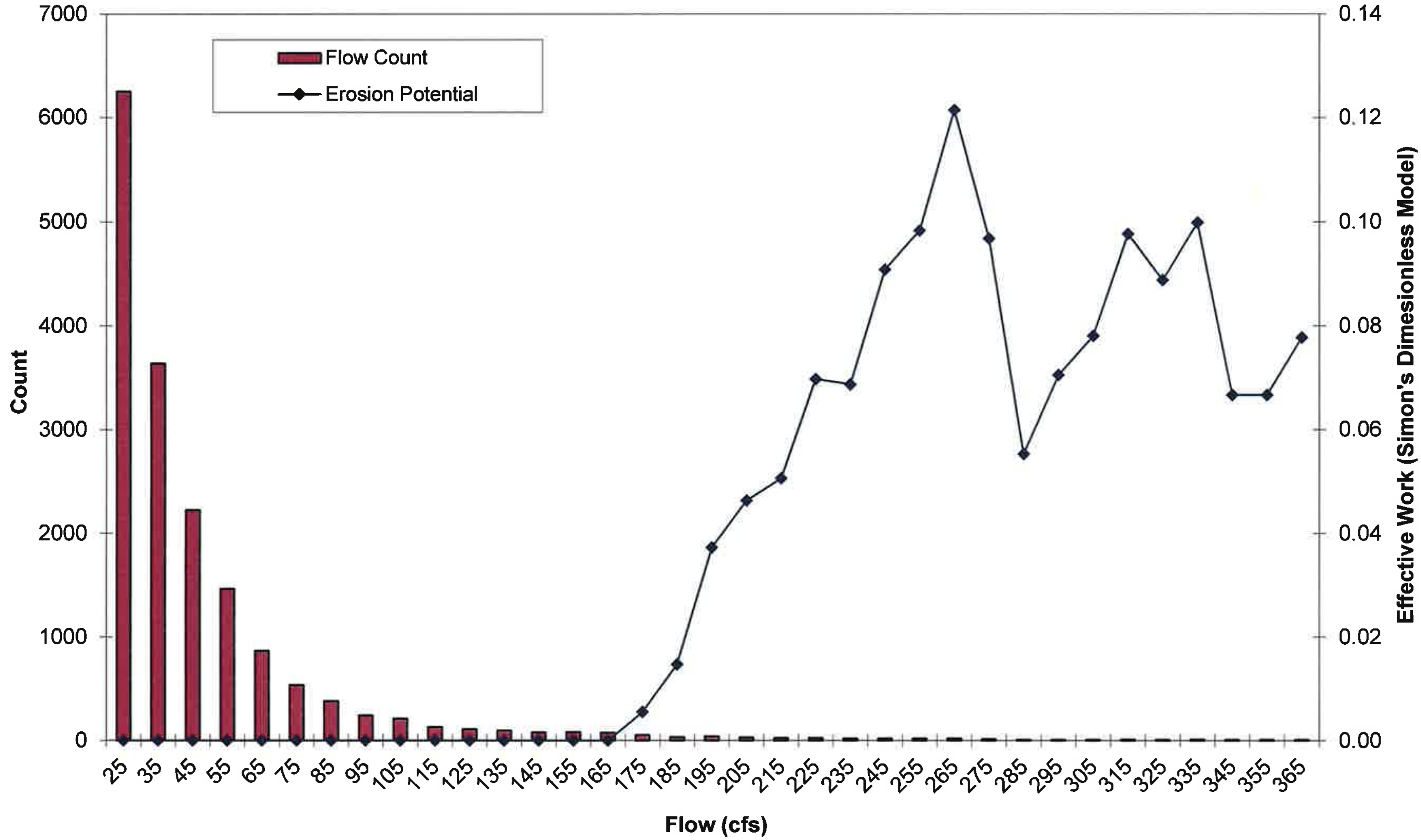


Figure 10
City of Elk Grove
Southeast Policy Area Drainage Study
SHED C CHANNEL REACH 4 – CHANNEL FORMING FLOW CALCULATIONS

WEST YOST ASSOCIATES
Consulting Engineers

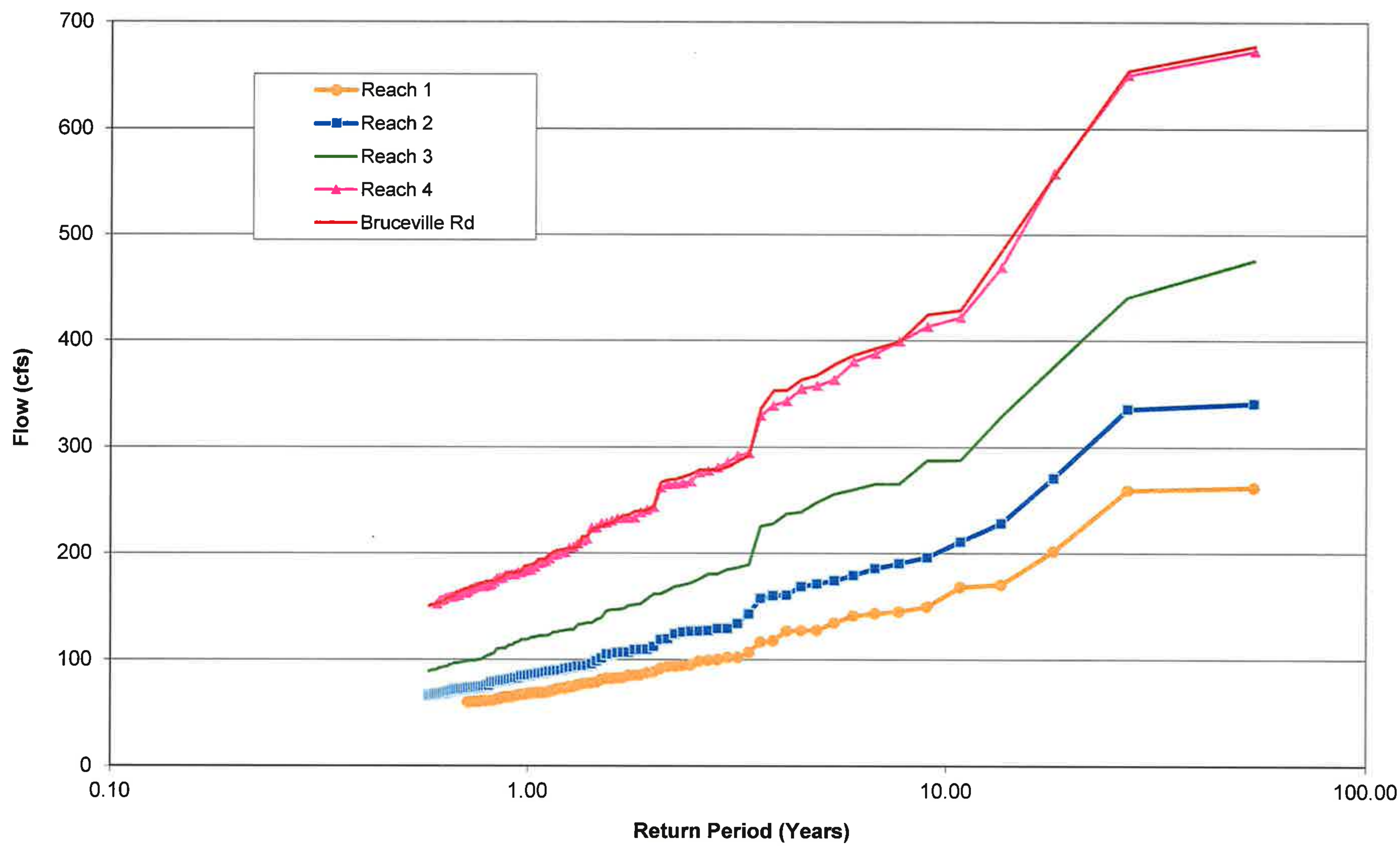


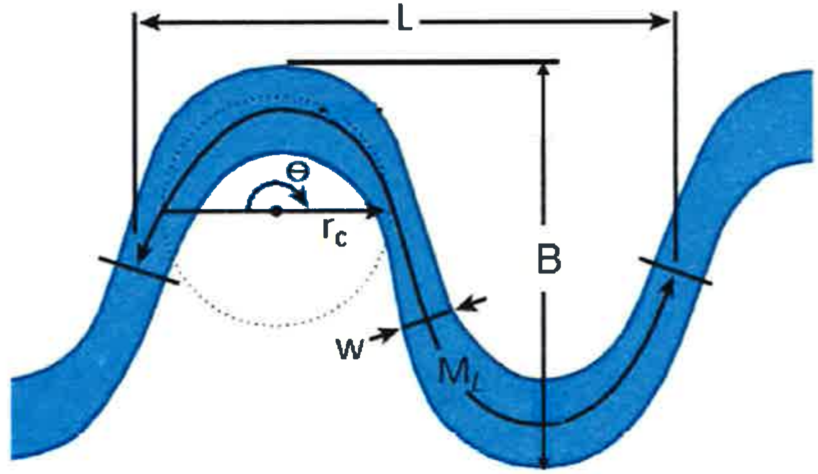
Figure 11

City of Elk Grove

Southeast Policy Area Drainage Study

FLOW FREQUENCY FOR SHED C CHANNEL FOR MITIGATED BUILDOUT CONDITIONS

WEST YOST ASSOCIATES Consulting Engineers



L meander wavelength
M_L meander arc length
w average width at bankfull discharge
B meander amplitude
r_c radius of curvature
Θ arc angle

