APPENDIX D

Drainage Master Plan

FINAL REPORT

Multi-Sport Park Complex and Grant Line Industrial Area Drainage Master Plan

PREPARED FOR

City of Elk Grove

September 2020

WEST YOST ASSOCIATES

FINAL REPORT | SEPTEMBER 2020

Multi-Sport Park Complex and Grant Line Industrial Area Drainage Master Plan

Prepared for

City of Elk Grove

Project No. 309-60-19-06

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List of Acronyms and Abbreviations

BMP	Best Management Practices
City	City of Elk Grove
cfs	Cubic feet per second
DEIR	Draft Environmental Impact Report
DMP	Drainage Master Plan
DWR	Department of Water Resources
FEMA	Federal Emergency Management Agency
FIRMs	Flood Insurance Rate Maps
GL	Grant Line
LAFCO	Local Agency Formation Commission
LID	Low Impact Development
LiDAR	Light Detecting and Ranging
MA	Mahon
MEP	Maximum Extent Practicable
MO	Mosher
Permit	Sacramento Areawide National Pollutant Discharge Elimination System Municipal Stormwater Permit No. CAS0085324
SAHM	Sacramento Area Hydrology Model
SB5	Senate Bill 5
SOIA	Sphere of Influence Amendment
Study Area	Elk Grove Multi-Sport Park Complex and and Grant Line Industrial Area
SWQDM	Stormwater Quality Design Manual
ULOP	Urban Level of Flood Protection Criteria
USGS	United States Geologic Survey
West Yost	West Yost Associates

MULTI-SPORT PARK COMPLEX AND GRANT LINE INDUSTRIAL AREA DRAINAGE MASTER PLAN

1.0 INTRODUCTION

The Elk Grove Multi-Sport Park Complex and Grant Line Industrial Area (Study Area) is an approximate 576-acre site located just south of the current City of Elk Grove (City) limits within Sacramento County as depicted on Figure 1, Location Map. The Study Area is within the City's Sphere of Influence Amendment (SOIA) lying entirely within the Sacramento County Urban Services Boundary. The boundaries of the SOIA area are located south of Grant Line Road (near its intersection with Waterman Road) and east of the Union Pacific Railroad tracks and State Route 99, extending east to a point just east of the intersection of Grant Line Road and Mosher Road. The SOIA area includes County Assessor Parcel Numbers 134-0190-002, 003, 009, 010, 013, 029, 030, and 032.

The City is coordinating with the Local Agency Formation Commission (LAFCO) on the future development proposed within the Study Area including the Multi-Sport Park complex (100 acres), commercial and industrial uses (358 acres) and mixed uses (118 acres). The proposed Multi-Sport Park complex would provide tournament and practice fields, an indoor sports facility, a stadium/amphitheater, fairgrounds/agrizone park. The Multi-Sport Park complex will include new landscaping, lighting, access roads, parking lots, and supportive infrastructure. The proposed future land uses include a mix of commercial, heavy/light industrial, parks and open space and mixed uses.

This drainage master plan (DMP) defines the approximate configuration, alignment, and size for the future drainage system that will serve the Study Area and defines the approximate locations and sizes of required detention basins, drainage ditches and storm drain trunk piping to mitigate for increased runoff due to development. The sizing of these facilities was based on runoff rates generated from future land use data based on the latest available information as reflected in the Draft Environmental Impact Report (DEIR) for the Elk Grove Sphere of Influence Amendment and Multi-Sport Park Complex (SCH#2015102067).

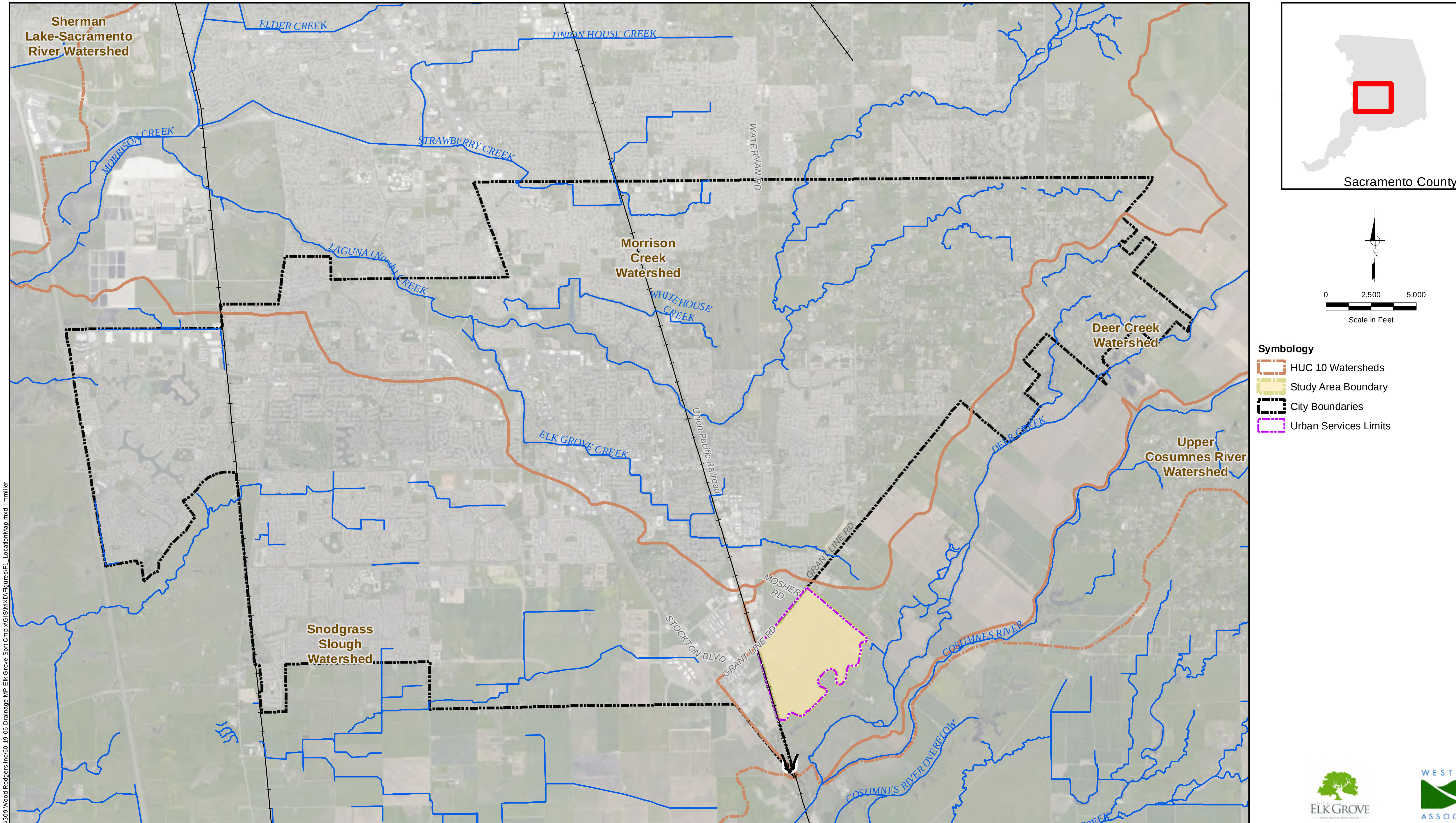


Figure 1

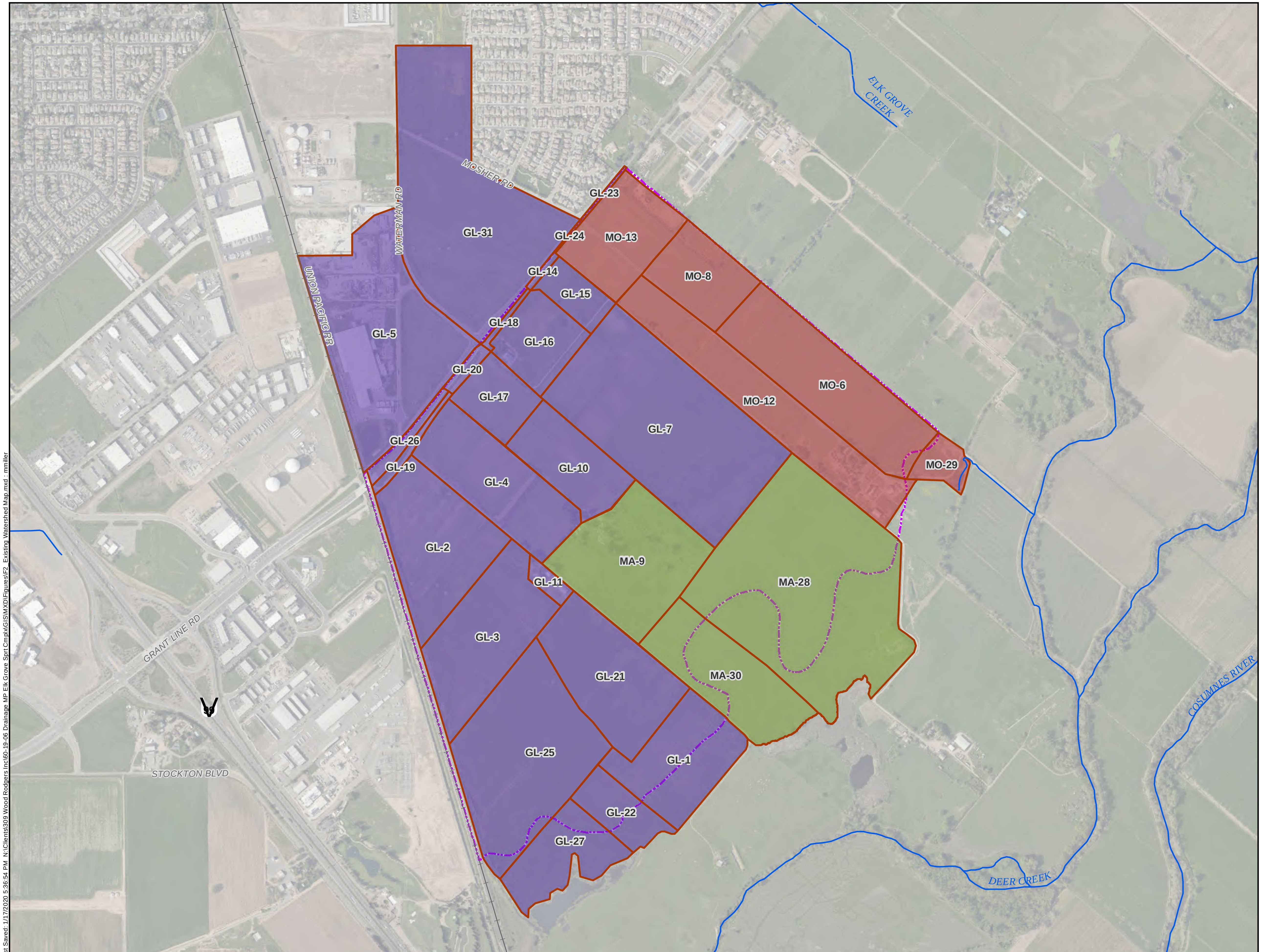
Location Map

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

2.0 EXISTING WATERSHED DESCRIPTION

The Study Area lies within a portion of the much larger Deer Creek/Cosumnes River watershed in southern Sacramento County and generally slopes from northeast to southwest with an average slope of about 0.10 percent. Figure 1 also presents the United States Geological Survey's (USGS) published "HUC10" watershed boundaries for this region. Three existing subsheds designated as the Mosher (MO), Mahon (MA) and Grant Line (GL) watersheds are shown on Figure 2. All three watersheds drain to Deer Creek through a series of ditches and by overland runoff. Three unnamed ponds located along the southern portion of the Study Area collect much of this runoff before discharging to Deer Creek as shown on Figure 3. Runoff from Grant Line Road is conveyed in a piped storm drain system to a ditch on the south side of the road. The roadside ditch conveys runoff to the southwest, parallel to Grant Line Road. The roadside ditch conveys runoff to another ditch that parallels the Union Pacific Railroad, which ultimately drains to a pond in the GL watershed in the far southwestern portion of the Study Area. A short reach of open channel conveys runoff from the pond to Deer Creek.

Within the Study Area, past agricultural practices have modified the natural stormwater runoff patterns such that an unusually small amount of peak runoff is ultimately discharged to Deer Creek to the south. These practices have included field leveling and the reuse of captured stormwater within a system of ditches, culverts and irrigation type sump ponds. Pumps within the sump ponds are used for irrigating fields through general field flooding practices, resulting in increased infiltration within the fields and reduced runoff. Figure 3 depicts this existing drainage system and lists calculated peak flow rates that are discharged to Deer Creek in the far southern portion of the Study area. Figure 4 presents the existing watershed map with topography shown, as well as the general direction of overland sheet flow in the Study Area.



Symbology

- Existing Conditions Subsheds
- Urban Services Limits

Existing Watersheds

- Mosher (MO)
- Grant Line (GL)
- Mahon (MA)

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Figure 2

Existing Watershed Map

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

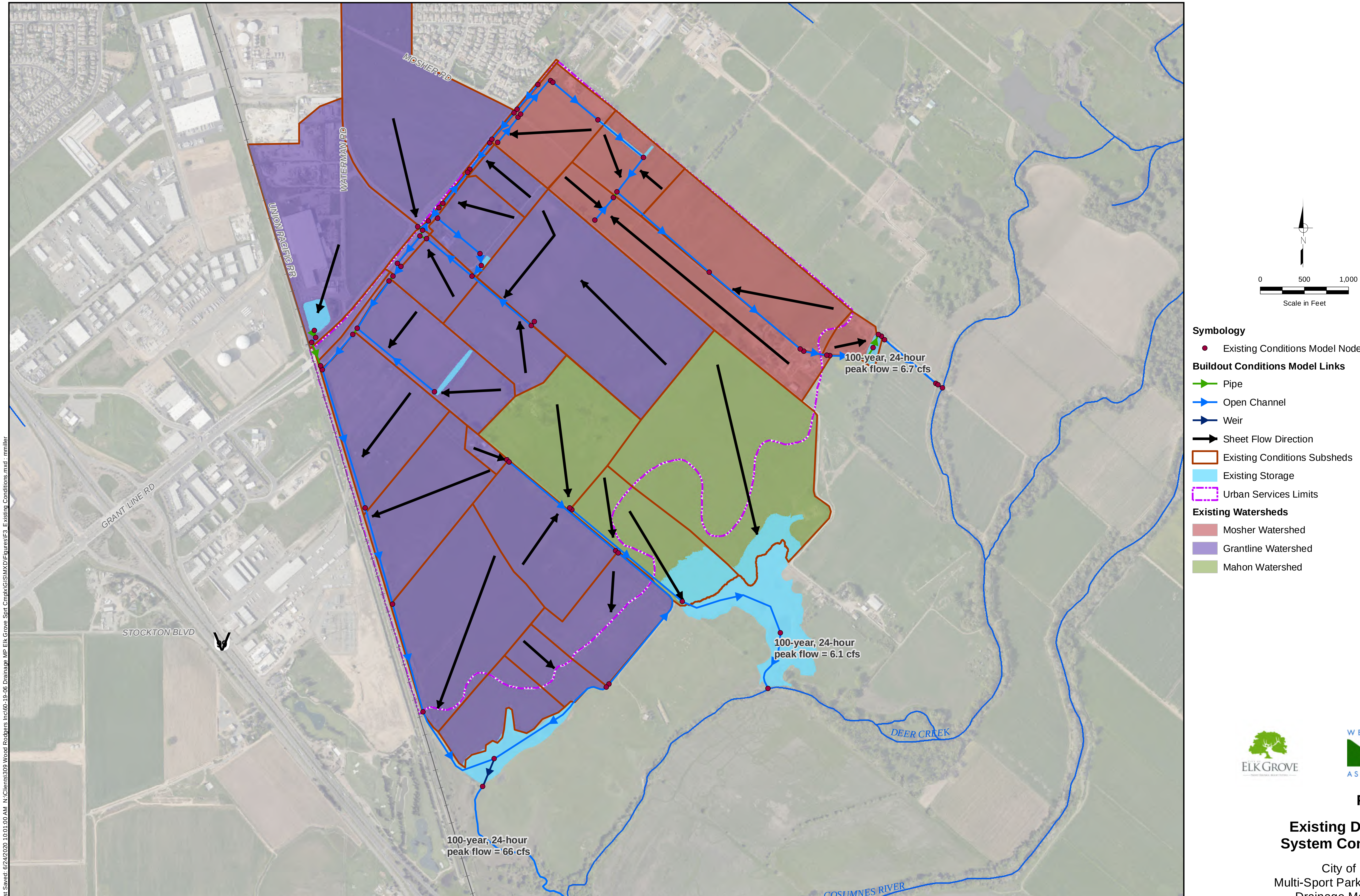

Figure 3

Existing Drainage System Conditions

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

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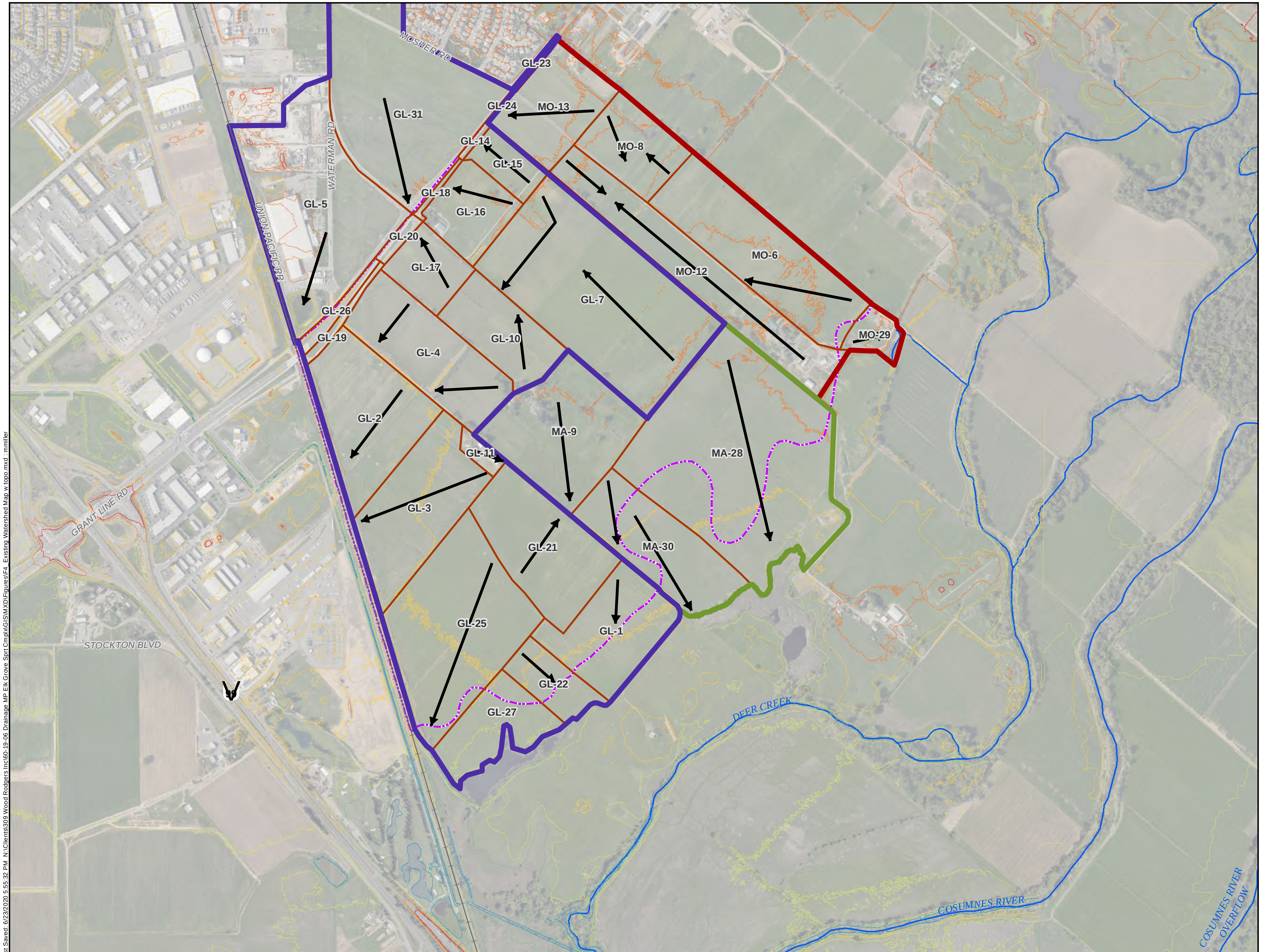

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N

0 500 1,000

Scale in Feet

Symbology

Sheet Flow Direction

Existing Conditions Subsheds

Urban Services Limits

Existing Watersheds

Mosher Watershed (MO)

Grant Line Watershed (GL)

Mahon Watershed (MA)

LiDAR Contour (ft. NAVD 88)

35

40

45

50

55

60

ELK GROVE

WEST YOST ASSOCIATES

Figure 4

Existing Watershed Map with Topography

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

3.0 DRAINAGE PLAN CONCEPT

As development occurs in the Study Area, drainage system improvements will be required to provide flood protection and mitigation, stormwater quality treatment, and hydromodification mitigation. The preliminary drainage plan proposed in this DMP was developed with input from City staff and consultants developing other infrastructure plans for the Study Area. The drainage concept for the DMP was developed with consideration of stormwater management systems designed to take maximum advantage of the natural hydrological processes of the existing landscape. Guiding principles and considerations included:

1. Designs should balance considerations related to environmental effects, capital and operating costs, property rights, economic development impacts, the phasing of individual developments and improved access to recreational opportunities without compromising public safety and/or property protection.
2. Stormwater management systems should be designed so that potential impacts to the flow, volume, and quality of downstream discharges to Deer Creek will be minimized.
3. The drainage plan must conform to applicable local, state, and federal laws and regulations. Specific reference to the Sacramento Region Stormwater Quality Design Manual (SWQDM) dated July 2018, as well as the Sacramento City/County Drainage Manual Volume 2.
4. Avoid the use of hydraulic pumping systems and extensive mass grading efforts.

Due to a lack of soils with high infiltration capacity in the area, detention basins were chosen to provide mitigation for potential flood control, water quality and hydromodification impacts. The detention basins were sized in conformance with City standards. Additionally, West Yost Associates (West Yost) modeled and sized major storm drain system trunk lines, identified suitable outfall locations to Deer Creek and evaluated and recommended, as necessary, adjustments to the configuration and capacity of existing drainage ditches and culverts. Only the major trunk line piping systems were sized for buildout conditions, as future detailed storm drain system designs will accompany submittals for each planned phase of development once more detailed site layouts are available.

4.0 OVERALL ANALYSIS APPROACH AND MODELING RESULTS

4.1 General Approach

For this study, West Yost developed hydrologic and hydraulic models using XPSWMM. The XPSWMM models were first used to estimate the flows and runoff volumes from the Study Area for existing conditions. The hydrologic modeling was created in conformance with the Sacramento City/County Drainage Manual, Volume 2, Hydrology. For the existing conditions evaluation, the study area was divided into subsheds based on existing topography, flow patterns and off-site contributing area. Hydrologic parameters for each subshed were determined using data collected from site visits, aerial photography, Light Detecting and Ranging (LiDAR) topographic mapping prepared by the State Department of Water Resources (DWR) in 2008, studies by others, and site-specific survey data collected for this project by Wood Rodgers. Flow hydrographs from each subshed were calculated using XPSWMM for the 2-, 10-, and 100-year, 24-hour design storms.

A hydraulic analysis of the major existing conveyance facilities within the Study Area, including ditches, culverts, and agricultural related storage ponds was performed using XPSWMM. The configuration of the existing conveyance facilities was determined based on field survey data, field observations, and as-built plans. The field survey defined the major ditch configurations and elevations, culvert sizes, shapes, and materials, and the stage/storage relationship for storage areas which could not readily be determined from the LiDAR topographic data. Using the XPSWMM hydrologic/hydraulic models, the existing flood flows and water surface elevations for the major drainage facilities in the Study Area were estimated for the 2-, 10-, and 100-year storm events.

We also used the XPSWMM models to calculate flood flows for buildout conditions and to size the major trunk drainage facilities. As discussed above, detention basins are proposed to provide mitigation for potential stormwater quality, flood control, and hydromodification impacts.

Stormwater quality treatment is proposed to be provided in detention basin using the dry extended detention approach with a 48-hour drawdown. The specific requirements for the water quality treatment facilities were determined from the Sacramento Region Stormwater Quality Design Manual, July 2018. The Sacramento Area Hydrology Model (SAHM) was used to determine the requirements for hydromodification mitigation.

4.2 Hydrologic and Hydraulic Modeling with XPSWMM – Existing Conditions

As shown on Figures 2 and 4, the study area is comprised of three major watersheds that discharge to Deer Creek at separate locations. Each of these major watersheds was subdivided for hydrologic modeling purposes. A total of thirty-one (31) subsheds were defined for existing conditions and the hydrologic data for each subshed is provided in Table 1. Figures 2 and 4 show the locations of the subsheds. The existing land use information for each subshed was determined based on a site investigation conducted by West Yost and a review of aerial photographs. The land use data, combined with hydrologic soil types determined from the Natural Resources Conservation Service soil survey for Sacramento County, was used to estimate the percent impervious and infiltration rates for each subshed. The hydrologic data was used as input to the XPSWMM model to calculate flow hydrographs for the 2-year, 10-year, and 100-year, 24-hour storms. The XPSWMM model was also used to route the calculated flows through the existing storm drain system and to estimate the resulting water surface elevations in the drainage system. Figure 5 presents the existing conditions model layout used in XPSWMM with the model nodes labeled and the model links shown as open channels or pipes/culverts. Hydraulic results from the XPSWMM model are summarized in Tables 2 and 3. Table 2 presents the calculated maximum water surface elevations at each node shown on Figure 5. Table 3 presents the calculated peak flow for each model link (a link represents a conveyance facility such as a pipe or ditch).The results from the existing conditions model revealed unusually low peak flows discharged at the three outfalls from the study area. The reason for this is that the agricultural practices in the area have promoted containment of flows on-site for irrigation and stock watering purposes. For development projects, the existing peak flows discharged from a project site is typically used as the target peak flow for the post-development condition. However, because the agricultural practices have significantly reduced the peak flows below normal levels, it is not appropriate to limit the peak discharges to these levels. Therefore, an evaluation was performed to determine the appropriate peak discharge allowed from the site. This is discussed in the next section.

4.3 Assessment of Allowable Discharge Rates to Deer Creek

A comparative hydrologic analysis was performed to evaluate the XPSWMM generated peak flow discharges for each watershed versus peak flow discharges generated from the Sacramento Method Charts as outlined within Part 1, Chapter 2 of the Sacramento City/County Drainage Manual, Volume 2. Use of the Sacramento Method Charts to estimate peak flow rates is a useful and accepted means of generating typical flows from specific watershed areas and land use types. For this analysis, the Study Area was broken down into its percentages of existing land use types including agricultural and agricultural-residential. Figure 6 shows the Sacramento City/County Drainage Manual Figure 2-21 with the areas and estimated discharge rates for each watershed.

The comparison of the peak flow discharges calculated with XPSWMM versus those determined from the Sacramento Method Charts analysis reflects a large disparity, with a significant increase in the peak discharges estimated with the Sacramento Method Charts versus those calculated with the XPSWMM model. As described earlier in Sections 2.0 and 4.1, the difference is caused by past agricultural practices, which have modified stormwater runoff patterns such that an unusually small amount of runoff is ultimately discharged to Deer Creek to the south. Table 4 compares the estimated discharges rates from each major watershed using the Sacramento Method Charts versus the existing conditions XPSWMM model. This comparison shows that the peak flows from the existing conditions XPSWMM model are approximately 7-percent to 28-percent of the peak flow that can be expected for typical watersheds of these sizes and land use based on the charts.

Since the peak flows from the Sacramento Method Charts are believed to be more typical and representative of agricultural land uses and runoff within the Sacramento County area, West Yost proposed these higher existing discharge rates be used to determine the maximum allowable flow rate that can be discharged at each outfall location for buildout conditions. After conferring with both City of Elk Grove and Sacramento County staff, West Yost was directed by the City to move forward with this recommendation and the higher existing discharge rates to Deer Creek developed from the Sacramento Method and Charts analysis were used to establish the maximum allowable peak flow discharged from each watershed for post-project conditions.

Table 1. Existing Conditions Hydrologic Data

Subshed ID	Area, acres	Mean Elevation, feet (NAVD88)	Basin Length, feet	Basin Centroid Length, feet	Basin Slope, ft/ft	Basin "n" Value	Impervious Percent	Infiltration Rate, inches/hour
GL-1	26.3	48.5	1984	784.6	0.0035	0.115	2.0	0.07
GL-2	34.1	49.0	2224	768.9	0.0018	0.115	2.0	0.07
GL-3	33.8	51.5	1596	1069.6	0.0019	0.115	2.0	0.07
GL-4	30.7	52.0	1187	535.0	0.0034	0.115	2.0	0.07
GL-5	60.1	52.0	2629	1224.7	0.0008	0.060	57.3	0.06
GL-7	73.4	54.5	2684	1397.8	0.0019	0.115	2.0	0.07
GL-10	19.1	52.5	1703	856.8	0.0018	0.115	2.2	0.07
GL-11	2.7	51.5	552	256.7	0.0018	0.100	10.0	0.07
GL-14	1.3	53.5	469	258.6	0.0021	0.106	18.5	0.06
GL-15	7.6	54.0	790	343.8	0.0025	0.115	2.0	0.07
GL-16	15.2	55.0	827	397.7	0.0048	0.115	2.0	0.07
GL-17	11.7	52.5	982	430.5	0.0031	0.115	2.0	0.07
GL-18	1.0	53.0	743	421.6	0.0027	0.115	2.0	0.07
GL-19	2.3	51.5	1273	635.4	0.0024	0.115	2.0	0.07
GL-20	2.0	52.0	652	315.4	0.0031	0.115	2.0	0.07
GL-21	32.8	51.5	1018	484.0	0.0029	0.115	2.0	0.07
GL-22	10.5	47.0	983	472.8	0.0081	0.115	2.0	0.07
GL-23	0.5	53.5	687	342.2	0.0044	0.083	63.7	0.05
GL-24	0.2	53.0	398	224.1	0.0050	0.081	68.2	0.05
GL-25	52.6	50.0	3020	1546.0	0.0013	0.115	2.0	0.07
GL-26	3.1	50.0	1211	563.1	0.0017	0.081	67.3	0.05
GL-27	18.0	47.5	858	514.4	0.0058	0.115	2.0	0.07
GL-31	77.3	51.5	3674	1946.8	0.0003	0.115	2.0	0.07
MA-9	37.8	52.0	1965	1109.3	0.0020	0.100	10.0	0.07
MA-28	91.8	50.0	2941	1338.8	0.0041	0.115	2.0	0.07
MA-30	29.1	48.5	1865	920.7	0.0038	0.115	2.0	0.07
MO-6	41.1	55.0	2728	1233.1	0.0015	0.115	2.0	0.07
MO-8	17.3	55.0	1318	653.1	0.0030	0.114	3.0	0.07
MO-12	38.7	56.0	3378	1666.8	0.0018	0.100	10.0	0.07
MO-13	21.1	54.5	940	546.2	0.0032	0.115	2.0	0.07
MO-29	5.5	56.0	744	332.0	0.0054	0.115	2.0	0.07

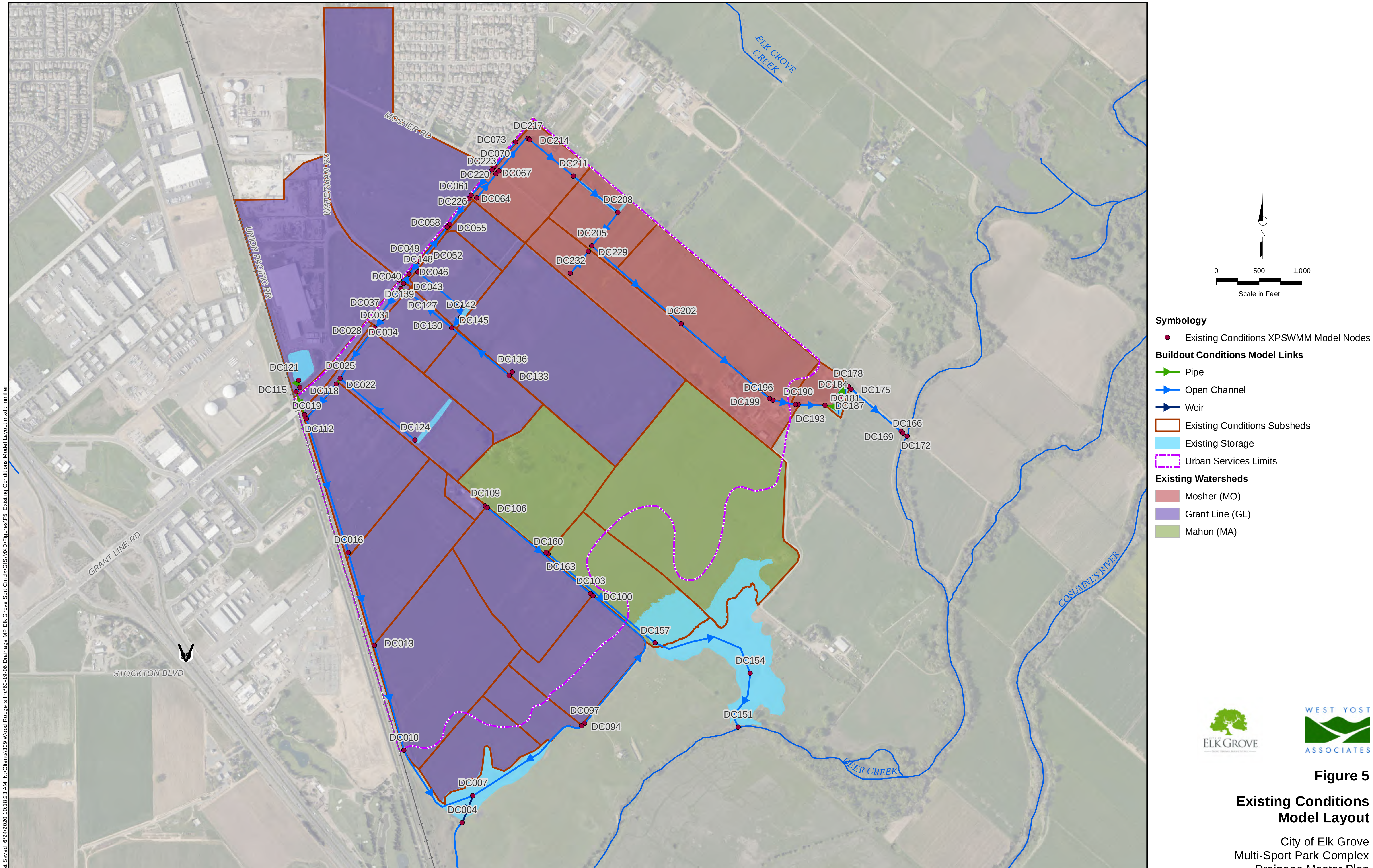
Table 2. Existing Conditions XPSWMM Node Results					
			Maximum Water Surface Elevation, feet (NAVD88)		
Node Name	Ground Elevation, feet (NAVD88)	Invert Elevation, feet (NAVD88)	2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
DC001	40.0	31.0	31.0	31.1	31.2
DC004	43.0	38.0	38.1	38.3	38.4
DC007	46.4	38.0	43.2	43.7	44.1
DC010	48.5	41.8	44.5	45.0	45.6
DC013	51.3	45.1	46.9	47.3	47.9
DC016	48.0	45.5	47.7	48.1	48.3
DC019	49.0	46.2	48.5	48.6	48.7
DC022	49.6	46.5	48.6	48.8	48.9
DC025	50.6	46.8	48.7	48.9	49.0
DC028	52.8	48.7	50.1	50.1	50.2
DC031	52.1	48.9	50.2	50.3	50.3
DC034	52.0	48.9	50.4	50.4	50.5
DC037	53.6	49.2	51.7	52.0	52.2
DC040	53.6	41.5	51.7	52.0	52.2
DC043	53.7	42.2	51.8	52.0	52.2
DC046	53.6	44.0	51.8	52.1	52.5
DC049	54.2	50.1	51.8	52.1	52.5
DC052	53.3	50.2	51.8	52.2	52.5
DC055	53.9	50.8	51.9	52.2	52.6
DC058	54.0	50.9	51.9	52.3	52.7
DC061	55.1	51.5	52.2	52.5	52.8
DC064	54.2	51.5	52.2	53.0	53.7
DC067	53.7	51.0	52.2	53.0	53.1
DC070	54.5	51.6	52.2	53.0	53.0
DC073	54.6	52.2	52.5	53.0	53.0
DC094	49.7	43.0	43.9	44.1	44.2
DC097	49.0	43.4	46.5	47.7	49.1
DC100	51.2	47.6	48.6	48.8	49.2
DC103	50.6	47.7	49.0	49.5	49.9
DC106	51.5	49.3	50.0	50.2	50.4
DC109	51.5	50.0	50.6	51.0	51.3
DC112	50.0	47.1	48.5	48.6	48.7
DC115	51.5	48.4	48.9	48.9	48.9
DC121	50.0	38.0	41.6	44.1	47.5
DC124	53.0	48.0	51.1	51.2	51.2
DC127	53.1	46.6	51.5	52.0	52.5
DC130	52.7	46.4	51.5	52.0	52.5
DC133	53.6	50.0	51.5	52.0	52.5
DC136	53.5	50.3	51.7	52.2	52.8
DC139	54.0	42.3	51.8	52.1	52.2
DC140	53.0	44.5	52.1	52.2	52.3
DC142	53.0	40.0	51.5	52.1	52.6
DC145	54.3	50.9	53.2	53.4	53.5
DC148	53.2	51.1	53.2	53.4	53.5
DC151	52.5	38.0	38.0	38.0	38.0
DC154	46.0	43.0	44.0	44.7	45.4
DC157	45.9	44.8	45.2	45.3	45.4
DC160	52.0	49.6	50.7	50.8	50.9
DC163	51.2	49.6	50.8	51.1	51.6
DC169	47.0	44.6	45.4	45.5	45.5
DC172	47.4	44.5	46.3	47.0	47.0
DC175	52.2	47.1	47.7	47.9	47.9
DC178	55.7	50.3	51.1	51.4	51.5
DC181	54.6	49.1	51.1	51.4	51.5
DC184	54.0	50.0	52.8	53.2	53.5
DC187	57.0	50.8	52.8	53.2	53.5
DC190	57.2	51.1	52.8	53.2	53.5
DC193	57.0	51.1	53.0	53.6	54.0
DC196	56.9	51.3	53.0	53.6	54.0
DC199	56.1	51.0	53.1	53.7	54.2
DC202	55.3	50.9	53.1	53.8	54.2
DC205	55.2	50.8	53.1	53.8	54.2
DC208	54.0	50.8	53.1	53.8	54.2
DC211	55.6	50.8	53.1	53.8	54.2
DC214	55.0	51.5	53.1	53.8	54.2
DC217	55.3	51.6	53.4	54.3	54.4
DC220	54.7	50.9	53.4	54.3	54.4
DC223	53.9	51.6	53.0	53.2	53.9
DC226	53.7	52.0	53.0	53.1	53.7
DC229	53.7	51.5	53.1	53.3	53.7
DC232	53.8	52.4	53.1	53.3	53.7