Figure 12. Typical Low Flow Channel Meander Dimensions

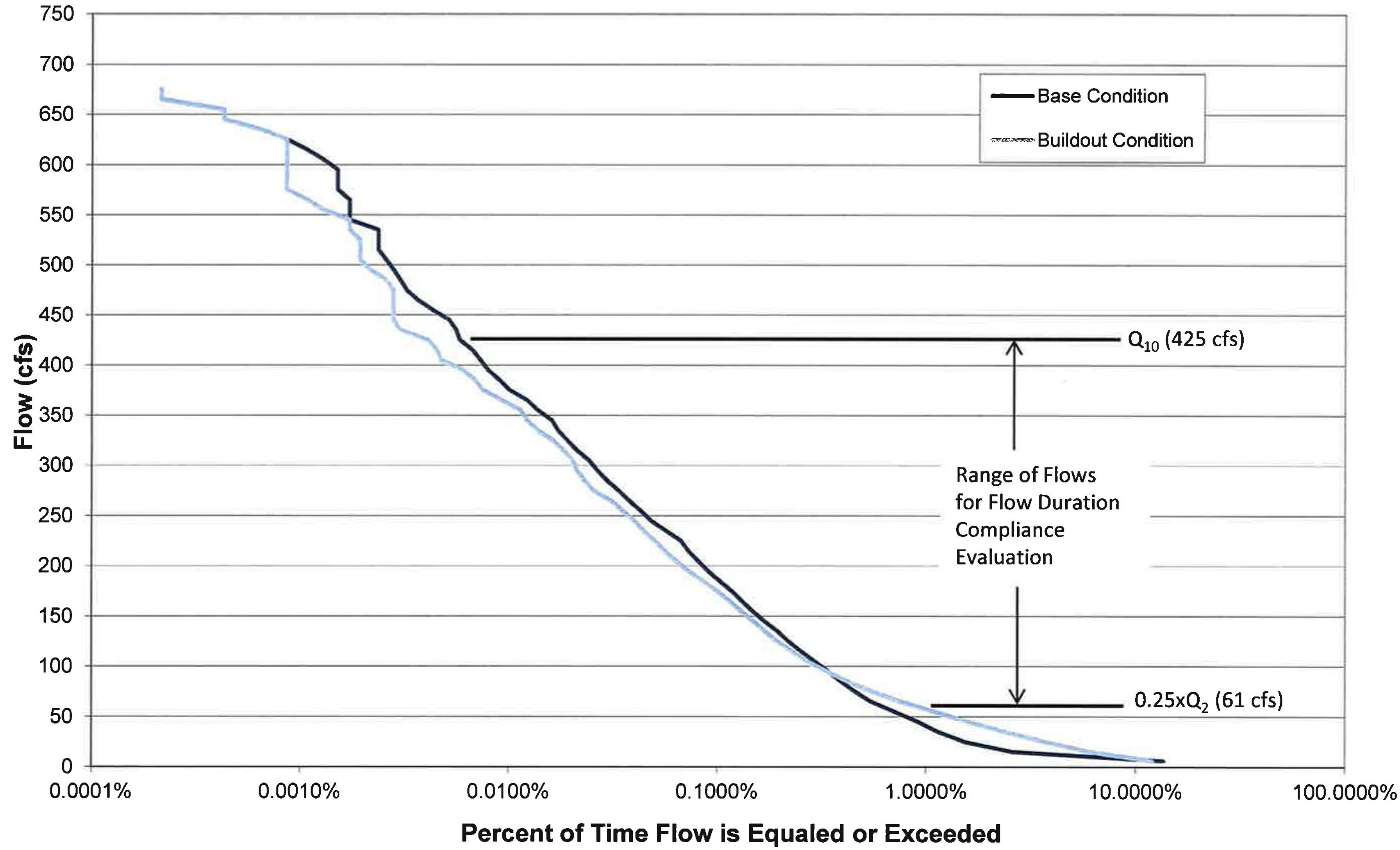


Figure 13

City of Elk Grove

Southeast Policy Area Drainage Study

FLOW DURATION COMPARISON AT BRUCEVILLE ROAD

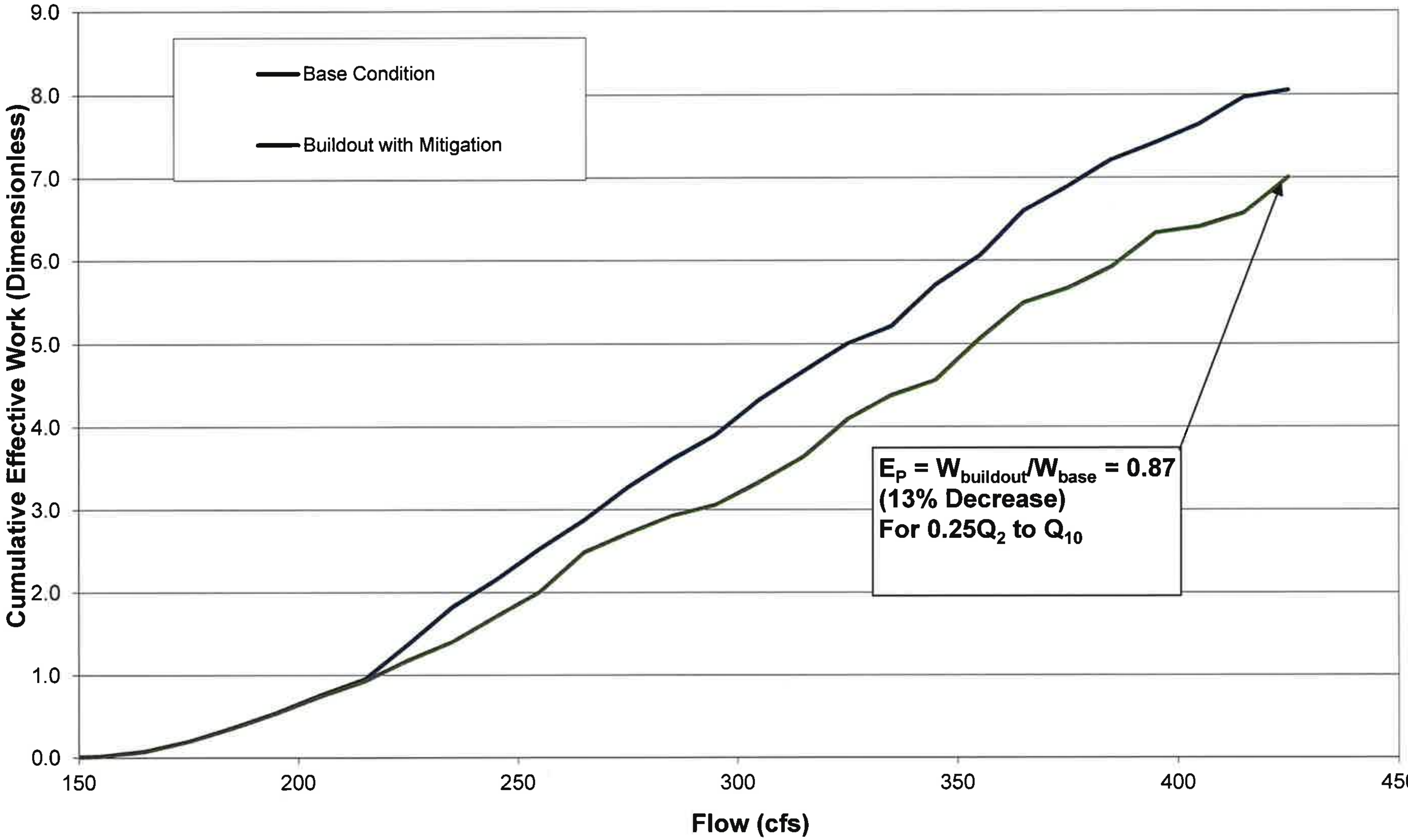
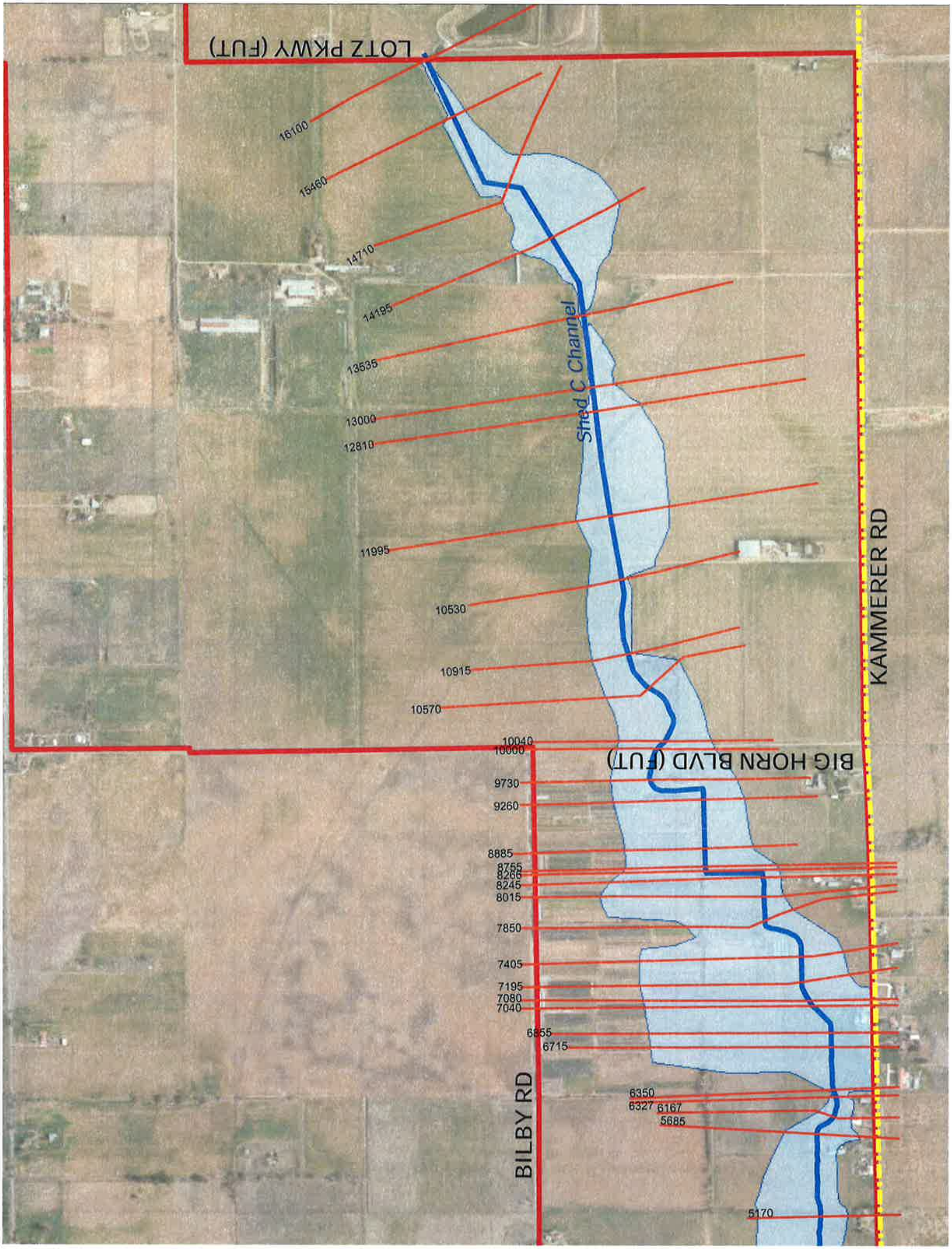
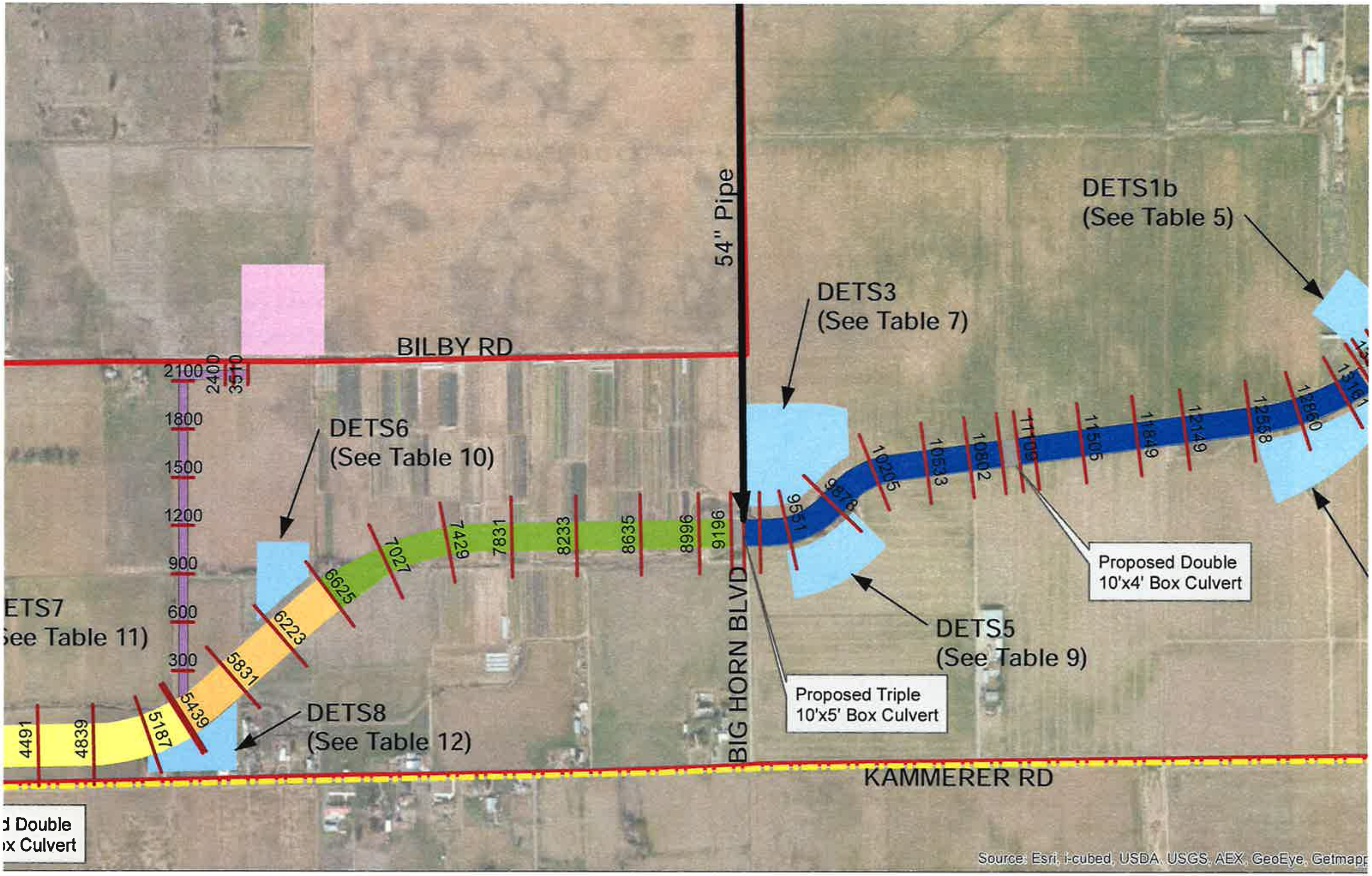


Figure 14
City of Elk Grove
Southeast Policy Area Drainage Study
CUMULATIVE EFFECTIVE WORK AT
BRUCEVILLE ROAD