Table 3. Existing Conditions XPSWMM Link Results							
					Maximum Flowrate, cfs		
Link Name	Upstream Node Name	Downstream Node Name	Link Shape	Conduit Diameter, inches	2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
DCC004	DC004	DC001	Trapezoidal	-	4.4	36.1	66.9
DCC010	DC010	DC007	Natural	-	34.5	57.1	90.4
DCC013	DC013	DC010	Natural	-	22.2	32.3	50.0
DCC016	DC016	DC013	Natural	-	16.9	25.8	35.6
DCC019	DC019	DC016	Natural	-	14.2	14.9	16.9
DCC022	DC022	DC019	Natural	-	10.2	11.4	13.5
DCC025	DC025	DC022	Circular	30	10.3	11.6	13.8
DCC028	DC028	DC025	Natural	-	10.3	11.1	11.6
DCC031	DC031	DC028	Circular	30	10.3	11.1	11.7
DCC034	DC034	DC031	Natural	-	10.3	11.1	11.7
DCC037	DC037	DC034	Circular	18	10.3	11.1	11.7
DCC040	DC040	DC037	Natural	-	10.9	12.1	11.0
DCC043	DC043	DC040	Circular	36	12.9	17.5	15.2
DCC046	DC046	DC043	Circular	30	2.5	5.8	15.0
DCC049	DC049	DC046	Natural	-	2.2	3.4	-4.9
DCC052	DC052	DC049	Circular	18	2.1	3.4	4.7
DCC055	DC055	DC052	Natural	-	1.8	3.3	-5.1
DCC058	DC058	DC055	Circular	18	2.2	3.5	4.3
DCC061	DC061	DC058	Natural	-	1.9	2.9	3.7
DCC064	DC064	DC061	Circular	12	0.0	1.9	2.4
DCC067	DC067	DC064	Natural	-	0.1	-1.2	-10.7
DCC070	DC070	DC067	Circular	12	0.0	-0.5	-0.8
DCC073	DC073	DC070	Natural	-	0.3	0.6	0.9
DCC094	DC094	DC007	Natural	-	11.7	18.9	27.2
DCC097	DC097	DC094	Circular	18	0.0	12.0	15.0
DCC100	DC100	DC097	Natural	-	5.3	7.4	9.1
DCC103	DC103	DC100	Circular	18	5.3	7.5	8.8
DCC106	DC106	DC103	Natural	-	1.0	2.1	3.4
DCC109	DC109	DC106	Circular	12	0.0	2.6	2.9
DCC112	DC112	DC019	Natural	-	2.8	3.5	3.9
DCC115	DC115	DC112	Circular	24	2.4	2.7	2.7
DCC124	DC124	DC025	Trapezoidal	-	0.5	1.5	3.1
DCC127	DC127	DC040	Circular	12	0.0	2.5	2.9
DCC130	DC130	DC127	Natural	-	-2.8	-8.4	-16.9
DCC133	DC133	DC130	Natural	-	9.9	16.5	21.1
DCC136	DC136	DC133	Circular	18	6.1	5.7	6.3
DCC139	DC139	DC043	Circular	36	13.3	11.8	12.6
DCC140	DC140	DC139	Circular	36	0.0	11.8	12.6
DCC142	DC142	DC130	Circular	10	-3.2	-2.7	-2.6
DCC145	DC145	DC142	Circular	10	2.3	2.4	2.5
DCC148	DC148	DC145	Natural	-	4.6	6.6	4.8
DCC160	DC160	DC157	Natural	-	5.4	9.6	14.0
DCC163	DC163	DC160	Circular	18	5.4	9.6	14.0
DCC172	DC172	DC169	Circular	12	0.0	4.6	4.6
DCC175	DC175	DC172	Natural	-	3.5	5.6	6.7
DCC178	DC178	DC175	Circular	24	3.5	5.6	6.7
DCC181	DC181	DC178	Natural	-	3.5	5.6	6.7
DCC184	DC184	DC181	Circular	15	3.5	5.6	6.7
DCC187	DC187	DC184	Circular	24	5.0	8.0	12.3
DCC190	DC190	DC187	Natural	-	4.7	5.8	6.6
DCC193	DC193	DC190	Circular	18	4.8	5.9	6.7
DCC196	DC196	DC193	Natural	-	4.9	6.1	6.9
DCC199	DC199	DC196	Circular	18	5.0	6.3	7.2
DCC202	DC202	DC199	Natural	-	5.7	9.0	10.8
DCC205	DC205	DC202	Natural	-	-3.2	-10.6	-23.6
DCC208	DC208	DC205	Natural	-	2.7	7.1	15.9
DCC211	DC211	DC208	Trapezoidal	-	-10.1	-10.1	-10.1
DCC214	DC214	DC211	Natural	36	3.4	4.2	3.9
DCC217	DC217	DC214	Circular	15	0.0	5.4	4.9
DCC220	DC220	DC217	Natural	-	5.7	10.8	10.8
DCC223	DC223	DC220	Circular	8	0.0	-1.1	-1.1
DCC226	DC226	DC223	Natural	-	-0.1	-3.1	-13.6
DCC229	DC229	DC205	Circular	10	0.0	1.0	-1.0
DCC232	DC232	DC229	Natural	-	2.7	2.1	3.9

Table 4. Comparison of Discharge Rates to Deer Creek

Watershed	Total Tributary Area, acres	Existing Conditions Percent Impervious	Estimated Typical Discharge[(a)], cfs	Modeled Existing Conditions Discharge[(b)], cfs	Percent of Estimated Typical Discharge
Mosher	102.7	4.6	65	6.7	10%
Mahon	158.7	3.9	85	6.1	7%
Grant Line	537.4	2.6	235	66.0	28%

(a) Based on Figure 2-21 of the Sacramento City/County Drainage Manual
(b) Based on XPSWMM model that factors in the effects of the existing agricultural operations on peak flows.



ELK GROVE

WEST YOST ASSOCIATES

Figure 5

Existing Conditions Model Layout

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

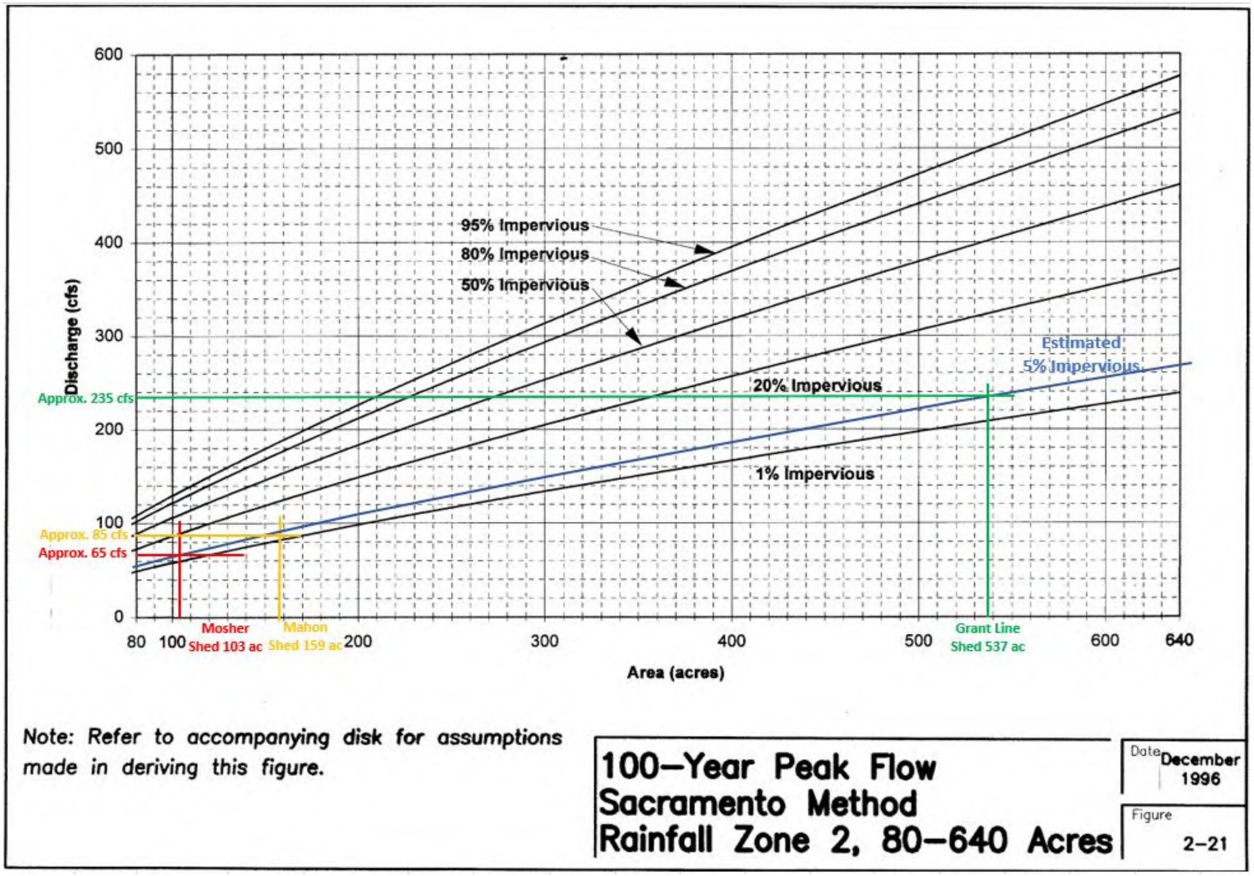


Figure 6. Sacramento Method Chart

4.4 Hydrologic and Hydraulic Modeling with XPSWMM – Buildout Conditions

For buildout conditions, the XPSWMM model parameters were updated to represent the proposed future development of the Study Area as depicted in future land use and conceptual plans presented in the DEIR. Buildout conditions Alternative A and Alternative B land use from the DEIR were used to calculate estimated percent impervious and infiltration rates for each subshed. The buildout conditions subshed hydrologic parameters for Alternative A and Alternative B are summarized in Tables 5a and 5b, respectively, and were used as input to the XPSWMM hydraulic model. The buildout conditions hydraulic model layout is presented on Figure 7 for Alternative A and Figure 7b for Alternative B.

4.4.1 Buildout Watershed Boundaries and Land Use

Subshed boundaries for buildout conditions are shown on Figure 8a for Alternative A and Figure 8b for Alternative B. The three major watersheds (Grant Line, Mahon, and Mosher) were divided into twenty-four (24) subsheds. All subsheds within the Study Area will drain directly into one of seven proposed detention basins. The subshed boundaries for areas outside of the Study Area were unchanged from the existing condition.

For buildout conditions, we evaluated two land-use alternatives as defined by the City:

- Alternative A – This land-use plan was included for evaluation in the DEIR that was previously prepared for the project and is presented on Figure 8a. It includes a variety of uses including parks and open space, resource management and conservation, regional commercial, light industrial, heavy industrial and mixed use.
- Alternative B – This alternative, also included from the DEIR, is identical to Alternative A with the exception that roughly one-half of the City's 100-acre parcel intended for development of the Multi-Sport Parks Complex under Alternative A, will instead be reserved for light industrial use adjacent to Grant Line Road. The land-use plan for Alternative B is presented in Figure 8b.

Table 5a. Buildout Conditions Hydrologic Data - Alternative A

Subshed ID	Area, acres	Mean Elevation, Feet (NAVD88)	Basin Length, Feet	Basin Centroid Length, Feet	Basin Slope, ft/ft	Basin "n" Value	Impervious Percent	Infiltration Rate, inches/hour
GL-1	15.2	49.0	1707.4	690	0.0012	0.033	80.0	0.06
GL-2	7.5	50.0	973.0	481	0.0021	0.033	80.0	0.06
GL-3	39.8	50.5	2374.9	1178	0.0013	0.032	84.2	0.05
GL-4	32.4	52.0	1946.4	977	0.0010	0.031	90.0	0.05
GL-5	32.9	52.0	1930.9	818	0.0010	0.033	80.1	0.05
GL-6	20.5	53.5	1838.8	774	0.0005	0.031	90.0	0.05
GL-7	92.8	54.5	3903.0	1778	0.0003	0.092	27.6	0.06
GL-8	8.2	50.0	2072.9	848	0.0010	0.030	95.0	0.04
GL-13	77.8	51.5	3673.9	1947	0.0003	0.115	2.0	0.07
GL-14	60.2	52.0	2628.9	1225	0.0008	0.060	57.3	0.06
GL-17	45.6	51.5	2344.9	1198	0.0013	0.032	85.0	0.05
GL-18	36.7	48.5	1790.1	1001	0.0028	0.033	84.6	0.05
GL-19	33.6	47.5	2544.0	982	0.0004	0.032	84.2	0.05
GL-23	12.6	49.5	2838.6	1100	0.0011	0.115	2.0	0.07
GL-24	21.9	47.0	2475.4	992	0.0032	0.115	2.0	0.07
MA-15	53.0	52.5	2329.7	1145	0.0021	0.084	36.1	0.06
MA-16	38.1	49.0	1742.9	781	0.0023	0.115	2.0	0.07
MA-20	18.8	51.5	1700.8	887	0.0053	0.115	2.0	0.07
MA-22	34.7	52.5	2673.2	1430	0.0011	0.087	29.5	0.06
MO-9	46.7	53.0	2707.0	1526	0.0007	0.037	60.0	0.07
MO-10	17.9	55.5	2110.1	1049	0.0005	0.037	60.0	0.07
MO-11	17.1	55.0	1557.0	531	0.0013	0.037	60.0	0.07
MO-12	21.0	54.5	975.1	322	0.0031	0.037	60.0	0.07
MO-21	14.7	54.5	1655.5	666	0.0006	0.037	60.0	0.07

Table 5b. Buildout Conditions Hydrologic Data - Alternative B

Subshed ID	Area, acres	Mean Elevation, Feet (NAVD88)	Basin Length, Feet	Basin Centroid Length, Feet	Basin Slope, ft/ft	Basin "n"Value	Impervious Percent	Infiltration Rate, inches/hour
GL-1	15.2	49.0	1707.4	690	0.0012	0.033	80.0	0.06
GL-2	7.5	50.0	973.0	481	0.0021	0.033	80.0	0.06
GL-3	39.8	50.5	2374.9	1178	0.0013	0.032	84.2	0.05
GL-4	32.4	52.0	1946.4	977	0.0010	0.031	90.0	0.05
GL-5	32.9	52.0	1930.9	818	0.0010	0.033	80.1	0.05
GL-6	20.5	53.5	1838.8	774	0.0005	0.031	90.0	0.05
GL-7	103.9	55.5	4203.0	1928	0.0007	0.068	47.1	0.06
GL-8	8.2	50.0	2072.9	848	0.0010	0.030	95.0	0.04
GL-13	77.8	51.5	3673.9	1947	0.0003	0.115	2.0	0.07
GL-14	60.2	52.0	2628.9	1225	0.0008	0.060	57.3	0.06
GL-17	45.6	51.5	2344.9	1198	0.0013	0.032	85.0	0.05
GL-18	36.7	48.5	1790.1	1001	0.0028	0.033	84.6	0.05
GL-19	33.6	47.5	2544.0	982	0.0004	0.032	84.2	0.05
GL-23	12.6	49.5	2838.6	1100	0.0011	0.115	2.0	0.07
GL-24	21.9	47.0	2475.4	992	0.0032	0.115	2.0	0.07
MA-15	41.9	53.5	2029.7	995	0.0034	0.115	2.0	0.07
MA-16	38.1	49.0	1742.9	781	0.0023	0.115	2.0	0.07
MA-20	18.8	51.5	1700.8	887	0.0053	0.115	2.0	0.07
MA-22	34.7	52.5	2673.2	1430	0.0011	0.087	29.5	0.06
MO-9	46.7	53.0	2707.0	1526	0.0007	0.037	60.0	0.07
MO-10	17.9	55.5	2110.1	1049	0.0005	0.037	60.0	0.07
MO-11	17.1	55.0	1557.0	531	0.0013	0.037	60.0	0.07
MO-12	21.0	54.5	975.1	322	0.0031	0.037	60.0	0.07
MO-21	14.7	54.5	1655.5	666	0.0006	0.037	60.0	0.07

Table 6a. Buildout Conditions XPSWMM Node Results - Alternative A

Node Name	Ground Elevation, feet (NAVD88)	Invert Elevation, feet (NAVD88)	Maximum Water Surface Elevation, feet (NAVD88)		
			2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
B003	56.0	47.2	49.6	51.7	55.0
Basin A	55.0	47.0	52.1	53.1	53.8
Basin B	51.0	45.0	48.3	49.2	50.0
Basin C	51.0	45.0	48.4	48.8	49.0
Basin D	49.0	42.0	46.7	47.4	48.1
Basin E	53.0	45.0	47.7	50.7	51.8
Basin F	51.0	47.0	49.0	49.4	50.1
Basin G	53.0	45.0	49.2	50.4	52.0
C003	52.0	47.1	48.9	51.0	51.2
D003	49.5	42.0	46.7	47.4	48.5
D006	49.0	43.6	48.0	48.1	48.6
D009	50.0	44.2	48.4	49.0	49.1
D012	52.0	42.4	46.7	49.1	51.0
D015	53.0	42.8	47.0	52.0	52.3
DC001	40.0	31.0	31.0	31.1	31.2
DC004	43.0	38.0	38.1	38.3	38.4
DC007	46.4	38.0	43.2	43.6	44.4
DC010	48.5	41.0	43.2	43.6	44.5
DC013	51.3	44.0	44.4	44.9	45.5
DC016	48.0	45.0	45.5	46.2	46.7
DC019	49.0	46.0	46.6	47.3	47.9
DC022	50.3	46.5	47.7	48.9	49.4
DC025	50.6	46.8	47.7	48.9	49.4
DC028	52.8	48.7	49.1	49.3	49.5
DC031	52.1	48.9	49.2	49.3	49.5
DC034	52.0	48.9	49.4	49.5	49.6
DC037	53.6	49.2	49.5	49.7	49.9
DC040	53.6	41.5	45.9	49.6	49.8
DC043	53.7	42.2	44.5	46.3	51.6
DC046	53.6	44.0	44.5	46.3	51.6
DC049	54.2	50.1	50.1	50.1	51.6
DC052	53.3	50.2	50.2	50.2	51.6
DC055	53.9	50.8	50.8	50.8	51.6
DC058	54.0	50.9	50.9	50.9	51.6
DC061	55.1	51.5	51.5	51.5	51.6
DC094	49.7	43.0	43.6	43.7	44.4
DC097	49.0	43.4	44.4	45.1	47.1
DC112	50.0	47.1	47.3	47.4	47.9
DC115	51.5	48.4	48.4	48.4	48.4
DC121	50.0	38.0	38.0	38.0	38.0
DC139	54.0	42.3	44.5	46.4	51.8
DC140	53.0	44.5	46.1	48.5	53.4
DC154	49.0	40.0	40.8	41.7	42.7
DC169	47.0	44.6	45.5	45.5	45.5
DC172	47.4	44.5	46.5	47.1	47.2
DC175	52.2	45.6	46.6	47.5	48.0
DC193	57.0	47.8	52.1	53.4	54.8
DC202	57.2	48.8	53.2	55.8	56.3
DC205	57.0	50.3	54.6	56.1	56.3
E003	54.0	47.2	49.5	51.0	53.3
F003	52.0	47.6	49.9	50.7	51.2
F006	53.5	48.5	52.5	52.6	52.7
MO-12	56.0	52.0	53.3	55.1	55.2
Node105	55.0	46.0	47.0	48.2	50.1
Node107	50.3	40.7	42.8	44.3	46.3
Node108	51.0	45.0	46.1	46.8	47.2
Node110	49.0	42.0	43.2	44.9	47.9
Node117	52.0	45.0	45.3	46.5	51.7
Node120	51.0	47.0	47.8	49.0	50.0
Node126	55.0	45.0	45.5	48.3	52.0

Table 6b. Buildout Conditions XPSWMM Node Results - Alternative B

Node Name	Ground Elevation, feet (NAVD88)	Invert Elevation, feet (NAVD88)	Maximum Water Surface Elevation, feet (NAVD88)		
			2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
B003	56.0	47.2	49.0	50.0	52.3
Basin A	55.0	47.0	52.2	53.1	53.8
Basin B	51.0	45.0	48.3	49.1	49.8
Basin C	51.0	45.0	48.4	48.8	49.4
Basin D	49.0	42.0	46.7	47.3	48.1
Basin E	53.0	45.0	48.0	50.1	51.9
Basin F	51.0	47.0	49.0	49.4	50.1
Basin G	53.0	45.0	47.3	49.2	51.6
C003	52.0	47.1	48.9	51.0	51.2
D003	49.5	42.0	46.7	47.4	48.4
D006	49.0	43.6	48.0	48.1	48.6
D009	50.0	44.2	48.3	49.1	49.1
D012	52.0	42.4	46.7	49.1	51.0
D015	53.0	42.8	46.9	52.0	52.3
DC001	40.0	31.0	31.0	31.1	31.2
DC004	43.0	38.0	38.1	38.3	38.4
DC007	46.4	38.0	43.2	43.7	44.5
DC010	48.5	41.0	43.2	43.7	44.5
DC013	51.3	44.0	44.5	45.0	45.5
DC016	48.0	45.0	45.5	46.3	46.7
DC019	49.0	46.0	46.6	47.4	47.9
DC022	50.3	46.5	47.7	48.9	49.4
DC025	50.6	46.8	47.7	48.9	49.4
DC028	52.8	48.7	49.1	49.3	49.5
DC031	52.1	48.9	49.2	49.3	49.5
DC034	52.0	48.9	49.4	49.5	49.6
DC037	53.6	49.2	49.5	49.7	49.9
DC040	53.6	41.5	45.9	49.6	49.8
DC043	53.7	42.2	44.5	45.8	47.8
DC046	53.6	44.0	44.5	45.8	47.8
DC049	54.2	50.1	50.1	50.1	50.1
DC052	53.3	50.2	50.2	50.2	50.2
DC055	53.9	50.8	50.8	50.8	50.8
DC058	54.0	50.9	50.9	50.9	50.9
DC061	55.1	51.5	51.5	51.5	51.5
DC094	49.7	43.0	43.6	43.7	44.5
DC097	49.0	43.4	44.4	45.1	47.1
DC112	50.0	47.1	47.5	47.6	47.9
DC115	51.5	48.4	48.9	49.0	49.0
DC121	50.0	38.0	41.6	44.2	47.5
DC139	54.0	42.3	44.5	45.9	48.1
DC140	53.0	44.5	46.0	47.6	52.3
DC154	49.0	40.0	40.9	41.5	42.2
DC169	47.0	44.6	45.5	45.5	45.5
DC172	47.4	44.5	46.5	47.1	47.2
DC175	52.2	45.6	46.7	47.5	48.0
DC193	57.0	47.8	52.2	53.4	54.8
DC202	57.2	48.8	53.9	55.8	56.3
DC205	57.0	50.3	56.0	56.1	56.2
E003	54.0	47.2	49.5	50.5	51.9
F003	52.0	47.6	49.9	50.8	51.2
F006	53.5	48.5	52.5	52.6	52.7
MO-12	56.0	52.0	53.3	54.2	55.2
Node105	55.0	46.0	47.0	48.2	50.1
Node107	50.3	40.7	43.0	44.1	45.1
Node108	51.0	45.0	46.2	47.7	49.3
Node110	49.0	42.0	43.3	44.9	47.9
Node120	51.0	47.0	47.8	49.1	50.0
Node126	55.0	45.0	47.3	49.1	51.6

Table 7a. Buildout Conditions XPSWMM Link Results - Alternative A									
Link Name	Upstream Node Name	Downstream Node Name	Link Length, feet	Link Shape	Conduit Diameter, inches	Roughness Coefficient	Maximum Flowrate, cfs		
							2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
DCC004	DC004	DC001	1861	Trapezoidal	-	0.035	5.1	28.9	75.6
DCC010	DC010	DC007	392	Natural	-	0.035	13.5	76.8	179.9
DCC013	DC013	DC010	1269	Natural	-	0.035	4.8	23.0	44.7
DCC016	DC016	DC013	1131	Natural	-	0.035	5.0	23.3	45.4
DCC019	DC019	DC016	1622	Natural	-	0.035	5.2	23.9	45.8
DCC022	DC022	DC019	540	Natural	-	0.035	3.5	21.9	41.9
DCC025	DC025	DC022	81	Circular	36	0.015	0.5	0.7	-4.2
DCC028	DC028	DC025	648	Natural	-	0.035	0.6	1.2	1.5
DCC031	DC031	DC028	70	Circular	36	0.015	0.6	1.2	1.8
DCC034	DC034	DC031	145	Natural	-	0.035	0.6	1.2	1.9
DCC037	DC037	DC034	45	Circular	36	0.015	0.6	1.3	2.0
DCC040	DC040	DC037	400	Natural	-	0.035	0.0	-0.4	-0.9
DCC046	DC046	DC043	126	Circular	30	0.015	0.0	-0.1	-5.2
DCC049	DC049	DC046	193	Natural	-	0.035	0.0	0.0	-2.7
DCC052	DC052	DC049	65	Circular	18	0.015	0.0	0.0	-1.0
DCC055	DC055	DC052	450	Natural	-	0.035	0.0	0.0	-0.5
DCC058	DC058	DC055	35	Circular	18	0.015	0.0	0.0	-0.2
DCC061	DC061	DC058	359	Natural	-	0.035	0.0	0.0	-0.1
DCC094	DC094	DC007	470	Natural	-	0.035	3.3	6.4	10.7
DCC097	DC097	DC094	45	Circular	18	0.024	0.0	6.5	10.7
DCC112	DC112	DC019	67	Natural	-	0.035	0.5	0.8	1.2
DCC115	DC115	DC112	138	Circular	24	0.015	0.0	0.0	0.0
DCC139	DC139	DC043	56	Circular	36	0.015	17.0	33.6	42.2
DCC140	DC140	DC139	688	Circular	36	0.015	0.0	33.6	42.3
DCC172	DC172	DC169	29	Circular	12	0.015	0.0	4.8	5.0
DCC175	DC175	DC172	764	Natural	-	0.035	3.8	19.7	50.6
DCC187	DC193	Basin A	524	Circular	42	0.015	25.9	43.5	51.6
DCC202	DC202	DC193	1266	Circular	36	0.015	19.1	25.2	23.2
DCC205	DC205	DC202	1514	Circular	30	0.015	9.3	11.4	10.0
Link102	Node108	DC154	1342	Circular	42	0.015	7.1	19.3	27.6
Link104	Node110	DC010	458	Circular	72	0.015	9.4	65.3	147.1
Link105	D015	D012	935	Circular	42	0.015	26.4	50.4	45.9
Link106	D012	D003	1126	Circular	60	0.015	48.6	94.7	107.7
Link107	D003	Basin D	40	Circular	84	0.015	79.6	140.5	175.2
Link108	D009	D006	560	Circular	24	0.015	5.0	8.3	8.5
Link109	D006	D003	2022	Circular	30	0.015	0.0	11.3	9.7
Link113	Node117	Node129	286	Circular	60	0.015	0.7	21.6	45.6
Link117	Node120	DC022	50	Circular	42	0.015	3.5	21.5	40.6
Link118	F006	F003	826	Circular	24	0.015	0.0	11.6	11.4
Link121	B003	Basin B	1345	Circular	42	0.015	0.0	37.3	57.3
Link122	C003	Basin C	660	Circular	30	0.015	0.0	21.3	21.4
Link123	E003	Basin E	2260	Circular	60	0.015	0.0	46.8	73.6
Link124	MO-12	Basin G	800	Circular	30	0.015	0.0	29.4	27.1
Link99	Node105	DC175	600.0	Circular	42	0.015	3.9	19.7	50.7

Table 7b. Buildout Conditions XPSWMM Link Results - Alternative B							
Link Name	Upstream Node Name	Downstream Node Name	Link Shape	Conduit Diameter, inches	Maximum Flowrate, cfs		
					2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
DCC004	DC004	DC001	Trapezoidal	-	7.6	35.9	76.9
DCC010	DC010	DC007	Natural	-	15.4	80.8	183.4
DCC013	DC013	DC010	Natural	-	6.3	27.3	47.8
DCC016	DC016	DC013	Natural	-	6.3	27.3	48.5
DCC019	DC019	DC016	Natural	-	6.3	27.9	48.9
DCC022	DC022	DC019	Natural	-	3.5	23.7	42.8
DCC025	DC025	DC022	Circular	36	0.5	0.8	-3.8
DCC028	DC028	DC025	Natural	-	0.6	1.2	1.5
DCC031	DC031	DC028	Circular	36	0.6	1.2	1.8
DCC034	DC034	DC031	Natural	-	0.6	1.2	1.9
DCC037	DC037	DC034	Circular	36	0.6	1.3	2.0
DCC040	DC040	DC037	Natural	-	0.0	-0.4	-2.2
DCC046	DC046	DC043	Circular	30	0.0	-0.1	-0.1
DCC049	DC049	DC046	Natural	-	0.0	0.0	0.0
DCC052	DC052	DC049	Circular	18	0.0	0.0	0.0
DCC055	DC055	DC052	Natural	-	0.0	0.0	0.0
DCC058	DC058	DC055	Circular	18	0.0	0.0	0.0
DCC061	DC061	DC058	Natural	-	0.0	0.0	0.0
DCC094	DC094	DC007	Natural	-	3.2	6.4	10.7
DCC097	DC097	DC094	Circular	18	0.0	6.5	10.7
DCC112	DC112	DC019	Natural	-	2.4	2.7	2.7
DCC115	DC115	DC112	Circular	24	2.4	2.7	2.7
DCC139	DC139	DC043	Circular	36	15.2	29.3	45.7
DCC140	DC140	DC139	Circular	36	0.0	29.4	45.7
DCC172	DC172	DC169	Circular	12	0.0	4.8	5.0
DCC175	DC175	DC172	Natural	-	4.0	19.6	50.2
DCC187	DC193	Basin A	Circular	42	31.3	43.5	51.7
DCC202	DC202	DC193	Circular	36	23.3	25.2	23.1
DCC205	DC205	DC202	Circular	30	13.8	11.4	9.9
Link102	Node108	DC154	Circular	42	7.1	18.3	21.8
Link104	Node110	DC010	Circular	72	9.4	64.9	147.0
Link105	D015	D012	Circular	42	26.2	50.5	46.0
Link106	D012	D003	Circular	60	48.1	94.9	108.4
Link107	D003	Basin D	Circular	84	78.3	139.5	170.5
Link108	D009	D006	Circular	24	4.9	8.8	8.4
Link109	D006	D003	Circular	30	0.0	11.4	9.7
Link117	Node120	DC022	Circular	42	3.5	23.4	41.5
Link118	F006	F003	Circular	24	0.0	11.6	11.4
Link121	B003	Basin B	Circular	42	0.0	26.2	44.0
Link122	C003	Basin C	Circular	30	0.0	21.3	21.5
Link123	E003	Basin E	Circular	60	0.0	61.9	100.5
Link124	MO-12	Basin G	Circular	30	0.0	30.5	31.5
Link99	Node105	DC175	Circular	42	4.0	19.7	50.3