WEST YOST ASSOCIATES
Consulting Engineers


LOTZ PKWY (FUT)
16100
15460
14710
14195
13535
13000
12810
Shed C Channel
11995
10530
10915
10570
10040
10000
BIG HORN BLVD (FUT)
KAMMERER RD
9730
9260
8885
8755
8266
8245
8015
7850
7405
7195
7080
7040
6855
6715
6350
6327
6167
5685
5170
BILBY RD



ocation and Station
1
2
3

Notes

1. Detention basin locations and sizes are approximate.
   See Tables 4 through 12 for required storage volumes.

2. See Table 14 for channel dimensions.

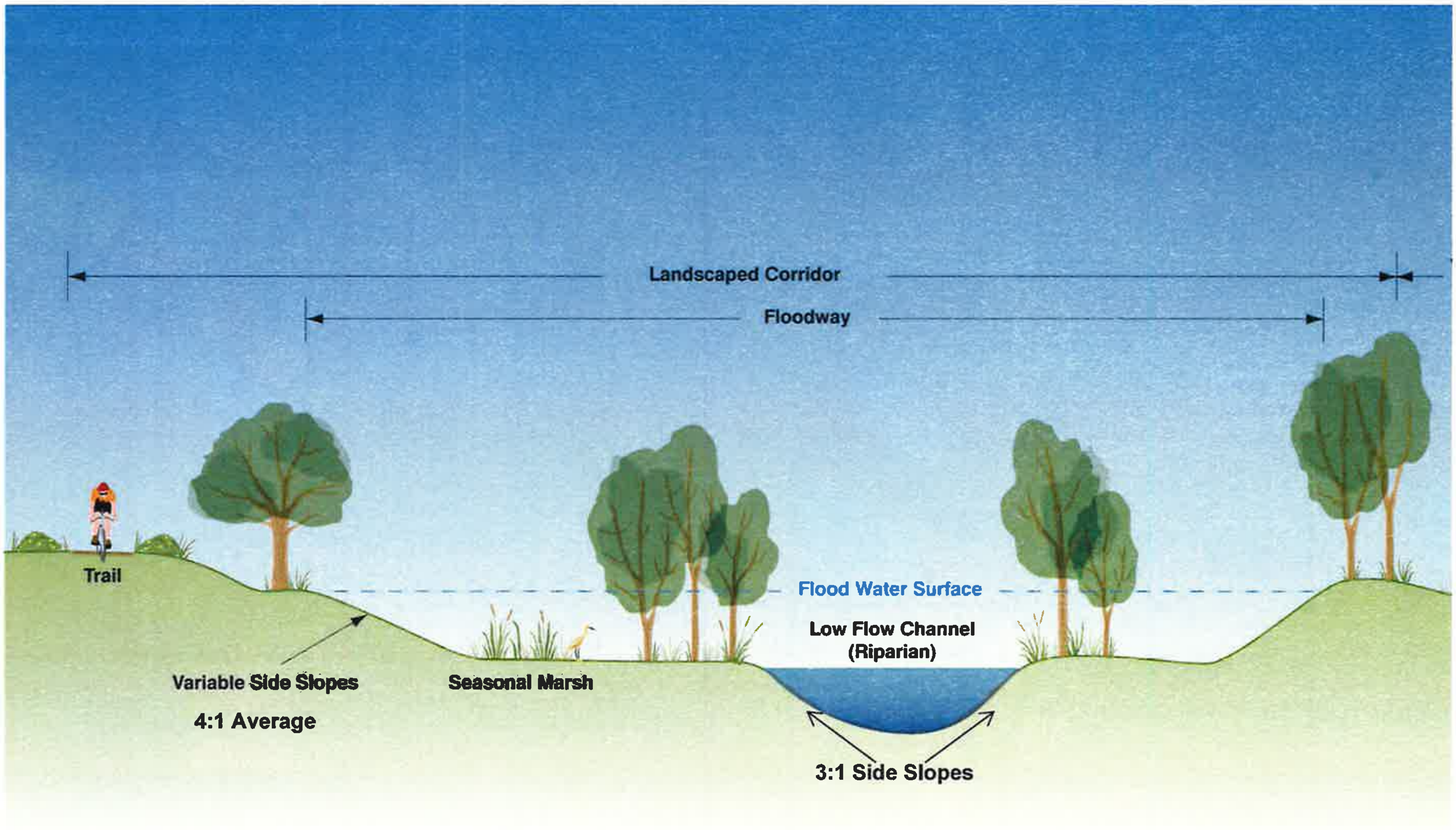
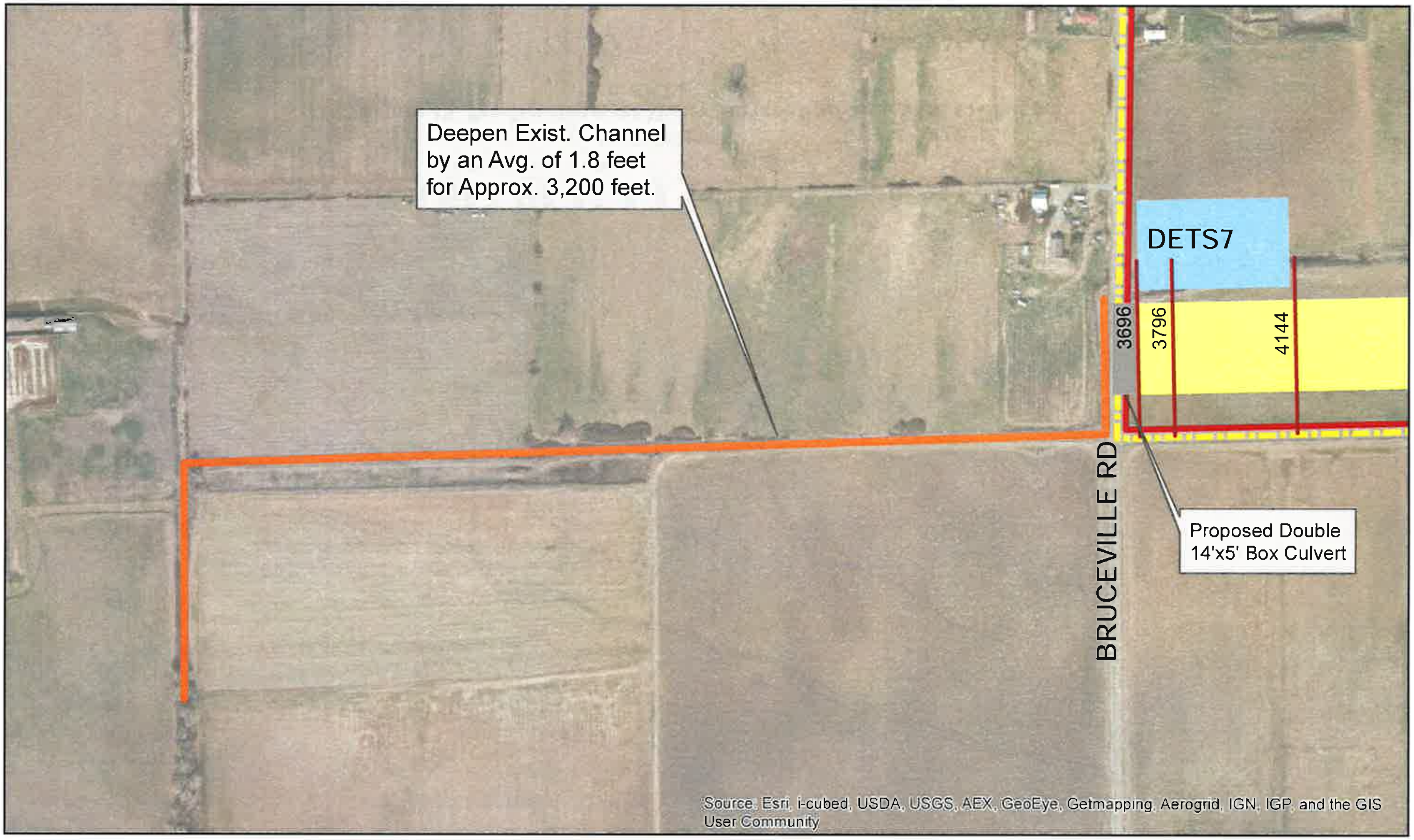


Figure 17. Shed C Channel – Proposed Cross Section



LEGEND

- City Limits
- Proposed Detention Basin
- HEC-RAS Cross Section Location and Station
- Proposed Channel Reach 4
- Offsite Channel Improvements
- Southeast Policy Area