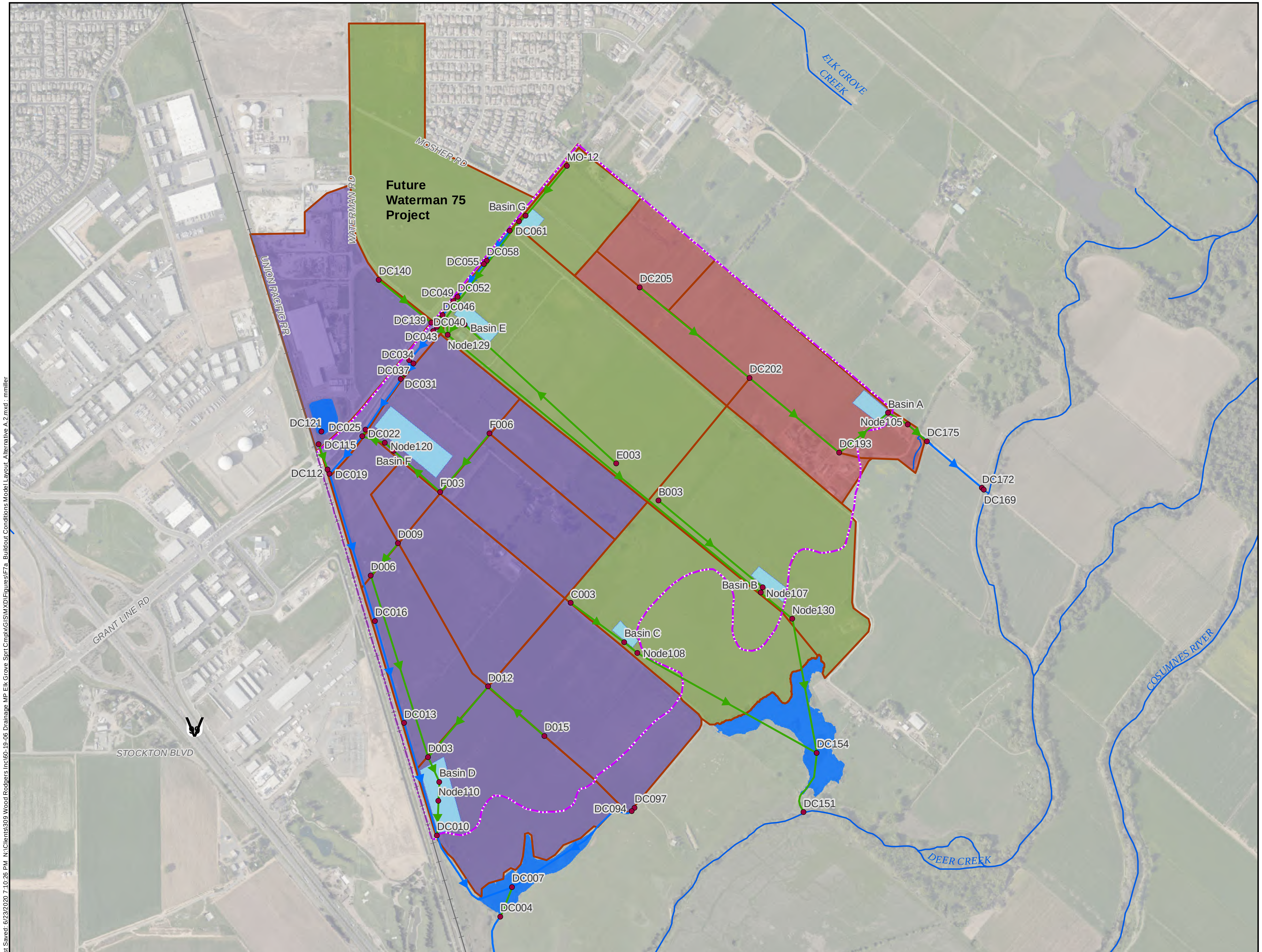


Figure 7a

Buildout Conditions Model Layout - Alternative A

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

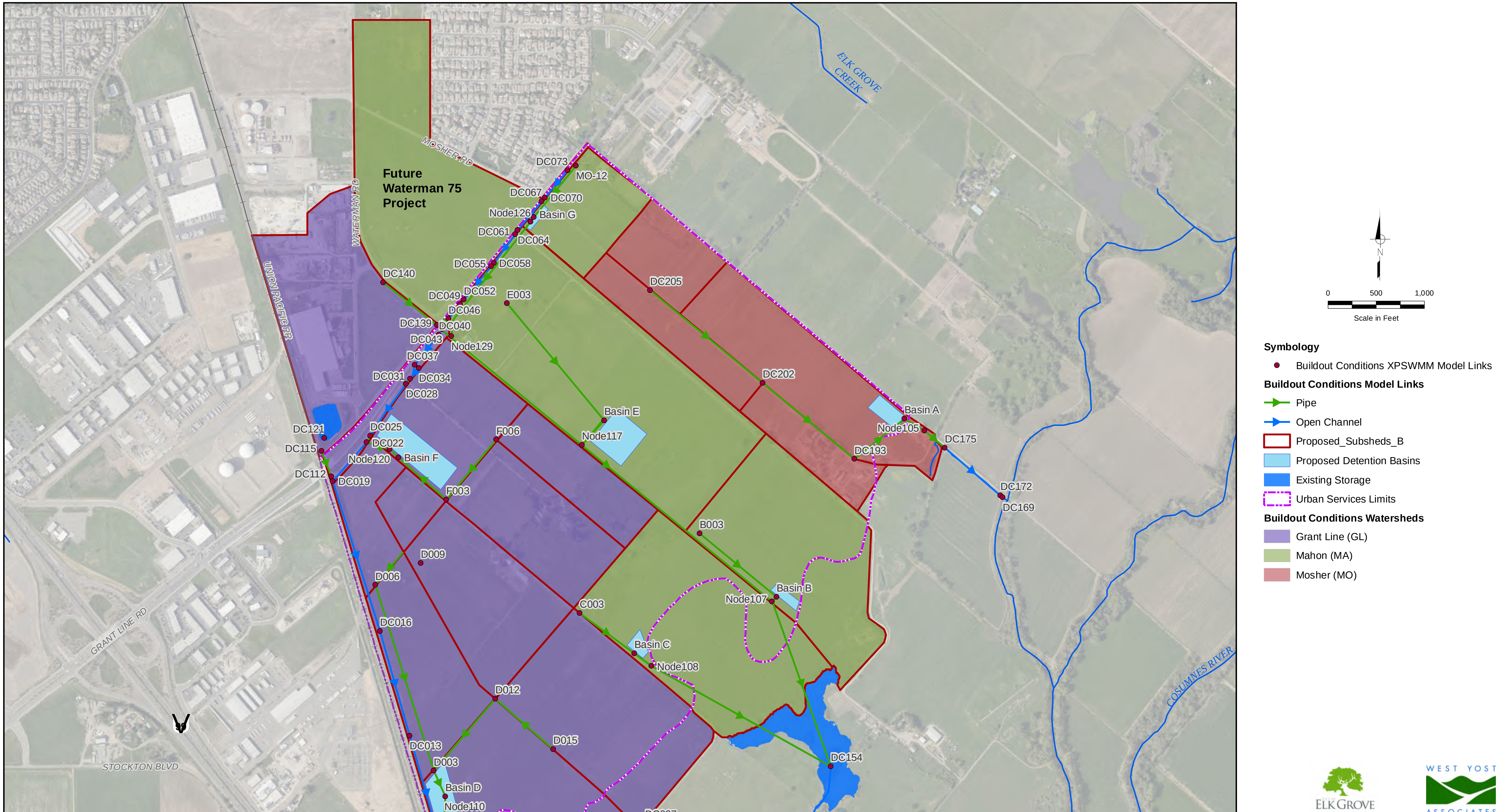
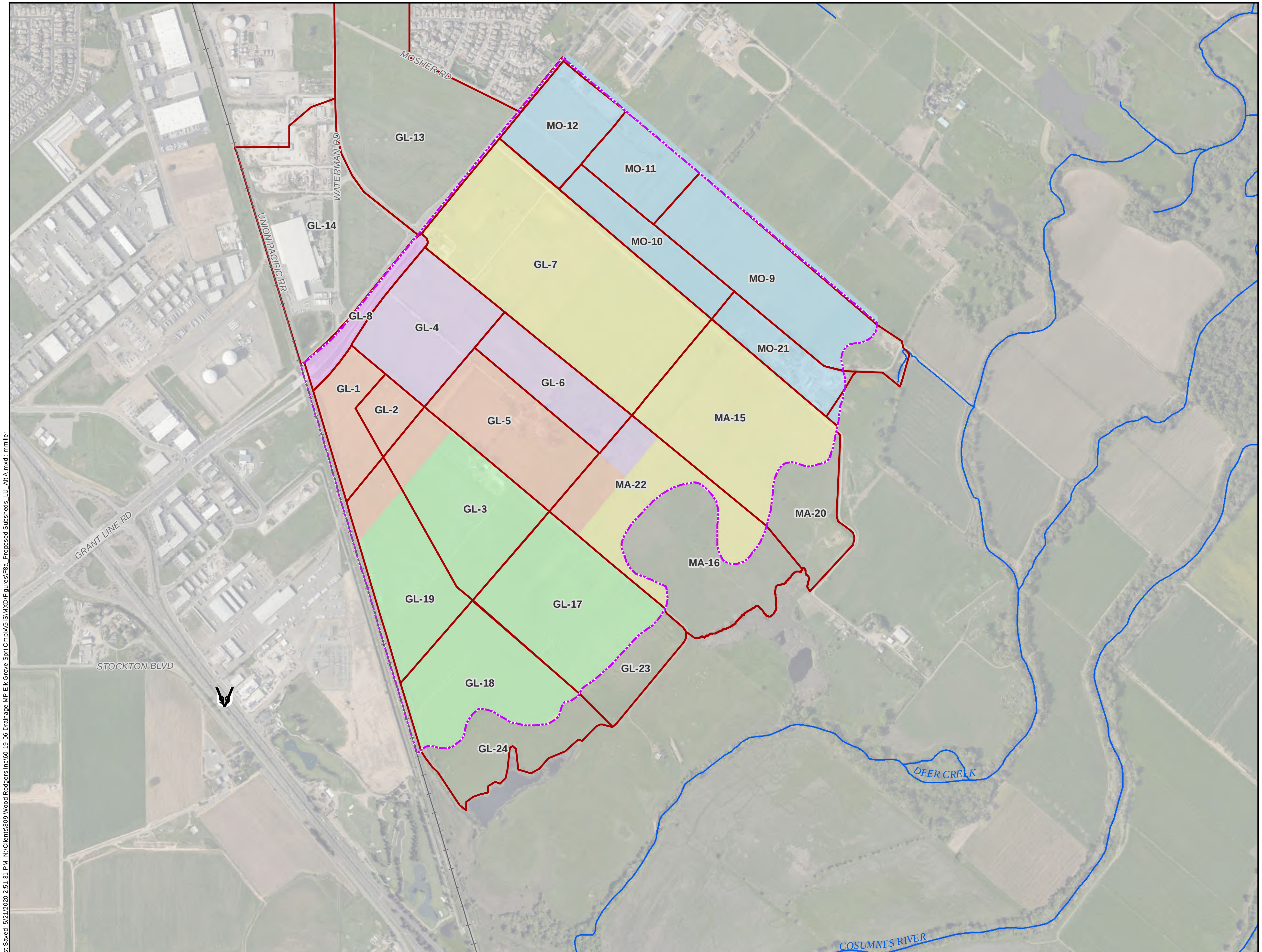


Figure 7b

Buildout Conditions Model Layout - Alternative B

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan



N

0 500 1,000
Scale in Feet

Symbology

Buildout Subsheds

Urban Services Limits

Proposed Land Use

Alternative A

Existing Right-of-Way (ROW), no APN

Heavy Industrial (HI)

Light Industrial (LI)

Mixed Use

Parks and Open Space (P/OS)

Regional Commercial (RC)

ELK GROVE

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Figure 8a

Buildout Subsheds and Land Use

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

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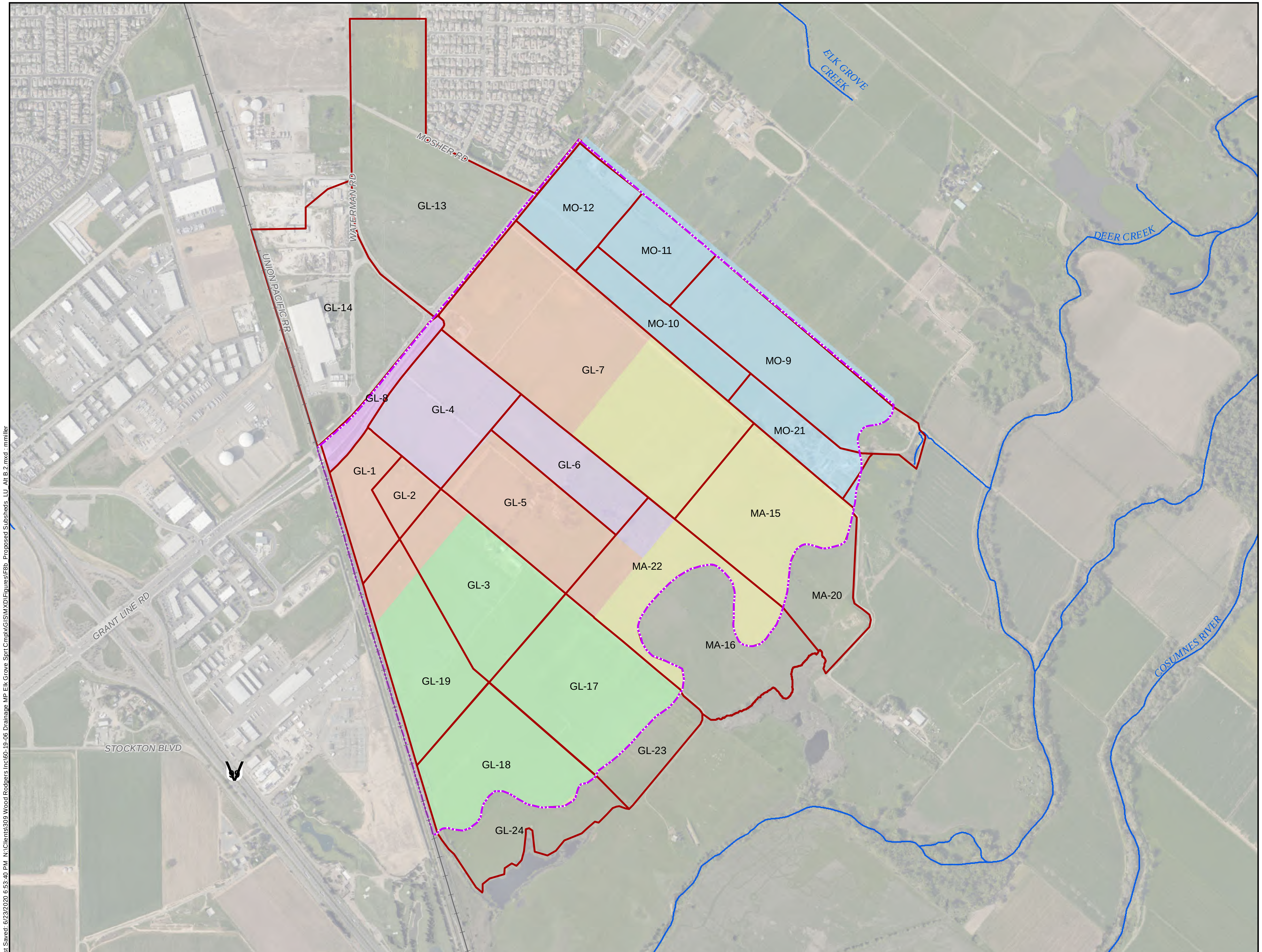

N

0 500 1,000

Scale in Feet

Symbology

Proposed_Subsheds_B

Urban Services Limits

Proposed Land Use

Alternative B

Existing Right-of-Way (ROW), no APN

Heavy Industrial (HI)

Light Industrial (LI)

Mixed Mosher Use

Parks and Open Space (P/OS)

Regional Commercial (RC)

ELK GROVE

WEST YOST ASSOCIATES

Figure 8b

Buildout Subsheds and Land Use - Alternative B

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

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4.4.2 Waterman 75 Outfall

The Waterman 75 project is a 95-acre mixed use development project proposed for the area north of the Waterman Road/Grant Line Road intersection (see Figures 7a and 7b). The Technical Drainage Study for Waterman Park (now Waterman 75), dated August 2009, established the size and alignment of a future outfall that will convey runoff from the Waterman 75 to Deer Creek. The future outfall was planned as a 48-inch pipe along the future extension of Waterman Road through the study area. An easement was obtained along this path as depicted on Figures 7a and 7b. The Waterman 75 project, as well as the City-owned parcel (see Subshed GL-7 on Figure 8a), are currently part of the Grant Line watershed and runoff from these areas is conveyed to the far south end of the study area before flowing to Deer Creek. However, when the Waterman 75 outfall is constructed, runoff from the City-owned parcel would have to cross that outfall to drain to the Grant Line watershed outfall. Due to elevation constraints, it is not possible for runoff from the City parcel to be conveyed across the path of the future Waterman 75 outfall. Therefore, it is planned for the City parcel to also drain to the Waterman 75 outfall. To accommodate this, the outfall pipe will need to be increased from its originally planned size of 48-inches to 60-inches.

As shown on Figures 8a and 8b, the proposed outfall will discharge to an existing pond at the south end of the Mahon watershed. According to the drainage study for Waterman 75, the proposed outfall will discharge into the existing pond at its upstream end. However, based on the currently available topographic data (State of California LiDAR data from 2008), even if the outfall is placed at the minimum allowable slope, it will not daylight at the pond. The invert elevation estimated for the proposed 60-inch is approximately 40.4 feet. The existing ground elevation at the end of the existing drainage easement is approximately 44 feet. The elevation of the pond bottom is uncertain because it was filled with water when the topographic data was created, but it is below elevation 43 feet and is likely to be several feet below this. Regardless, the pond will need to be modified to accommodate the new outfall. The following modifications will be required:

- Reconfigure the outlet of the pond – the outfall from the pond should be configured to be at or below the elevation of the 60-inch outfall pipe, which is currently estimated to be about at elevation 40.4 feet.
- Lower the elevation of the pond – The pond stores water for use by the property owner so if the change to the outfall results in a lower outlet, the rest of the pond will need to be lowered to maintain a large enough pool for the current agricultural operations.

Detailed survey data will be needed during the design phase to determine exactly how the existing pond will need to be reconfigured.

4.4.3 Detention Basins

Seven (7) detention basins are proposed at key locations within the Study Area to provide runoff storage volume that will mitigate for potential increases in peak flood flows and will provide flow duration control to mitigate for hydromodification effects and water quality concerns. Other basin design considerations include existing drainage systems, final grading, proposed land uses, circulation patterns, storm drain trunk line layout, floodplain limits, as well as available outfall locations and tailwater conditions. The general locations of the detention basins are shown in Figure 9a for land use Alternative A and in Figure 9b for land use Alternative B.

Underground pipe systems will convey post-project 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 future proposed projects in the Study Area 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 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.

To determine the required sizes and outlet configurations for the detention basins, the following steps were taken:

- The total tributary area to be served by each detention basin was determined.
- The stormwater quality treatment volume for each detention basin was determined based on the SWQDM Figure E-3 for maximized detention volume for a 48-hour drawdown time.
- Hydrologic modeling was performed with the SAHM to determine the required volume and outlet configuration to provide hydromodification mitigation.
- Hydrologic and Hydraulic modeling was performed with XPSWMM to determine the required storage volumes and outlet configurations.
- The City’s stated preference under the land use Alternative B scenario is to keep any basin off the industrial zoned portion of the sports complex parcel (Subshed GL-7 on Figure 7a).

N

0 500 1,000

Scale in Feet

Symbology

- Proposed Trunk Lines
- Existing SD Pipe
- Existing SD Open Channel
- Channel Improvements
- Buildout Overland Flow Direction
- Waterman Easement
- Urban Services Limits
- Buildout Subsheds
- Proposed Detention Basins

Layer

- Proposed Road
- Existing Storage

Buildout Watersheds

- Grant Line (GL)
- Mahon (MA)
- Mosher (MO)

Proposed Improvements to Existing Storm Drain System

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Figure 9a

Buildout Conditions Detention Basin Layout - Alternative A

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

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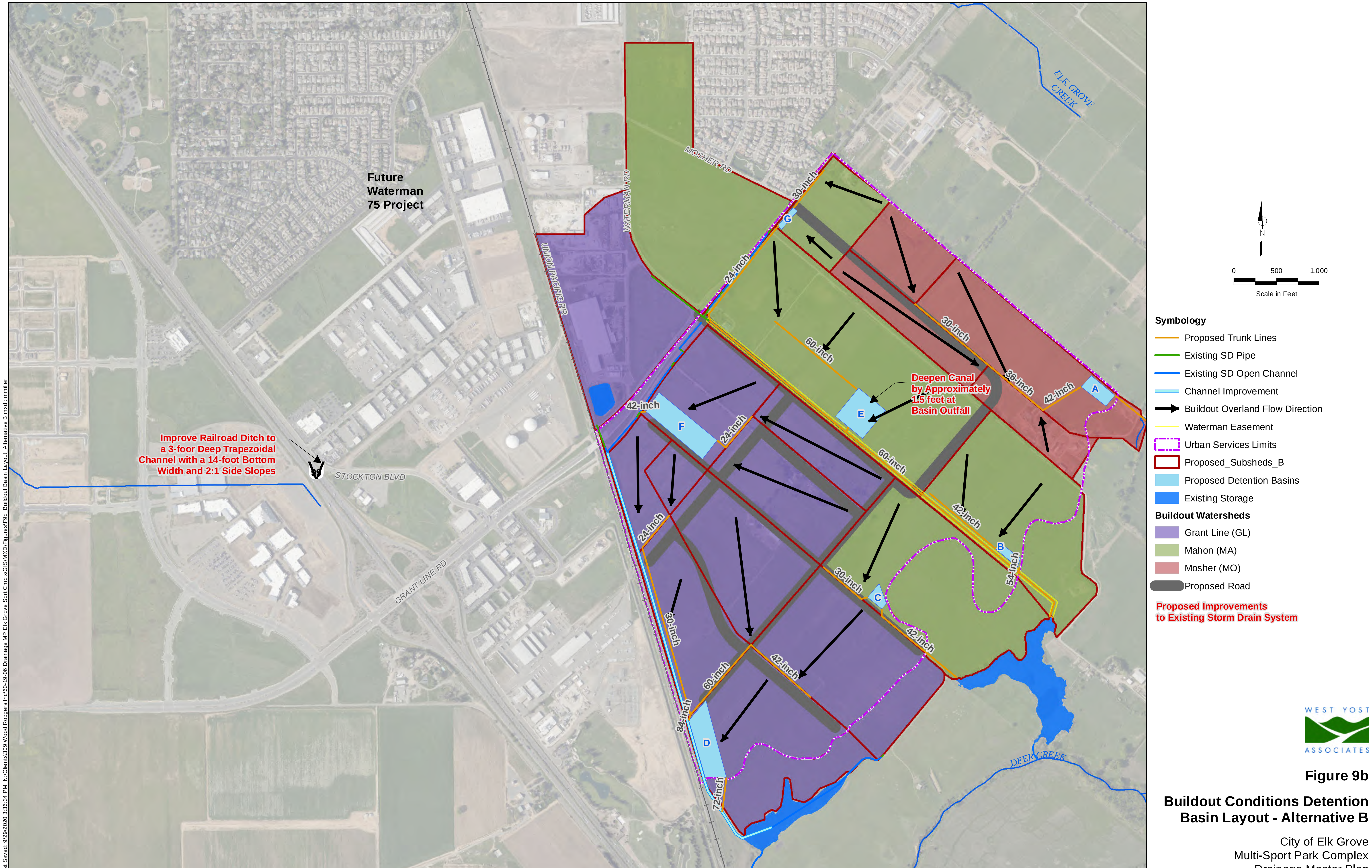


WEST YOST ASSOCIATES

Figure 9b

Buildout Conditions Detention Basin Layout - Alternative B

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

The analysis was completed as an iterative process to verify that the modeled detention basin sizes and outlet configurations would meet the stormwater quality, hydromodification, and flood control requirements (further described below). Combinations of detention basin volumes and outlet configurations were iteratively tested with the model until the desired results were achieved. The detention basin outlets were configured with 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 should also be provided in case the riser becomes plugged. The configuration of the typical outlet is shown on Figure 10. Tables 8a and 8b provide summaries of the detention basin volumes and outlet sizes for Alternatives A and B, respectively.

Appendix A presents elevation and storage design data for each detention basin and lists the stormwater quality basin design data including pool depths and peak stages for all evaluated storm events. Figure 11 presents typical detention basin configurations from the SWQDM. More discussion of the results from the modeling and the effectiveness of the detention basins in providing mitigation is presented later in this report.

In accordance with the SWQDM, the proposed detention basins have been configured with 4:1 side slopes, a basin length that is three times the width, and a depth between 4 and 8 feet where possible. The basins were designed to have 1 foot of freeboard during the 100-year, 24-hour storm event.

4.4.4 Hydromodification Mitigation

Hydromodification control measures address changes to runoff characteristics from urbanization and other sources that would otherwise result in the artificially altered rate of erosion or sedimentation within receiving waters. Based on the Hydromodification Mitigation Applicability Flow Chart provided in the 2018 SQDM, the Study Area is not an exempt project and is therefore subject to hydromodification management requirements.

All proposed basins were sized to provide hydromodification mitigation using the SAHM. The analysis was performed based on a pre-project and post-project evaluation of flow durations for flows ranging from 25-percent of the 2-year storm frequency to the 10-year storm frequency. Results of the hydromodification analyses are presented in Appendix B.

4.4.5 Flood Control Mitigation

As discussed above, the allowable flood flow discharged to Deer Creek at each of the three Study Area outfalls was established based on typical peak flow rates determined using the Sacramento Method Charts. The allowable flow and the calculated post-project 100-year peak flow at each outfall are presented in Table 9. As shown in the table, the buildout conditions flows are less than or equal to the target flow at each outfall.

Table 8a. Alternative A Detention Basin Summary

Watershed	Basin	Tributary Area, acres	Basin Area[(a)], acres	Basin Depth, feet	Basin Volume[(b)], acre-feet	Stormwater Quality Volume, acre-feet	Orifice Diameter, inches	Riser Diameter, inches	Notch Height, feet
Mosher	A	0.0	1.5	8.0	9.1	4.3	6.0	30.0	1.5
Mahon	B	0.0	1.3	6.0	6.1	0.0	4.5	60.0	1.5
	C	34.7	0.7	6.0	2.8	0.7	2.5	36.0	1.5
Grant Line	D	178.3	4.6	7.0	27.6	8.2	9.5	120.0	1.5
	E	92.8	1.9	8.0	11.1	1.9	5.0	48.0	1.5
	F	85.8	5.5	4.5	22.6	5.3	9.0	84.0	1.0
	G	21.0	0.8	8.0	3.9	0.8	4.0	54.0	1.0

(a) This does not include a maintenance path around the perimeter.
(b) Total basin volume, including 1 foot of freeboard during the 100-year, 24-hour storm event.

Table 8b. Alternative B Detention Basin Summary

Watershed	Basin	Tributary Area, acres	Basin Area[a], acres	Basin Depth, feet	Basin Volume[b], acre-feet	Stormwater Quality Volume, acre-feet	Orifice Diameter, inches	Riser Diameter, inches	Notch Height, feet
Mosher	A	117.5	1.5	8.0	9.1	4.3	6.0	30.0	1.5
Mahon	B	41.9	0.7	6.0	2.8	0.7	4.5	60.0	1.5
	C	34.7	0.7	6.0	2.8	0.7	2.5	36.0	1.5
Grant Line	D	178.3	4.6	7.0	27.6	8.2	9.5	120.0	1.5
	E	103.9	4.0	8.0	26.9	2.9	6.0	48.0	1.5
	F	85.8	5.5	4.5	22.6	5.3	9.0	84.0	1.0
	G	21.0	0.4	8.0	1.6	0.8	5.5	54.0	1.0

(a) This does not include a maintenance path around the perimeter.
(b) Total basin volume, including 1 foot of freeboard during the 100-year, 24-hour storm event.

Table 9. Flood Control Results for 100-year Storm

Watershed	Total Tributary Area, acres	Allowable 100-year Peak Flow[(a)]	Calculated Peak 100-Year Flow for Alternative A	Calculated Peak 100-Year Flow for Alternative B
Mosher	102.7	65	51	51
Mahon	158.7	85	83	58
Grant Line	537.4	235	76	77

(a) See Table 4

Because the selected allowable discharge rates are higher than the existing peak flows discharged to Deer Creek, an approximate analysis was performed to ensure no significant negative impacts would occur in Deer Creek. For this evaluation, the total 100-year peak flow discharged from the study area to Deer Creek was determined for existing conditions. Based on the XPSWM model for existing conditions, the peak flows discharged to Deer Creek at the three outfalls are 7 cubic feet per second (cfs) (Mosher Watershed), 6 cfs (Mahon Watershed), and 68 cfs (Grant Line Watershed). The total combined peak 100-year flow is 81 cfs. The total peak flow discharged from the three Study Area outfalls under post-project conditions is 212 cfs for the worst-case alternative (Alternative B).

The 100-year peak flow within Deer Creek at the Study Area was estimated from a previously prepared HEC-RAS model to be in the range of 44,000 cfs. The total increase in peak flow from the Study Area to Deer Creek during the 100-year event is 131 cfs. West Yost used the existing HEC-RAS hydraulic model of Deer Creek to perform an approximate analysis of the potential water surface rise to the existing 100-year floodplain limits resulting from un-mitigated peak flow increases from the Study Area. It was conservatively assumed that the peak flow timing within Deer Creek matched the timing of the peak flow releases from the Study Area (coinciding hydrographs) during the 100-year, 10-day event. The resulting maximum increase in water surface rise in Deer Creek was calculated to be 0.02 feet, which is insignificant based on Sacramento County's floodplain ordinance which considers any increase greater than 0.10 feet to be significant. The analysis also found that tailwater water surface elevations at the proposed Deer Creek outfalls would not be impacted and that new basin designs would consider a free-outfall condition to Deer Creek.

West Yost has confirmed in written correspondence from the Sacramento County local floodplain administrator that the proposed increases to peak flows from the study area are acceptable. Based on this, the proposed detention basins provide adequate flood control performance.

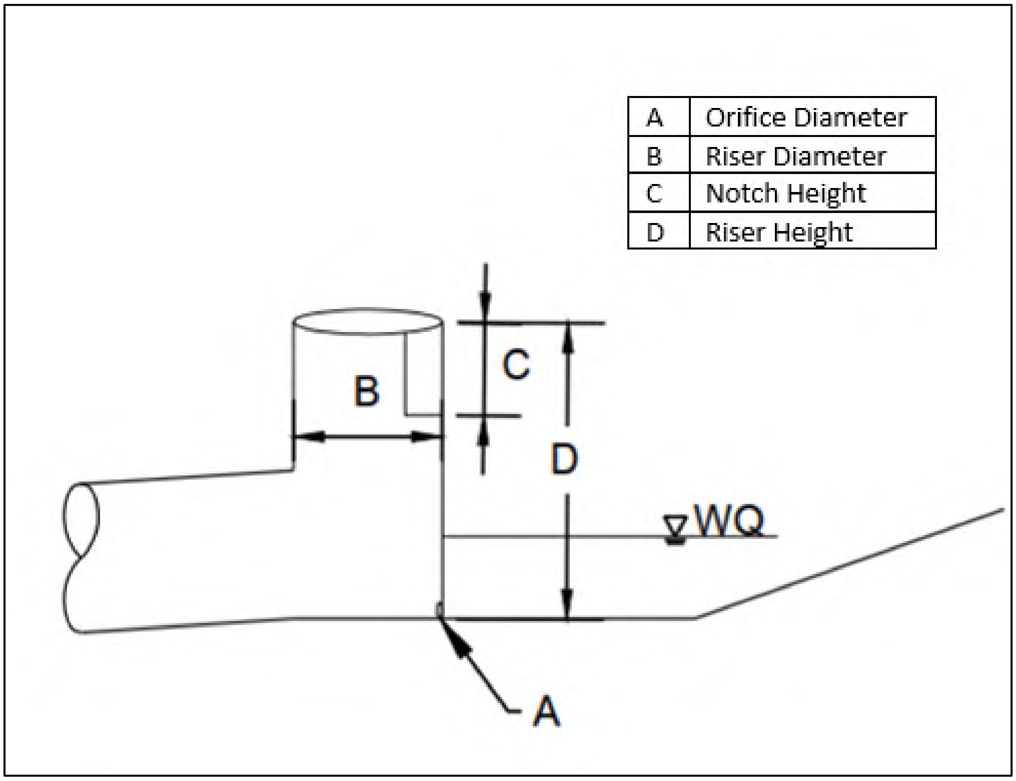


Figure 10. Typical Detention Basin Outlet Details

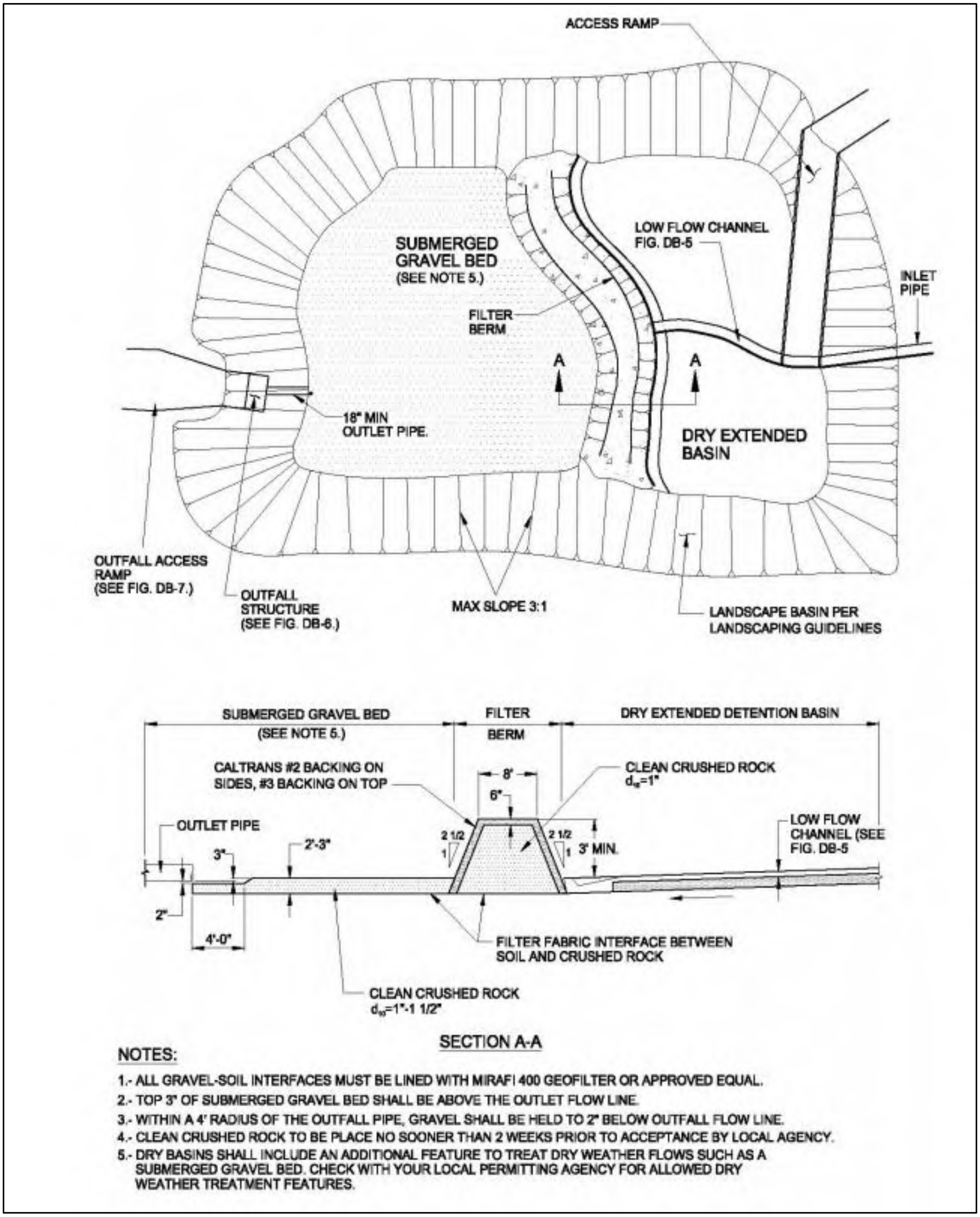


Figure 11. Typical Detention Basin Configuration

4.4.6 Stormwater Quality Mitigation

For stormwater quality treatment purposes, the detention basins were assumed to be configured per SWQDM as a dry extended type basin. 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 11.

Stormwater quality treatment will be provided in the detention basins. A dry basin was assumed because it is the typical approach used in the region and requires less on-going maintenance than a wet basin. The design criteria for stormwater quality treatment are based on the requirements set forth in the SWQDM. The water quality storage volume will be released over 48 hours in compliance with the requirements of the manual. The water quality flows will be released through an orifice constructed in a riser at the detention basin outlet. A summary of the water quality treatment volume requirements is provided in Tables 8a and 8b.

4.4.7 Summary of Results - Buildout Conditions

Using XPSWMM, the proposed trunk lines and detention basins required to serve each land-use alternative were sized. Schematic layouts of the proposed drainage facilities for Alternatives A and B are provided on Figures 7a and 7b, respectively. For each alterative, the XPSMM model was used to calculate the post-project peak flows and water surface elevations. The model results for Alternative A are provided in Table 6a, which lists peak water surface elevations, and Table 7a, which list the calculated peak flows. The locations of the nodes listed in the tables are shown on Figure 7a. For each of the proposed detention basins, the configuration data and results can be bound in Appendix A.

For Alternative B, the resulting peak water surface elevations and flows are provided in Tables 6b and 7b. The system layout and node locations are shown on Figure 7b. For each of the proposed detention basins, the configuration data and results can be bound in Appendix A.

4.5 Stormwater Permitting Compliance

Stormwater discharge for this project is subject to the requirements of Sacramento Areawide National Pollutant Discharge Elimination System Municipal Stormwater Permit No. CAS0085324 (Permit) – Order No. R5-2016-0040. This permit requires that Best Management Practices (BMPs) be implemented to the Maximum Extent Practicable (MEP) to reduce the discharge of pollutants to Waters of the United States. The Multi-Sport Park Complex project and development proposed within the Study Area are classified from the SWQDM as Commercial/Industrial Development with greater than 1 acre of impervious surfaces. Projects in this category are required to implement source controls, low impact development (LID) controls, treatment controls, and hydromodification controls.

Source control measures are designed to prevent pollutants from contacting site runoff, leaving the site, and entering the municipal storm drain system or local waterways. Source control measures that are required for street projects could include storm drain markings and drought tolerant irrigation and landscaping plans.

LID measures seek to mimic a site's predevelopment balance of runoff and infiltration by using design techniques that infiltrate, store, evaporate, and detain runoff close to its source. LID controls are integrated into site design and can be distributed throughout the site in a series of small-scale measures. Acceptable LID measures applicable to this development could include disconnected pavements, vegetated swales and disconnected rooftops to name a few. Recommended source control and LID facilities, and their design, are not a part of this DMP and instead would be a part of future parcel specific development plans.

Treatment control measures are engineered technologies designed to remove pollutants from site runoff. These measures address impacts to stormwater pollutant concentration and/or pollutant load that would otherwise result from urbanization. Hydromodification controls are being addressed through design and construction of the proposed detention basin system.

5.0 EVALUATION OF POTENTIAL FEMA FLOODPLAIN IMPACTS

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) for the Study Area show that far southern portions of the Study Area are located in Zone AE floodplain associated with Deer Creek, which is defined as an area that is within 1-percent annual chance (100-year) floodplain, with the base flood elevation defined. For the Study Area, the base flood elevation varies from a low elevation of approximately 45.0 feet (North American Vertical Datum of 1988) at the far southwestern (downstream) corner to a high of approximately 54.0 feet at the far northeastern (upstream) corner. This limits of the FEMA floodplain in the vicinity of the Study Area shown on Figure 12. The FIRMs for the Study Area are included in Appendix C.

The limits of the 200-year floodplain were defined for the Study Area as part of a hydraulic analysis performed by West Yost in 2017 at the request of the City. These limits are depicted on Figure 12 and generally reflect increasing encroachment of flood waters to the north of the 100-year limits.

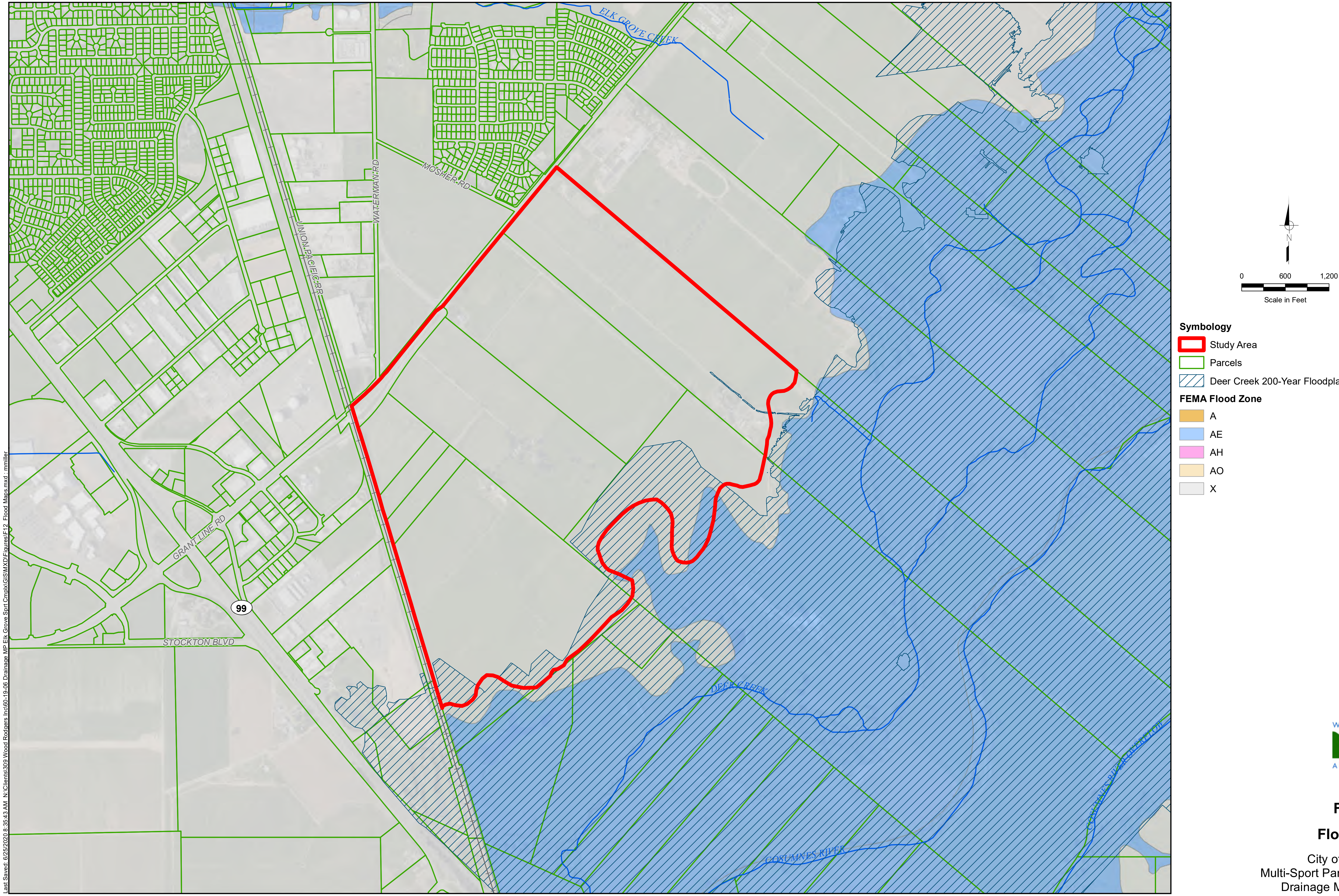
5.1 Urban Level of Flood Protection Analysis

The passage of Senate Bill 5 (SB5) in 2007 changed the standard of flood protection for new developments in Sacramento-San Joaquin Valley communities. Among other requirements, SB5 requires all communities within the Valley to make findings related to an urban level of flood protection (i.e., 200-year protection) before entering into development agreements, issuing permits for new structures, or approving parcel maps in urban or urbanizing areas. When reviewing a new development application, communities with land-use authority must follow a three-step process established in the California DWR Urban Level of Flood Protection Criteria (ULOP), November 2013.

According to the ULOP, a development area meets the “Applicable Location” requirement for the urban level of protection if all of the following conditions apply:

1. It is located in an urban area that is a developed area with 10,000 residents or more.
2. It is located with an area that is mapped by FEMA as a special flood hazard area or an area of moderate hazard.
3. It is located within the Sacramento-San Joaquin Valley.
4. It is located with an area with a potential flood depth above 3 feet.
5. It is located within a watershed with a contributing area of more than 10 square miles.

For the Study Area, Conditions 1, 2 and 3 are clearly met. Based on FEMA floodplain mapping, Condition 2 is met for southern portions of the Study Area within the floodplain of Deer Creek. Figure 12 shows the special flood hazard areas mapped by FEMA in the study area.



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WEST YOST ASSOCIATES

Figure 12

Flood Maps

City of Elk Grove
Multi-Sport Park Complex
Drainage Master Plan

For Condition 4 above, a comparison of existing LiDAR based topography with water surface elevation data generated from the 2017 hydraulic analysis was performed. The results of this analysis indicate no portions of the Study Area contained within the mapped 200-year floodplain limits will experience depths of flooding greater than 1-feet. Therefore, the Study Area does not meet Condition 4 as there are no areas with a potential flood depth exceeding 3 feet deep.

For Condition 5 above, the Study Area is within the larger Deer Creek watershed as depicted on Figure 2, with a total contributing area of more than 10 square miles. Therefore, the Study Area does meet Condition 5.

In summary, because not all of the five required conditions are met (200-year flood depths do not exceed 3 feet), the ULOP requirements are not applicable to the Study Area and no further analysis is required.

6.0 DRAINAGE EASEMENTS AND FUTURE MAINTENANCE RESPONSIBILITIES

West Yost has confirmed that the Study Area does not fall within the Sacramento County Stormwater Utility fee area. There is one known drainage easement that was established for the Waterman 75 outfall pipe. It is the City of Elk Grove's intent to annex the entire LAFCO approved SOIA area and once completed, the City will be responsible for maintenance of the drainage facilities within the annexed area and off-site, until drainage reaches the Deer Creek outfalls. Drainage easements within the annexed area and drainage facilities from the detention basins to Deer Creek will be granted to the City of Elk Grove.

7.0 QUALITATIVE ASSESSMENT OF LAND-USE ALTERNATIVE C

The City is considering a third land land-use alternative, Alternative C, that would revise the proposed land use on the City-owned parcel (APN 134-0190-009) and on the parcel to the south owned by Kendrick (APN 134-0190-001). The City parcel corresponds with Subshed GL-7 on Figures 8a and 8b while the Kendrick property corresponds to Subsheds GL-4, GL-5, and GL-6. A qualitatively evaluation was performed to estimate the changes required to the proposed drainage plan to accommodate the land use associated with Alternative C.

Under Alternatives A and B, the land use for the City parcel is proposed as park and open space (Alternative A) and a mix of open space and light industrial land uses (Alternative B). The Kendrick property is proposed as a mix of commercial and light industrial with no difference between Alternatives A and B. Under land-use Alternative C, the City and Kendrick properties are primarily proposed for light industrial development, with approximately 20 acres of the Kendrick property retained as regional commercial development. Based on the City hydrology standards, the estimated post-project imperviousness of the City and Kendrick parcels were determined for each land-use alternative as presented in Table 10. The estimated impervious cover for the City parcel is anticipated to increase significantly under Alternative C while there is a slight reduction anticipated for the Kendrick property. Based on this, the drainage facilities proposed to serve the City property under Alternatives A and B would need to be revised (enlarged) for Alternative C. The drainage facilities proposed to serve the Kendrick property under Alternatives A and B, as defined herein, would be adequate for Alternative C and could possibly be downsized somewhat, but not significantly.

Table 10. Alternative C - Estimated Differences in Imperviousness

Parcel	Subsheds	Total Watershed Area, ac	Impervious Cover, percent		
			Alternative A	Alternative B	Alternative C
City	GL-7	92.8 (A) 103.9 (B)	27.6	47.1	80.0
Kendrick	GL-4, GL-5, GL-6	85.8	86.2	86.2	85.0

The changes to the drainage facilities serving the City property to accommodate Alternative C were qualitatively estimated. The imperviousness of the City parcel under Alternative C is closer to that for Alternative B than for Alternative A, so Alternative B was used for a comparative analysis. The City parcel is proposed to drain to Detention Basin E (see Figures 9a and 9b). We assumed that the peak flow released from Detention Basin E cannot be increased beyond what was assumed for Alternative B. This is reasonable because enlarging the outfall pipe from Basin B to Deer Creek would increase the cost of the outfall significantly and make it difficult to meet the City standards for the required cover over pipe systems. Therefore, we have assumed that Detention Basin E would be enlarged to accommodate the additional runoff volume anticipated with Alternative C. Testing with a hydrologic model indicated that the total runoff from the City parcel will increase by about 15 percent during the 100-year storm. However, a significant percentage of this increase occurs before the peak runoff occurs and thus the required increase in detention storage is likely to be more than 15 percent. Based on the results from the hydraulic modeling for Detention Basin E, the peak 100-year water surface in the basin occurs at hour 14 of the 24-hour storm. The estimated increase in runoff volume prior to the detention basin reaching the peak 100-year stage is estimated to be 23 percent. There will also be a smaller increase in volume required for stormwater quality treatment. Based on this, we estimate that the storage volume in Detention Basin E would need to be increased by approximately 25 percent. This additional storage volume would increase the required area of Basin E by 0.3 to 0.5 acres.

8.0 CONSIDERATIONS FOR THE FUTURE WIDENING OF GRANT LINE ROAD

The drainage facilities proposed herein are based on the current configuration of Grant Line Road. A future project is planned to widen Grant Line Road from 4 to 6 lanes along the study area frontage and beyond. When that occurs, there will be a need for the City to develop a drainage plan for the widened road. Depending on timing and the details of the road design, it is possible that mitigation for drainage impacts (stormwater quality, hydromodification, and flood control impacts) from the road project could be mitigated in one of the detention basins that are proposed with the project.

Ideally, the City road project could be entirely served by the detention basin serving the City-owned parcel, Detention Basin E, but this is most likely infeasible. Only that portion of Grant Line Road north of Waterman Road could feasibly be drained to Basin E because runoff generated south of Waterman Road would have to cross the 48-inch pipe that extends across Grant Line Road from Waterman Road. Because of this, any runoff generated south of Waterman would most likely need to be served Detention Basin F or in a drainage facility constructed specifically for the road project.

Because the additional impervious area that would be generated by the road project would be relatively small compared to the areas being served by the proposed detention basins, the detention basins would need to be incrementally increased in size to accommodate the runoff. Once the road project is better defined, the feasibility of using Detention Basin E or another basin can be assessed in detail.

9.0 SUMMARY OF RECOMMENDED FACILITIES

It is recommended that a multi-functional drainage system be constructed within the Study Area to accommodate future development. which accommodates the anticipated increase in stormwater runoff and meets regulatory discharge requirements for stormwater quality, hydromodification and flood control. The multi-functional system is broken down and described in further detail below to include drainage channels (ditches) and culverts, a system of dry extended type detention basins and a storm drain trunk system which will convey runoff to the detention basins. In recommending these facilities, West Yost considered the most likely phased future development pattern and preferences identified by the City for basin locations within the sports complex parcel. We attempted to avoid the need for any hydraulic pump systems, and none are ultimately recommended. Other constraint considerations for the storm drain trunk system design included providing adequate cover, reducing mass grading efforts, avoiding high 100-year hydraulic gradient levels and providing means for future specific designs to address overland flow routing.

Two alternative land-use plans were evaluated. The recommended drainage facility layouts between the alternatives are very similar. The main differences between the alternatives are the sizes of the various facilities change in some locations due to different runoff rates from the different land uses proposed. Other differences between the alternatives are described below.

9.1 Drainage Channels and Culverts

Some existing open drainage ditches/channels will be improved for continued use within the planned system as indicated on Figures 9a and 9b. This includes the existing ditch adjacent and parallel to the Union Pacific Railroad (railroad ditch) and the existing drainage canal located at the southeastern corner of the Mosher parcel. The railroad ditch will be improved to a larger trapezoidal channel that has capacity to convey the 100-year flow. If it is not possible to obtain permission to improve the existing railroad ditch, a parallel ditch will be required or fill. It may also be possible to fill the low areas adjacent to the ditch rather than improving the ditch. This may be accomplished by the future placement of fill during grading of the adjacent industrial zoned parcels.

The other proposed channel improvement is along the existing ditch that conveys runoff from the Mosher property/watershed to Deer Creek. To avoid pipe cover issues and to allow the proposed detention basin to be deeper, it is proposed that the existing ditch be deepened by 1.5 feet. This deepening would need to occur when the detention basin is constructed for this watershed. The proposed ditch improvements are the same between Alternatives A and B.

9.2 Detention Basins

Runoff from the Study Area will be directed via underground storm drain collection systems and overland flow paths into one of seven proposed detention basins as depicted in Figures 9a and 9b. The general locations of the basins are included on these figures. Tables 8a and 8b present the assumed dimensions and storage volumes for the detention basins. When the final basins are designed, they will likely differ from the shapes assumed for this study and this is acceptable if the elevation-storage volume relationship is reasonably close. Significant deviations may need to be tested with modeling.

The detention basin outlets are configured as open top risers with an orifice to control flows from small, frequent storms, and a notch in the riser to control larger, less frequent storms (see Figure 10). Very large storms will flow over the top of the riser. All flows entering the riser will ultimately be conveyed to one of three existing ponds via underground storm drain piping systems or open channels. Runoff entering these existing ponds is ultimately discharge to Deer Creek at the locations depicted in Figures 9a and 9b. At the time of design, alternative outlet configurations may be acceptable if the criteria are met for stormwater quality treatment, hydromodification mitigation, and flood control mitigation. For the detention basins, the primary differences between Alternatives A and B are the sizes of the basins. The exception to this is that for Alternative B, Detention Basin E was moved to the southwest. This is the basin that serves the City-owned parcel and it was desired to locate the detention basin within the open space/park land use rather than the light industrial land use area closer to Grant Line Road.

9.3 Storm Drain Trunk Line System

Proposed storm drain trunk pipes are shown on Figures 9a and 9b. Pipes greater than 24-inch in diameter were included in the analysis. As stated earlier, in conceptually designing these pipes, West Yost considered the need to maintain adequate piping cover, keep hydraulic grade lines low and to consider a layout that most efficiently provides for overland flow routing. During the project design, the pipe layout will need to accommodate the proposed site layout that is proposed at the time and it will almost certainly deviate from the alignments shown on Figures 9a and 9b and that is acceptable.

As discussed above, the Waterman 75 project, located northeast of the Waterman Road/Grant Line Road intersection, is planning to construct a pipe outfall through the study area to Deer Creek. This outfall is proposed to be increased from 48-inches, as proposed by Waterman 75, to 60-inches to accommodate runoff from some of the Study Area. There will also be some improvements required to the existing pond at end of the proposed outfall at the Mahon property. When the proposed outfall is constructed, the pond will need to be deepened by a few feet and the outlet will need modification to accommodate the lowered outfall. The details of these improvements will occur at the time of the drainage outfall design.

9.4 Estimated Costs for Trunk Drainage Facilities

The cost to construct the future trunk drainage facilities for the Study Area was estimated for Alternative B. Based on input from the City, Alternative A is no longer being considered for implementation and therefore a cost estimate was not prepared for it. Costs for Alternative A would be slightly less than those estimated for Alternative B.

The cost estimate for Alternative B was based on the following significant assumptions:

- Unit costs are based on current construction costs (August 2020 ENR 20 Cities CCI of 11455).
- The unit costs used to determine construction costs were based on cost data from constructed projects, manufacturer quotes, estimating guides, and engineering judgment.

- The nominal unit cost for excavation of channels and detention basins is estimated assuming on-site disposal without a significant haul distance.
- A construction contingency of 15 percent was included to account for the planning level uncertainties and construction cost uncertainties associated with the estimates. Mobilization was assumed to be 5 percent of the construction cost. Engineering, administration, and environmental permitting were assumed to be 25 percent of the construction cost.
- Due to significant uncertainties, costs were not estimated for land acquisition. These costs should be estimated by City staff with expertise in real estate valuation.

As indicated in Table 11, the cost to implement the recommended trunk drainage facilities for Alternative B is estimated to be $22.2 million without land acquisition costs. In addition to a total estimated cost, Table 11 also breaks out the cost by watershed. There are two facilities that are shared by multiple watersheds (Waterman 75 outfall pipe, and the railroad ditch improvements) and costs are separately estimated for those.

Table 11. Estimated Trunk Drainage Costs for Alternative B

Drainage Facility	Unit	Unit Cost in Dollars	Watershed A		Watershed B		Watershed C		Watershed D		Watershed E		Watershed F		Watershed G		Waterman 75 Outfall Pipe (For Watersheds E, G, and C.)		Railroad Ditch Improvements (Serves Watersheds D and F.)		Total Drainage Facility Quantity	Estimated Cost in Dollars
			Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars	Quantity	Cost in Dollars		
24-inch Pipe	LF	144	0	0	0	0	0	0	501	72,144	0	0	620	89,280	1,400	201,600	0	0	0	0	2,521	363,024
30-inch Pipe	LF	360	1,124	404,640	0	0	663	238,680	2,036	732,960	0	0	0	0	573	206,280	0	0	0	0	4,396	1,582,560
36-inch Pipe	LF	432	835	360,720	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	835	
42-inch Pipe	LF	504	1,123	565,992	1,024	516,096	1,227	618,408	935	471,240	0	0	61	30,744	0	0	0	0	0	0	4,370	2,202,480
48-inch Pipe	LF	576	0	0	60	34,560	0	0	0	0	60	34,560	0	0	0	0	0	0	0	0	120	69,120
54-inch Pipe	LF	648	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60-inch Pipe	LF	720	0	0	0	0	0	0	1,081	778,320	1,265	910,800	0	0	0	0	5,410	3,895,200	0	0	7,756	5,584,320
72-inch Pipe	LF	864	0	0	0	0	0	0	409	353,376	0	0	0	0	0	0	0	0	0	0	409	353,376
48-inch Manhole	EA	6,500	3	19,500	0	0	0	0	8	52,000	0	0	3	19,500	0	0	0	0	0	0	14	91,000
60-inch Manhole	EA	7,000	6	42,000	3	21,000	7	49,000	3	21,000	0	0	0	0	0	0	0	0	0	0	19	133,000
72-inch Manhole	EA	7,500	0	0	0	0	0	0	3	22,500	4	30,000	0	0	0	0	10	75,000	0	0	17	127,500
84-inch Manhole	EA	8,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	42,500	0	0	5	42,500
10' Access/Maintenance Rd. (3" AC)	SF	2.44	13,000	31,761	9,000	21,989	9,000	21,989	21,640	52,870	18,200	44,466	23,600	57,659	7,000	17,102	0	0	0	0	101,440	247,836
10' Access/Maintenance Rd. (6" AB)	SF	1.75	22,600	39,440	9,000	15,706	9,000	15,706	21,640	37,765	18,200	31,761	23,600	41,185	7,000	12,216	0	0	0	0	111,040	193,779
Geotextile Under Maintenance Road	SY	0.35	2,511	876	1,000	349	1,000	349	2,404	839	2,022	706	2,622	915	778	271	0	0	0	0	12,338	4,306
Fencing and Gates - 3' High Post & Cable	LF	25.60	1,300	33,274	900	23,036	900	23,036	2,160	55,286	1,820	46,583	2,360	60,405	700	17,917	0	0	0	0	10,140	259,535
Fencing and Gates - Pipe Gate	EA	4,000	1	4,000	1	4,000	1	4,000	1	4,000	1	4,000	1	4,000	1	4,000	0	0	0	0	7	28,000
Misc. Metal	LB	7.00	500	3,500	500	3,500	500	3,500	500	3,500	500	3,500	500	3,500	500	3,500	0	0	0	0	3,500	24,500
Excavation	CY	6.00	23,400	140,400	4,500	27,000	4,500	27,000	44,600	267,600	43,500	261,000	36,500	219,000	2,600	15,600	0	0	5,000	30,000	164,600	987,600
Erosion Control Rip Rap	Ton	105	50	5,250	50	5,250	50	5,250	50	5,250	50	5,250	50	5,250	50	5,250	0	0	100	10,500	450	47,250
Landscaping (includes hydroseeding)	SF	2.20	90,000	198,000	40,600	89,320	40,600	89,320	226,100	497,420	194,900	428,780	267,400	588,280	25,000	55,000	0	0	48,000	105,600	932,600	2,051,720
Landscape Irrigation	SF	1.55	38,400	59,418	25,600	39,612	25,600	39,612	66,000	102,125	55,000	85,104	72,200	111,718	19,200	29,709	0	0	0	0	302,000	467,298
Misc. Concrete - Outlet	CY	1,400	17	23,800	17	23,800	17	23,800	17	23,800	17	23,800	17	23,800	17	23,800	17	23,800	0	0	136	190,400
Misc. Concrete - Weir Structure	CY	1,400	20	28,000	20	28,000	20	28,000	20	28,000	20	28,000	20	28,000	20	28,000	0	0	0	0	140	196,000
Misc. Concrete - Ramp (Assumed 6")	CY	800	10	8,000	10	8,000	10	8,000	10	8,000	10	8,000	10	8,000	10	8,000	0	0	0	0	70	56,000
Rounded Subtotal Cost				1,968,600		861,200		1,195,600		3,590,000		1,946,300		1,291,200		628,200						15,303,100
																					Contingency (15%)	2,295,465
																					Mobilization (5%)	765,155
																					Engineering, Administration, Environmental Permitting (25%)	3,825,775
																					Rounded Estimated Total Without Land Costs	**22,189,000**
Land for Detention Basins and Channels (Cost to be determined by others)	AC		2.8		1.0		1.0		5.2		4.5		6.1		0.6				4.6			n/a
Land Acquisition Soft Costs (To be determined by others)	LS																					n/a
																					Estimated Implementation Cost - Rounded Total	**n/a**

10.0 PHASING PLAN FOR DRAINAGE SYSTEM DEVELOPMENT

Development of this DMP included consideration of the planned phased development of the Study Area. The planned first phase of development is understood to occur on the City's sports complex parcel with design and construction of recreational facilities as presented within the existing DEIR. This first phase would occur within the sports complex parcel under both land use Alternatives A and B. As public access to this parcel and planned circulation patterns will also occur across the northern portion of the Mosher parcel (see Figures 8a and 8b), limited, roadway related drainage improvements within the Mosher parcel must be included with the first phase of development. Details for these limited improvements would be prepared during the detailed designs for the sports complex parcel. Therefore, Basins B and E as well the storm drain trunk line system serving these basins would need to move forward together as the first phase of infrastructure development. Necessary modifications to the Railroad ditch and the culverts along the access road (see Figures 9a and 9b) will also need to occur to accommodate planned discharges.

There appears to be some flexibility in the phasing of developments for subsequent phases. Planned mixed use development within the MA and MO watersheds, which would include the construction of Basins A, C and G and storm drain system appurtenances, could occur independent of development within the much larger GL watershed. This independence in these watersheds applies to both land use Alternatives A and B.

The future planned commercial and industrial developments within the remaining portion of the GL watershed can also occur independent of the MA watershed. This would include construction of Basins F and D as well as system appurtenances.

11.0 REFERENCES

Sacramento County Water Resources Division and City of Sacramento Department of Utilities Division of Engineering Services, October 2006. Hydrology Standards, Volume 2 of the Sacramento City/County Drainage Manual.

Sacramento Stormwater Quality Partnership, July 2018. Stormwater Quality Design Manual for the Sacramento Region.

APPENDIX A
Detention Basin Storage Data

Buildout Conditions Basin Water Surface Elevation

Basin	Maximum Water Surface Elevation, feet (NAVD88)		
	2-Year, 24-Hour Storm	10-Year, 24-Hour Storm	100-Year, 24-Hour Storm
Alternative A			
Basin A	52.1	53.1	53.8
Basin B	48.3	49.2	50.0
Basin C	48.4	48.8	49.0
Basin D	46.7	47.4	48.1
Basin E	47.7	51.9	51.8
Basin F	49.0	49.4	50.1
Basin G	49.2	50.4	52.0
Alternative B			
Basin A	52.2	53.1	53.8
Basin B	48.3	49.1	49.8
Basin C	48.4	48.8	49.4
Basin D	46.7	47.3	48.1
Basin E	48.0	50.1	51.9
Basin F	49.0	49.4	50.1
Basin G	47.3	49.2	51.6

Buildout Conditions Basin Water Quality Data				
Basin	Required Water Quality Volume, acre-feet	Water Quality Depth, feet	Water Quality Elevaton, feet (NAVD88)	Water Quality Area, acres
Alternative A				
Basin A	4.3	3.9	50.9	1.1
Basin B	1.2	1.5	46.5	1.3
Basin C	0.7	1.9	46.9	0.7
Basin D	8.2	2.3	44.3	3.7
Basin E	1.9	1.8	46.8	1.1
Basin F	5.3	1.1	48.1	1.1
Basin G	0.8	4.1	49.1	0.2
Alternative B				
Basin A	4.3	3.9	50.9	1.1
Basin B	0.7	1.8	46.8	0.4
Basin C	0.7	1.9	46.9	0.7
Basin D	8.2	2.3	44.3	3.7
Basin E	2.9	1.0	47.0	2.9
Basin F	5.3	1.1	48.1	4.8
Basin G	0.8	4.1	49.1	0.2

Basin A Elevation-Volume Data					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
47.0	0.0	86	386	0.76	0.00
48.0	1.0	94	394	0.85	0.81
49.0	2.0	102	402	0.94	1.70
50.0	3.0	110	410	1.04	2.69
51.0	4.0	118	418	1.13	3.77
52.0	5.0	126	426	1.23	4.96
53.0	6.0	134	434	1.34	6.24
54.0	7.0	142	442	1.44	7.63
55.0	8.0	150	450	1.55	9.12

Basin B Elevation-Volume Data - Alternative A					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
45.00	0.00	92.00	356.00	0.75	0.00
46.00	1.00	100.00	364.00	0.84	0.79
47.00	2.00	108.00	372.00	0.92	1.67
48.00	3.00	116.00	380.00	1.01	2.64
49.00	4.00	124.00	388.00	1.10	3.70
50.00	5.00	132.00	396.00	1.20	4.85

Basin B Elevation-Volume Data - Alternative B					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
45.00	0.00	52.00	236.00	0.28	0.00
46.00	1.00	60.00	244.00	0.34	0.31
47.00	2.00	68.00	252.00	0.39	0.67
48.00	3.00	76.00	260.00	0.45	1.10
49.00	4.00	84.00	268.00	0.52	1.58
50.00	5.00	92.00	276.00	0.58	2.13

Basin C Elevation-Volume Data					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
45.00	0.00	52.00	236.00	0.28	0.00
46.00	1.00	60.00	244.00	0.34	0.31
47.00	2.00	68.00	252.00	0.39	0.67
48.00	3.00	76.00	260.00	0.45	1.10
49.00	4.00	84.00	268.00	0.52	1.58
50.00	5.00	92.00	276.00	0.58	2.13

Basin D Elevation-Volume Data					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
42.0	0.0	202	718	3.33	0.00
43.0	1.0	210	726	3.50	3.41
44.0	2.0	218	#N/A	3.67	7.00
45.0	3.0	226	742	3.85	10.76
46.0	4.0	234	750	4.03	14.70
47.0	5.0	242	758	4.21	18.82
48.0	6.0	250	766	4.40	23.13
49.0	7.0	258	774	4.58	27.62

Basin E Elevation-Volume Data - Alternative A					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
46.0	0.0	86.0	476.0	0.9	0.0
47.0	1.0	94.0	484.0	1.0	1.0
48.0	2.0	102.0	492.0	1.2	2.1
49.0	3.0	110.0	500.0	1.3	3.3
50.0	4.0	118.0	508.0	1.4	4.6
51.0	5.0	126.0	516.0	1.5	6.1
52.0	6.0	134.0	524.0	1.6	7.6
53.0	7.0	142.0	532.0	1.7	9.3
54.0	8.0	150.0	540.0	1.9	11.1

Basin E Elevation-Volume Data - Alternative B					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
46.0	0.0	86.0	476.0	2.8	0.0
47.0	1.0	94.0	484.0	2.9	2.9
48.0	2.0	102.0	492.0	3.1	5.9
49.0	3.0	110.0	500.0	3.2	9.0
50.0	4.0	118.0	508.0	3.4	12.3
51.0	5.0	126.0	516.0	3.5	15.7
52.0	6.0	134.0	524.0	3.7	19.3
53.0	7.0	142.0	532.0	3.8	23.0
54.0	8.0	150.0	540.0	4.0	26.9

Basin F Elevation-Volume Data					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
47.0	0.0	246	810	4.57	0.00
48.0	1.0	254	818	4.77	4.67
49.0	2.0	262	826	4.97	9.54
50.0	3.0	270	834	5.17	14.61
51.0	4.0	278	842	5.37	19.88
51.5	4.5	282	846	5.48	22.59

Basin G Elevation-Volume Data - Alternative A					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
45.0	0.0	41	251	0.24	0.00
46.0	1.0	49	259	0.29	0.26
47.0	2.0	57	267	0.35	0.58
48.0	3.0	65	275	0.41	0.96

Basin G Elevation-Volume Data - Alternative B					
Elevation, feet (NAVD88)	Basin Depth, feet	Basin Width, feet	Basin Length, feet	Basin Area, acres	Volume, ac-ft
45.0	0.0	41	251	0.24	0.00
46.0	1.0	49	259	0.29	0.26
47.0	2.0	57	267	0.35	0.58
48.0	3.0	65	275	0.41	0.96

APPENDIX B

Sacramento Area Hydrology Model Output

SAHM

PROJECT REPORT

General Model Information

Project Name:	Alternative A&B Grant Line Basins (D,F)
Site Name:	Grant Line
Site Address:	
City:	
Report Date:	6/23/2020
Gage:	ELK GROV
Data Start:	1963/10/01
Data End:	2004/09/30
Timestep:	Hourly
Precip Scale:	0.94
Version Date:	2016/03/29

POC Thresholds

Low Flow Threshold for POC1:	25 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year

Landuse Basin Data
Pre-Project Land Use

Grant Line Watershed

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	264.16
Pervious Total	264.16
Impervious Land Use	acre
Imperv,Flat(0-1%)	5.283
Impervious Total	5.283
Basin Total	269.443

Element Flows To:

Surface	Interflow	Groundwater
Outfall to Existing Storage		

Mitigated Land Use

Basin D (GL-1, GL-2, GL-3, GL-17, GL-18, GL-19)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	48.17
Pervious Total	48.17
Impervious Land Use	acre
Imperv,Flat(0-1%)	130.17
Impervious Total	130.17
Basin Total	178.34

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1 (Basin D)	SSD Table 1 (Basin D)	

Basin F (GL-4, GL-5, GL-6)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	11.83
Pervious Total	11.83
Impervious Land Use	acre
Imperv,Flat(0-1%)	74
Impervious Total	74
Basin Total	85.83

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 3 (Basin F)	SSD Table 3 (Basin F)	

Routing Elements
Pre-Project Routing

Outfall to Existing Storage

Bottom Length:	233.00 ft.
Bottom Width:	8.00 ft.
Manning's n:	0.03
Channel bottom slope 1:	0.013 To 1
Channel Left side slope 0:	2.5 To 1
Channel right side slope 2:	2.5 To 1
Discharge Structure	
Riser Height:	0 ft.
Riser Diameter:	0 in.
Element Flows To:	
Outlet 1	Outlet 2

Channel Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.042	0.000	0.000	0.000
0.0556	0.044	0.002	0.368	0.000
0.1111	0.045	0.004	1.173	0.000
0.1667	0.047	0.007	2.318	0.000
0.2222	0.048	0.010	3.764	0.000
0.2778	0.050	0.012	5.490	0.000
0.3333	0.051	0.015	7.482	0.000
0.3889	0.053	0.018	9.731	0.000
0.4444	0.054	0.021	12.23	0.000
0.5000	0.056	0.024	14.98	0.000
0.5556	0.057	0.027	17.97	0.000
0.6111	0.059	0.031	21.20	0.000
0.6667	0.060	0.034	24.67	0.000
0.7222	0.062	0.037	28.39	0.000
0.7778	0.063	0.041	32.34	0.000
0.8333	0.065	0.044	36.53	0.000
0.8889	0.066	0.048	40.97	0.000
0.9444	0.068	0.052	45.65	0.000
1.0000	0.069	0.056	50.57	0.000
1.0556	0.071	0.060	55.74	0.000
1.1111	0.072	0.064	61.15	0.000
1.1667	0.074	0.068	66.81	0.000
1.2222	0.075	0.072	72.73	0.000
1.2778	0.077	0.076	78.89	0.000
1.3333	0.078	0.080	85.31	0.000
1.3889	0.079	0.085	91.98	0.000
1.4444	0.081	0.089	98.92	0.000
1.5000	0.082	0.094	106.1	0.000
1.5556	0.084	0.098	113.5	0.000
1.6111	0.085	0.103	121.2	0.000
1.6667	0.087	0.108	129.2	0.000
1.7222	0.088	0.113	137.5	0.000
1.7778	0.090	0.118	146.0	0.000
1.8333	0.091	0.123	154.8	0.000
1.8889	0.093	0.128	163.9	0.000
1.9444	0.094	0.133	173.3	0.000