FIGURE 18

City of Elk Grove
Southeast Policy Area
Drainage Study

PROPOSED OFFSITE
CHANNEL IMPROVEMENTS

WEST YOST ASSOCIATES
Consulting Engineers

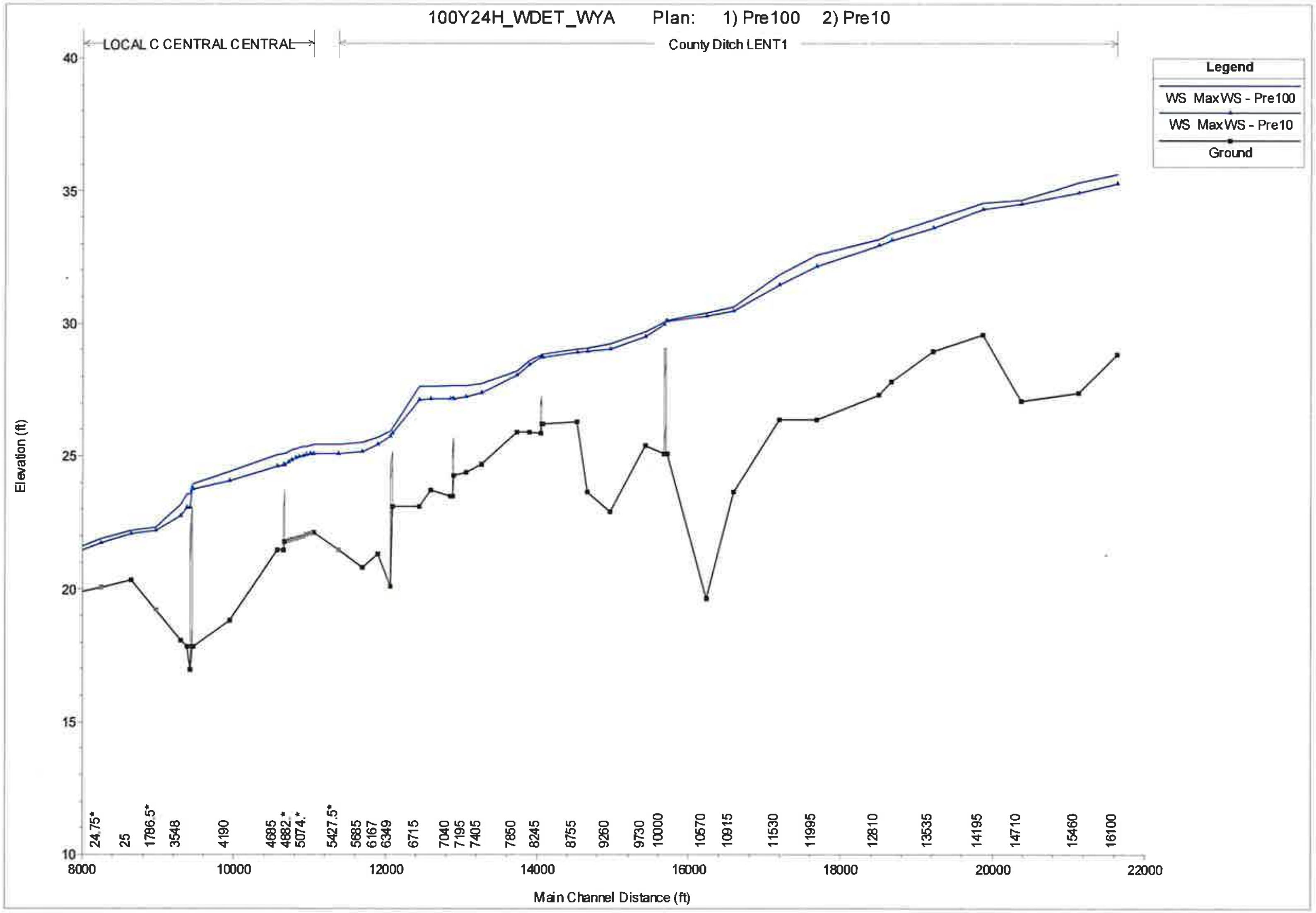


Figure 19. Pre-Development Water Surface Profiles – Shed C Channel

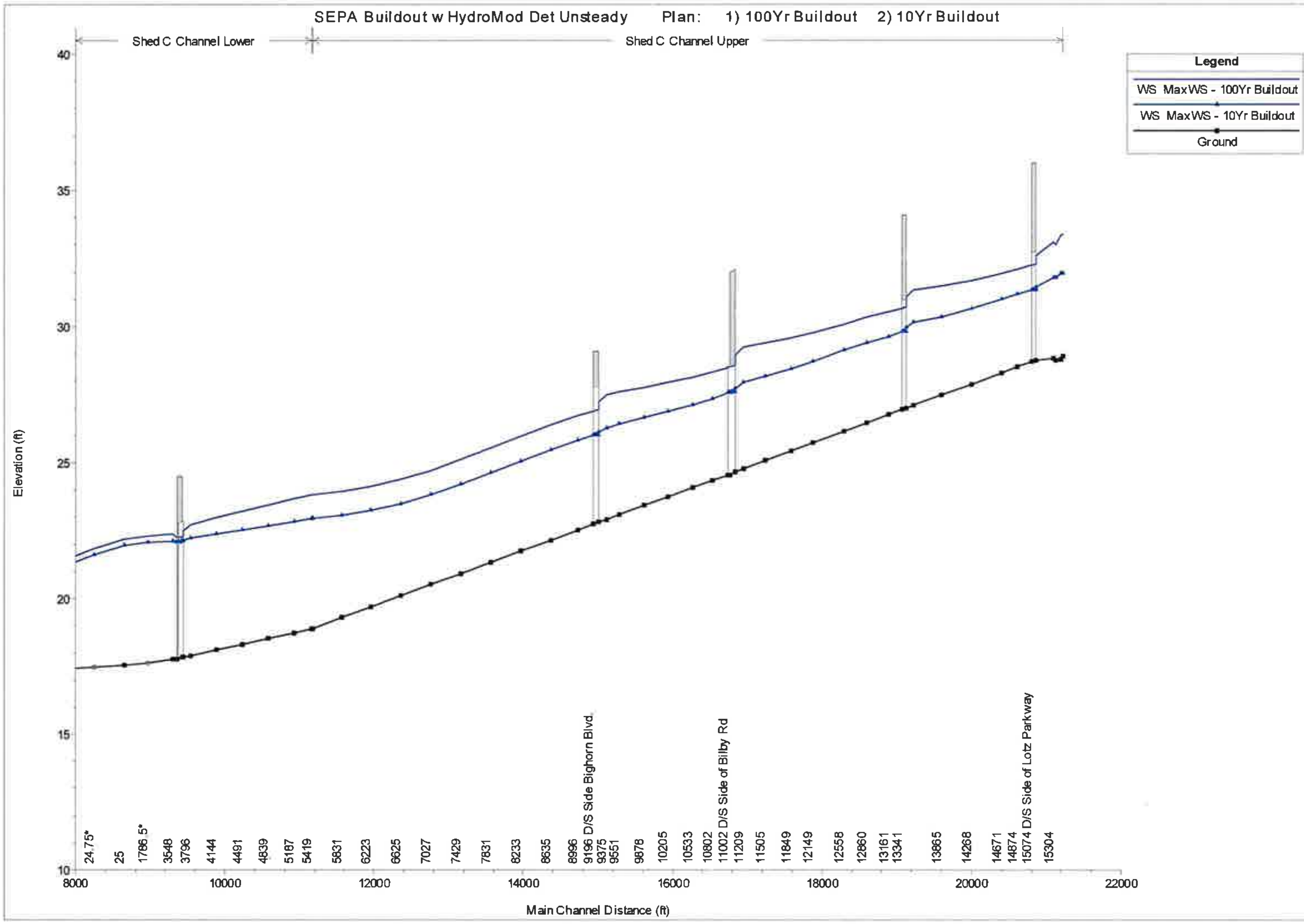


Figure 20. Buildout Water Surface Profiles – Shed C Channel

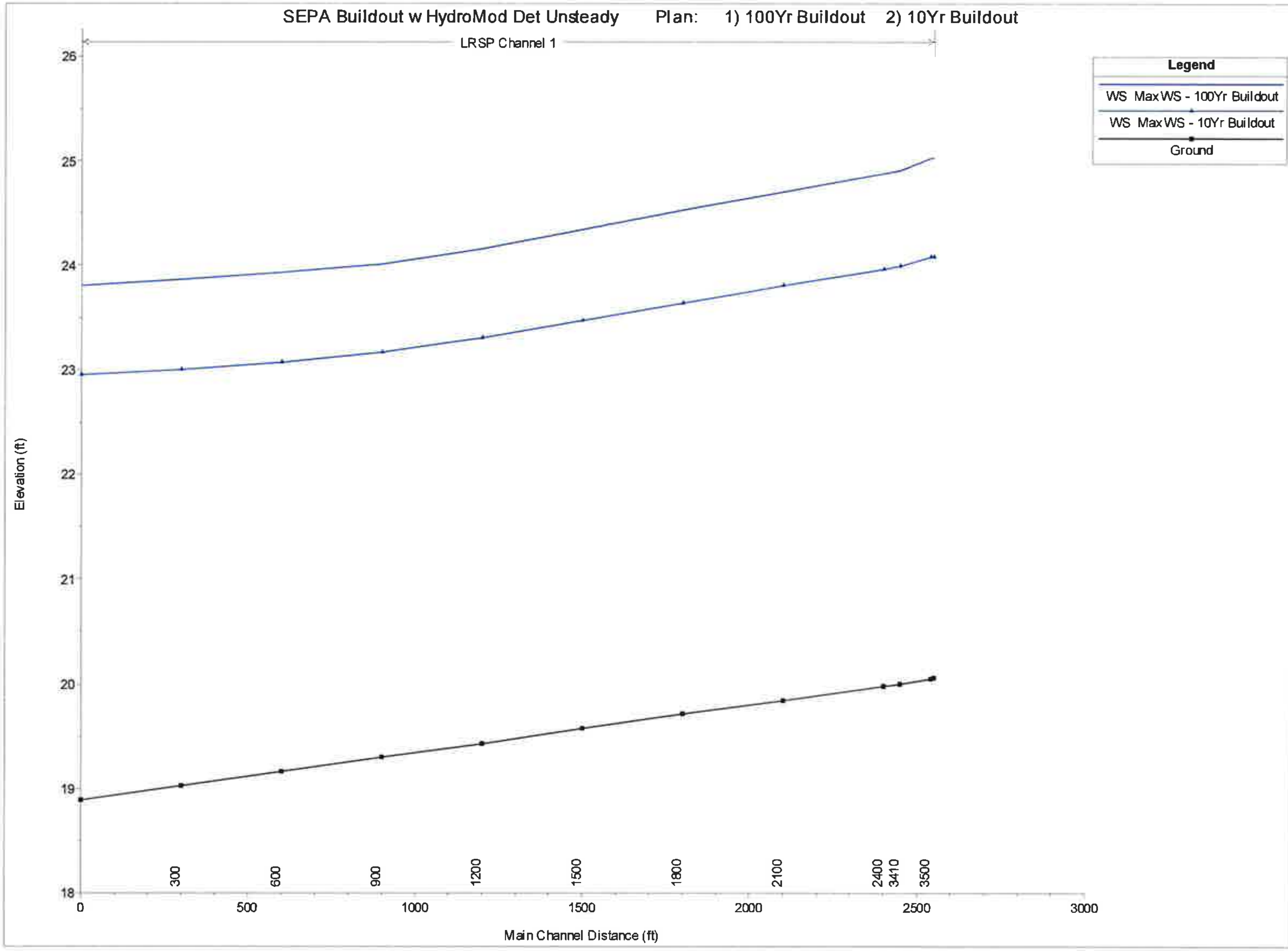
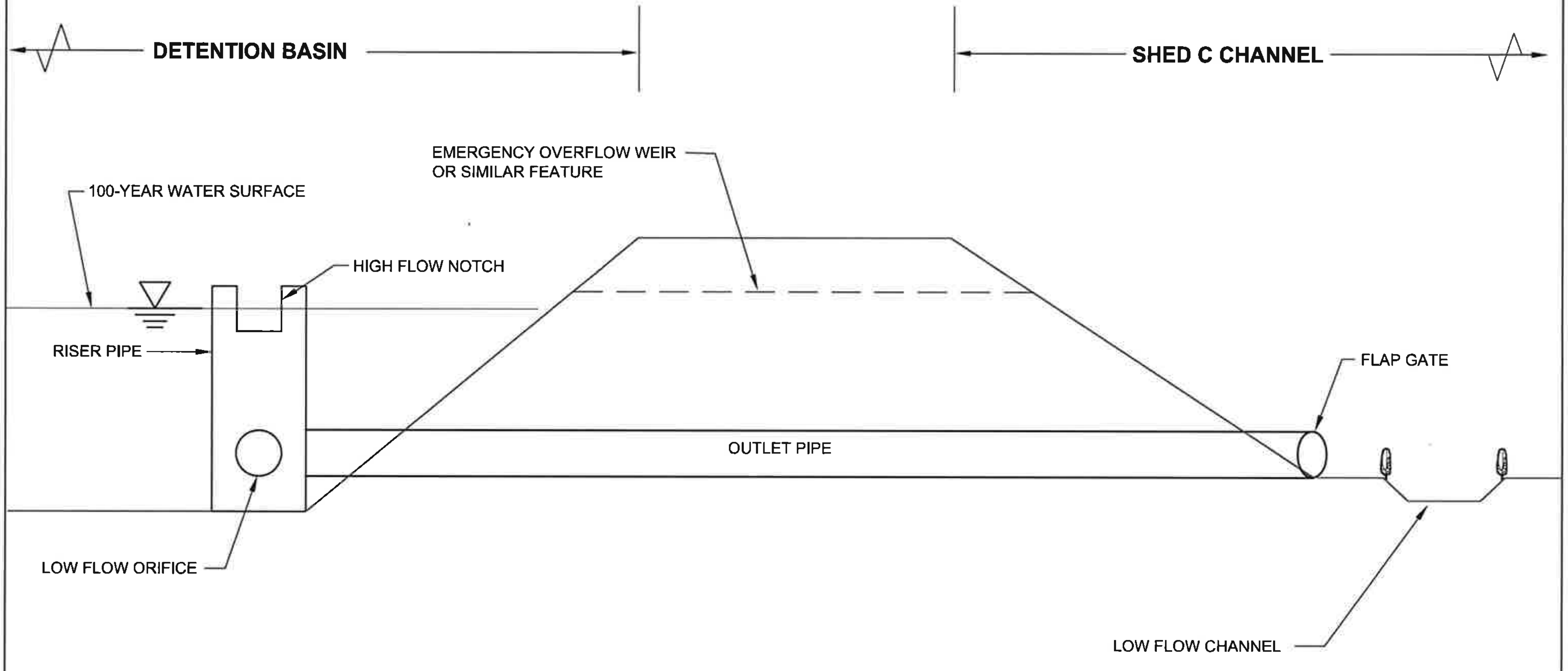