2.0000	0.096	0.139	182.9	0.000
2.0556	0.097	0.144	192.8	0.000
2.1111	0.099	0.150	203.0	0.000
2.1667	0.100	0.155	213.6	0.000
2.2222	0.102	0.161	224.3	0.000
2.2778	0.103	0.166	235.4	0.000
2.3333	0.105	0.172	246.8	0.000
2.3889	0.106	0.178	258.5	0.000
2.4444	0.108	0.184	270.5	0.000
2.5000	0.109	0.190	282.8	0.000
2.5556	0.111	0.196	295.4	0.000
2.6111	0.112	0.202	308.3	0.000
2.6667	0.114	0.209	321.5	0.000
2.7222	0.115	0.215	335.0	0.000
2.7778	0.117	0.222	348.9	0.000
2.8333	0.118	0.228	363.0	0.000
2.8889	0.120	0.235	377.5	0.000
2.9444	0.121	0.242	392.3	0.000
3.0000	0.123	0.248	407.4	0.000
3.0556	0.124	0.255	422.9	0.000
3.1111	0.126	0.262	438.7	0.000
3.1667	0.127	0.269	454.8	0.000
3.2222	0.129	0.276	471.3	0.000
3.2778	0.130	0.284	488.1	0.000
3.3333	0.132	0.291	505.2	0.000
3.3889	0.133	0.298	522.7	0.000
3.4444	0.135	0.306	540.5	0.000
3.5000	0.136	0.313	558.7	0.000
3.5556	0.137	0.321	577.3	0.000
3.6111	0.139	0.329	596.1	0.000
3.6667	0.140	0.336	615.4	0.000
3.7222	0.142	0.344	635.0	0.000
3.7778	0.143	0.352	654.9	0.000
3.8333	0.145	0.360	675.2	0.000
3.8889	0.146	0.368	695.9	0.000
3.9444	0.148	0.376	717.0	0.000
4.0000	0.149	0.385	738.4	0.000
4.0556	0.151	0.393	760.2	0.000
4.1111	0.152	0.402	782.3	0.000
4.1667	0.154	0.410	804.9	0.000
4.2222	0.155	0.419	827.8	0.000
4.2778	0.157	0.427	851.1	0.000
4.3333	0.158	0.436	874.8	0.000
4.3889	0.160	0.445	898.9	0.000
4.4444	0.161	0.454	923.3	0.000
4.5000	0.163	0.463	948.2	0.000
4.5556	0.164	0.472	973.4	0.000
4.6111	0.166	0.481	999.0	0.000
4.6667	0.167	0.491	1025.	0.000
4.7222	0.169	0.500	1051.	0.000
4.7778	0.170	0.509	1078.	0.000
4.8333	0.172	0.519	1105.	0.000
4.8889	0.173	0.529	1133.	0.000
4.9444	0.175	0.538	1161.	0.000
5.0000	0.176	0.548	1189.	0.000
5.0556	0.178	0.558	1218.	0.000

Mitigated Routing

SSD Table 1 (Basin D)

Depth: 7 ft.
Element Flows To:
Outlet 1 Outlet 2
Existing Railroad Ditch

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	3.330	0.000	0.000	30629	5.000	0.000	0.000
1.000	3.500	3.410	1.897	0.000	0.000	0.000	0.000
2.000	3.670	7.000	3.098	0.000	0.000	0.000	0.000
3.000	3.850	10.76	3.949	0.000	0.000	0.000	0.000
4.000	4.030	14.70	5.979	0.000	0.000	0.000	0.000
5.000	4.210	18.82	45.85	0.000	0.000	0.000	0.000
6.000	4.400	23.13	200.2	0.000	0.000	0.000	0.000
7.000	4.580	27.62	394.4	0.000	0.000	0.000	0.000

SSD Table 3 (Basin F)

Depth: 4 ft.
Element Flows To:
Outlet 1 Outlet 2
Outfall to Existing Storage

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	4.670	0.000	0.000	0.000	0.000	0.000	0.000
1.000	4.870	4.770	1.731	0.000	0.000	0.000	0.000
2.000	5.070	9.740	4.463	0.000	0.000	0.000	0.000
3.000	5.270	14.91	78.28	0.000	0.000	0.000	0.000
4.000	5.480	20.28	191.2	0.000	0.000	0.000	0.000

Outfall to Existing Storage

Bottom Length:	233.00 ft.
Bottom Width:	8.00 ft.
Manning's n:	0.03
Channel bottom slope 1:	0.013 To 1
Channel Left side slope 0:	2.5 To 1
Channel right side slope 2:	2.5 To 1
Discharge Structure	
Riser Height:	0 ft.
Riser Diameter:	0 in.
Element Flows To:	
Outlet 1	Outlet 2

Channel Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.042	0.000	0.000	0.000
0.0556	0.044	0.002	0.368	0.000
0.1111	0.045	0.004	1.173	0.000
0.1667	0.047	0.007	2.318	0.000
0.2222	0.048	0.010	3.764	0.000
0.2778	0.050	0.012	5.490	0.000
0.3333	0.051	0.015	7.482	0.000
0.3889	0.053	0.018	9.731	0.000
0.4444	0.054	0.021	12.23	0.000
0.5000	0.056	0.024	14.98	0.000
0.5556	0.057	0.027	17.97	0.000
0.6111	0.059	0.031	21.20	0.000
0.6667	0.060	0.034	24.67	0.000
0.7222	0.062	0.037	28.39	0.000
0.7778	0.063	0.041	32.34	0.000
0.8333	0.065	0.044	36.53	0.000
0.8889	0.066	0.048	40.97	0.000
0.9444	0.068	0.052	45.65	0.000
1.0000	0.069	0.056	50.57	0.000
1.0556	0.071	0.060	55.74	0.000
1.1111	0.072	0.064	61.15	0.000
1.1667	0.074	0.068	66.81	0.000
1.2222	0.075	0.072	72.73	0.000
1.2778	0.077	0.076	78.89	0.000
1.3333	0.078	0.080	85.31	0.000
1.3889	0.079	0.085	91.98	0.000
1.4444	0.081	0.089	98.92	0.000
1.5000	0.082	0.094	106.1	0.000
1.5556	0.084	0.098	113.5	0.000
1.6111	0.085	0.103	121.2	0.000
1.6667	0.087	0.108	129.2	0.000
1.7222	0.088	0.113	137.5	0.000
1.7778	0.090	0.118	146.0	0.000
1.8333	0.091	0.123	154.8	0.000
1.8889	0.093	0.128	163.9	0.000
1.9444	0.094	0.133	173.3	0.000
2.0000	0.096	0.139	182.9	0.000
2.0556	0.097	0.144	192.8	0.000
2.1111	0.099	0.150	203.0	0.000
2.1667	0.100	0.155	213.6	0.000

2.2222	0.102	0.161	224.3	0.000
2.2778	0.103	0.166	235.4	0.000
2.3333	0.105	0.172	246.8	0.000
2.3889	0.106	0.178	258.5	0.000
2.4444	0.108	0.184	270.5	0.000
2.5000	0.109	0.190	282.8	0.000
2.5556	0.111	0.196	295.4	0.000
2.6111	0.112	0.202	308.3	0.000
2.6667	0.114	0.209	321.5	0.000
2.7222	0.115	0.215	335.0	0.000
2.7778	0.117	0.222	348.9	0.000
2.8333	0.118	0.228	363.0	0.000
2.8889	0.120	0.235	377.5	0.000
2.9444	0.121	0.242	392.3	0.000
3.0000	0.123	0.248	407.4	0.000
3.0556	0.124	0.255	422.9	0.000
3.1111	0.126	0.262	438.7	0.000
3.1667	0.127	0.269	454.8	0.000
3.2222	0.129	0.276	471.3	0.000
3.2778	0.130	0.284	488.1	0.000
3.3333	0.132	0.291	505.2	0.000
3.3889	0.133	0.298	522.7	0.000
3.4444	0.135	0.306	540.5	0.000
3.5000	0.136	0.313	558.7	0.000
3.5556	0.137	0.321	577.3	0.000
3.6111	0.139	0.329	596.1	0.000
3.6667	0.140	0.336	615.4	0.000
3.7222	0.142	0.344	635.0	0.000
3.7778	0.143	0.352	654.9	0.000
3.8333	0.145	0.360	675.2	0.000
3.8889	0.146	0.368	695.9	0.000
3.9444	0.148	0.376	717.0	0.000
4.0000	0.149	0.385	738.4	0.000
4.0556	0.151	0.393	760.2	0.000
4.1111	0.152	0.402	782.3	0.000
4.1667	0.154	0.410	804.9	0.000
4.2222	0.155	0.419	827.8	0.000
4.2778	0.157	0.427	851.1	0.000
4.3333	0.158	0.436	874.8	0.000
4.3889	0.160	0.445	898.9	0.000
4.4444	0.161	0.454	923.3	0.000
4.5000	0.163	0.463	948.2	0.000
4.5556	0.164	0.472	973.4	0.000
4.6111	0.166	0.481	999.0	0.000
4.6667	0.167	0.491	1025.	0.000
4.7222	0.169	0.500	1051.	0.000
4.7778	0.170	0.509	1078.	0.000
4.8333	0.172	0.519	1105.	0.000
4.8889	0.173	0.529	1133.	0.000
4.9444	0.175	0.538	1161.	0.000
5.0000	0.176	0.548	1189.	0.000
5.0556	0.178	0.558	1218.	0.000

Existing Railroad Ditch

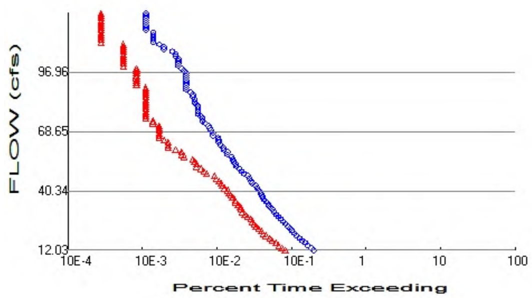
Bottom Length: 4400.00 ft.
Bottom Width: 10.00 ft.
Manning's n: 0.03
Channel bottom slope 1: 0.002 To 1
Channel Left side slope 0: 2 To 1
Channel right side slope 2: 2 To 1
Discharge Structure
Riser Height: 0 ft.
Riser Diameter: 0 in.
Element Flows To:
Outlet 1 Outlet 2
Outfall to Existing Storage

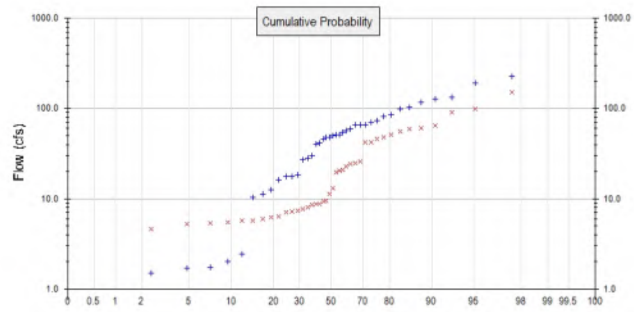
Channel Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	1.010	0.000	0.000	0.000
0.0444	1.028	0.045	0.124	0.000
0.0889	1.046	0.091	0.394	0.000
0.1333	1.064	0.138	0.777	0.000
0.1778	1.081	0.186	1.257	0.000
0.2222	1.099	0.234	1.827	0.000
0.2667	1.117	0.283	2.482	0.000
0.3111	1.135	0.333	3.216	0.000
0.3556	1.153	0.384	4.028	0.000
0.4000	1.171	0.436	4.913	0.000
0.4444	1.189	0.488	5.871	0.000
0.4889	1.207	0.542	6.900	0.000
0.5333	1.225	0.596	7.998	0.000
0.5778	1.243	0.651	9.164	0.000
0.6222	1.261	0.706	10.39	0.000
0.6667	1.279	0.763	11.69	0.000
0.7111	1.297	0.820	13.06	0.000
0.7556	1.315	0.878	14.49	0.000
0.8000	1.333	0.937	15.99	0.000
0.8444	1.351	0.997	17.55	0.000
0.8889	1.369	1.057	19.18	0.000
0.9333	1.387	1.118	20.87	0.000
0.9778	1.405	1.180	22.62	0.000
1.0222	1.423	1.243	24.44	0.000
1.0667	1.441	1.307	26.32	0.000
1.1111	1.459	1.371	28.26	0.000
1.1556	1.477	1.437	30.27	0.000
1.2000	1.495	1.503	32.34	0.000
1.2444	1.512	1.569	34.48	0.000
1.2889	1.530	1.637	36.68	0.000
1.3333	1.548	1.705	38.95	0.000
1.3778	1.566	1.775	41.27	0.000
1.4222	1.584	1.845	43.67	0.000
1.4667	1.602	1.916	46.12	0.000
1.5111	1.620	1.987	48.64	0.000
1.5556	1.638	2.060	51.23	0.000
1.6000	1.656	2.133	53.88	0.000
1.6444	1.674	2.207	56.60	0.000
1.6889	1.692	2.282	59.38	0.000
1.7333	1.710	2.357	62.22	0.000

1.7778	1.728	2.434	65.14	0.000
1.8222	1.746	2.511	68.11	0.000
1.8667	1.764	2.589	71.16	0.000
1.9111	1.782	2.668	74.27	0.000
1.9556	1.800	2.747	77.45	0.000
2.0000	1.818	2.828	80.69	0.000
2.0444	1.836	2.909	84.00	0.000
2.0889	1.854	2.991	87.38	0.000
2.1333	1.872	3.074	90.83	0.000
2.1778	1.890	3.157	94.35	0.000
2.2222	1.908	3.242	97.93	0.000
2.2667	1.925	3.327	101.5	0.000
2.3111	1.943	3.413	105.3	0.000
2.3556	1.961	3.500	109.1	0.000
2.4000	1.979	3.587	112.9	0.000
2.4444	1.997	3.676	116.8	0.000
2.4889	2.015	3.765	120.8	0.000
2.5333	2.033	3.855	124.9	0.000
2.5778	2.051	3.946	129.1	0.000
2.6222	2.069	4.037	133.3	0.000
2.6667	2.087	4.130	137.6	0.000
2.7111	2.105	4.223	141.9	0.000
2.7556	2.123	4.317	146.3	0.000
2.8000	2.141	4.412	150.8	0.000
2.8444	2.159	4.507	155.4	0.000
2.8889	2.177	4.604	160.1	0.000
2.9333	2.195	4.701	164.8	0.000
2.9778	2.213	4.799	169.6	0.000
3.0222	2.231	4.898	174.4	0.000
3.0667	2.249	4.997	179.4	0.000
3.1111	2.267	5.097	184.4	0.000
3.1556	2.285	5.199	189.5	0.000
3.2000	2.303	5.301	194.7	0.000
3.2444	2.321	5.403	199.9	0.000
3.2889	2.339	5.507	205.2	0.000
3.3333	2.356	5.611	210.6	0.000
3.3778	2.374	5.716	216.1	0.000
3.4222	2.392	5.822	221.6	0.000
3.4667	2.410	5.929	227.3	0.000
3.5111	2.428	6.037	233.0	0.000
3.5556	2.446	6.145	238.7	0.000
3.6000	2.464	6.254	244.6	0.000
3.6444	2.482	6.364	250.5	0.000
3.6889	2.500	6.475	256.6	0.000
3.7333	2.518	6.586	262.7	0.000
3.7778	2.536	6.699	268.8	0.000
3.8222	2.554	6.812	275.1	0.000
3.8667	2.572	6.926	281.4	0.000
3.9111	2.590	7.040	287.8	0.000
3.9556	2.608	7.156	294.3	0.000
4.0000	2.626	7.272	300.9	0.000
4.0444	2.644	7.389	307.6	0.000

Analysis Results
POC 1





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #1
Total Pervious Area: 264.16
Total Impervious Area: 5.283

Mitigated Landuse Totals for POC #1
Total Pervious Area: 60
Total Impervious Area: 204.17

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #1

Return Period	**Flow(cfs)**
2 year	48.1198
5 year	83.406343
10 year	125.268667
25 year	197.350429

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	11.3641
5 year	49.6617
10 year	63.442919
25 year	109.086752

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #1

Year	**Pre-Project**	**Mitigated**
1964	51.314	13.157
1965	40.540	25.626
1966	1.507	5.476
1967	127.882	90.260
1968	12.406	7.269
1969	116.906	20.589
1970	66.612	42.016
1971	66.062	45.897
1972	2.437	5.993
1973	133.518	20.897
1974	18.296	6.155
1975	1.695	4.620
1976	1.730	5.277
1977	1.014	3.482

1978	59.812	24.692
1979	54.616	8.761
1980	48.048	8.685
1981	1.996	7.437
1982	73.521	60.947
1983	104.199	48.020
1984	57.074	22.663
1985	11.248	6.317
1986	84.885	64.223
1987	26.919	11.364
1988	17.740	5.696
1989	48.120	5.343
1990	41.355	8.062
1991	30.015	8.582
1992	51.402	19.670
1993	49.739	24.083
1994	17.709	5.652
1995	227.914	149.918
1996	99.436	50.893
1997	190.159	99.479
1998	69.597	59.206
1999	65.516	42.018
2000	81.435	55.882
2001	16.135	7.097
2002	28.244	7.639
2003	10.295	9.329
2004	45.573	9.443

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #1

Rank	Pre-Project	Mitigated
1	227.9140	149.9180
2	190.1590	99.4794
3	133.5180	90.2596
4	127.8820	64.2228
5	116.9060	60.9473
6	104.1990	59.2057
7	99.4356	55.8815
8	84.8847	50.8929
9	81.4352	48.0201
10	73.5206	45.8968
11	69.5965	42.0175
12	66.6117	42.0162
13	66.0616	25.6257
14	65.5156	24.6918
15	59.8117	24.0826
16	57.0744	22.6631
17	54.6162	20.8971
18	51.4021	20.5886
19	51.3136	19.6699
20	49.7386	13.1567
21	48.1198	11.3641
22	48.0477	9.4430
23	45.5725	9.3292
24	41.3552	8.7613
25	40.5401	8.6848
26	30.0145	8.5815
27	28.2437	8.0616

28	26.9193	7.6394
29	18.2960	7.4368
30	17.7398	7.2686
31	17.7088	7.0974
32	16.1347	6.3173
33	12.4064	6.1552
34	11.2481	5.9934
35	10.2946	5.6962
36	2.4372	5.6523
37	1.9963	5.4761
38	1.7301	5.3431
39	1.6948	5.2769
40	1.5074	4.6197
41	1.0139	3.4824

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
12.0300	719	296	41	Pass
13.1738	660	266	40	Pass
14.3176	588	244	41	Pass
15.4614	549	222	40	Pass
16.6053	498	198	39	Pass
17.7491	463	184	39	Pass
18.8929	419	165	39	Pass
20.0367	395	150	37	Pass
21.1806	365	141	38	Pass
22.3244	342	131	38	Pass
23.4682	322	121	37	Pass
24.6120	298	114	38	Pass
25.7559	278	107	38	Pass
26.8997	258	103	39	Pass
28.0435	240	92	38	Pass
29.1873	224	85	37	Pass
30.3312	210	79	37	Pass
31.4750	198	75	37	Pass
32.6188	186	74	39	Pass
33.7626	177	69	38	Pass
34.9065	167	65	38	Pass
36.0503	157	63	40	Pass
37.1941	148	58	39	Pass
38.3379	143	55	38	Pass
39.4818	138	52	37	Pass
40.6256	130	50	38	Pass
41.7694	125	45	36	Pass
42.9132	118	42	35	Pass
44.0571	106	41	38	Pass
45.2009	103	38	36	Pass
46.3447	98	35	35	Pass
47.4885	92	33	35	Pass
48.6324	82	26	31	Pass
49.7762	77	24	31	Pass
50.9200	72	22	30	Pass
52.0638	66	19	28	Pass
53.2077	63	19	30	Pass
54.3515	60	18	30	Pass
55.4953	58	17	29	Pass
56.6391	56	13	23	Pass
57.7830	50	12	24	Pass
58.9268	50	12	24	Pass
60.0706	44	10	22	Pass
61.2144	43	8	18	Pass
62.3583	40	8	20	Pass
63.5021	38	8	21	Pass
64.6459	38	7	18	Pass
65.7897	37	6	16	Pass
66.9336	32	6	18	Pass
68.0774	32	6	18	Pass
69.2212	30	6	20	Pass
70.3650	29	6	20	Pass
71.5089	28	6	21	Pass

72.6527	25	5	20	Pass
73.7965	23	5	21	Pass
74.9403	23	4	17	Pass
76.0842	22	4	18	Pass
77.2280	20	4	20	Pass
78.3718	20	4	20	Pass
79.5157	20	4	20	Pass
80.6595	20	4	20	Pass
81.8033	19	4	21	Pass
82.9471	18	4	22	Pass
84.0910	18	4	22	Pass
85.2348	17	4	23	Pass
86.3786	17	4	23	Pass
87.5224	16	4	25	Pass
88.6663	14	4	28	Pass
89.8101	14	4	28	Pass
90.9539	14	3	21	Pass
92.0977	14	3	21	Pass
93.2416	14	3	21	Pass
94.3854	14	3	21	Pass
95.5292	14	3	21	Pass
96.6730	14	3	21	Pass
97.8169	13	3	23	Pass
98.9607	12	3	25	Pass
100.1045	11	2	18	Pass
101.2483	11	2	18	Pass
102.3922	11	2	18	Pass
103.5360	11	2	18	Pass
104.6798	10	2	20	Pass
105.8236	10	2	20	Pass
106.9675	9	2	22	Pass
108.1113	7	2	28	Pass
109.2551	7	2	28	Pass
110.3989	6	2	33	Pass
111.5428	5	1	20	Pass
112.6866	5	1	20	Pass
113.8304	5	1	20	Pass
114.9742	5	1	20	Pass
116.1181	5	1	20	Pass
117.2619	4	1	25	Pass
118.4057	4	1	25	Pass
119.5495	4	1	25	Pass
120.6934	4	1	25	Pass
121.8372	4	1	25	Pass
122.9810	4	1	25	Pass
124.1248	4	1	25	Pass
125.2687	4	1	25	Pass

Water Quality

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 4
POC #4 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

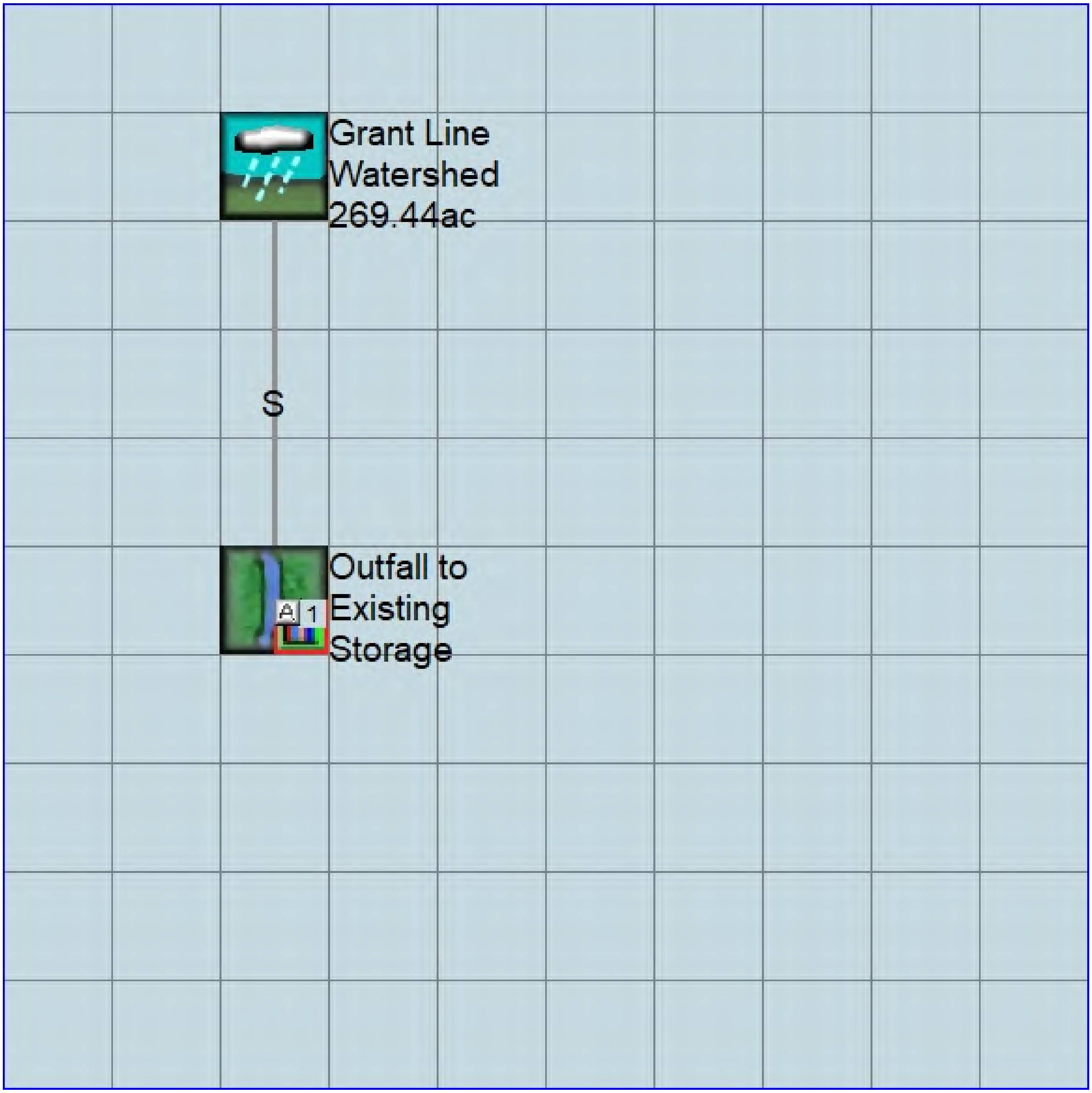
No PERLND changes have been made.

IMPLND Changes

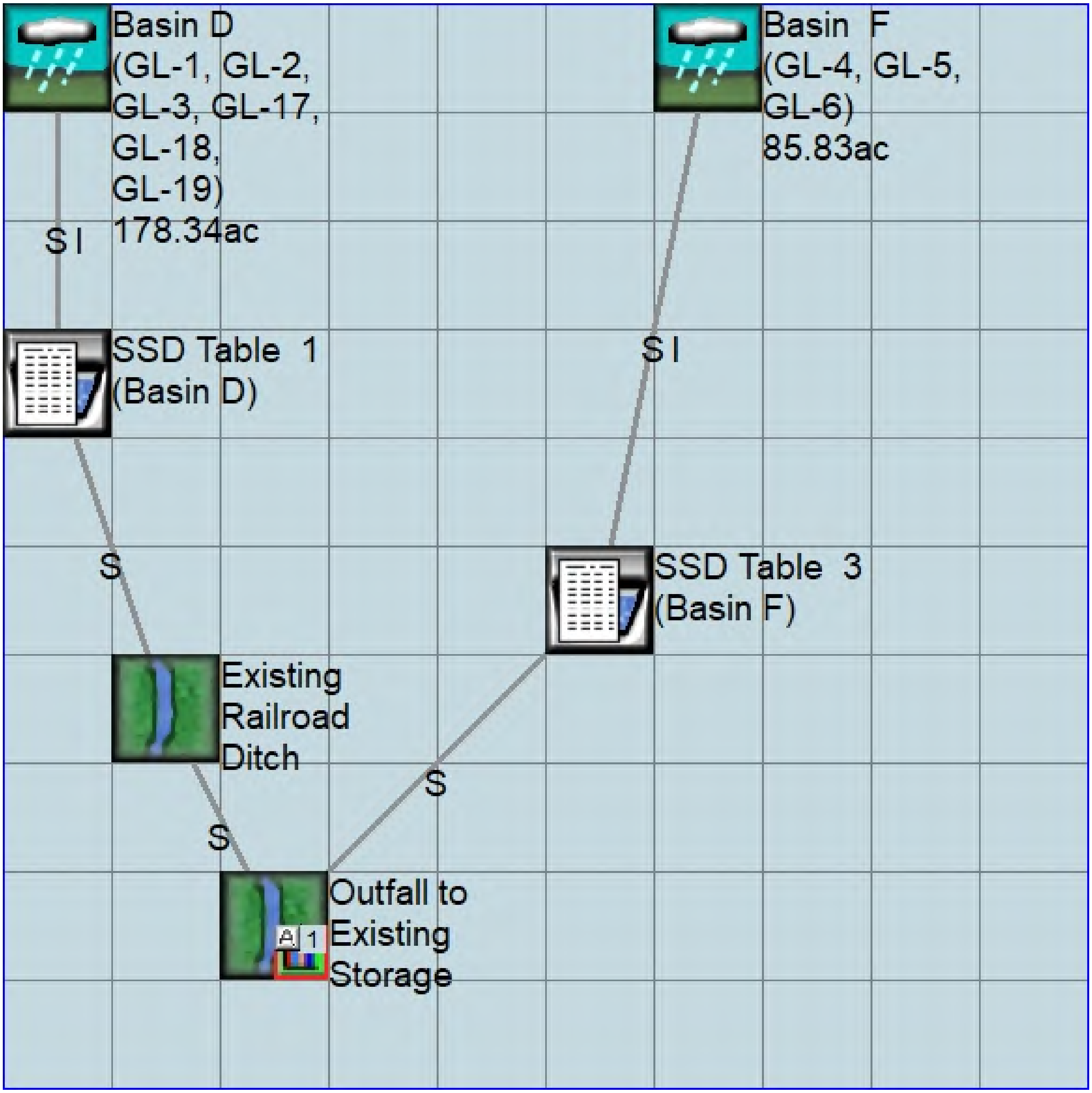
No IMPLND changes have been made.

Appendix

Pre-Project Schematic



Mitigated Schematic



Pre-Project UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1963 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Updated Grant Line Basins (D,E,F,G).wdm
MESSU      25   MitUpdated Grant Line Basins (D,E,F,G).MES
           27   MitUpdated Grant Line Basins (D,E,F,G).L61
           28   MitUpdated Grant Line Basins (D,E,F,G).L62
           30   POCUpdated Grant Line Basins (D,E,F,G)1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      53
      IMPLND       1
      RCHRES       1
      RCHRES       2
      RCHRES       3
      RCHRES       4
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Outfall to Existing Stora   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   53     D,Agric,Flat(0-1%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   53         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   53         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   53         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   53              0         5      0.03       400      0.01         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   53             40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   53              0       0.3       0.2       0.7       0.5         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53       0.5  0.5  0.5 0.55  0.6 0.65 0.65 0.65 0.65 0.65 0.55  0.5
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   53              0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    1     Imperv,Flat(0-1%)       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
```

```
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1        0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            100      0.01      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin D (GL-1, GL-2, GL-3, GL-17, GL-18, GL-19)***
PERLND  53                       48.17     RCHRES   1      2
PERLND  53                       48.17     RCHRES   1      3
IMPLND   1                      130.17     RCHRES   1      5
Basin  F (GL-4, GL-5, GL-6)***
PERLND  53                       11.83     RCHRES   2      2
PERLND  53                       11.83     RCHRES   2      3
IMPLND   1                          74     RCHRES   2      5

******Routing******
RCHRES   1                           1     RCHRES   3      6
RCHRES   2                           1     RCHRES   4      6
RCHRES   2                                 COPY     1     16
RCHRES   3                           1     RCHRES   4      6
RCHRES   3                                 COPY     1     16
RCHRES   4                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     SSD Table  1 (Ba-016    1    1    1    1   28    0    1
    2     SSD Table  3 (Ba-025    1    1    1    1   28    0    1
    3     Existing Railroa-029    1    1    1    1   28    0    1
    4     Outfall to Exist-028    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
```

```
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
    4         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
    4         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                     ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    3        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    4        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50          ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1             1      0.01       0.0       0.0       0.5       0.0
    2             2      0.01       0.0       0.0       0.5       0.0
    3             3      0.83       0.0       0.0       0.5       0.0
    4             4      0.04       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                        ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    4           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
    8    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  3.330000  0.000000  0.000000
  1.000000  3.500000  3.410000  1.897062
  2.000000  3.670000  7.000000  3.097890
  3.000000  3.850000  10.76000  3.949050
  4.000000  4.030000  14.70000  5.978834
  5.000000  4.210000  18.82000  45.84682
  6.000000  4.400000  23.13000  200.1723
  7.000000  4.580000  27.62000  394.4430
  END FTABLE  1
  FTABLE      2
    5    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  4.670000  0.000000  0.000000
  1.000000  4.870000  4.770000  1.730771
```

2.000000	5.070000	9.740000	4.462701
3.000000	5.270000	14.91000	78.28070
4.000000	5.480000	20.28000	191.1565

END FTABLE 2
FTABLE 4
91 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.042792	0.000000	0.000000		
0.055556	0.044278	0.002419	0.367989		
0.111111	0.045764	0.004920	1.173668		
0.166667	0.047250	0.007503	2.318312		
0.222222	0.048736	0.010170	3.764218		
0.277778	0.050222	0.012919	5.490082		
0.333333	0.051708	0.015750	7.482345		
0.388889	0.053195	0.018664	9.731889		
0.444444	0.054681	0.021660	12.23243		
0.500000	0.056167	0.024740	14.97963		
0.555556	0.057653	0.027901	17.97055		
0.611111	0.059140	0.031146	21.20328		
0.666667	0.060626	0.034472	24.67672		
0.722222	0.062112	0.037882	28.39038		
0.777778	0.063599	0.041374	32.34428		
0.833333	0.065085	0.044948	36.53883		
0.888889	0.066571	0.048605	40.97476		
0.944444	0.068058	0.052345	45.65310		
1.000000	0.069544	0.056167	50.57506		
1.055556	0.071030	0.060072	55.74207		
1.111111	0.072517	0.064060	61.15570		
1.166667	0.074003	0.068130	66.81768		
1.222222	0.075490	0.072282	72.72982		
1.277778	0.076976	0.076517	78.89404		
1.333333	0.078463	0.080835	85.31237		
1.388889	0.079949	0.085235	91.98686		
1.444444	0.081436	0.089718	98.91966		
1.500000	0.082923	0.094284	106.1130		
1.555556	0.084409	0.098932	113.5690		
1.611111	0.085896	0.103663	121.2901		
1.666667	0.087382	0.108476	129.2784		
1.722222	0.088869	0.113372	137.5365		
1.777778	0.090356	0.118350	146.0665		
1.833333	0.091842	0.123411	154.8710		
1.888889	0.093329	0.128555	163.9523		
1.944444	0.094816	0.133781	173.3128		
2.000000	0.096302	0.139090	182.9550		
2.055556	0.097789	0.144481	192.8813		
2.111111	0.099276	0.149956	203.0942		
2.166667	0.100763	0.155512	213.5960		
2.222222	0.102250	0.161151	224.3894		
2.277778	0.103736	0.166873	235.4767		
2.333333	0.105223	0.172678	246.8604		
2.388889	0.106710	0.178565	258.5431		
2.444444	0.108197	0.184534	270.5271		
2.500000	0.109684	0.190587	282.8150		
2.555556	0.111171	0.196721	295.4092		
2.611111	0.112658	0.202939	308.3122		
2.666667	0.114145	0.209239	321.5265		
2.722222	0.115632	0.215622	335.0545		
2.777778	0.117119	0.222087	348.8988		
2.833333	0.118606	0.228635	363.0618		
2.888889	0.120093	0.235265	377.5459		
2.944444	0.121580	0.241979	392.3537		
3.000000	0.123067	0.248774	407.4875		
3.055556	0.124554	0.255653	422.9499		
3.111111	0.126041	0.262614	438.7433		
3.166667	0.127528	0.269657	454.8701		
3.222222	0.129015	0.276783	471.3328		
3.277778	0.130503	0.283992	488.1338		
3.333333	0.131990	0.291284	505.2755		
3.388889	0.133477	0.298658	522.7604		

3.444444	0.134964	0.306114	540.5909
3.500000	0.136451	0.313654	558.7695
3.555556	0.137939	0.321276	577.2984
3.611111	0.139426	0.328980	596.1801
3.666667	0.140913	0.336767	615.4171
3.722222	0.142400	0.344637	635.0117
3.777778	0.143888	0.352590	654.9663
3.833333	0.145375	0.360625	675.2833
3.888889	0.146862	0.368743	695.9651
3.944444	0.148350	0.376943	717.0140
4.000000	0.149837	0.385226	738.4324
4.055556	0.151325	0.393591	760.2226
4.111111	0.152812	0.402040	782.3871
4.166667	0.154300	0.410571	804.9282
4.222222	0.155787	0.419184	827.8482
4.277778	0.157275	0.427880	851.1494
4.333333	0.158762	0.436659	874.8342
4.388889	0.160250	0.445520	898.9050
4.444444	0.161737	0.454465	923.3639
4.500000	0.163225	0.463491	948.2135
4.555556	0.164712	0.472601	973.4558
4.611111	0.166200	0.481793	999.0934
4.666667	0.167688	0.491067	1025.128
4.722222	0.169175	0.500425	1051.563
4.777778	0.170663	0.509865	1078.400
4.833333	0.172150	0.519387	1105.641
4.888889	0.173638	0.528992	1133.289
4.944444	0.175126	0.538680	1161.345
5.000000	0.176614	0.548451	1189.813

END FTABLE 4
FTABLE 3
91 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	1.010101	0.000000	0.000000		
0.044444	1.028058	0.045292	0.124065		
0.088889	1.046016	0.091383	0.394573		
0.133333	1.063973	0.138272	0.777006		
0.177778	1.081931	0.185958	1.257521		
0.222222	1.099888	0.234443	1.827831		
0.266667	1.117845	0.283726	2.482282		
0.311111	1.135803	0.333807	3.216734		
0.355556	1.153760	0.384686	4.028024		
0.400000	1.171718	0.436364	4.913661		
0.444444	1.189675	0.488839	5.871646		
0.488889	1.207632	0.542113	6.900352		
0.533333	1.225590	0.596184	7.998441		
0.577778	1.243547	0.651054	9.164805		
0.622222	1.261505	0.706722	10.39852		
0.666667	1.279462	0.763188	11.69883		
0.711111	1.297419	0.820452	13.06509		
0.755556	1.315377	0.878514	14.49678		
0.800000	1.333334	0.937374	15.99346		
0.844444	1.351292	0.997032	17.55477		
0.888889	1.369249	1.057489	19.18045		
0.933333	1.387207	1.118743	20.87025		
0.977778	1.405164	1.180796	22.62402		
1.022222	1.423121	1.243647	24.44164		
1.066667	1.441079	1.307296	26.32302		
1.111111	1.459036	1.371743	28.26811		
1.155556	1.476994	1.436988	30.27692		
1.200000	1.494951	1.503031	32.34946		
1.244444	1.512909	1.569873	34.48578		
1.288889	1.530866	1.637512	36.68595		
1.333333	1.548823	1.705949	38.95007		
1.377778	1.566781	1.775185	41.27824		
1.422222	1.584738	1.845219	43.67061		
1.466667	1.602696	1.916051	46.12731		
1.511111	1.620653	1.987681	48.64851		
1.555556	1.638611	2.060109	51.23439		