Figure 21. Buildout Water Surface Profiles – Laguna Ridge Specific Plan Channel



City of Elk Grove
SOUTHEAST POLICY AREA
DRAINAGE STUDY
FIGURE 22
TYPICAL DETENTION BASIN OUTLET

WEST YOST ASSOCIATES
Consulting Engineers

ATTACHMENT A

HEC-RAS Output – Pre-Development Conditions

HEC-RAS Profile: Max WS

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
LOCAL C CENTRAL	CENTRAL	5170	Max WS	Pre100	781.98	22.10	25.42		25.43	0.000439	1.57	1289.16	1463.65	0.16
LOCAL C CENTRAL	CENTRAL	5170	Max WS	Pre10	501.02	22.10	25.10		25.11	0.000509	1.57	858.39	1202.65	0.17
LOCAL C CENTRAL	CENTRAL	5122.*	Max WS	Pre100	781.71	22.06	25.40		25.41	0.000495	1.66	1211.56	1378.73	0.17
LOCAL C CENTRAL	CENTRAL	5122.*	Max WS	Pre10	500.60	22.06	25.07		25.08	0.000578	1.66	802.52	1125.56	0.18
LOCAL C CENTRAL	CENTRAL	5074.*	Max WS	Pre100	781.46	22.02	25.37		25.38	0.000559	1.75	1138.05	1298.37	0.18
LOCAL C CENTRAL	CENTRAL	5074.*	Max WS	Pre10	500.26	22.02	25.04		25.05	0.000659	1.76	749.44	1053.77	0.19
LOCAL C CENTRAL	CENTRAL	5026.*	Max WS	Pre100	781.13	21.98	25.34		25.35	0.000643	1.87	1057.29	1210.25	0.19
LOCAL C CENTRAL	CENTRAL	5026.*	Max WS	Pre10	500.04	21.98	25.00		25.02	0.000759	1.87	691.95	966.79	0.21
LOCAL C CENTRAL	CENTRAL	4978.*	Max WS	Pre100	780.82	21.94	25.30		25.32	0.000732	1.98	987.61	1132.23	0.21
LOCAL C CENTRAL	CENTRAL	4978.*	Max WS	Pre10	499.39	21.94	24.97		24.98	0.000853	1.97	643.26	885.38	0.22
LOCAL C CENTRAL	CENTRAL	4930.*	Max WS	Pre100	780.27	21.89	25.26		25.28	0.000847	2.12	913.94	1050.88	0.22
LOCAL C CENTRAL	CENTRAL	4930.*	Max WS	Pre10	499.25	21.89	24.92		24.94	0.000997	2.11	590.92	814.15	0.24
LOCAL C CENTRAL	CENTRAL	4882.*	Max WS	Pre100	779.60	21.85	25.22		25.24	0.001057	2.36	818.09	954.10	0.25
LOCAL C CENTRAL	CENTRAL	4882.*	Max WS	Pre10	498.56	21.85	24.86		24.89	0.001301	2.39	518.84	736.15	0.27
LOCAL C CENTRAL	CENTRAL	4834.*	Max WS	Pre100	778.68	21.81	25.16		25.19	0.001267	2.56	748.53	887.96	0.27
LOCAL C CENTRAL	CENTRAL	4834.*	Max WS	Pre10	498.50	21.81	24.78		24.82	0.001760	2.74	454.64	684.79	0.31
LOCAL C CENTRAL	CENTRAL	4786	Max WS	Pre100	776.50	21.77	25.08		25.12	0.001722	2.95	646.90	796.31	0.31
LOCAL C CENTRAL	CENTRAL	4786	Max WS	Pre10	494.75	21.77	24.65		24.72	0.003081	3.52	350.44	588.93	0.41
LOCAL C CENTRAL	CENTRAL	4785			Culvert									
LOCAL C CENTRAL	CENTRAL	4770	Max WS	Pre100	776.85	21.47	25.07		25.08	0.000296	1.35	1113.27	828.45	0.13
LOCAL C CENTRAL	CENTRAL	4770	Max WS	Pre10	495.46	21.47	24.65		24.66	0.000270	1.17	800.30	686.08	0.13
LOCAL C CENTRAL	CENTRAL	4685	Max WS	Pre100	776.62	21.47	25.04		25.05	0.000259	0.77	1132.38	1175.84	0.11
LOCAL C CENTRAL	CENTRAL	4685	Max WS	Pre10	494.96	21.47	24.63		24.63	0.000325	0.71	728.83	755.51	0.12
LOCAL C CENTRAL	CENTRAL	4190	Max WS	Pre100	777.07	18.79	24.40		24.49	0.001746	3.60	481.93	577.72	0.33
LOCAL C CENTRAL	CENTRAL	4190	Max WS	Pre10	492.61	18.79	24.08		24.16	0.001351	2.98	334.54	358.85	0.28
LOCAL C CENTRAL	CENTRAL	4000	Max WS	Pre100	775.24	17.84	23.93		23.98	0.000280	1.75	646.77	656.79	0.14
LOCAL C CENTRAL	CENTRAL	4000	Max WS	Pre10	491.94	17.84	23.75		23.78	0.000139	1.21	538.05	555.64	0.10
LOCAL C CENTRAL	CENTRAL	3696	Max WS	Pre100	802.18	17.84	23.93		23.98	0.000302	1.82	643.05	653.59	0.15
LOCAL C CENTRAL	CENTRAL	3696	Max WS	Pre10	504.11	17.84	23.75		23.77	0.000146	1.24	536.74	554.31	0.10
LOCAL C CENTRAL	CENTRAL	3695			Culvert									
LOCAL C CENTRAL	CENTRAL	3660	Max WS	Pre100	801.83	16.98	23.54		23.59	0.000441	2.07	691.94	658.10	0.17
LOCAL C CENTRAL	CENTRAL	3660	Max WS	Pre10	503.75	16.98	23.04		23.08	0.000375	1.76	409.99	432.33	0.16
LOCAL C CENTRAL	CENTRAL	3620	Max WS	Pre100	801.72	17.85	23.55		23.56	0.000228	1.40	1221.95	872.99	0.12
LOCAL C CENTRAL	CENTRAL	3620	Max WS	Pre10	503.79	17.85	23.05		23.06	0.000225	1.27	825.92	703.55	0.12
LOCAL C CENTRAL	CENTRAL	3548	Max WS	Pre100	801.51	18.08	23.16	22.07	23.78	0.005737	6.65	193.36	356.79	0.58
LOCAL C CENTRAL	CENTRAL	3548	Max WS	Pre10	503.65	18.08	22.76		23.16	0.003896	5.12	103.79	93.92	0.47
LOCAL C CENTRAL	CENTRAL	1786.5*	Max WS	Pre100	801.03	19.20	22.33		22.33	0.000033	0.32	2544.01	1571.15	0.04
LOCAL C CENTRAL	CENTRAL	1786.5*	Max WS	Pre10	499.18	19.20	22.19		22.19	0.000017	0.22	2327.90	1513.14	0.03
LOCAL C CENTRAL	CENTRAL	25	Max WS	Pre100	799.14	20.33	22.20		22.21	0.000795	0.55	1326.57	3078.87	0.16
LOCAL C CENTRAL	CENTRAL	25	Max WS	Pre10	496.97	20.33	22.07		22.08	0.000791	0.43	948.49	2914.10	0.15
LOCAL C CENTRAL	CENTRAL	24.75*	Max WS	Pre100	795.18	20.06	21.89		21.90	0.000871	0.65	1212.44	2661.62	0.17
LOCAL C CENTRAL	CENTRAL	24.75*	Max WS	Pre10	494.32	20.06	21.74		21.74	0.001077	0.57	812.96	2437.12	0.18
LOCAL C CENTRAL	CENTRAL	24.5*	Max WS	Pre100	792.28	19.78	21.46		21.47	0.001404	0.82	951.02	2177.34	0.21
LOCAL C CENTRAL	CENTRAL	24.5*	Max WS	Pre10	494.26	19.78	21.28		21.30	0.002193	0.78	589.17	1880.74	0.25
LOCAL C CENTRAL	CENTRAL	24.25*	Max WS	Pre100	790.42	19.51	20.85		20.87	0.002688	1.05	782.42	2100.08	0.29
LOCAL C CENTRAL	CENTRAL	24.25*	Max WS	Pre10	493.23	19.51	20.67		20.69	0.002533	1.13	477.63	1229.52	0.29
LOCAL C CENTRAL	CENTRAL	24	Max WS	Pre100	787.43	19.24	20.42		20.43	0.000557	0.61	1404.28	2395.91	0.14
LOCAL C CENTRAL	CENTRAL	24	Max WS	Pre10	490.74	19.24	20.22		20.23	0.000476	0.58	978.44	1885.64	0.13
LOCAL C CENTRAL	CENTRAL	23.5*	Max WS	Pre100	838.07	18.15	19.93		19.94	0.001711	1.04	810.65	1468.16	0.25
LOCAL C CENTRAL	CENTRAL	23.5*	Max WS	Pre10	513.53	18.15	19.74		19.75	0.001646	0.91	562.21	1188.79	0.23
LOCAL C CENTRAL	CENTRAL	23	Max WS	Pre100	830.29	17.05	19.39		19.40	0.000777	0.80	1144.04	1880.59	0.17
LOCAL C CENTRAL	CENTRAL	23	Max WS	Pre10	511.57	17.05	19.17		19.18	0.000881	0.71	758.86	1622.42	0.17
LOCAL C CENTRAL	CENTRAL	22.75*	Max WS	Pre100	824.21	16.91	19.07		19.08	0.000816	0.87	966.77	1355.93	0.18
LOCAL C CENTRAL	CENTRAL	22.75*	Max WS	Pre10	509.52	16.91	18.82		18.83	0.000906	0.79	658.89	1135.20	0.18
LOCAL C CENTRAL	CENTRAL	22.5*	Max WS	Pre100	819.89	16.78	18.75		18.77	0.000793	0.84	984.23	1411.12	0.17
LOCAL C CENTRAL	CENTRAL	22.5*	Max WS	Pre10	507.72	16.78	18.50		18.51	0.000736	0.76	673.06	1053.09	0.17
LOCAL C CENTRAL	CENTRAL	22.25*	Max WS	Pre100	814.04	16.65	18.49		18.50	0.000624	0.81	1032.00	1471.13	0.16
LOCAL C CENTRAL	CENTRAL	22.25*	Max WS	Pre10	504.78	16.65	18.24		18.24	0.000641	0.71	711.24	1120.98	0.15
LOCAL C CENTRAL	CENTRAL	22	Max WS	Pre100	811.46	16.51	18.32		18.32	0.000300	0.62	1543.30	2026.43	0.11
LOCAL C CENTRAL	CENTRAL	22	Max WS	Pre10	502.36	16.51	18.05		18.06	0.000360	0.56	1035.04	1802.09	0.12
LOCAL C CENTRAL	CENTRAL	21.8571*	Max WS	Pre100	905.56	16.20	18.16		18.17	0.000402	0.73	1431.83	1875.77	0.13