```
  1.600000  1.656568  2.133335  53.88514
  1.644444  1.674526  2.207359  56.60095
  1.688889  1.692483  2.282182  59.38205
  1.733333  1.710440  2.357802  62.22864
  1.777778  1.728398  2.434221  65.14097
  1.822222  1.746355  2.511438  68.11926
  1.866667  1.764313  2.589452  71.16377
  1.911111  1.782270  2.668265  74.27474
  1.955556  1.800228  2.747876  77.45244
  2.000000  1.818185  2.828286  80.69714
  2.044444  1.836143  2.909493  84.00909
  2.088889  1.854100  2.991498  87.38858
  2.133333  1.872058  3.074302  90.83588
  2.177778  1.890015  3.157903  94.35129
  2.222222  1.907972  3.242303  97.93509
  2.266667  1.925930  3.327501  101.5876
  2.311111  1.943887  3.413497  105.3090
  2.355556  1.961845  3.500291  109.0998
  2.400000  1.979802  3.587883  112.9601
  2.444444  1.997760  3.676273  116.8903
  2.488889  2.015717  3.765462  120.8907
  2.533333  2.033675  3.855448  124.9616
  2.577778  2.051632  3.946233  129.1033
  2.622222  2.069590  4.037816  133.3162
  2.666667  2.087547  4.130196  137.6005
  2.711111  2.105505  4.223375  141.9565
  2.755556  2.123462  4.317352  146.3847
  2.800000  2.141420  4.412127  150.8852
  2.844444  2.159377  4.507701  155.4585
  2.888889  2.177335  4.604072  160.1048
  2.933333  2.195292  4.701242  164.8245
  2.977778  2.213250  4.799209  169.6179
  3.022222  2.231207  4.897975  174.4853
  3.066667  2.249165  4.997539  179.4270
  3.111111  2.267122  5.097901  184.4435
  3.155556  2.285080  5.199061  189.5349
  3.200000  2.303037  5.301019  194.7017
  3.244444  2.320995  5.403775  199.9442
  3.288889  2.338952  5.507329  205.2627
  3.333333  2.356909  5.611682  210.6575
  3.377778  2.374867  5.716833  216.1289
  3.422222  2.392825  5.822781  221.6774
  3.466667  2.410782  5.929528  227.3032
  3.511111  2.428740  6.037073  233.0066
  3.555556  2.446697  6.145416  238.7881
  3.600000  2.464655  6.254557  244.6478
  3.644444  2.482612  6.364496  250.5863
  3.688889  2.500570  6.475234  256.6037
  3.733333  2.518527  6.586769  262.7005
  3.777778  2.536485  6.699103  268.8769
  3.822222  2.554442  6.812235  275.1333
  3.866667  2.572400  6.926164  281.4701
  3.911111  2.590357  7.040892  287.8875
  3.955556  2.608315  7.156418  294.3859
  4.000000  2.626272  7.272742  300.9657
  END FTABLE  3
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.941          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.941          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.85           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.85           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
```

```
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   4 HYDR   RO     1 1        1      WDM   1008 FLOW     ENGL      REPL
RCHRES   4 HYDR   STAGE  1 1        1      WDM   1009 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK        6
RCHRES     ROFLOW                          RCHRES         INFLOW
  END MASS-LINK    6

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Pre-Project HSPF Message File

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1964/ 5/31 24: 0

RCHRES :    2

RELERR       STORS        STOR       MATIN      MATDIF
-7.387E-02     0.00000  0.0000E+00     0.00000  -5.676E-10

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1969/ 6/30 24: 0

RCHRES :    2

RELERR       STORS        STOR       MATIN      MATDIF
-4.437E-02     0.00000  0.0000E+00     0.00000  -9.701E-10

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
```

```
DATE/TIME: 1971/ 6/30 24: 0

RCHRES :    2

RELERR       STORS        STOR       MATIN      MATDIF
-1.159E-03     0.00000  0.0000E+00     0.00000  -4.235E-08

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1973/ 6/30 24: 0

RCHRES :    2

RELERR       STORS        STOR       MATIN      MATDIF
-5.811E-02     0.00000  0.0000E+00     0.00000  -7.311E-10

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1975/ 2/28 24: 0

RCHRES :    2

RELERR       STORS        STOR       MATIN      MATDIF
-2.811E-03     0.00000  0.0000E+00     0.00000  -1.608E-08

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
```

```
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

The count for the WARNING printed above has reached its maximum.

If the condition is encountered again the message will not be repeated.

Disclaimer

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Local (360)943-0304

www.clearcreeksolutions.com

SAHM

PROJECT REPORT

General Model Information

Project Name:	Alternative A&B (Basin A)
Site Name:	Mosher
Site Address:	
City:	
Report Date:	6/24/2020
Gage:	ELK GROV
Data Start:	1963/10/01
Data End:	2004/09/30
Timestep:	Hourly
Precip Scale:	0.94
Version Date:	2016/03/29

POC Thresholds

Low Flow Threshold for POC1:	25 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year

Landuse Basin Data
Pre-Project Land Use

MO-6, MO-8, MO-12, MO-13, MO-29

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	118.02
Pervious Total	118.02
Impervious Land Use	acre
Imperv,Flat(0-1%)	5.74
Impervious Total	5.74
Basin Total	123.76

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

MO-9, MO-10, MO-11, MO-12

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	58.72
Pervious Total	58.72
Impervious Land Use	acre
Imperv,Flat(0-1%)	58.72
Impervious Total	58.72
Basin Total	117.44

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

Routing Elements
Pre-Project Routing

Mitigated Routing

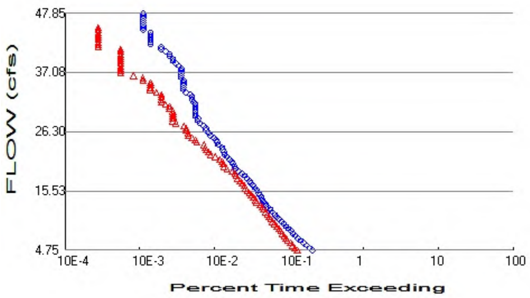
SSD Table 1

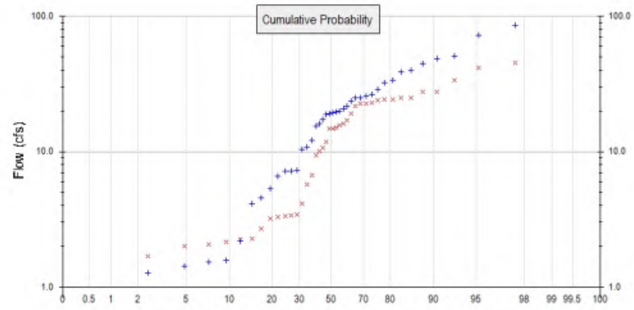
Depth: 8 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.760	0.000	0.000	30629	5.000	0.000	0.000
1.000	0.850	0.810	0.846	0.000	0.000	0.000	0.000
2.000	0.940	1.700	1.292	0.000	0.000	0.000	0.000
3.000	1.040	2.690	1.620	0.000	0.000	0.000	0.000
4.000	1.130	3.770	2.090	0.000	0.000	0.000	0.000
5.000	1.230	4.960	3.991	0.000	0.000	0.000	0.000
6.000	1.340	6.240	20.39	0.000	0.000	0.000	0.000
7.000	1.440	7.630	31.71	0.000	0.000	0.000	0.000
8.000	1.550	9.120	38.49	0.000	0.000	0.000	0.000

Analysis Results
POC 1





+ Pre-Project   x Mitigated

Pre-Project Landuse Totals for POC #1
Total Pervious Area: 118.02
Total Impervious Area: 5.74

Mitigated Landuse Totals for POC #1
Total Pervious Area: 58.72
Total Impervious Area: 58.72

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #1

Return Period	**Flow(cfs)**
2 year	19.0042
5 year	32.834529
10 year	47.8523
25 year	74.971914

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	14.8053
5 year	24.262214
10 year	27.573881
25 year	42.31979

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #1

Year	**Pre-Project**	**Mitigated**
1964	19.998	15.610
1965	15.474	14.883
1966	1.277	2.139
1967	48.814	33.568
1968	5.350	3.172
1969	44.776	23.038
1970	25.784	23.970
1971	24.923	22.613
1972	2.163	2.005
1973	51.036	27.624
1974	7.138	3.424
1975	1.534	1.694
1976	1.576	2.065
1977	0.923	1.333

1978	23.603	16.096
1979	20.697	11.824
1980	19.372	10.127
1981	1.420	3.333
1982	28.732	22.668
1983	39.995	21.716
1984	21.765	19.148
1985	4.525	3.296
1986	33.437	27.415
1987	10.323	10.645
1988	7.264	2.246
1989	19.004	2.702
1990	16.045	9.436
1991	12.201	6.659
1992	19.610	17.014
1993	18.927	14.934
1994	7.140	2.287
1995	86.386	45.387
1996	38.556	24.193
1997	72.286	41.598
1998	26.460	25.104
1999	24.953	24.314
2000	32.031	24.875
2001	6.599	3.375
2002	10.847	4.137
2003	4.145	5.673
2004	17.259	14.805

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #1

Rank	Pre-Project	Mitigated
1	86.3862	45.3874
2	72.2862	41.5980
3	51.0358	33.5681
4	48.8138	27.6235
5	44.7755	27.4151
6	39.9951	25.1044
7	38.5557	24.8748
8	33.4371	24.3139
9	32.0311	24.1933
10	28.7320	23.9703
11	26.4600	23.0378
12	25.7835	22.6678
13	24.9534	22.6129
14	24.9229	21.7164
15	23.6033	19.1478
16	21.7653	17.0141
17	20.6969	16.0964
18	19.9981	15.6101
19	19.6100	14.9339
20	19.3723	14.8833
21	19.0042	14.8053
22	18.9273	11.8238
23	17.2592	10.6447
24	16.0449	10.1269
25	15.4735	9.4359
26	12.2012	6.6588
27	10.8473	5.6725

28	10.3233	4.1370
29	7.2641	3.4239
30	7.1398	3.3746
31	7.1382	3.3327
32	6.5992	3.2963
33	5.3499	3.1719
34	4.5254	2.7023
35	4.1451	2.2873
36	2.1627	2.2461
37	1.5761	2.1390
38	1.5335	2.0653
39	1.4205	2.0051
40	1.2768	1.6944
41	0.9231	1.3332

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
4.7511	742	463	62	Pass
5.1864	679	428	63	Pass
5.6218	616	400	64	Pass
6.0571	565	377	66	Pass
6.4925	515	344	66	Pass
6.9279	474	328	69	Pass
7.3632	438	310	70	Pass
7.7986	405	289	71	Pass
8.2340	380	278	73	Pass
8.6693	351	263	74	Pass
9.1047	327	247	75	Pass
9.5401	306	230	75	Pass
9.9754	284	217	76	Pass
10.4108	260	204	78	Pass
10.8462	244	193	79	Pass
11.2815	231	184	79	Pass
11.7169	211	177	83	Pass
12.1523	202	162	80	Pass
12.5876	187	157	83	Pass
13.0230	176	147	83	Pass
13.4584	169	133	78	Pass
13.8937	159	127	79	Pass
14.3291	154	121	78	Pass
14.7645	146	113	77	Pass
15.1998	142	106	74	Pass
15.6352	134	99	73	Pass
16.0706	126	95	75	Pass
16.5059	118	90	76	Pass
16.9413	111	84	75	Pass
17.3767	106	80	75	Pass
17.8120	98	73	74	Pass
18.2474	91	70	76	Pass
18.6828	84	68	80	Pass
19.1181	76	62	81	Pass
19.5535	69	53	76	Pass
19.9889	67	48	71	Pass
20.4242	64	47	73	Pass
20.8596	61	46	75	Pass
21.2950	57	42	73	Pass
21.7303	53	37	69	Pass
22.1657	49	32	65	Pass
22.6011	48	30	62	Pass
23.0364	47	28	59	Pass
23.4718	46	27	58	Pass
23.9072	41	26	63	Pass
24.3425	39	21	53	Pass
24.7779	38	20	52	Pass
25.2133	35	18	51	Pass
25.6486	32	16	50	Pass
26.0840	31	16	51	Pass
26.5194	28	15	53	Pass
26.9547	28	15	53	Pass
27.3901	26	14	53	Pass

27.8255	23	11	47	Pass
28.2608	22	10	45	Pass
28.6962	22	10	45	Pass
29.1316	20	10	50	Pass
29.5669	20	10	50	Pass
30.0023	20	10	50	Pass
30.4377	20	9	45	Pass
30.8730	20	9	45	Pass
31.3084	20	8	40	Pass
31.7438	19	7	36	Pass
32.1791	18	7	38	Pass
32.6145	18	7	38	Pass
33.0499	17	7	41	Pass
33.4852	15	6	40	Pass
33.9206	14	5	35	Pass
34.3559	14	5	35	Pass
34.7913	14	5	35	Pass
35.2267	14	5	35	Pass
35.6620	14	4	28	Pass
36.0974	13	4	30	Pass
36.5328	13	3	23	Pass
36.9681	13	2	15	Pass
37.4035	13	2	15	Pass
37.8389	13	2	15	Pass
38.2742	12	2	16	Pass
38.7096	11	2	18	Pass
39.1450	10	2	20	Pass
39.5803	10	2	20	Pass
40.0157	9	2	22	Pass
40.4511	9	2	22	Pass
40.8864	8	2	25	Pass
41.3218	7	2	28	Pass
41.7572	7	1	14	Pass
42.1925	5	1	20	Pass
42.6279	5	1	20	Pass
43.0633	5	1	20	Pass
43.4986	5	1	20	Pass
43.9340	5	1	20	Pass
44.3694	5	1	20	Pass
44.8047	4	1	25	Pass
45.2401	4	1	25	Pass
45.6755	4	0	0	Pass
46.1108	4	0	0	Pass
46.5462	4	0	0	Pass
46.9816	4	0	0	Pass
47.4169	4	0	0	Pass
47.8523	4	0	0	Pass

Water Quality

Model Default Modifications

Total of 0 changes have been made.

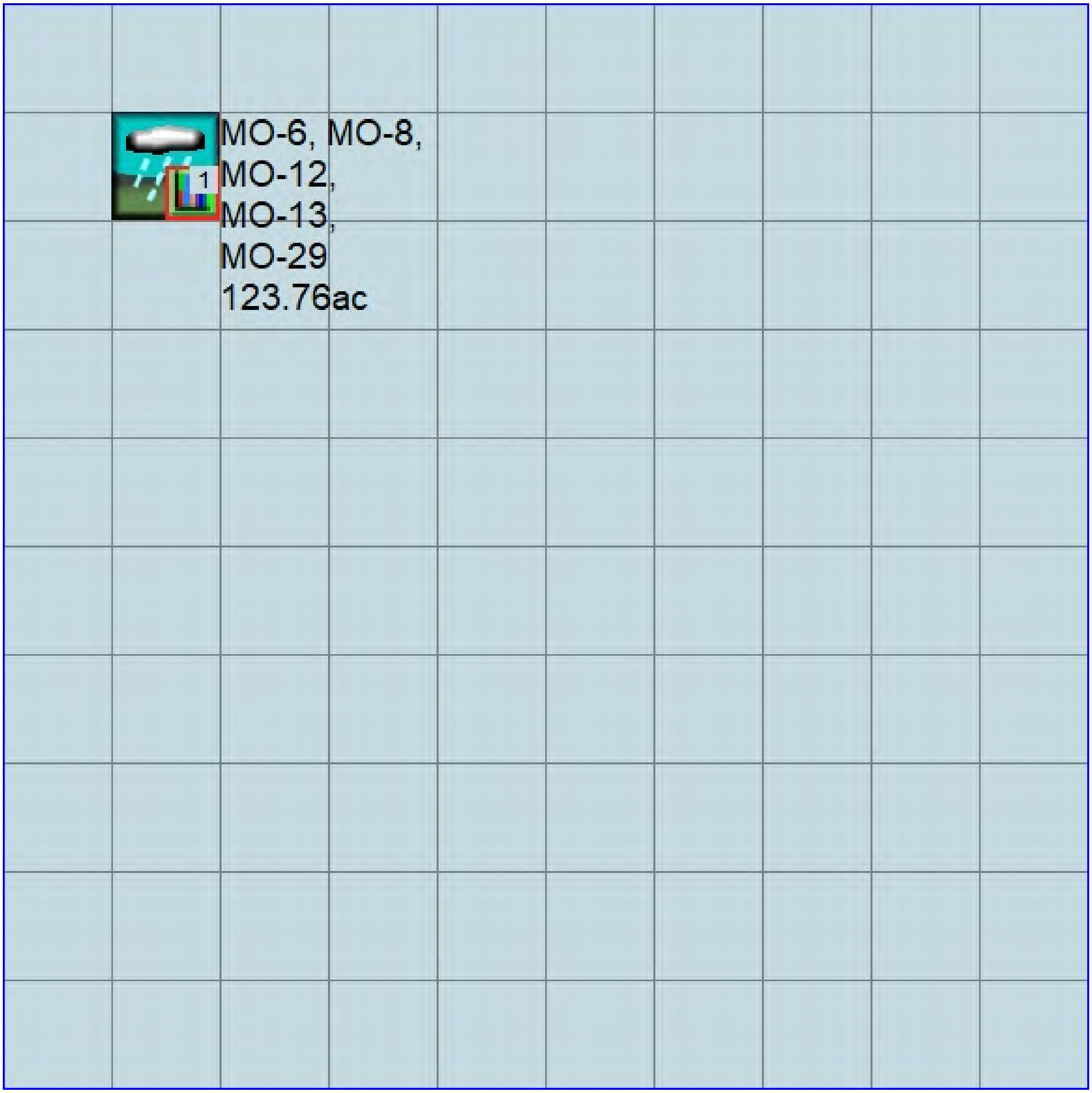
PERLND Changes

No PERLND changes have been made.

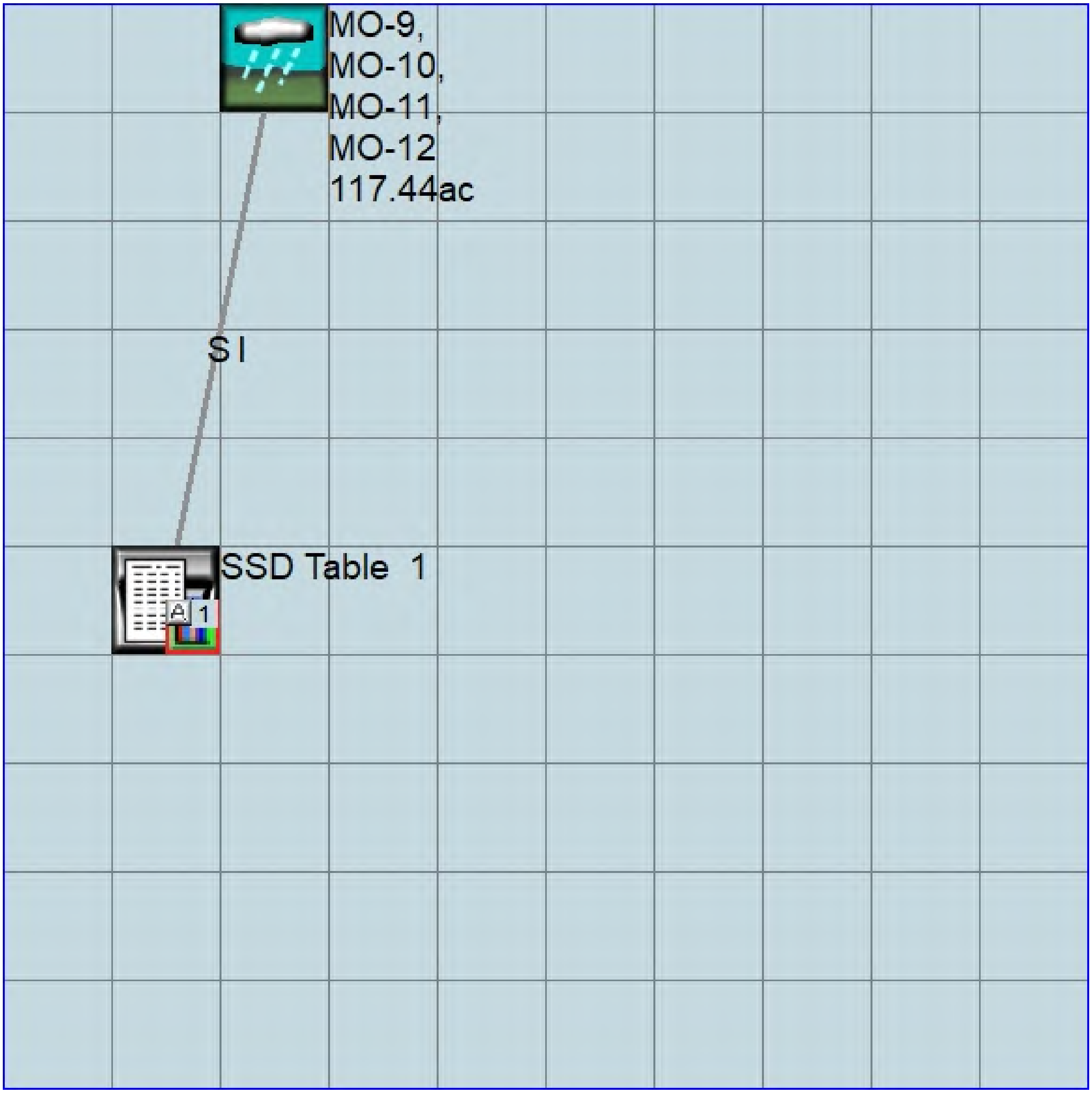
IMPLND Changes

No IMPLND changes have been made.

Appendix
Pre-Project Schematic



Mitigated Schematic



Pre-Project UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1963 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Basin A.wdm
MESSU      25   PreBasin A.MES
           27   PreBasin A.L61
           28   PreBasin A.L62
           30   POCBasin A1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      53
      IMPLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        MO-6, MO-8, MO-12, MO-13,   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                            in  out           ***
   53     D,Agric,Flat(0-1%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   53         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   53         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   53         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   53             0         5      0.03       400      0.01         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   53            40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   53             0       0.3       0.2       0.7       0.5         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53       0.5  0.5  0.5 0.55  0.6 0.65 0.65 0.65 0.65 0.65 0.55  0.5
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   53             0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out          ***
    1     Imperv,Flat(0-1%)       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
  END IWAT-PARM1
```

```
  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            100      0.01      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
MO-6, MO-8, MO-12, MO-13, MO-29***
PERLND  53                      118.02     COPY   501     12
PERLND  53                      118.02     COPY   501     13
IMPLND   1                        5.74     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
```

```
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                          ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.941          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.941          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.85           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.85           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>        <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                 <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY            INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY            INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY            INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1963 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Basin A.wdm
MESSU      25   MitBasin A.MES
           27   MitBasin A.L61
           28   MitBasin A.L62
           30   POCBasin A1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      53
      IMPLND       1
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        SSD Table  1                MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   53     D,Agric,Flat(0-1%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   53         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
```

```
   53         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   53         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   53             0         5      0.03       400      0.01         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   53            40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   53             0       0.3       0.2       0.7       0.5         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53       0.5  0.5  0.5 0.55  0.6 0.65 0.65 0.65 0.65 0.65 0.55  0.5
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   53             0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    1     Imperv,Flat(0-1%)       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
```

```
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            100      0.01      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
MO-9, MO-10, MO-11, MO-12***
PERLND  53                       58.72     RCHRES   1      2
PERLND  53                       58.72     RCHRES   1      3
IMPLND   1                       58.72     RCHRES   1      5

******Routing******
PERLND  53                       58.72     COPY     1     12
IMPLND   1                       58.72     COPY     1     15
PERLND  53                       58.72     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     SSD Table  1           1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
```

```
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
    9    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.760000  0.000000  0.000000
  1.000000  0.850000  0.810000  0.846042
  2.000000  0.940000  1.700000  1.292350
  3.000000  1.040000  2.690000  1.620047
  4.000000  1.130000  3.770000  2.089526
  5.000000  1.230000  4.960000  3.990685
  6.000000  1.340000  6.240000  20.38779
  7.000000  1.440000  7.630000  31.70563
  8.000000  1.550000  9.120000  38.49028
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC      ENGL    0.941          PERLND   1 999 EXTNL  PREC
WDM      2 PREC      ENGL    0.941          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP      ENGL    0.85           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP      ENGL    0.85           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK       3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3
```

```
  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16

END MASS-LINK

END RUN
```

Pre-Project HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1995/ 1/10  8: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
9 3.3236E+05 3.9727E+05 4.9519E+05
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1995/ 1/10  8: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
4.7916E+03 1.2545E+05 -3.267E+05    2.3875  2.3869E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1995/ 1/10  9: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
9 3.3236E+05 3.9727E+05 4.3131E+05
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1995/ 1/10  9: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
4.7916E+03 1.2545E+05 -1.986E+05    1.4971  1.4971E+00      3
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1997/ 1/22 19: 0

RCHRES:     1
```

The volume of water in this reach/mixed reservoir is greater than the value in the "volume" column of the last row of RCHTAB(). To continue the simulation the table has been extrapolated, based on information contained in the last two rows. This will usually result in some loss of accuracy. If depth is being calculated it will also cause an error condition. Relevant data are:

NROWS	V1	V2	VOL
9	3.3236E+05	3.9727E+05	4.4326E+05

ERROR/WARNING ID: 341 5

DATE/TIME: 1997/ 1/22 19: 0

RCHRES: 1

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0). Probably ftable was extrapolated. If extrapolation was small, no problem. Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
4.7916E+03	1.2545E+05	-2.225E+05	1.6677	1.6676E+00	3

ERROR/WARNING ID: 341 6

DATE/TIME: 1997/ 1/22 20: 0

RCHRES: 1

The volume of water in this reach/mixed reservoir is greater than the value in the "volume" column of the last row of RCHTAB(). To continue the simulation the table has been extrapolated, based on information contained in the last two rows. This will usually result in some loss of accuracy. If depth is being calculated it will also cause an error condition. Relevant data are:

NROWS	V1	V2	VOL
9	3.3236E+05	3.9727E+05	4.1074E+05

ERROR/WARNING ID: 341 5

DATE/TIME: 1997/ 1/22 20: 0

RCHRES: 1

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0). Probably ftable was extrapolated. If extrapolation was small, no problem. Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
4.7916E+03	1.2545E+05	-1.573E+05	1.1988	1.1988E+00	3

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Local (360)943-0304

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SAHM

PROJECT REPORT

General Model Information

Project Name:	Updated Mahon_(Basins B,C,E,G)_Alternative A
Site Name:	Mahon
Site Address:	
City:	
Report Date:	6/24/2020
Gage:	ELK GROV
Data Start:	1963/10/01
Data End:	2004/09/30
Timestep:	Hourly
Precip Scale:	0.94
Version Date:	2016/03/29

POC Thresholds

Low Flow Threshold for POC1:	25 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year
Low Flow Threshold for POC2:	25 Percent of the 2 Year
High Flow Threshold for POC2:	10 Year
Low Flow Threshold for POC3:	25 Percent of the 2 Year
High Flow Threshold for POC3:	10 Year
Low Flow Threshold for POC4:	25 Percent of the 2 Year
High Flow Threshold for POC4:	10 Year
Low Flow Threshold for POC5:	25 Percent of the 2 Year
High Flow Threshold for POC5:	10 Year

Landuse Basin Data
Pre-Project Land Use

Basin B (MA-15)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	51.91
Pervious Total	51.91
Impervious Land Use	acre
Imperv,Flat(0-1%)	1.06
Impervious Total	1.06
Basin Total	52.97

Element Flows To:

Surface	Interflow	Groundwater

Basin E (GL-7)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	90.95
Pervious Total	90.95
Impervious Land Use	acre
Imperv,Flat(0-1%)	1.86
Impervious Total	1.86
Basin Total	92.81

Element Flows To:

Surface	Interflow	Groundwater

Basin G (MO-12)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	20.62
Pervious Total	20.62
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.42
Impervious Total	0.42
Basin Total	21.04

Element Flows To:

Surface	Interflow	Groundwater

Basin C (MA-22)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	34.01
Pervious Total	34.01
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.69
Impervious Total	0.69
Basin Total	34.7

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin B (MA-15)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	33.83
Pervious Total	33.83
Impervious Land Use	acre
Imperv,Flat(0-1%)	19.14
Impervious Total	19.14
Basin Total	52.97

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

Basin C (MA-22)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	24.47
Pervious Total	24.47
Impervious Land Use	acre
Imperv,Flat(0-1%)	10.23
Impervious Total	10.23
Basin Total	34.7

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 2	SSD Table 2	

Basin E (GL-7)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	67.17
Pervious Total	67.17
Impervious Land Use	acre
Imperv,Flat(0-1%)	25.64
Impervious Total	25.64
Basin Total	92.81

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 4	SSD Table 4	

Basin G (MO-12)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	20.62
Pervious Total	20.62
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.42
Impervious Total	0.42
Basin Total	21.04

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 5	SSD Table 5	

Routing Elements
Pre-Project Routing

Mitigated Routing

SSD Table 1

Depth: 6 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	**Area (ac.)**	**Volume (ac-ft.)**	**Outlet Struct**	**NotUsed**	**NotUsed**	**NotUsed**	**NotUsed**
0.000	0.750	0.000	0.000	30629	5.000	0.000	0.000
1.000	0.840	0.790	0.495	0.000	0.000	0.000	0.000
2.000	0.920	1.670	0.739	0.000	0.000	0.000	0.000
3.000	1.010	2.640	0.921	0.000	0.000	0.000	0.000
4.000	1.100	3.700	1.602	0.000	0.000	0.000	0.000
5.000	1.200	4.850	4.332	0.000	0.000	0.000	0.000
6.000	1.350	6.130	55.19	0.000	0.000	0.000	0.000

SSD Table 2

Depth: 6 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.280	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.340	0.310	0.161	0.000	0.000	0.000	0.000
2.000	0.390	0.670	0.234	0.000	0.000	0.000	0.000
3.000	0.450	1.100	0.289	0.000	0.000	0.000	0.000
4.000	0.520	1.580	0.335	0.000	0.000	0.000	0.000
5.000	0.580	2.130	2.040	0.000	0.000	0.000	0.000
6.000	0.690	2.770	28.32	0.000	0.000	0.000	0.000

SSD Table 4

Depth: 8 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.940	0.000	0.000	0.000	0.000	0.000	0.000
1.000	1.040	0.990	0.603	0.000	0.000	0.000	0.000
2.000	1.150	2.090	0.908	0.000	0.000	0.000	0.000
3.000	1.260	3.300	1.663	0.990	0.000	0.000	0.000
4.000	1.380	4.620	4.447	2.090	0.000	0.000	0.000
5.000	1.490	6.050	43.57	3.300	0.000	0.000	0.000
6.000	1.610	7.600	75.27	4.620	0.000	0.000	0.000
7.000	1.730	9.280	92.18	6.050	0.000	0.000	0.000
8.000	1.860	11.07	105.8	7.600	0.000	0.000	0.000

SSD Table 5

Depth: 8 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

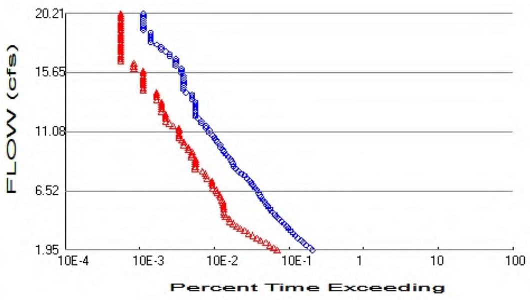
Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.240	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.290	0.260	0.396	0.000	0.000	0.000	0.000
2.000	0.350	0.580	0.587	0.000	0.000	0.000	0.000
3.000	0.410	0.960	0.730	0.000	0.000	0.000	0.000
4.000	0.470	1.410	1.380	0.000	0.000	0.000	0.000
5.000	0.540	1.910	4.081	0.000	0.000	0.000	0.000
6.000	0.610	2.490	49.11	0.000	0.000	0.000	0.000
7.000	0.680	3.140	93.96	0.000	0.000	0.000	0.000
8.000	0.760	3.860	114.8	0.000	0.000	0.000	0.000

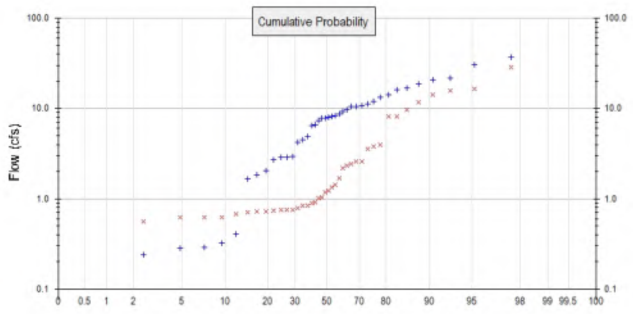
Analysis Results

POC 1

POC #1 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 2





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #2
Total Pervious Area: 51.91
Total Impervious Area: 1.06

Mitigated Landuse Totals for POC #2
Total Pervious Area: 33.83
Total Impervious Area: 19.14

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #2

Return Period	**Flow(cfs)**
2 year	7.80584
5 year	13.842471
10 year	20.211952
25 year	31.789595

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	1.18834
5 year	6.356571
10 year	13.608424
25 year	18.804681

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #2

Year	**Pre-Project**	**Mitigated**
1964	8.248	1.240
1965	6.493	1.339
1966	0.239	0.626
1967	20.630	16.435
1968	2.038	0.725
1969	18.874	2.321
1970	10.816	3.565
1971	10.484	3.819
1972	0.408	0.619
1973	21.511	2.610
1974	2.916	0.758
1975	0.283	0.553
1976	0.292	0.618
1977	0.172	0.426
1978	9.699	2.182