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
LOCAL C CENTRAL	CENTRAL	21.8571*	Max WS	Pre10	544.68	16.20	17.88		17.89	0.000467	0.66	936.65	1636.60	0.13
LOCAL C CENTRAL	CENTRAL	21.7142*	Max WS	Pre100	896.18	15.89	17.98		17.99	0.000471	0.78	1297.14	1718.51	0.14
LOCAL C CENTRAL	CENTRAL	21.7142*	Max WS	Pre10	541.12	15.89	17.67		17.67	0.000558	0.72	807.28	1381.31	0.15
LOCAL C CENTRAL	CENTRAL	21.5714*	Max WS	Pre100	890.02	15.58	17.78		17.79	0.000514	0.82	1182.79	1559.22	0.15
LOCAL C CENTRAL	CENTRAL	21.5714*	Max WS	Pre10	537.58	15.58	17.42		17.43	0.000622	0.78	710.32	1049.11	0.16
LOCAL C CENTRAL	CENTRAL	21.4285*	Max WS	Pre100	882.97	15.26	17.56		17.57	0.000541	0.85	1088.76	1382.74	0.15
LOCAL C CENTRAL	CENTRAL	21.4285*	Max WS	Pre10	533.63	15.26	17.15		17.16	0.000691	0.84	641.57	871.54	0.17
LOCAL C CENTRAL	CENTRAL	21.2857*	Max WS	Pre100	820.43	14.95	17.34		17.35	0.000473	0.81	1038.27	1178.64	0.14
LOCAL C CENTRAL	CENTRAL	21.2857*	Max WS	Pre10	527.47	14.95	16.87		16.88	0.000701	0.88	600.52	710.99	0.17
LOCAL C CENTRAL	CENTRAL	21.1428*	Max WS	Pre100	669.91	14.64	17.19		17.19	0.000252	0.62	1102.52	1161.48	0.10
LOCAL C CENTRAL	CENTRAL	21.1428*	Max WS	Pre10	501.85	14.64	16.59		16.60	0.000591	0.86	583.18	626.39	0.16
LOCAL C CENTRAL	CENTRAL	21	Max WS	Pre100	634.38	14.33	17.10		17.11	0.000156	0.51	1276.93	1292.27	0.08
LOCAL C CENTRAL	CENTRAL	21	Max WS	Pre10	377.78	14.33	16.42		16.43	0.000236	0.59	635.82	597.85	0.10
LOCAL C CENTRAL	CENTRAL	20.6666*	Max WS	Pre100	628.01	13.21	17.06		17.06	0.000046	0.29	2176.22	1809.80	0.05
LOCAL C CENTRAL	CENTRAL	20.6666*	Max WS	Pre10	357.76	13.21	16.35		16.36	0.000077	0.33	1093.90	1088.33	0.06
LOCAL C CENTRAL	CENTRAL	20.3333*	Max WS	Pre100	624.77	12.09	17.05		17.05	0.000014	0.18	3519.18	2632.44	0.03
LOCAL C CENTRAL	CENTRAL	20.3333*	Max WS	Pre10	352.12	12.09	16.33		16.33	0.000025	0.18	1923.51	1992.37	0.03
LOCAL C CENTRAL	CENTRAL	20	Max WS	Pre100	623.52	10.97	17.05		17.05	0.000005	0.12	5373.51	3416.40	0.02
LOCAL C CENTRAL	CENTRAL	20	Max WS	Pre10	351.19	10.97	16.33		16.33	0.000006	0.11	3230.56	2588.00	0.02
County Ditch	LENT1	16100	Max WS	Pre100	338.78	28.80	35.58		35.61	0.000153	1.33	255.17	61.12	0.11
County Ditch	LENT1	16100	Max WS	Pre10	205.63	28.80	35.23		35.24	0.000071	0.88	234.31	58.70	0.08
County Ditch	LENT1	15460	Max WS	Pre100	334.68	27.38	35.29		35.35	0.000916	2.30	236.40	239.16	0.22
County Ditch	LENT1	15460	Max WS	Pre10	196.84	27.38	34.91		35.01	0.001099	2.46	80.16	23.21	0.23
County Ditch	LENT1	14710	Max WS	Pre100	286.71	27.08	34.62		34.70	0.000688	2.34	146.32	89.29	0.20
County Ditch	LENT1	14710	Max WS	Pre10	194.73	27.08	34.47		34.51	0.000369	1.68	133.54	85.00	0.14
County Ditch	LENT1	14195	Max WS	Pre100	230.48	29.56	34.50		34.54	0.000573	1.68	136.90	50.71	0.18
County Ditch	LENT1	14195	Max WS	Pre10	189.49	29.56	34.27		34.30	0.000474	1.51	125.61	47.51	0.16
County Ditch	LENT1	13535	Max WS	Pre100	230.37	28.93	33.89		33.97	0.001717	2.39	96.37	33.40	0.25
County Ditch	LENT1	13535	Max WS	Pre10	189.27	28.93	33.58		33.66	0.001555	2.19	86.47	31.77	0.23
County Ditch	LENT1	13000	Max WS	Pre100	230.33	27.82	33.36		33.39	0.000472	1.48	189.43	105.92	0.13
County Ditch	LENT1	13000	Max WS	Pre10	188.59	27.82	33.09		33.11	0.000473	1.41	162.83	91.04	0.13
County Ditch	LENT1	12810	Max WS	Pre100	227.88	27.31	33.15		33.24	0.001330	2.44	102.75	73.48	0.22
County Ditch	LENT1	12810	Max WS	Pre10	187.44	27.31	32.90		32.98	0.001145	2.19	87.89	47.79	0.20
County Ditch	LENT1	11995	Max WS	Pre100	411.68	26.38	32.54		32.55	0.000268	0.86	680.31	727.57	0.08
County Ditch	LENT1	11995	Max WS	Pre10	319.64	26.38	32.15		32.17	0.000794	1.40	294.15	264.58	0.14
County Ditch	LENT1	11530	Max WS	Pre100	411.37	26.37	31.82		31.95	0.002373	2.86	143.93	36.66	0.25
County Ditch	LENT1	11530	Max WS	Pre10	319.44	26.37	31.43		31.53	0.001883	2.45	130.12	35.07	0.22
County Ditch	LENT1	10915	Max WS	Pre100	408.89	23.64	30.61		30.67	0.001856	2.07	250.99	270.99	0.22
County Ditch	LENT1	10915	Max WS	Pre10	319.35	23.64	30.44		30.49	0.001625	1.91	205.52	235.94	0.20
County Ditch	LENT1	10570	Max WS	Pre100	400.04	19.63	30.39		30.40	0.000008	0.31	1537.50	544.12	0.02
County Ditch	LENT1	10570	Max WS	Pre10	319.31	19.63	30.25		30.25	0.000006	0.26	1458.94	517.81	0.02
County Ditch	LENT1	10040	Max WS	Pre100	532.00	25.08	30.10		30.12	0.001010	1.62	520.52	722.12	0.16
County Ditch	LENT1	10040	Max WS	Pre10	389.92	25.08	30.06		30.08	0.000620	1.26	493.02	705.56	0.13
County Ditch	LENT1	10030			Culvert									
County Ditch	LENT1	10000	Max WS	Pre100	532.92	25.08	30.04		30.07	0.001243	1.77	475.01	681.99	0.18
County Ditch	LENT1	10000	Max WS	Pre10	388.48	25.08	29.94		30.00	0.002543	2.49	245.24	427.05	0.26
County Ditch	LENT1	9730	Max WS	Pre100	530.48	25.38	29.66		29.68	0.001690	1.62	491.00	867.33	0.20
County Ditch	LENT1	9730	Max WS	Pre10	387.32	25.38	29.50		29.52	0.001995	1.67	356.88	750.53	0.21
County Ditch	LENT1	9260	Max WS	Pre100	525.40	22.91	29.20		29.24	0.000888	1.87	415.25	529.97	0.16
County Ditch	LENT1	9260	Max WS	Pre10	379.74	22.91	29.03		29.06	0.000632	1.55	335.96	419.95	0.13
County Ditch	LENT1	8885	Max WS	Pre100	523.23	23.62	29.06		29.07	0.000179	0.72	1019.92	1036.55	0.07
County Ditch	LENT1	8885	Max WS	Pre10	378.03	23.62	28.93		28.94	0.000129	0.60	891.30	959.92	0.06
County Ditch	LENT1	8755	Max WS	Pre100	522.84	26.30	29.02		29.03	0.000448	0.73	898.37	1330.51	0.10
County Ditch	LENT1	8755	Max WS	Pre10	377.78	26.30	28.90		28.90	0.000377	0.63	745.63	1195.96	0.09
County Ditch	LENT1	8266	Max WS	Pre100	522.90	26.20	28.80		28.81	0.000532	0.72	1014.39	2170.13	0.11
County Ditch	LENT1	8266	Max WS	Pre10	371.64	26.20	28.71		28.71	0.000458	0.63	822.77	1938.62	0.10
County Ditch	LENT1	8265			Culvert									
County Ditch	LENT1	8245	Max WS	Pre100	522.90	25.85	28.80		28.81	0.000375	1.34	710.64	560.19	0.15
County Ditch	LENT1	8245	Max WS	Pre10	371.26	25.85	28.71		28.71	0.000235	1.03	660.23	553.58	0.12
County Ditch	LENT1	8015	Max WS	Pre100	522.17	25.90	28.58		28.62	0.002420	2.28	538.10	1567.20	0.34
County Ditch	LENT1	8015	Max WS	Pre10	381.21	25.90	28.43		28.49	0.003235	2.45	333.79	1183.29	0.39

HEC-RAS Profile: Max WS **(Continued)**

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
County Ditch	LENT1	7850	Max WS	Pre100	517.87	25.90	28.21		28.25	0.002207	2.63	608.17	1889.32	0.34
County Ditch	LENT1	7850	Max WS	Pre10	368.03	25.90	28.03		28.07	0.001988	2.33	365.85	783.82	0.32
County Ditch	LENT1	7405	Max WS	Pre100	427.85	24.67	27.71		27.71	0.000200	0.95	1293.70	2018.88	0.11
County Ditch	LENT1	7405	Max WS	Pre10	364.22	24.67	27.36		27.37	0.000687	1.60	689.61	1456.97	0.19
County Ditch	LENT1	7195	Max WS	Pre100	385.74	24.38	27.67		27.67	0.000159	0.92	953.60	980.00	0.10
County Ditch	LENT1	7195	Max WS	Pre10	336.31	24.38	27.23		27.24	0.000542	1.52	538.61	841.96	0.17
County Ditch	LENT1	7080	Max WS	Pre100	341.06	24.25	27.63		27.64	0.000152	0.92	751.25	616.00	0.09
County Ditch	LENT1	7080	Max WS	Pre10	334.12	24.25	27.13		27.15	0.000695	1.74	442.32	616.00	0.20
County Ditch	LENT1	7079			Culvert									
County Ditch	LENT1	7040	Max WS	Pre100	341.06	23.50	27.63		27.63	0.000005	0.20	3895.33	2900.00	0.02
County Ditch	LENT1	7040	Max WS	Pre10	334.38	23.50	27.14		27.14	0.000023	0.36	2451.34	2900.00	0.04
County Ditch	LENT1	6855	Max WS	Pre100	281.39	23.71	27.63		27.63	0.000007	0.22	2708.09	1750.00	0.02
County Ditch	LENT1	6855	Max WS	Pre10	334.22	23.71	27.13		27.13	0.000033	0.43	1833.76	1750.00	0.04
County Ditch	LENT1	6715	Max WS	Pre100	292.22	23.08	27.62		27.62	0.000039	0.56	1291.88	1100.34	0.05
County Ditch	LENT1	6715	Max WS	Pre10	334.17	23.08	27.11		27.12	0.000146	0.99	818.95	765.83	0.09
County Ditch	LENT1	6350	Max WS	Pre100	547.49	23.08	26.03		26.28	0.008286	5.78	243.31	484.57	0.66
County Ditch	LENT1	6350	Max WS	Pre10	332.87	23.08	25.86		26.07	0.006538	4.87	165.50	388.66	0.58
County Ditch	LENT1	6349			Culvert									
County Ditch	LENT1	6327	Max WS	Pre100	522.87	20.08	25.95		25.98	0.000205	1.42	560.41	379.06	0.12
County Ditch	LENT1	6327	Max WS	Pre10	332.52	20.08	25.74		25.76	0.000108	1.00	483.28	350.97	0.09
County Ditch	LENT1	6167	Max WS	Pre100	513.71	21.29	25.70		25.78	0.002610	3.52	406.94	849.83	0.38
County Ditch	LENT1	6167	Max WS	Pre10	331.55	21.29	25.44		25.56	0.003173	3.63	225.79	558.98	0.41
County Ditch	LENT1	5685	Max WS	Pre100	505.82	20.80	25.49		25.50	0.000182	1.13	1003.30	1018.06	0.11
County Ditch	LENT1	5685	Max WS	Pre10	329.76	20.80	25.17		25.18	0.000152	0.97	715.24	775.44	0.10
County Ditch	LENT1	5427.5*	Max WS	Pre100	492.73	21.45	25.42		25.43	0.000265	1.30	1014.25	1220.86	0.13
County Ditch	LENT1	5427.5*	Max WS	Pre10	342.88	21.45	25.10		25.10	0.000312	1.31	676.95	914.45	0.14

ATTACHMENT B

HEC-RAS Output – Buildout Conditions

HEC-RAS Profile: Max WS

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Shed C Channel	Upper	16230	Max WS	100Yr Final	0.00	28.89	33.37		33.37	0.000000	0.00	80.92	18.12	0.00
Shed C Channel	Upper	16230	Max WS	10Yr Final	0.00	28.89	31.96		31.96	0.000000	0.00	55.46	18.09	0.00
Shed C Channel	Upper	16225	Max WS	100Yr Final	0.00	28.89	33.37		33.37	0.000000	0.00	80.92	18.12	0.00
Shed C Channel	Upper	16225	Max WS	10Yr Final	0.00	28.89	31.96		31.96	0.000000	0.00	55.46	18.09	0.00
Shed C Channel	Upper	16220			Lat Struct									
Shed C Channel	Upper	16200	Max WS	100Yr Final	0.00	28.78	33.37		33.37	0.000000	0.00	82.91	18.13	0.00
Shed C Channel	Upper	16200	Max WS	10Yr Final	0.00	28.78	31.96		31.96	0.000000	0.00	57.45	18.09	0.00
Shed C Channel	Upper	16125	Max WS	100Yr Final	271.26	28.73	32.98		33.18	0.000308	3.53	76.82	18.12	0.30
Shed C Channel	Upper	16125	Max WS	10Yr Final	133.84	28.73	31.78		31.87	0.000201	2.44	54.95	18.08	0.25
Shed C Channel	Upper	15304	Max WS	100Yr Final	271.64	28.80	33.09		33.16	0.000687	2.18	124.41	43.79	0.23
Shed C Channel	Upper	15304	Max WS	10Yr Final	133.88	28.80	31.81		31.86	0.000691	1.81	74.08	34.89	0.22
Shed C Channel	Upper	15128	Max WS	100Yr Final	270.04	28.75	32.60		32.86	0.002050	4.13	65.39	130.57	0.37
Shed C Channel	Upper	15128	Max WS	10Yr Final	133.51	28.75	31.47		31.60	0.001593	2.89	46.23	121.55	0.31
Shed C Channel	Upper	15100			Culvert									
Shed C Channel	Upper	15074	Max WS	100Yr Final	265.21	28.70	32.25		32.55	0.002585	4.40	60.34	128.20	0.41
Shed C Channel	Upper	15074	Max WS	10Yr Final	133.36	28.70	31.33		31.47	0.001776	2.98	44.71	120.84	0.32
Shed C Channel	Upper	14874	Max WS	100Yr Final	263.11	28.50	32.10		32.13	0.000519	1.82	251.85	128.58	0.18
Shed C Channel	Upper	14874	Max WS	10Yr Final	133.11	28.50	31.17		31.20	0.000620	1.59	135.61	121.14	0.18
Shed C Channel	Upper	14671	Max WS	100Yr Final	326.22	28.29	31.95		32.00	0.000735	2.20	259.66	129.04	0.21
Shed C Channel	Upper	14671	Max WS	10Yr Final	169.14	28.29	30.99		31.04	0.000945	1.98	139.06	121.35	0.23
Shed C Channel	Upper	14268	Max WS	100Yr Final	323.18	27.88	31.69		31.73	0.000596	2.04	278.86	130.27	0.19
Shed C Channel	Upper	14268	Max WS	10Yr Final	167.75	27.88	30.63		30.68	0.000830	1.88	146.11	121.84	0.21
Shed C Channel	Upper	13865	Max WS	100Yr Final	321.80	27.47	31.48		31.52	0.000461	1.86	305.40	131.86	0.17
Shed C Channel	Upper	13865	Max WS	10Yr Final	167.16	27.47	30.34		30.38	0.000660	1.74	160.50	122.76	0.19
Shed C Channel	Upper	13495	Max WS	100Yr Final	321.33	27.10	31.33		31.36	0.000356	1.70	335.07	133.66	0.15
Shed C Channel	Upper	13495	Max WS	10Yr Final	166.96	27.10	30.13		30.16	0.000493	1.56	180.70	124.08	0.17
Shed C Channel	Upper	13400			Lat Struct									
Shed C Channel	Upper	13395	Max WS	100Yr Final	363.33	27.00	31.09		31.32	0.001657	3.87	94.00	132.50	0.34
Shed C Channel	Upper	13395	Max WS	10Yr Final	187.16	27.00	29.97		30.09	0.001272	2.74	68.35	123.57	0.28
Shed C Channel	Upper	13368			Culvert									
Shed C Channel	Upper	13341	Max WS	100Yr Final	359.83	26.94	30.66		30.96	0.002429	4.40	81.86	138.14	0.40
Shed C Channel	Upper	13341	Max WS	10Yr Final	186.89	26.94	29.79		29.93	0.001591	2.98	62.72	131.20	0.31
Shed C Channel	Upper	13161	Max WS	100Yr Final	358.58	26.76	30.54		30.60	0.000779	2.28	267.39	138.65	0.22
Shed C Channel	Upper	13161	Max WS	10Yr Final	186.65	26.76	29.64		29.69	0.000882	1.97	145.71	131.43	0.22
Shed C Channel	Upper	12860	Max WS	100Yr Final	356.61	26.45	30.32		30.38	0.000679	2.17	280.72	139.40	0.21
Shed C Channel	Upper	12860	Max WS	10Yr Final	186.34	26.45	29.39		29.44	0.000780	1.89	154.11	131.93	0.21
Shed C Channel	Upper	12670			Lat Struct									
Shed C Channel	Upper	12558	Max WS	100Yr Final	410.41	26.14	30.08		30.14	0.000829	2.43	289.55	139.86	0.23
Shed C Channel	Upper	12558	Max WS	10Yr Final	215.57	26.14	29.11		29.17	0.000999	2.15	157.34	132.12	0.24
Shed C Channel	Upper	12149	Max WS	100Yr Final	405.79	25.73	29.77		29.83	0.000716	2.30	303.61	140.71	0.21
Shed C Channel	Upper	12149	Max WS	10Yr Final	214.36	25.73	28.71		28.77	0.000957	2.11	159.65	132.27	0.23
Shed C Channel	Upper	11849	Max WS	100Yr Final	403.96	25.42	29.57		29.62	0.000618	2.18	319.81	141.61	0.20
Shed C Channel	Upper	11849	Max WS	10Yr Final	213.54	25.42	28.44		28.50	0.000864	2.05	164.88	132.58	0.22
Shed C Channel	Upper	11505	Max WS	100Yr Final	402.95	25.07	29.38		29.43	0.000511	2.04	342.74	142.89	0.18
Shed C Channel	Upper	11505	Max WS	10Yr Final	212.90	25.07	28.16		28.21	0.000778	1.96	174.13	133.13	0.21
Shed C Channel	Upper	11209	Max WS	100Yr Final	402.69	24.77	29.25		29.29	0.000426	1.92	366.51	144.22	0.17
Shed C Channel	Upper	11209	Max WS	10Yr Final	212.69	24.77	27.95		28.00	0.000665	1.85	186.35	133.86	0.20
Shed C Channel	Upper	11109	Max WS	100Yr Final	402.40	24.67	28.93		29.28	0.002341	4.72	85.20	142.47	0.40
Shed C Channel	Upper	11109	Max WS	10Yr Final	212.54	24.67	27.72		27.91	0.001992	3.49	60.97	132.78	0.35
Shed C Channel	Upper	11055			Culvert									
Shed C Channel	Upper	11002	Max WS	100Yr Final	401.66	24.56	28.49		28.89	0.003060	5.11	78.54	139.84	0.45
Shed C Channel	Upper	11002	Max WS	10Yr Final	212.31	24.56	27.55		27.74	0.002129	3.55	59.73	132.30	0.36
Shed C Channel	Upper	10802	Max WS	100Yr Final	401.38	24.36	28.33		28.39	0.000766	2.35	293.42	140.15	0.22
Shed C Channel	Upper	10802	Max WS	10Yr Final	212.07	24.36	27.35		27.40	0.000932	2.09	160.01	132.30	0.23
Shed C Channel	Upper	10533	Max WS	100Yr Final	401.10	24.08	28.13		28.19	0.000686	2.26	305.95	140.85	0.21
Shed C Channel	Upper	10533	Max WS	10Yr Final	211.84	24.08	27.11		27.16	0.000860	2.03	165.74	132.64	0.22

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Shed C Channel	Upper	10205	Max WS	100Yr Final	400.97	23.75	27.93		27.98	0.000569	2.14	323.89	141.85	0.20
Shed C Channel	Upper	10205	Max WS	10Yr Final	211.71	23.75	26.85		26.90	0.000758	1.94	175.34	133.21	0.21
Shed C Channel	Upper	9878	Max WS	100Yr Final	400.96	23.42	27.76		27.80	0.000492	2.01	346.41	143.10	0.18
Shed C Channel	Upper	9878	Max WS	10Yr Final	211.70	23.42	26.63		26.67	0.000629	1.81	190.03	134.08	0.19
Shed C Channel	Upper	9600			Lat Struct									
Shed C Channel	Upper	9551	Max WS	100Yr Final	438.74	23.09	27.59		27.64	0.000494	2.07	369.67	144.47	0.18
Shed C Channel	Upper	9551	Max WS	10Yr Final	230.57	23.09	26.42		26.47	0.000612	1.84	206.67	135.10	0.19
Shed C Channel	Upper	9400			Lat Struct									
Shed C Channel	Upper	9375	Max WS	100Yr Final	532.57	22.91	27.46		27.53	0.000690	2.47	377.20	144.86	0.21
Shed C Channel	Upper	9375	Max WS	10Yr Final	280.28	22.91	26.27		26.33	0.000867	2.20	210.32	135.31	0.23
Shed C Channel	Upper	9275	Max WS	100Yr Final	571.72	22.81	27.22		27.44	0.001462	3.82	149.78	143.67	0.32
Shed C Channel	Upper	9275	Max WS	10Yr Final	299.68	22.81	26.12		26.23	0.001040	2.66	112.59	134.91	0.26
Shed C Channel	Upper	9235			Culvert									
Shed C Channel	Upper	9196	Max WS	100Yr Final	570.76	22.73	26.87		27.13	0.001790	4.05	140.81	158.55	0.35
Shed C Channel	Upper	9196	Max WS	10Yr Final	299.46	22.73	25.97		26.09	0.001112	2.71	110.30	151.36	0.27
Shed C Channel	Upper	8996	Max WS	100Yr Final	570.40	22.52	26.73		26.81	0.001031	2.85	361.55	159.03	0.26
Shed C Channel	Upper	8996	Max WS	10Yr Final	299.22	22.52	25.81		25.87	0.001028	2.36	218.61	151.68	0.25
Shed C Channel	Upper	8635	Max WS	100Yr Final	569.47	22.15	26.36		26.44	0.001027	2.84	361.53	159.05	0.26
Shed C Channel	Upper	8635	Max WS	10Yr Final	298.69	22.15	25.44		25.51	0.001018	2.35	219.15	151.72	0.25
Shed C Channel	Upper	8233	Max WS	100Yr Final	568.50	21.75	25.94		26.02	0.001043	2.86	359.03	158.92	0.26
Shed C Channel	Upper	8233	Max WS	10Yr Final	298.21	21.75	25.03		25.10	0.001030	2.36	217.75	151.65	0.25
Shed C Channel	Upper	7831	Max WS	100Yr Final	567.59	21.34	25.52		25.60	0.001053	2.87	357.35	158.89	0.26
Shed C Channel	Upper	7831	Max WS	10Yr Final	297.81	21.34	24.62		24.68	0.001033	2.36	217.27	151.65	0.25
Shed C Channel	Upper	7429	Max WS	100Yr Final	566.65	20.93	25.09		25.18	0.001072	2.88	354.54	158.72	0.26
Shed C Channel	Upper	7429	Max WS	10Yr Final	297.57	20.93	24.20		24.27	0.001043	2.37	216.23	151.58	0.25
Shed C Channel	Upper	7027	Max WS	100Yr Final	565.52	20.52	24.65		24.74	0.001105	2.91	350.05	158.45	0.27
Shed C Channel	Upper	7027	Max WS	10Yr Final	297.49	20.52	23.78		23.85	0.001066	2.39	214.22	151.45	0.25
Shed C Channel	Upper	6625	Max WS	100Yr Final	564.52	20.11	24.32		24.37	0.000681	2.32	491.31	223.14	0.21
Shed C Channel	Upper	6625	Max WS	10Yr Final	297.45	20.11	23.44		23.48	0.000716	1.99	297.26	216.06	0.21
Shed C Channel	Upper	6250			Lat Struct									
Shed C Channel	Upper	6223	Max WS	100Yr Final	583.85	19.70	24.07		24.11	0.000603	2.24	525.52	224.32	0.20
Shed C Channel	Upper	6223	Max WS	10Yr Final	310.17	19.70	23.18		23.21	0.000601	1.88	329.37	217.22	0.19
Shed C Channel	Upper	5831	Max WS	100Yr Final	583.82	19.30	23.86		23.89	0.000482	2.07	568.74	225.86	0.18
Shed C Channel	Upper	5831	Max WS	10Yr Final	309.27	19.30	22.98		23.01	0.000430	1.66	373.76	218.84	0.16
Shed C Channel	Upper	5439	Max WS	100Yr Final	583.71	18.90	23.69		23.72	0.000372	1.89	622.47	227.75	0.16
Shed C Channel	Upper	5439	Max WS	10Yr Final	306.31	18.90	22.84		22.86	0.000286	1.43	431.83	220.96	0.13
Shed C Channel	Lower	5419	Max WS	100Yr Final	735.01	18.88	23.69		23.75	0.000576	2.35	586.77	225.54	0.20
Shed C Channel	Lower	5419	Max WS	10Yr Final	391.32	18.88	22.84		22.88	0.000453	1.81	398.02	218.73	0.17
Shed C Channel	Lower	5187	Max WS	100Yr Final	734.48	18.74	23.56		23.62	0.000571	2.34	588.34	225.52	0.20
Shed C Channel	Lower	5187	Max WS	10Yr Final	390.82	18.74	22.74		22.78	0.000428	1.77	406.54	219.00	0.17
Shed C Channel	Lower	5185			Lat Struct									
Shed C Channel	Lower	4839	Max WS	100Yr Final	753.80	18.54	23.35		23.41	0.000607	2.41	586.55	225.58	0.20
Shed C Channel	Lower	4839	Max WS	10Yr Final	401.48	18.54	22.60		22.63	0.000422	1.77	417.88	219.49	0.16
Shed C Channel	Lower	4491	Max WS	100Yr Final	753.53	18.33	23.14		23.20	0.000607	2.41	586.28	225.52	0.20
Shed C Channel	Lower	4491	Max WS	10Yr Final	400.76	18.33	22.46		22.49	0.000382	1.71	433.68	220.04	0.16
Shed C Channel	Lower	4144	Max WS	100Yr Final	753.36	18.12	22.93		22.99	0.000607	2.41	586.16	225.47	0.20
Shed C Channel	Lower	4144	Max WS	10Yr Final	400.17	18.12	22.33		22.36	0.000341	1.64	452.73	220.69	0.15
Shed C Channel	Lower	3800			Lat Struct									
Shed C Channel	Lower	3796	Max WS	100Yr Final	760.13	17.91	22.72		22.78	0.000621	2.44	585.20	225.50	0.21
Shed C Channel	Lower	3796	Max WS	10Yr Final	402.26	17.91	22.22		22.25	0.000304	1.58	474.75	221.54	0.14
Shed C Channel	Lower	3696	Max WS	100Yr Final	771.61	17.85	22.48		22.71	0.001551	3.78	203.89	237.07	0.31
Shed C Channel	Lower	3696	Max WS	10Yr Final	407.19	17.85	22.14		22.21	0.000558	2.16	188.84	234.33	0.18
Shed C Channel	Lower	3695			Culvert									
Shed C Channel	Lower	3596	Max WS	100Yr Final	767.57	17.77	22.25		22.51	0.001635	4.08	188.10	242.80	0.34
Shed C Channel	Lower	3596	Max WS	10Yr Final	405.76	17.77	22.08		22.16	0.000520	2.24	180.94	241.43	0.19
Shed C Channel	Lower	3548	Max WS	100Yr Final	770.96	17.77	22.36		22.42	0.000589	2.33	520.43	243.71	0.19