1979	8.746	1.003
1980	7.775	1.028
1981	0.324	0.722
1982	11.929	8.171
1983	16.806	8.187
1984	9.209	2.439
1985	1.848	0.747
1986	14.150	14.161
1987	4.222	0.903
1988	2.858	0.701
1989	7.806	0.756
1990	6.651	0.888
1991	4.934	0.838
1992	8.196	1.422
1993	7.952	2.573
1994	2.864	0.679
1995	36.645	28.875
1996	16.000	1.678
1997	30.647	15.874
1998	11.296	11.839
1999	10.549	3.937
2000	13.433	9.623
2001	2.695	0.731
2002	4.483	0.828
2003	1.641	0.782
2004	7.303	1.188

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #2

Rank	Pre-Project	Mitigated
1	36.6452	28.8754
2	30.6471	16.4351
3	21.5112	15.8737
4	20.6300	14.1614
5	18.8742	11.8389
6	16.8055	9.6234
7	16.0004	8.1865
8	14.1498	8.1711
9	13.4327	3.9372
10	11.9294	3.8194
11	11.2960	3.5649
12	10.8158	2.6099
13	10.5492	2.5732
14	10.4843	2.4387
15	9.6992	2.3207
16	9.2092	2.1820
17	8.7458	1.6776
18	8.2483	1.4224
19	8.1959	1.3387
20	7.9515	1.2402
21	7.8058	1.1883
22	7.7755	1.0278
23	7.3035	1.0029
24	6.6509	0.9032
25	6.4928	0.8884
26	4.9341	0.8383
27	4.4835	0.8280
28	4.2217	0.7824

29	2.9158	0.7577
30	2.8641	0.7563
31	2.8576	0.7466
32	2.6950	0.7310
33	2.0378	0.7246
34	1.8482	0.7224
35	1.6414	0.7012
36	0.4076	0.6786
37	0.3238	0.6263
38	0.2917	0.6194
39	0.2835	0.6179
40	0.2386	0.5533
41	0.1719	0.4260

Duration Flows

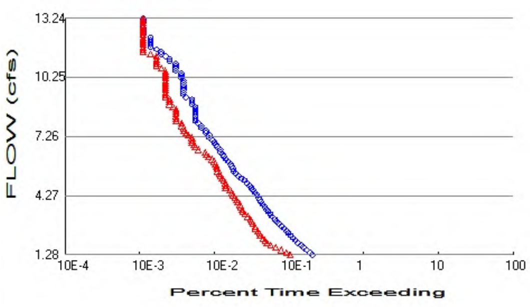
The Facility PASSED

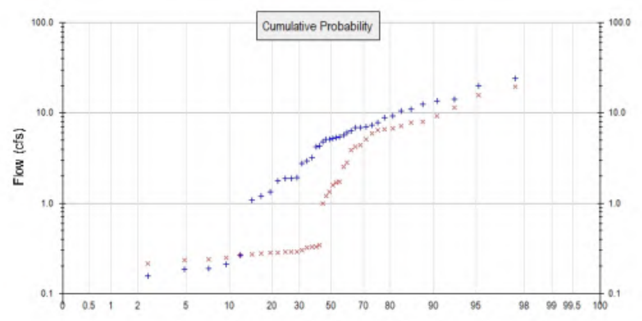
Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.9515	735	248	33	Pass
2.1359	681	224	32	Pass
2.3204	613	197	32	Pass
2.5048	561	176	31	Pass
2.6893	517	150	29	Pass
2.8737	469	133	28	Pass
3.0582	438	118	26	Pass
3.2426	410	102	24	Pass
3.4271	376	91	24	Pass
3.6115	353	80	22	Pass
3.7960	332	72	21	Pass
3.9804	308	65	21	Pass
4.1649	284	58	20	Pass
4.3493	261	57	21	Pass
4.5338	242	51	21	Pass
4.7182	231	49	21	Pass
4.9027	213	48	22	Pass
5.0871	201	48	23	Pass
5.2715	189	48	25	Pass
5.4560	179	47	26	Pass
5.6404	171	47	27	Pass
5.8249	161	46	28	Pass
6.0093	151	43	28	Pass
6.1938	147	42	28	Pass
6.3782	140	39	27	Pass
6.5627	133	38	28	Pass
6.7471	127	34	26	Pass
6.9316	119	34	28	Pass
7.1160	112	33	29	Pass
7.3005	106	33	31	Pass
7.4849	98	29	29	Pass
7.6694	91	28	30	Pass
7.8538	82	27	32	Pass
8.0383	76	25	32	Pass
8.2227	69	20	28	Pass
8.4072	65	20	30	Pass
8.5916	64	20	31	Pass
8.7761	61	20	32	Pass
8.9605	59	20	33	Pass
9.1450	55	18	32	Pass
9.3294	52	18	34	Pass
9.5139	48	18	37	Pass
9.6983	47	16	34	Pass
9.8828	43	16	37	Pass
10.0672	43	14	32	Pass
10.2517	39	14	35	Pass
10.4361	38	13	34	Pass
10.6206	36	12	33	Pass
10.8050	34	12	35	Pass
10.9895	31	12	38	Pass
11.1739	31	12	38	Pass
11.3584	28	12	42	Pass
11.5428	28	10	35	Pass

11.7273	24	9	37	Pass
11.9117	24	8	33	Pass
12.0962	22	8	36	Pass
12.2806	20	8	40	Pass
12.4651	20	8	40	Pass
12.6495	20	7	35	Pass
12.8340	20	7	35	Pass
13.0184	20	7	35	Pass
13.2029	20	7	35	Pass
13.3873	20	7	35	Pass
13.5718	18	6	33	Pass
13.7562	18	6	33	Pass
13.9407	18	6	33	Pass
14.1251	15	6	40	Pass
14.3096	14	4	28	Pass
14.4940	14	4	28	Pass
14.6785	14	4	28	Pass
14.8629	14	4	28	Pass
15.0474	14	4	28	Pass
15.2318	14	4	28	Pass
15.4163	14	4	28	Pass
15.6007	13	4	30	Pass
15.7852	13	4	30	Pass
15.9696	13	3	23	Pass
16.1541	11	3	27	Pass
16.3385	11	3	27	Pass
16.5230	11	2	18	Pass
16.7074	11	2	18	Pass
16.8919	9	2	22	Pass
17.0763	9	2	22	Pass
17.2608	8	2	25	Pass
17.4452	7	2	28	Pass
17.6297	7	2	28	Pass
17.8141	6	2	33	Pass
17.9986	5	2	40	Pass
18.1830	5	2	40	Pass
18.3675	5	2	40	Pass
18.5519	5	2	40	Pass
18.7364	5	2	40	Pass
18.9208	4	2	50	Pass
19.1053	4	2	50	Pass
19.2897	4	2	50	Pass
19.4742	4	2	50	Pass
19.6586	4	2	50	Pass
19.8431	4	2	50	Pass
20.0275	4	2	50	Pass
20.2120	4	2	50	Pass

Water Quality

POC 3





+ Pre-Project   x Mitigated

Pre-Project Landuse Totals for POC #3
Total Pervious Area: 34.01
Total Impervious Area: 0.69

Mitigated Landuse Totals for POC #3
Total Pervious Area: 24.47
Total Impervious Area: 10.23

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #3

Return Period	**Flow(cfs)**
2 year	5.11248
5 year	9.067354
10 year	13.239795
25 year	20.824019

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**
2 year	1.33556
5 year	6.666256
10 year	8.906848
25 year	16.451162

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #3

Year	**Pre-Project**	**Mitigated**
1964	5.402	1.204
1965	4.253	1.596
1966	0.155	0.239
1967	13.514	11.435
1968	1.334	0.275
1969	12.363	6.732
1970	7.085	6.506
1971	6.868	3.917
1972	0.265	0.248
1973	14.091	5.165
1974	1.910	0.285
1975	0.185	0.214
1976	0.190	0.235
1977	0.112	0.177
1978	6.353	2.830

1979	5.729	1.002
1980	5.092	1.679
1981	0.211	0.289
1982	7.814	6.579
1983	11.008	7.241
1984	6.032	4.225
1985	1.210	0.283
1986	9.269	9.191
1987	2.765	0.339
1988	1.871	0.290
1989	5.112	0.291
1990	4.356	0.330
1991	3.231	0.323
1992	5.368	1.715
1993	5.209	4.418
1994	1.876	0.266
1995	24.005	19.344
1996	10.480	2.516
1997	20.076	15.770
1998	7.400	7.998
1999	6.910	5.989
2000	8.799	7.790
2001	1.765	0.271
2002	2.937	0.326
2003	1.075	0.299
2004	4.784	1.336

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #3

Rank	Pre-Project	Mitigated
1	24.0048	19.3444
2	20.0756	15.7704
3	14.0907	11.4349
4	13.5137	9.1909
5	12.3633	7.9980
6	11.0081	7.7899
7	10.4801	7.2408
8	9.2688	6.7316
9	8.7987	6.5791
10	7.8137	6.5064
11	7.3998	5.9892
12	7.0846	5.1652
13	6.9103	4.4176
14	6.8676	4.2245
15	6.3526	3.9173
16	6.0325	2.8304
17	5.7289	2.5156
18	5.4024	1.7149
19	5.3684	1.6793
20	5.2086	1.5960
21	5.1125	1.3356
22	5.0920	1.2045
23	4.7841	1.0015
24	4.3563	0.3393
25	4.2529	0.3300
26	3.2314	0.3258
27	2.9366	0.3228
28	2.7652	0.2985

29	1.9096	0.2906
30	1.8757	0.2905
31	1.8712	0.2895
32	1.7650	0.2847
33	1.3341	0.2825
34	1.2105	0.2745
35	1.0748	0.2711
36	0.2654	0.2656
37	0.2115	0.2479
38	0.1899	0.2387
39	0.1845	0.2355
40	0.1554	0.2138
41	0.1119	0.1773

Duration Flows

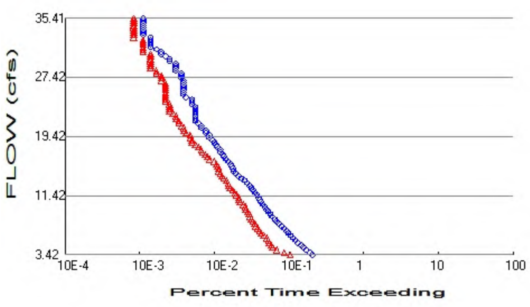
The Facility PASSED

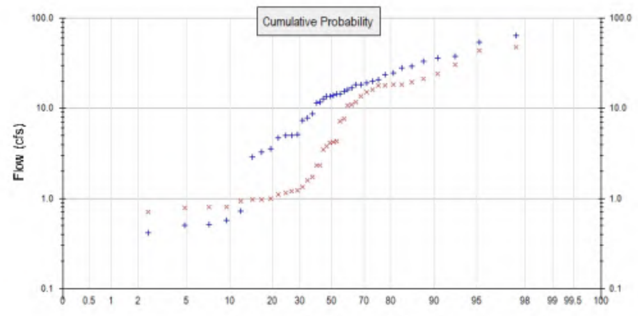
Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.2781	735	372	50	Pass
1.3989	681	331	48	Pass
1.5198	614	283	46	Pass
1.6406	561	237	42	Pass
1.7614	517	205	39	Pass
1.8822	469	183	39	Pass
2.0031	438	172	39	Pass
2.1239	410	160	39	Pass
2.2447	376	148	39	Pass
2.3655	353	144	40	Pass
2.4864	332	137	41	Pass
2.6072	308	129	41	Pass
2.7280	284	126	44	Pass
2.8488	261	117	44	Pass
2.9697	242	114	47	Pass
3.0905	231	110	47	Pass
3.2113	213	100	46	Pass
3.3321	201	92	45	Pass
3.4530	189	86	45	Pass
3.5738	179	84	46	Pass
3.6946	171	81	47	Pass
3.8154	161	80	49	Pass
3.9363	151	74	49	Pass
4.0571	147	71	48	Pass
4.1779	140	68	48	Pass
4.2987	133	64	48	Pass
4.4196	127	61	48	Pass
4.5404	119	58	48	Pass
4.6612	112	51	45	Pass
4.7820	106	51	48	Pass
4.9029	98	51	52	Pass
5.0237	91	48	52	Pass
5.1445	82	46	56	Pass
5.2653	76	43	56	Pass
5.3862	69	42	60	Pass
5.5070	65	39	60	Pass
5.6278	64	39	60	Pass
5.7486	61	38	62	Pass
5.8695	59	37	62	Pass
5.9903	55	36	65	Pass
6.1111	52	33	63	Pass
6.2319	48	30	62	Pass
6.3528	47	28	59	Pass
6.4736	43	27	62	Pass
6.5944	43	22	51	Pass
6.7152	39	20	51	Pass
6.8361	38	19	50	Pass
6.9569	36	18	50	Pass
7.0777	34	18	52	Pass
7.1985	31	18	58	Pass
7.3194	31	16	51	Pass
7.4402	28	15	53	Pass
7.5610	28	14	50	Pass

7.6818	24	14	58	Pass
7.8027	24	13	54	Pass
7.9235	22	13	59	Pass
8.0443	20	11	55	Pass
8.1651	20	11	55	Pass
8.2860	20	11	55	Pass
8.4068	20	11	55	Pass
8.5276	20	11	55	Pass
8.6484	20	11	55	Pass
8.7693	20	10	50	Pass
8.8901	18	9	50	Pass
9.0109	18	9	50	Pass
9.1317	18	9	50	Pass
9.2526	15	8	53	Pass
9.3734	14	8	57	Pass
9.4942	14	8	57	Pass
9.6150	14	8	57	Pass
9.7359	14	8	57	Pass
9.8567	14	8	57	Pass
9.9775	14	8	57	Pass
10.0983	14	8	57	Pass
10.2192	13	8	61	Pass
10.3400	13	8	61	Pass
10.4608	13	8	61	Pass
10.5816	11	8	72	Pass
10.7025	11	7	63	Pass
10.8233	11	6	54	Pass
10.9441	11	6	54	Pass
11.0649	9	6	66	Pass
11.1858	9	6	66	Pass
11.3066	8	6	75	Pass
11.4274	7	5	71	Pass
11.5482	7	4	57	Pass
11.6691	6	4	66	Pass
11.7899	5	4	80	Pass
11.9107	5	4	80	Pass
12.0315	5	4	80	Pass
12.1524	5	4	80	Pass
12.2732	5	4	80	Pass
12.3940	4	4	100	Pass
12.5148	4	4	100	Pass
12.6357	4	4	100	Pass
12.7565	4	4	100	Pass
12.8773	4	4	100	Pass
12.9981	4	4	100	Pass
13.1190	4	4	100	Pass
13.2398	4	4	100	Pass

Water Quality

POC 4





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #4
Total Pervious Area: 90.95
Total Impervious Area: 1.86

Mitigated Landuse Totals for POC #4
Total Pervious Area: 67.17
Total Impervious Area: 25.64

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #4

Return Period	**Flow(cfs)**
2 year	13.6774
5 year	24.254071
10 year	35.414424
25 year	55.69991

Flow Frequency Return Periods for Mitigated. POC #4

Return Period	**Flow(cfs)**
2 year	4.11918
5 year	18.1697
10 year	23.352
25 year	44.353276

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #4

Year	**Pre-Project**	**Mitigated**
1964	14.453	4.209
1965	11.376	4.119
1966	0.419	0.801
1967	36.147	30.606
1968	3.571	0.980
1969	33.071	15.070
1970	18.951	17.858
1971	18.370	11.062
1972	0.715	0.801
1973	37.691	17.969
1974	5.109	1.220
1975	0.497	0.705
1976	0.512	0.789
1977	0.302	0.561
1978	16.995	7.711

1979	15.324	3.453
1980	13.625	3.761
1981	0.568	0.975
1982	20.903	16.233
1983	29.446	18.320
1984	16.136	13.518
1985	3.238	1.160
1986	24.792	24.067
1987	7.397	2.306
1988	5.007	1.108
1989	13.677	1.331
1990	11.654	2.302
1991	8.646	1.720
1992	14.361	7.242
1993	13.932	11.656
1994	5.019	0.932
1995	64.208	47.201
1996	28.036	10.750
1997	53.698	43.683
1998	19.792	21.066
1999	18.484	18.366
2000	23.536	19.578
2001	4.722	0.991
2002	7.856	1.568
2003	2.876	1.204
2004	12.797	4.354

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #4

Rank	Pre-Project	Mitigated
1	64.2076	47.2011
2	53.6981	43.6832
3	37.6910	30.6062
4	36.1469	24.0665
5	33.0705	21.0656
6	29.4459	19.5776
7	28.0357	18.3661
8	24.7924	18.3200
9	23.5363	17.9693
10	20.9025	17.8577
11	19.7921	16.2326
12	18.9510	15.0698
13	18.4838	13.5178
14	18.3701	11.6555
15	16.9950	11.0621
16	16.1358	10.7502
17	15.3240	7.7106
18	14.4526	7.2420
19	14.3606	4.3541
20	13.9322	4.2092
21	13.6774	4.1192
22	13.6246	3.7609
23	12.7967	3.4531
24	11.6536	2.3060
25	11.3764	2.3021
26	8.6457	1.7199
27	7.8559	1.5682
28	7.3972	1.3306

29	5.1091	1.2197
30	5.0187	1.2042
31	5.0073	1.1599
32	4.7222	1.1076
33	3.5709	0.9915
34	3.2385	0.9803
35	2.8761	0.9752
36	0.7152	0.9324
37	0.5677	0.8010
38	0.5118	0.8006
39	0.4974	0.7891
40	0.4187	0.7046
41	0.3017	0.5608

Duration Flows

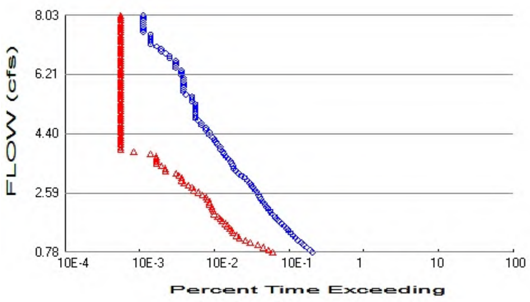
The Facility PASSED

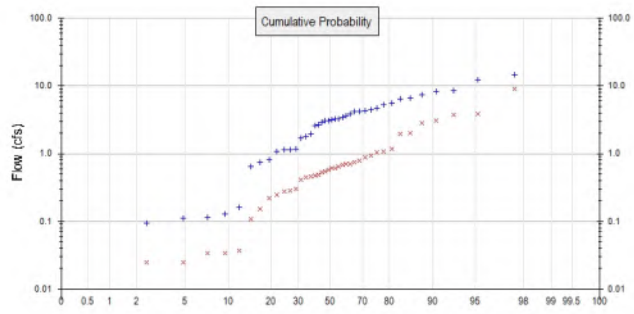
Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
3.4194	735	372	50	Pass
3.7425	681	311	45	Pass
4.0657	613	245	39	Pass
4.3889	561	217	38	Pass
4.7121	517	208	40	Pass
5.0353	469	196	41	Pass
5.3584	438	190	43	Pass
5.6816	410	183	44	Pass
6.0048	376	165	43	Pass
6.3280	353	152	43	Pass
6.6512	332	144	43	Pass
6.9744	308	136	44	Pass
7.2975	284	129	45	Pass
7.6207	261	124	47	Pass
7.9439	242	118	48	Pass
8.2671	231	112	48	Pass
8.5903	213	108	50	Pass
8.9135	201	105	52	Pass
9.2366	189	100	52	Pass
9.5598	179	95	53	Pass
9.8830	171	93	54	Pass
10.2062	161	88	54	Pass
10.5294	151	80	52	Pass
10.8525	147	77	52	Pass
11.1757	140	76	54	Pass
11.4989	133	72	54	Pass
11.8221	127	68	53	Pass
12.1453	119	63	52	Pass
12.4685	112	58	51	Pass
12.7916	106	56	52	Pass
13.1148	99	55	55	Pass
13.4380	91	52	57	Pass
13.7612	82	48	58	Pass
14.0844	76	45	59	Pass
14.4076	69	43	62	Pass
14.7307	65	41	63	Pass
15.0539	64	41	64	Pass
15.3771	61	40	65	Pass
15.7003	59	38	64	Pass
16.0235	55	36	65	Pass
16.3467	52	31	59	Pass
16.6698	48	29	60	Pass
16.9930	47	27	57	Pass
17.3162	43	25	58	Pass
17.6394	43	24	55	Pass
17.9626	39	22	56	Pass
18.2857	38	20	52	Pass
18.6089	36	18	50	Pass
18.9321	34	18	52	Pass
19.2553	31	17	54	Pass
19.5785	31	17	54	Pass
19.9017	28	15	53	Pass
20.2248	28	14	50	Pass

20.5480	24	14	58	Pass
20.8712	24	13	54	Pass
21.1944	22	12	54	Pass
21.5176	20	12	60	Pass
21.8408	20	11	55	Pass
22.1639	20	11	55	Pass
22.4871	20	10	50	Pass
22.8103	20	9	45	Pass
23.1335	20	9	45	Pass
23.4567	20	9	45	Pass
23.7799	18	9	50	Pass
24.1030	18	8	44	Pass
24.4262	18	8	44	Pass
24.7494	15	8	53	Pass
25.0726	14	8	57	Pass
25.3958	14	8	57	Pass
25.7189	14	8	57	Pass
26.0421	14	8	57	Pass
26.3653	14	8	57	Pass
26.6885	14	8	57	Pass
27.0117	14	7	50	Pass
27.3349	13	7	53	Pass
27.6580	13	7	53	Pass
27.9812	13	6	46	Pass
28.3044	11	6	54	Pass
28.6276	11	5	45	Pass
28.9508	11	5	45	Pass
29.2740	11	5	45	Pass
29.5971	9	5	55	Pass
29.9203	9	5	55	Pass
30.2435	8	5	62	Pass
30.5667	7	5	71	Pass
30.8899	7	4	57	Pass
31.2131	6	4	66	Pass
31.5362	5	4	80	Pass
31.8594	5	4	80	Pass
32.1826	5	4	80	Pass
32.5058	5	4	80	Pass
32.8290	5	3	60	Pass
33.1521	4	3	75	Pass
33.4753	4	3	75	Pass
33.7985	4	3	75	Pass
34.1217	4	3	75	Pass
34.4449	4	3	75	Pass
34.7681	4	3	75	Pass
35.0912	4	3	75	Pass
35.4144	4	3	75	Pass

Water Quality

POC 5





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #5
Total Pervious Area: 20.62
Total Impervious Area: 0.42

Mitigated Landuse Totals for POC #5
Total Pervious Area: 20.62
Total Impervious Area: 0.42

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #5

Return Period	**Flow(cfs)**
2 year	3.10028
5 year	5.498146
10 year	8.02812
25 year	12.62681

Flow Frequency Return Periods for Mitigated. POC #5

Return Period	**Flow(cfs)**
2 year	0.570883
5 year	1.135143
10 year	3.001078
25 year	4.855831

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #5

Year	**Pre-Project**	**Mitigated**
1964	3.276	0.602
1965	2.579	0.521
1966	0.095	0.034
1967	8.194	3.052
1968	0.809	0.107
1969	7.497	0.781
1970	4.296	0.933
1971	4.164	0.685
1972	0.162	0.025
1973	8.544	1.075
1974	1.158	0.298
1975	0.112	0.025
1976	0.116	0.034
1977	0.068	0.017
1978	3.852	0.704

1979	3.474	0.571
1980	3.088	0.540
1981	0.128	0.036
1982	4.738	1.981
1983	6.675	1.931
1984	3.658	0.885
1985	0.734	0.243
1986	5.620	3.856
1987	1.677	0.410
1988	1.135	0.283
1989	3.100	0.453
1990	2.642	0.475
1991	1.960	0.481
1992	3.255	0.637
1993	3.158	0.747
1994	1.138	0.217
1995	14.556	9.105
1996	6.355	0.710
1997	12.173	3.793
1998	4.487	2.837
1999	4.190	1.180
2000	5.335	1.050
2001	1.070	0.273
2002	1.781	0.445
2003	0.652	0.150
2004	2.901	0.602

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #5

Rank	Pre-Project	Mitigated
1	14.5555	9.1050
2	12.1730	3.8560
3	8.5441	3.7933
4	8.1942	3.0524
5	7.4967	2.8367
6	6.6750	1.9808
7	6.3551	1.9311
8	5.6203	1.1803
9	5.3353	1.0750
10	4.7382	1.0498
11	4.4868	0.9328
12	4.2959	0.8853
13	4.1901	0.7813
14	4.1643	0.7469
15	3.8523	0.7099
16	3.6579	0.7039
17	3.4738	0.6846
18	3.2760	0.6369
19	3.2553	0.6024
20	3.1583	0.6022
21	3.1003	0.5709
22	3.0881	0.5400
23	2.9009	0.5212
24	2.6416	0.4807
25	2.5789	0.4747
26	1.9596	0.4526
27	1.7808	0.4448
28	1.6768	0.4096

29	1.1581	0.2978
30	1.1375	0.2833
31	1.1349	0.2726
32	1.0704	0.2427
33	0.8092	0.2168
34	0.7341	0.1498
35	0.6519	0.1074
36	0.1615	0.0365
37	0.1285	0.0339
38	0.1156	0.0336
39	0.1123	0.0248
40	0.0946	0.0246
41	0.0681	0.0168

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.7751	735	216	29	Pass
0.8483	681	190	27	Pass
0.9216	614	162	26	Pass
0.9949	563	137	24	Pass
1.0681	517	109	21	Pass
1.1414	469	93	19	Pass
1.2146	438	78	17	Pass
1.2879	410	72	17	Pass
1.3612	376	64	17	Pass
1.4344	353	62	17	Pass
1.5077	333	58	17	Pass
1.5810	309	54	17	Pass
1.6542	284	50	17	Pass
1.7275	261	46	17	Pass
1.8008	242	43	17	Pass
1.8740	231	40	17	Pass
1.9473	213	36	16	Pass
2.0205	201	35	17	Pass
2.0938	189	34	17	Pass
2.1671	179	33	18	Pass
2.2403	171	31	18	Pass
2.3136	161	31	19	Pass
2.3869	151	29	19	Pass
2.4601	147	28	19	Pass
2.5334	140	25	17	Pass
2.6066	133	22	16	Pass
2.6799	127	19	14	Pass
2.7532	119	18	15	Pass
2.8264	112	16	14	Pass
2.8997	106	14	13	Pass
2.9730	99	13	13	Pass
3.0462	91	13	14	Pass
3.1195	82	12	14	Pass
3.1928	76	11	14	Pass
3.2660	69	8	11	Pass
3.3393	65	8	12	Pass
3.4125	64	7	10	Pass
3.4858	61	6	9	Pass
3.5591	59	6	10	Pass
3.6323	55	6	10	Pass
3.7056	52	6	11	Pass
3.7789	48	5	10	Pass
3.8521	47	3	6	Pass
3.9254	43	2	4	Pass
3.9986	43	2	4	Pass
4.0719	39	2	5	Pass
4.1452	38	2	5	Pass
4.2184	36	2	5	Pass
4.2917	34	2	5	Pass
4.3650	31	2	6	Pass
4.4382	31	2	6	Pass
4.5115	28	2	7	Pass
4.5848	28	2	7	Pass

4.6580	24	2	8	Pass
4.7313	24	2	8	Pass
4.8045	22	2	9	Pass
4.8778	20	2	10	Pass
4.9511	20	2	10	Pass
5.0243	20	2	10	Pass
5.0976	20	2	10	Pass
5.1709	20	2	10	Pass
5.2441	20	2	10	Pass
5.3174	20	2	10	Pass
5.3906	18	2	11	Pass
5.4639	18	2	11	Pass
5.5372	18	2	11	Pass
5.6104	15	2	13	Pass
5.6837	14	2	14	Pass
5.7570	14	2	14	Pass
5.8302	14	2	14	Pass
5.9035	14	2	14	Pass
5.9768	14	2	14	Pass
6.0500	14	2	14	Pass
6.1233	14	2	14	Pass
6.1965	13	2	15	Pass
6.2698	13	2	15	Pass
6.3431	13	2	15	Pass
6.4163	11	2	18	Pass
6.4896	11	2	18	Pass
6.5629	11	2	18	Pass
6.6361	11	2	18	Pass
6.7094	9	2	22	Pass
6.7826	9	2	22	Pass
6.8559	8	2	25	Pass
6.9292	7	2	28	Pass
7.0024	7	2	28	Pass
7.0757	6	2	33	Pass
7.1490	5	2	40	Pass
7.2222	5	2	40	Pass
7.2955	5	2	40	Pass
7.3688	5	2	40	Pass
7.4420	5	2	40	Pass
7.5153	4	2	50	Pass
7.5885	4	2	50	Pass
7.6618	4	2	50	Pass
7.7351	4	2	50	Pass
7.8083	4	2	50	Pass
7.8816	4	2	50	Pass
7.9549	4	2	50	Pass
8.0281	4	2	50	Pass

Water Quality

POC 6

POC #6 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 7

POC #7 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

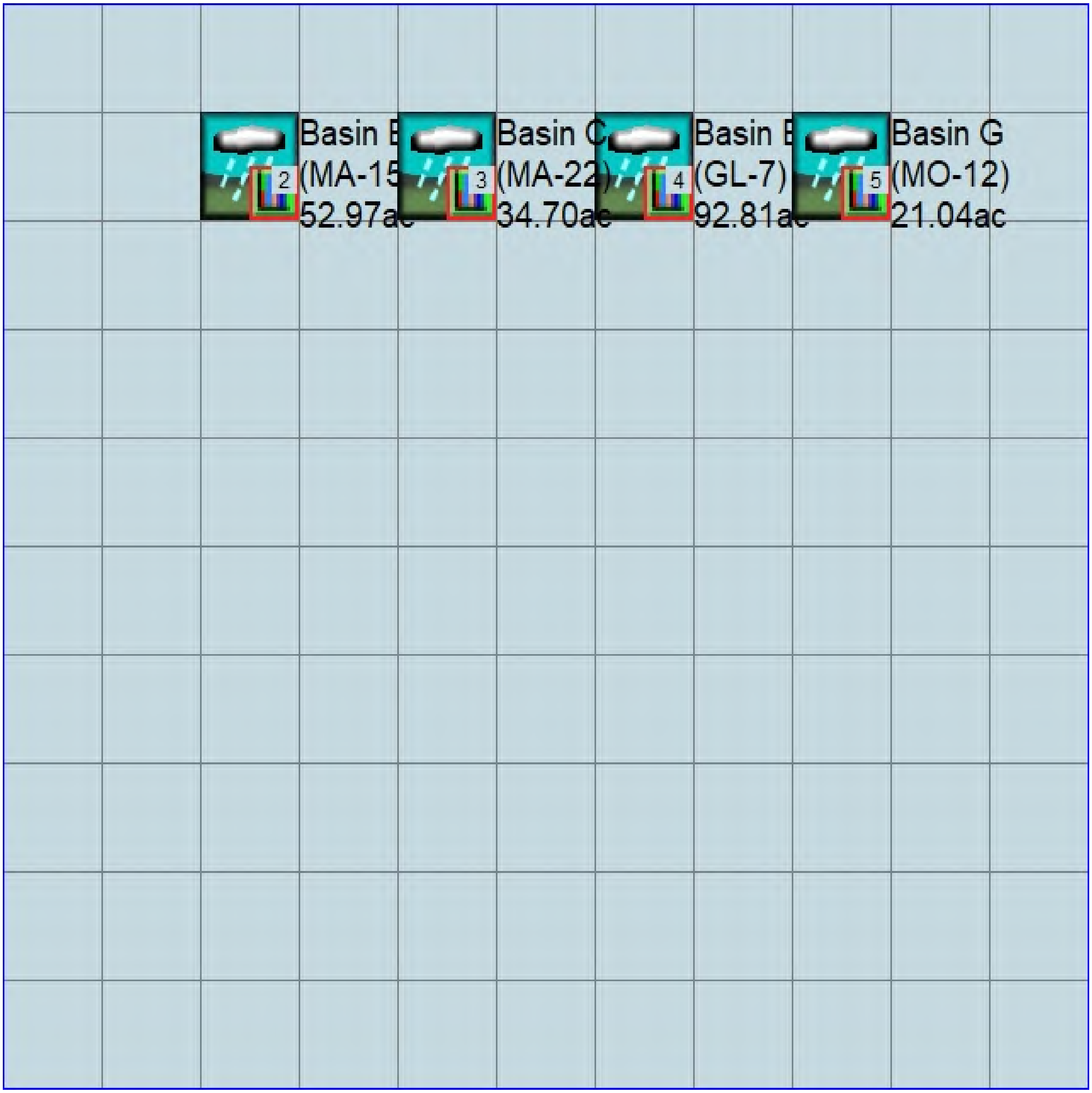
PERLND Changes

No PERLND changes have been made.

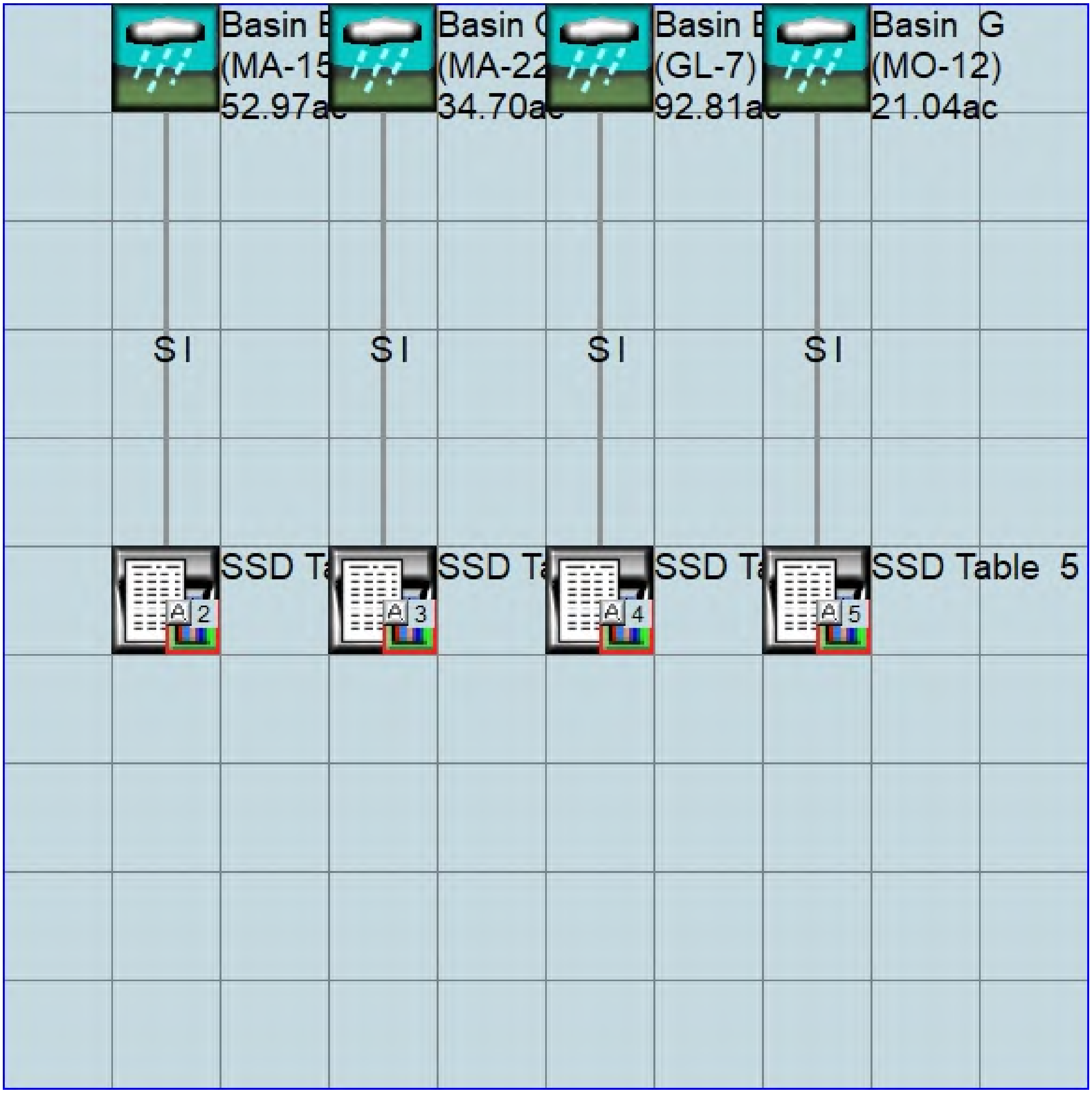
IMPLND Changes

No IMPLND changes have been made.