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Shed C Channel	Lower	3548	Max WS	10Yr Final	406.45	17.77	22.11		22.13	0.000229	1.40	459.12	241.69	0.12
Shed C Channel	Lower	1786.5*	Max WS	100Yr Final	769.86	17.62	22.28		22.28	0.000032	0.31	2497.95	1551.72	0.04
Shed C Channel	Lower	1786.5*	Max WS	10Yr Final	405.76	17.62	22.08		22.08	0.000013	0.19	2189.89	1446.05	0.03
Shed C Channel	Lower	25	Max WS	100Yr Final	767.58	17.55	22.17		22.18	0.000761	0.54	1306.33	3043.54	0.15
Shed C Channel	Lower	25	Max WS	10Yr Final	405.21	17.55	21.95		21.95	0.001102	0.45	672.87	2362.82	0.17
Shed C Channel	Lower	24.75*	Max WS	100Yr Final	765.56	17.48	21.84		21.85	0.000996	0.67	1123.40	2597.67	0.18
Shed C Channel	Lower	24.75*	Max WS	10Yr Final	404.73	17.48	21.62		21.63	0.001950	0.62	567.35	2283.57	0.23
Shed C Channel	Lower	24.5*	Max WS	100Yr Final	763.79	17.40	21.41		21.42	0.001672	0.86	868.78	2071.60	0.23
Shed C Channel	Lower	24.5*	Max WS	10Yr Final	404.44	17.40	21.14		21.16	0.003371	0.95	388.21	1252.98	0.31
Shed C Channel	Lower	24.25*	Max WS	100Yr Final	763.22	17.32	20.81		20.83	0.002507	1.05	758.25	1957.84	0.28
Shed C Channel	Lower	24.25*	Max WS	10Yr Final	403.73	17.32	20.50		20.53	0.004140	1.19	338.15	1045.86	0.35
Shed C Channel	Lower	24	Max WS	100Yr Final	763.18	17.24	20.37		20.38	0.000669	0.66	1284.58	2307.85	0.15
Shed C Channel	Lower	24	Max WS	10Yr Final	402.97	17.24	20.09		20.10	0.000695	0.60	742.58	1717.37	0.15
Shed C Channel	Lower	23.5*	Max WS	100Yr Final	815.53	17.15	19.92		19.94	0.001592	1.00	814.08	1463.97	0.24
Shed C Channel	Lower	23.5*	Max WS	10Yr Final	429.21	17.15	19.65		19.66	0.001966	0.92	467.46	1120.82	0.25
Shed C Channel	Lower	23	Max WS	100Yr Final	812.70	17.05	19.40		19.41	0.000866	1.66	1162.35	1888.99	0.21
Shed C Channel	Lower	23	Max WS	10Yr Final	428.32	17.05	19.10		19.11	0.000929	1.53	654.12	1549.46	0.21
Shed C Channel	Lower	22.75*	Max WS	100Yr Final	810.19	16.91	19.06		19.07	0.000813	0.86	956.02	1328.36	0.18
Shed C Channel	Lower	22.75*	Max WS	10Yr Final	427.23	16.91	18.74		18.75	0.000944	0.76	574.10	1079.69	0.18
Shed C Channel	Lower	22.5*	Max WS	100Yr Final	808.34	16.78	18.75		18.76	0.000787	0.83	976.58	1406.25	0.17
Shed C Channel	Lower	22.5*	Max WS	10Yr Final	425.92	16.78	18.42		18.43	0.000726	0.72	589.79	970.47	0.16
Shed C Channel	Lower	22.25*	Max WS	100Yr Final	806.15	16.65	18.49		18.50	0.000618	0.80	1028.35	1467.11	0.16
Shed C Channel	Lower	22.25*	Max WS	10Yr Final	423.36	16.65	18.16		18.17	0.000630	0.67	630.93	1044.01	0.15
Shed C Channel	Lower	22	Max WS	100Yr Final	805.06	16.51	18.32		18.32	0.000296	0.61	1541.58	2025.84	0.11
Shed C Channel	Lower	22	Max WS	10Yr Final	421.58	16.51	17.98		17.99	0.000343	0.53	910.57	1643.71	0.11
Shed C Channel	Lower	21.8571*	Max WS	100Yr Final	905.35	16.20	18.16		18.17	0.000402	0.73	1431.74	1875.73	0.13
Shed C Channel	Lower	21.8571*	Max WS	10Yr Final	468.55	16.20	17.81		17.82	0.000467	0.63	831.43	1515.06	0.13
Shed C Channel	Lower	21.7142*	Max WS	100Yr Final	897.50	15.89	17.98		17.99	0.000474	0.78	1295.97	1718.12	0.14
Shed C Channel	Lower	21.7142*	Max WS	10Yr Final	466.41	15.89	17.60		17.60	0.000551	0.69	716.33	1255.76	0.15
Shed C Channel	Lower	21.5714*	Max WS	100Yr Final	889.89	15.58	17.78		17.79	0.000517	0.82	1179.64	1558.21	0.15
Shed C Channel	Lower	21.5714*	Max WS	10Yr Final	464.55	15.58	17.34		17.35	0.000641	0.76	626.22	974.84	0.16
Shed C Channel	Lower	21.4285*	Max WS	100Yr Final	884.37	15.26	17.56		17.57	0.000549	0.86	1083.34	1378.14	0.15
Shed C Channel	Lower	21.4285*	Max WS	10Yr Final	462.35	15.26	17.05		17.06	0.000734	0.83	556.47	748.60	0.17
Shed C Channel	Lower	21.2857*	Max WS	100Yr Final	838.68	14.95	17.32		17.33	0.000520	0.84	1017.77	1167.80	0.15
Shed C Channel	Lower	21.2857*	Max WS	10Yr Final	459.69	14.95	16.74		16.76	0.000735	0.89	517.79	624.98	0.17
Shed C Channel	Lower	21.1428*	Max WS	100Yr Final	661.52	14.64	17.15		17.16	0.000268	0.63	1064.42	1120.77	0.11
Shed C Channel	Lower	21.1428*	Max WS	10Yr Final	405.60	14.64	16.47		16.48	0.000488	0.79	512.02	539.13	0.14
Shed C Channel	Lower	21	Max WS	100Yr Final	604.43	14.33	17.07		17.07	0.000155	0.50	1232.49	1262.26	0.08
Shed C Channel	Lower	21	Max WS	10Yr Final	347.41	14.33	16.31		16.32	0.000247	0.61	574.18	543.21	0.10
Shed C Channel	Lower	20.6666*	Max WS	100Yr Final	593.95	13.21	17.03		17.03	0.000045	0.28	2114.52	1796.49	0.05
Shed C Channel	Lower	20.6666*	Max WS	10Yr Final	336.18	13.21	16.24		16.24	0.000065	0.34	975.62	969.45	0.06
Shed C Channel	Lower	20.3333*	Max WS	100Yr Final	589.74	12.09	17.02		17.02	0.000013	0.17	3432.72	2482.06	0.03
Shed C Channel	Lower	20.3333*	Max WS	10Yr Final	333.13	12.09	16.21		16.21	0.000031	0.20	1694.79	1839.06	0.04
Shed C Channel	Lower	20	Max WS	100Yr Final	588.73	10.97	17.01		17.01	0.000005	0.11	5259.03	3390.08	0.02
Shed C Channel	Lower	20	Max WS	10Yr Final	332.75	10.97	16.21		16.21	0.000008	0.11	2924.00	2533.18	0.02
LRSP Channel	1	3510	Max WS	100Yr Final	0.00	20.05	25.01		25.01	0.000000	0.00	162.73	48.78	0.00
LRSP Channel	1	3510	Max WS	10Yr Final	0.00	20.05	24.07		24.07	0.000000	0.00	119.25	43.10	0.00
LRSP Channel	1	3500	Max WS	100Yr Final	0.00	20.04	25.01		25.01	0.000000	0.00	163.29	48.87	0.00
LRSP Channel	1	3500	Max WS	10Yr Final	0.00	20.04	24.07		24.07	0.000000	0.00	119.73	43.19	0.00
LRSP Channel	1	3455			Lat Struct									
LRSP Channel	1	3410	Max WS	100Yr Final	260.09	20.00	24.89		24.96	0.000586	2.54	159.27	48.36	0.20
LRSP Channel	1	3410	Max WS	10Yr Final	163.83	20.00	23.97		24.02	0.000532	2.10	117.41	42.85	0.19
LRSP Channel	1	2400	Max WS	100Yr Final	259.79	19.98	24.86		24.93	0.000594	2.49	153.22	48.33	0.20
LRSP Channel	1	2400	Max WS	10Yr Final	163.66	19.98	23.94		23.99	0.000555	2.08	111.50	42.83	0.19
LRSP Channel	1	2100	Max WS	100Yr Final	258.06	19.84	24.68		24.75	0.000606	2.50	151.21	48.06	0.20
LRSP Channel	1	2100	Max WS	10Yr Final	162.76	19.84	23.78		23.82	0.000565	2.09	110.26	42.63	0.19
LRSP Channel	1	1800	Max WS	100Yr Final	256.06	19.71	24.49		24.56	0.000626	2.52	148.56	47.74	0.21
LRSP Channel	1	1800	Max WS	10Yr Final	161.67	19.71	23.60		23.65	0.000583	2.11	108.44	42.39	0.19

HEC-RAS Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
LRSP Channel	1	1500	Max WS	100Yr Final	253.05	19.57	24.30		24.37	0.000639	2.53	146.10	47.41	0.21
LRSP Channel	1	1500	Max WS	10Yr Final	160.05	19.57	23.42		23.48	0.000595	2.11	106.83	42.14	0.20
LRSP Channel	1	1200	Max WS	100Yr Final	247.53	19.43	24.11		24.18	0.000633	2.50	145.11	47.87	0.21
LRSP Channel	1	1200	Max WS	10Yr Final	156.27	19.43	23.25		23.30	0.000587	2.08	106.06	42.50	0.19
LRSP Channel	1	900	Max WS	100Yr Final	200.70	19.30	23.93		23.98	0.000440	2.07	141.30	46.78	0.17
LRSP Channel	1	900	Max WS	10Yr Final	135.41	19.30	23.09		23.13	0.000458	1.83	104.04	41.73	0.17
LRSP Channel	1	600	Max WS	100Yr Final	159.51	19.16	23.83		23.86	0.000267	1.62	143.33	47.02	0.14
LRSP Channel	1	600	Max WS	10Yr Final	109.94	19.16	22.97		22.99	0.000295	1.47	104.87	41.83	0.14
LRSP Channel	1	300	Max WS	100Yr Final	154.72	19.03	23.76		23.79	0.000239	1.55	146.01	47.38	0.13
LRSP Channel	1	300	Max WS	10Yr Final	97.60	19.03	22.90		22.92	0.000218	1.28	107.36	42.20	0.12
LRSP Channel	1	0	Max WS	100Yr Final	151.30	18.89	23.69		23.72	0.000215	1.48	149.44	47.78	0.12
LRSP Channel	1	0	Max WS	10Yr Final	85.01	18.89	22.84		22.86	0.000151	1.08	111.00	42.69	0.10