Appendix
Pre-Project Schematic



Mitigated Schematic



Pre-Project UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1963 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Updated Mahon_(Basins B,C,E,G)_Alternative A.wdm
MESSU      25   MitUpdated Mahon_(Basins B,C,E,G)_Alternative A.MES
           27   MitUpdated Mahon_(Basins B,C,E,G)_Alternative A.L61
           28   MitUpdated Mahon_(Basins B,C,E,G)_Alternative A.L62
           31   POCUpdated Mahon_(Basins B,C,E,G)_Alternative A2.dat
           32   POCUpdated Mahon_(Basins B,C,E,G)_Alternative A3.dat
           33   POCUpdated Mahon_(Basins B,C,E,G)_Alternative A4.dat
           34   POCUpdated Mahon_(Basins B,C,E,G)_Alternative A5.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      53
      IMPLND       1
      RCHRES       1
      RCHRES       2
      RCHRES       3
      RCHRES       4
      COPY         2
      COPY       502
      COPY         3
      COPY       503
      COPY         4
      COPY       504
      COPY         5
      COPY       505
      DISPLY       2
      DISPLY       3
      DISPLY       4
      DISPLY       5
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2        SSD Table  1                MAX                    1    2   31    9
    3        SSD Table  2                MAX                    1    2   32    9
    4        SSD Table  4                MAX                    1    2   33    9
    5        SSD Table  5                MAX                    1    2   34    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
    2         1    1
  502         1    1
    3         1    1
  503         1    1
    4         1    1
  504         1    1
    5         1    1
  505         1    1
  END TIMESERIES
END COPY
GENER
```

```
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   53     D,Agric,Flat(0-1%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   53         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   53         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   53         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   53             0         5      0.03       400      0.01         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   53            40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   53             0       0.3       0.2       0.7       0.5         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53       0.5  0.5  0.5 0.55  0.6 0.65 0.65 0.65 0.65 0.65 0.55  0.5
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   53             0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND
```

```
IMPLND
  GEN-INFO
    <PLS ><-------Name-------> Unit-systems Printer ***
    # - #                      User t-series Engl Metr ***
                                    in  out          ***
    1     Imperv,Flat(0-1%)       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI      ***
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            100      0.01      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin B (MA-15)***
PERLND  53                       33.83     RCHRES   1      2
PERLND  53                       33.83     RCHRES   1      3
IMPLND   1                       19.14     RCHRES   1      5
Basin C (MA-22)***
PERLND  53                       24.47     RCHRES   2      2
PERLND  53                       24.47     RCHRES   2      3
IMPLND   1                       10.23     RCHRES   2      5
Basin E (GL-7)***
PERLND  53                       67.17     RCHRES   3      2
PERLND  53                       67.17     RCHRES   3      3
IMPLND   1                       25.64     RCHRES   3      5
Basin  G (MO-12)***
PERLND  53                       20.62     RCHRES   4      2
PERLND  53                       20.62     RCHRES   4      3
IMPLND   1                        0.42     RCHRES   4      5

******Routing******
PERLND  53                       33.83     COPY     2     12
IMPLND   1                       19.14     COPY     2     15
```

```
PERLND  53                      33.83     COPY     2     13
PERLND  53                      24.47     COPY     3     12
IMPLND   1                      10.23     COPY     3     15
PERLND  53                      24.47     COPY     3     13
PERLND  53                      67.17     COPY     4     12
IMPLND   1                      25.64     COPY     4     15
PERLND  53                      67.17     COPY     4     13
PERLND  53                      20.62     COPY     5     12
IMPLND   1                       0.42     COPY     5     15
PERLND  53                      20.62     COPY     5     13
RCHRES   1                          1     COPY   502     16
RCHRES   2                          1     COPY   503     16
RCHRES   3                          1     COPY   504     16
RCHRES   4                          1     COPY   505     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   12.1        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   12.1        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   12.1        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   12.1        DISPLY   5     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                     ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG                ***
                                           in  out                               ***
    1     SSD Table  1           1    1    1    1   28    0    1
    2     SSD Table  2           1    1    1    1   28    0    1
    3     SSD Table  4           1    1    1    1   28    0    1
    4     SSD Table  5           1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
    4         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
    4         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                          ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *          ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    3        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    4        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1
```

```
  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1            1      0.01       0.0       0.0       0.5       0.0
    2            2      0.01       0.0       0.0       0.5       0.0
    3            3      0.01       0.0       0.0       0.5       0.0
    4            4      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                           ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1          0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2          0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3          0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    4          0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
    7    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.750000  0.000000  0.000000
  1.000000  0.840000  0.790000  0.494568
  2.000000  0.920000  1.670000  0.739304
  3.000000  1.010000  2.640000  0.921164
  4.000000  1.100000  3.700000  1.602421
  5.000000  1.200000  4.850000  4.331640
  6.000000  1.350000  6.130000  55.19165
  END FTABLE  1
  FTABLE      2
    7    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.280000  0.000000  0.000000
  1.000000  0.340000  0.310000  0.160901
  2.000000  0.390000  0.670000  0.233784
  3.000000  0.450000  1.100000  0.288827
  4.000000  0.520000  1.580000  0.334943
  5.000000  0.580000  2.130000  2.040437
  6.000000  0.690000  2.770000  28.31964
  END FTABLE  2
  FTABLE      3
    9    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.940000  0.000000  0.000000
  1.000000  1.040000  0.990000  0.602993
  2.000000  1.150000  2.090000  0.907664
  3.000000  1.260000  3.300000  1.662985
  4.000000  1.380000  4.620000  4.447191
  5.000000  1.490000  6.050000  43.57301
  6.000000  1.610000  7.600000  75.26561
  7.000000  1.730000  9.280000  92.17936
  8.000000  1.860000  11.07000  105.8081
  END FTABLE  3
  FTABLE      4
    9    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.240000  0.000000  0.000000
  1.000000  0.290000  0.260000  0.395565
  2.000000  0.350000  0.580000  0.587360
  3.000000  0.410000  0.960000  0.730419
```

```
  4.000000  0.470000  1.410000  1.379524
  5.000000  0.540000  1.910000  4.080676
  6.000000  0.610000  2.490000  49.10884
  7.000000  0.680000  3.140000  93.96486
  8.000000  0.760000  3.860000  114.8116
  END FTABLE  4
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC      ENGL    0.941          PERLND   1 999 EXTNL  PREC
WDM      2 PREC      ENGL    0.941          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP      ENGL    0.85           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP      ENGL    0.85           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL       REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL       REPL
COPY     2 OUTPUT MEAN   1 1     12.1      WDM    702 FLOW     ENGL       REPL
COPY   502 OUTPUT MEAN   1 1     12.1      WDM    802 FLOW     ENGL       REPL
RCHRES   2 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL       REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1005 STAG     ENGL       REPL
COPY     3 OUTPUT MEAN   1 1     12.1      WDM    703 FLOW     ENGL       REPL
COPY   503 OUTPUT MEAN   1 1     12.1      WDM    803 FLOW     ENGL       REPL
RCHRES   3 HYDR   RO     1 1        1      WDM   1010 FLOW     ENGL       REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1011 STAG     ENGL       REPL
COPY     4 OUTPUT MEAN   1 1     12.1      WDM    704 FLOW     ENGL       REPL
COPY   504 OUTPUT MEAN   1 1     12.1      WDM    804 FLOW     ENGL       REPL
RCHRES   4 HYDR   RO     1 1        1      WDM   1012 FLOW     ENGL       REPL
RCHRES   4 HYDR   STAGE  1 1        1      WDM   1013 STAG     ENGL       REPL
COPY     5 OUTPUT MEAN   1 1     12.1      WDM    705 FLOW     ENGL       REPL
COPY   505 OUTPUT MEAN   1 1     12.1      WDM    805 FLOW     ENGL       REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16
```

```
END MASS-LINK

END RUN
```

Pre-Project HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1995/ 1/10  8: 0

RCHRES:     2

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1          V2         VOL
7 9.2783E+04 1.2066E+05 1.2357E+05
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1995/ 1/10  8: 0

RCHRES:     2

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C       RDEP1       RDEP2  COUNT
4.7916E+03 5.0530E+04 -6.109E+04    1.0953  1.0952E+00      3
```

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SAHM

PROJECT REPORT

General Model Information

Project Name:	Updated Mahon_(Basins B,C,E,G)_Alternative B
Site Name:	Mahon
Site Address:	
City:	
Report Date:	6/24/2020
Gage:	ELK GROV
Data Start:	1963/10/01
Data End:	2004/09/30
Timestep:	Hourly
Precip Scale:	0.94
Version Date:	2016/03/29

POC Thresholds

Low Flow Threshold for POC1:	25 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year
Low Flow Threshold for POC2:	25 Percent of the 2 Year
High Flow Threshold for POC2:	10 Year
Low Flow Threshold for POC3:	25 Percent of the 2 Year
High Flow Threshold for POC3:	10 Year
Low Flow Threshold for POC4:	25 Percent of the 2 Year
High Flow Threshold for POC4:	10 Year
Low Flow Threshold for POC5:	25 Percent of the 2 Year
High Flow Threshold for POC5:	10 Year

Landuse Basin Data
Pre-Project Land Use

Basin B (MA-15)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	41.9
Pervious Total	41.9
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.84
Impervious Total	0.84
Basin Total	42.74

Element Flows To:

Surface	Interflow	Groundwater

Basin E (GL-7)

Bypass:	No	
GroundWater:	No	
Pervious Land Use	acre	
D,Agric,Flat(0-1%)	103.89	
Pervious Total	103.89	
Impervious Land Use	acre	
Imperv,Flat(0-1%)	2.078	
Impervious Total	2.078	
Basin Total	105.968	

Element Flows To:

Surface	Interflow	Groundwater

Basin G (MO-12)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	20.62
Pervious Total	20.62
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.42
Impervious Total	0.42
Basin Total	21.04

Element Flows To:

Surface	Interflow	Groundwater

Basin C (MA-22)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	34.01
Pervious Total	34.01
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.69
Impervious Total	0.69
Basin Total	34.7

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin B (MA-15)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	41.9
Pervious Total	41.9
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.84
Impervious Total	0.84
Basin Total	42.74

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

Basin C (MA-22)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	24.47
Pervious Total	24.47
Impervious Land Use	acre
Imperv,Flat(0-1%)	10.23
Impervious Total	10.23
Basin Total	34.7

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 2	SSD Table 2	

Basin E (GL-7)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	103.89
Pervious Total	103.89
Impervious Land Use	acre
Imperv,Flat(0-1%)	48.89
Impervious Total	48.89
Basin Total	152.78

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 4	SSD Table 4	

Basin G (MO-12)

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
D,Agric,Flat(0-1%)	20.62
Pervious Total	20.62
Impervious Land Use	acre
Imperv,Flat(0-1%)	0.42
Impervious Total	0.42
Basin Total	21.04

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 5	SSD Table 5	

Routing Elements
Pre-Project Routing

Mitigated Routing

SSD Table 1

Depth: 6 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	**Area (ac.)**	**Volume (ac-ft.)**	**Outlet Struct**	**NotUsed**	**NotUsed**	**NotUsed**	**NotUsed**
0.000	0.280	0.000	0.000	30629	5.000	0.000	0.000
1.000	0.340	0.310	0.495	0.000	0.000	0.000	0.000
2.000	0.390	0.670	0.739	0.000	0.000	0.000	0.000
3.000	0.450	1.100	0.921	0.000	0.000	0.000	0.000
4.000	0.520	1.580	1.602	0.000	0.000	0.000	0.000
5.000	0.580	2.130	4.332	0.000	0.000	0.000	0.000
6.000	0.690	2.770	55.19	0.000	0.000	0.000	0.000

SSD Table 2

Depth: 6 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.280	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.340	0.310	0.161	0.000	0.000	0.000	0.000
2.000	0.390	0.670	0.234	0.000	0.000	0.000	0.000
3.000	0.450	1.100	0.289	0.000	0.000	0.000	0.000
4.000	0.520	1.580	0.335	0.000	0.000	0.000	0.000
5.000	0.580	2.130	2.040	0.000	0.000	0.000	0.000
6.000	0.690	2.770	28.32	0.000	0.000	0.000	0.000

SSD Table 4

Depth: 8 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	2.800	0.000	0.000	0.000	0.000	0.000	0.000
1.000	2.930	2.870	0.846	0.000	0.000	0.000	0.000
2.000	3.070	5.870	1.292	0.000	0.000	0.000	0.000
3.000	3.210	9.010	1.620	0.990	0.000	0.000	0.000
4.000	3.360	12.30	1.892	2.090	0.000	0.000	0.000
5.000	3.510	15.73	3.461	3.300	0.000	0.000	0.000
6.000	3.660	19.31	20.31	4.620	0.000	0.000	0.000
7.000	3.810	23.05	65.45	6.050	0.000	0.000	0.000
8.000	3.970	26.93	85.53	7.600	0.000	0.000	0.000

SSD Table 5

Depth: 8 ft.
Element Flows To:
Outlet 1 Outlet 2

SSD Table Hydraulic Table

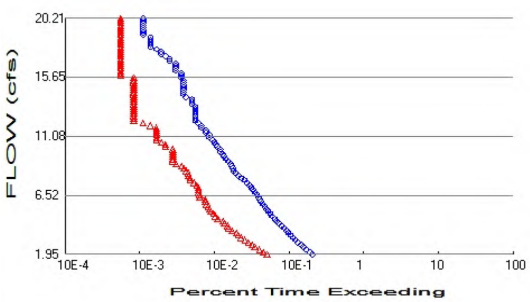
Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.040	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.070	0.060	0.396	0.000	0.000	0.000	0.000
2.000	0.110	0.150	0.587	0.000	0.000	0.000	0.000
3.000	0.150	0.280	0.730	0.000	0.000	0.000	0.000
4.000	0.190	0.450	1.380	0.000	0.000	0.000	0.000
5.000	0.240	0.660	4.081	0.000	0.000	0.000	0.000
6.000	0.280	0.920	49.11	0.000	0.000	0.000	0.000
7.000	0.330	1.230	93.96	0.000	0.000	0.000	0.000
8.000	0.390	1.590	114.8	0.000	0.000	0.000	0.000

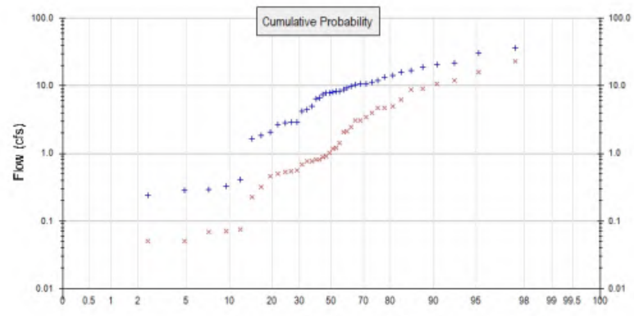
Analysis Results

POC 1

POC #1 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 2





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #2
Total Pervious Area: 41.9
Total Impervious Area: 0.84

Mitigated Landuse Totals for POC #2
Total Pervious Area: 41.9
Total Impervious Area: 0.84

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #2

Return Period	**Flow(cfs)**
2 year	7.80584
5 year	13.842471
10 year	20.211952
25 year	31.789595

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	1.00433
5 year	4.845876
10 year	10.214726
25 year	17.181262

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #2

Year	**Pre-Project**	**Mitigated**
1964	8.248	1.187
1965	6.493	0.874
1966	0.239	0.069
1967	20.630	11.859
1968	2.038	0.226
1969	18.874	3.048
1970	10.816	3.954
1971	10.484	2.048
1972	0.408	0.050
1973	21.511	4.718
1974	2.916	0.556
1975	0.283	0.051
1976	0.292	0.070
1977	0.172	0.034
1978	9.699	2.109

1979	8.746	1.004
1980	7.775	0.903
1981	0.324	0.075
1982	11.929	6.256
1983	16.806	8.709
1984	9.209	3.464
1985	1.848	0.500
1986	14.150	10.568
1987	4.222	0.690
1988	2.858	0.541
1989	7.806	0.771
1990	6.651	0.802
1991	4.934	0.817
1992	8.196	1.418
1993	7.952	3.031
1994	2.864	0.455
1995	36.645	23.213
1996	16.000	2.450
1997	30.647	15.762
1998	11.296	9.086
1999	10.549	4.684
2000	13.433	4.942
2001	2.695	0.530
2002	4.483	0.762
2003	1.641	0.315
2004	7.303	1.191

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #2

Rank	**Pre-Project**	**Mitigated**
1	36.6452	23.2127
2	30.6471	15.7621
3	21.5112	11.8594
4	20.6300	10.5675
5	18.8742	9.0859
6	16.8055	8.7089
7	16.0004	6.2556
8	14.1498	4.9420
9	13.4327	4.7178
10	11.9294	4.6843
11	11.2960	3.9539
12	10.8158	3.4639
13	10.5492	3.0484
14	10.4843	3.0311
15	9.6992	2.4498
16	9.2092	2.1092
17	8.7458	2.0476
18	8.2483	1.4182
19	8.1959	1.1910
20	7.9515	1.1869
21	7.8058	1.0043
22	7.7755	0.9026
23	7.3035	0.8744
24	6.6509	0.8165
25	6.4928	0.8023
26	4.9341	0.7712
27	4.4835	0.7624
28	4.2217	0.6895

29	2.9158	0.5558
30	2.8641	0.5413
31	2.8576	0.5298
32	2.6950	0.5001
33	2.0378	0.4550
34	1.8482	0.3149
35	1.6414	0.2264
36	0.4076	0.0751
37	0.3238	0.0702
38	0.2917	0.0693
39	0.2835	0.0509
40	0.2386	0.0503
41	0.1719	0.0344

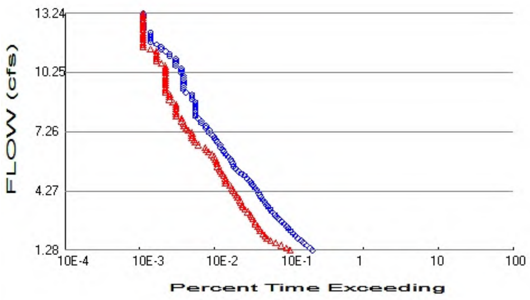
Duration Flows
The Facility PASSED

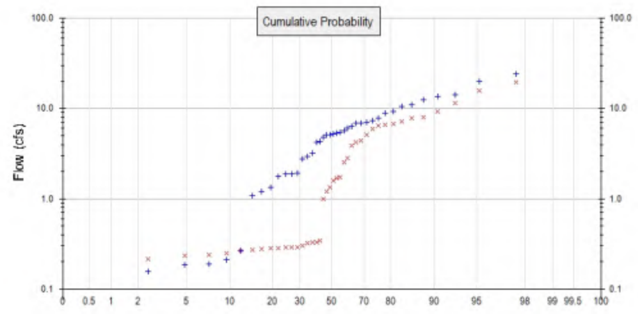
Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.9515	735	182	24	Pass
2.1359	681	163	23	Pass
2.3204	613	145	23	Pass
2.5048	561	124	22	Pass
2.6893	517	115	22	Pass
2.8737	469	103	21	Pass
3.0582	438	92	21	Pass
3.2426	410	81	19	Pass
3.4271	376	75	19	Pass
3.6115	353	71	20	Pass
3.7960	332	62	18	Pass
3.9804	308	56	18	Pass
4.1649	284	54	19	Pass
4.3493	261	49	18	Pass
4.5338	242	47	19	Pass
4.7182	231	40	17	Pass
4.9027	213	37	17	Pass
5.0871	201	35	17	Pass
5.2715	189	32	16	Pass
5.4560	179	31	17	Pass
5.6404	171	30	17	Pass
5.8249	161	28	17	Pass
6.0093	151	27	17	Pass
6.1938	147	27	18	Pass
6.3782	140	23	16	Pass
6.5627	133	23	17	Pass
6.7471	127	22	17	Pass
6.9316	119	22	18	Pass
7.1160	112	22	19	Pass
7.3005	106	21	19	Pass
7.4849	98	19	19	Pass
7.6694	91	17	18	Pass
7.8538	82	17	20	Pass
8.0383	76	16	21	Pass
8.2227	69	16	23	Pass
8.4072	65	15	23	Pass
8.5916	64	14	21	Pass
8.7761	61	13	21	Pass
8.9605	59	11	18	Pass
9.1450	55	10	18	Pass
9.3294	52	10	19	Pass
9.5139	48	10	20	Pass
9.6983	47	10	21	Pass
9.8828	43	10	23	Pass
10.0672	43	10	23	Pass
10.2517	39	8	20	Pass
10.4361	38	8	21	Pass
10.6206	36	7	19	Pass
10.8050	34	6	17	Pass
10.9895	31	6	19	Pass
11.1739	31	6	19	Pass
11.3584	28	6	21	Pass
11.5428	28	6	21	Pass

11.7273	24	6	25	Pass
11.9117	24	5	20	Pass
12.0962	22	4	18	Pass
12.2806	20	3	15	Pass
12.4651	20	3	15	Pass
12.6495	20	3	15	Pass
12.8340	20	3	15	Pass
13.0184	20	3	15	Pass
13.2029	20	3	15	Pass
13.3873	20	3	15	Pass
13.5718	18	3	16	Pass
13.7562	18	3	16	Pass
13.9407	18	3	16	Pass
14.1251	15	3	20	Pass
14.3096	14	3	21	Pass
14.4940	14	3	21	Pass
14.6785	14	3	21	Pass
14.8629	14	3	21	Pass
15.0474	14	3	21	Pass
15.2318	14	3	21	Pass
15.4163	14	3	21	Pass
15.6007	13	3	23	Pass
15.7852	13	2	15	Pass
15.9696	13	2	15	Pass
16.1541	11	2	18	Pass
16.3385	11	2	18	Pass
16.5230	11	2	18	Pass
16.7074	11	2	18	Pass
16.8919	9	2	22	Pass
17.0763	9	2	22	Pass
17.2608	8	2	25	Pass
17.4452	7	2	28	Pass
17.6297	7	2	28	Pass
17.8141	6	2	33	Pass
17.9986	5	2	40	Pass
18.1830	5	2	40	Pass
18.3675	5	2	40	Pass
18.5519	5	2	40	Pass
18.7364	5	2	40	Pass
18.9208	4	2	50	Pass
19.1053	4	2	50	Pass
19.2897	4	2	50	Pass
19.4742	4	2	50	Pass
19.6586	4	2	50	Pass
19.8431	4	2	50	Pass
20.0275	4	2	50	Pass
20.2120	4	2	50	Pass

Water Quality

POC 3





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #3
Total Pervious Area: 34.01
Total Impervious Area: 0.69

Mitigated Landuse Totals for POC #3
Total Pervious Area: 24.47
Total Impervious Area: 10.23

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #3

Return Period	Flow(cfs)
2 year	5.11248
5 year	9.067354
10 year	13.239795
25 year	20.824019

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	Flow(cfs)
2 year	1.33556
5 year	6.666256
10 year	8.906848
25 year	16.451162

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #3

Year	Pre-Project	Mitigated
1964	5.402	1.204
1965	4.253	1.596
1966	0.155	0.239
1967	13.514	11.435
1968	1.334	0.275
1969	12.363	6.732
1970	7.085	6.506
1971	6.868	3.917
1972	0.265	0.248
1973	14.091	5.165
1974	1.910	0.285
1975	0.185	0.214
1976	0.190	0.235
1977	0.112	0.177
1978	6.353	2.830

1979	5.729	1.002
1980	5.092	1.679
1981	0.211	0.289
1982	7.814	6.579
1983	11.008	7.241
1984	6.032	4.225
1985	1.210	0.283
1986	9.269	9.191
1987	2.765	0.339
1988	1.871	0.290
1989	5.112	0.291
1990	4.356	0.330
1991	3.231	0.323
1992	5.368	1.715
1993	5.209	4.418
1994	1.876	0.266
1995	24.005	19.344
1996	10.480	2.516
1997	20.076	15.770
1998	7.400	7.998
1999	6.910	5.989
2000	8.799	7.790
2001	1.765	0.271
2002	2.937	0.326
2003	1.075	0.299
2004	4.784	1.336

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #3

Rank	**Pre-Project**	**Mitigated**
1	24.0048	19.3444
2	20.0756	15.7704
3	14.0907	11.4349
4	13.5137	9.1909
5	12.3633	7.9980
6	11.0081	7.7899
7	10.4801	7.2408
8	9.2688	6.7316
9	8.7987	6.5791
10	7.8137	6.5064
11	7.3998	5.9892
12	7.0846	5.1652
13	6.9103	4.4176
14	6.8676	4.2245
15	6.3526	3.9173
16	6.0325	2.8304
17	5.7289	2.5156
18	5.4024	1.7149
19	5.3684	1.6793
20	5.2086	1.5960
21	5.1125	1.3356
22	5.0920	1.2045
23	4.7841	1.0015
24	4.3563	0.3393
25	4.2529	0.3300
26	3.2314	0.3258
27	2.9366	0.3228
28	2.7652	0.2985

29	1.9096	0.2906
30	1.8757	0.2905
31	1.8712	0.2895
32	1.7650	0.2847
33	1.3341	0.2825
34	1.2105	0.2745
35	1.0748	0.2711
36	0.2654	0.2656
37	0.2115	0.2479
38	0.1899	0.2387
39	0.1845	0.2355
40	0.1554	0.2138
41	0.1119	0.1773

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.2781	735	372	50	Pass
1.3989	681	331	48	Pass
1.5198	614	283	46	Pass
1.6406	561	237	42	Pass
1.7614	517	205	39	Pass
1.8822	469	183	39	Pass
2.0031	438	172	39	Pass
2.1239	410	160	39	Pass
2.2447	376	148	39	Pass
2.3655	353	144	40	Pass
2.4864	332	137	41	Pass
2.6072	308	129	41	Pass
2.7280	284	126	44	Pass
2.8488	261	117	44	Pass
2.9697	242	114	47	Pass
3.0905	231	110	47	Pass
3.2113	213	100	46	Pass
3.3321	201	92	45	Pass
3.4530	189	86	45	Pass
3.5738	179	84	46	Pass
3.6946	171	81	47	Pass
3.8154	161	80	49	Pass
3.9363	151	74	49	Pass
4.0571	147	71	48	Pass
4.1779	140	68	48	Pass
4.2987	133	64	48	Pass
4.4196	127	61	48	Pass
4.5404	119	58	48	Pass
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4.7820	106	51	48	Pass
4.9029	98	51	52	Pass
5.0237	91	48	52	Pass
5.1445	82	46	56	Pass
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5.3862	69	42	60	Pass
5.5070	65	39	60	Pass
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5.8695	59	37	62	Pass
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6.1111	52	33	63	Pass
6.2319	48	30	62	Pass
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6.4736	43	27	62	Pass
6.5944	43	22	51	Pass
6.7152	39	20	51	Pass
6.8361	38	19	50	Pass
6.9569	36	18	50	Pass
7.0777	34	18	52	Pass
7.1985	31	18	58	Pass
7.3194	31	16	51	Pass
7.4402	28	15	53	Pass
7.5610	28	14	50	Pass

7.6818	24	14	58	Pass
7.8027	24	13	54	Pass
7.9235	22	13	59	Pass
8.0443	20	11	55	Pass
8.1651	20	11	55	Pass
8.2860	20	11	55	Pass
8.4068	20	11	55	Pass
8.5276	20	11	55	Pass
8.6484	20	11	55	Pass
8.7693	20	10	50	Pass
8.8901	18	9	50	Pass
9.0109	18	9	50	Pass
9.1317	18	9	50	Pass
9.2526	15	8	53	Pass
9.3734	14	8	57	Pass
9.4942	14	8	57	Pass
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9.7359	14	8	57	Pass
9.8567	14	8	57	Pass
9.9775	14	8	57	Pass
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10.2192	13	8	61	Pass
10.3400	13	8	61	Pass
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10.9441	11	6	54	Pass
11.0649	9	6	66	Pass
11.1858	9	6	66	Pass
11.3066	8	6	75	Pass
11.4274	7	5	71	Pass
11.5482	7	4	57	Pass
11.6691	6	4	66	Pass
11.7899	5	4	80	Pass
11.9107	5	4	80	Pass
12.0315	5	4	80	Pass
12.1524	5	4	80	Pass
12.2732	5	4	80	Pass
12.3940	4	4	100	Pass
12.5148	4	4	100	Pass
12.6357	4	4	100	Pass
12.7565	4	4	100	Pass
12.8773	4	4	100	Pass
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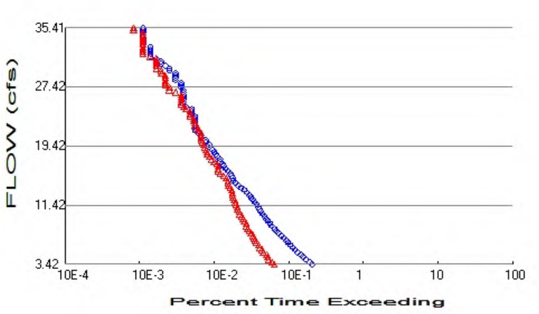
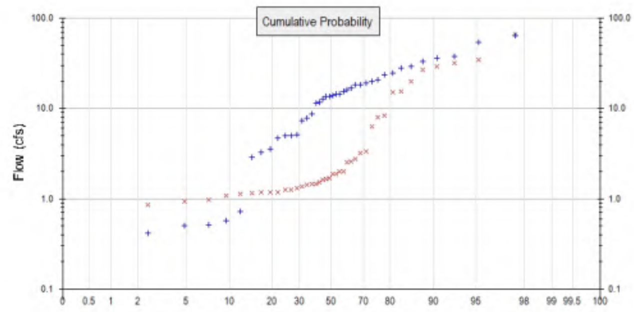
13.1190	4	4	100	Pass
13.2398	4	4	100	Pass

Water Quality

POC 4





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #4
Total Pervious Area: 103.89
Total Impervious Area: 2.078

Mitigated Landuse Totals for POC #4
Total Pervious Area: 103.89
Total Impervious Area: 48.89

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #4

Return Period	**Flow(cfs)**
2 year	13.6774
5 year	24.254071
10 year	35.414424
25 year	55.69991

Flow Frequency Return Periods for Mitigated. POC #4

Return Period	**Flow(cfs)**
2 year	1.6807
5 year	12.197997
10 year	28.563743
25 year	40.8761

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #4

Year	**Pre-Project**	**Mitigated**
1964	14.453	1.632
1965	11.376	1.887
1966	0.419	0.968
1967	36.147	31.837
1968	3.571	1.164
1969	33.071	8.317
1970	18.951	3.182
1971	18.370	8.057
1972	0.715	1.079
1973	37.691	2.566
1974	5.109	1.178
1975	0.497	0.857
1976	0.512	0.935
1977	0.302	0.676
1978	16.995	2.535

1979	15.324	1.681
1980	13.625	2.013
1981	0.568	1.316
1982	20.903	15.109
1983	29.446	15.506
1984	16.136	3.352
1985	3.238	1.186
1986	24.792	34.959
1987	7.397	1.505
1988	5.007	1.258
1989	13.677	1.243
1990	11.654	1.427
1991	8.646	1.458
1992	14.361	1.859
1993	13.932	2.768
1994	5.019	1.141
1995	64.208	66.026
1996	28.036	2.018
1997	53.698	26.647
1998	19.792	29.163
1999	18.484	6.387
2000	23.536	19.975
2001	4.722	1.135
2002	7.856	1.469
2003	2.876	1.362
2004	12.797	1.665

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #4

Rank	**Pre-Project**	**Mitigated**
1	64.2076	66.0259
2	53.6981	34.9585
3	37.6910	31.8369
4	36.1469	29.1626
5	33.0705	26.6474
6	29.4459	19.9753
7	28.0357	15.5058
8	24.7924	15.1090
9	23.5363	8.3167
10	20.9025	8.0568
11	19.7921	6.3866
12	18.9510	3.3525
13	18.4838	3.1818
14	18.3701	2.7675
15	16.9950	2.5663
16	16.1358	2.5355
17	15.3240	2.0177
18	14.4526	2.0128
19	14.3606	1.8871
20	13.9322	1.8593
21	13.6774	1.6807
22	13.6246	1.6645
23	12.7967	1.6316
24	11.6536	1.5054
25	11.3764	1.4695
26	8.6457	1.4575
27	7.8559	1.4269
28	7.3972	1.3622

29	5.1091	1.3163
30	5.0187	1.2577
31	5.0073	1.2429
32	4.7222	1.1858
33	3.5709	1.1785
34	3.2385	1.1643
35	2.8761	1.1412
36	0.7152	1.1350
37	0.5677	1.0794
38	0.5118	0.9679
39	0.4974	0.9352
40	0.4187	0.8567
41	0.3017	0.6758

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
3.4194	735	229	31	Pass
3.7425	681	213	31	Pass
4.0657	613	191	31	Pass
4.3889	561	187	33	Pass
4.7121	517	182	35	Pass
5.0353	469	164	34	Pass
5.3584	438	156	35	Pass
5.6816	410	148	36	Pass
6.0048	376	142	37	Pass
6.3280	353	131	37	Pass
6.6512	332	126	37	Pass
6.9744	308	124	40	Pass
7.2975	284	119	41	Pass
7.6207	261	112	42	Pass
7.9439	242	106	43	Pass
8.2671	231	101	43	Pass
8.5903	213	97	45	Pass
8.9135	201	97	48	Pass
9.2366	189	90	47	Pass
9.5598	179	88	49	Pass
9.8830	171	85	49	Pass
10.2062	161	80	49	Pass
10.5294	151	78	51	Pass
10.8525	147	74	50	Pass
11.1757	140	73	52	Pass
11.4989	133	70	52	Pass
11.8221	127	69	54	Pass
12.1453	119	67	56	Pass
12.4685	112	65	58	Pass
12.7916	106	63	59	Pass
13.1148	99	63	63	Pass
13.4380	91	62	68	Pass
13.7612	82	59	71	Pass
14.0844	76	56	73	Pass
14.4076	69	55	79	Pass
14.7307	65	55	84	Pass
15.0539	64	52	81	Pass
15.3771	61	48	78	Pass
15.7003	59	43	72	Pass
16.0235	55	41	74	Pass
16.3467	52	41	78	Pass
16.6698	48	41	85	Pass
16.9930	47	39	82	Pass
17.3162	43	36	83	Pass
17.6394	43	33	76	Pass
17.9626	39	31	79	Pass
18.2857	38	29	76	Pass
18.6089	36	29	80	Pass
18.9321	34	28	82	Pass
19.2553	31	27	87	Pass
19.5785	31	26	83	Pass
19.9017	28	25	89	Pass
20.2248	28	24	85	Pass

20.5480	24	24	100	Pass
20.8712	24	24	100	Pass
21.1944	22	24	109	Pass
21.5176	20	22	110	Pass
21.8408	20	22	110	Pass
22.1639	20	20	100	Pass
22.4871	20	20	100	Pass
22.8103	20	19	95	Pass
23.1335	20	19	95	Pass
23.4567	20	17	85	Pass
23.7799	18	17	94	Pass
24.1030	18	17	94	Pass
24.4262	18	15	83	Pass
24.7494	15	14	93	Pass
25.0726	14	13	92	Pass
25.3958	14	13	92	Pass
25.7189	14	13	92	Pass
26.0421	14	13	92	Pass
26.3653	14	13	92	Pass
26.6885	14	11	78	Pass
27.0117	14	9	64	Pass
27.3349	13	9	69	Pass
27.6580	13	8	61	Pass
27.9812	13	8	61	Pass
28.3044	11	8	72	Pass
28.6276	11	8	72	Pass
28.9508	11	8	72	Pass
29.2740	11	7	63	Pass
29.5971	9	7	77	Pass
29.9203	9	6	66	Pass
30.2435	8	6	75	Pass
30.5667	7	6	85	Pass
30.8899	7	6	85	Pass
31.2131	6	6	100	Pass
31.5362	5	5	100	Pass
31.8594	5	4	80	Pass
32.1826	5	4	80	Pass
32.5058	5	4	80	Pass
32.8290	5	4	80	Pass
33.1521	4	4	100	Pass
33.4753	4	4	100	Pass
33.7985	4	4	100	Pass
34.1217	4	4	100	Pass
34.4449	4	4	100	Pass
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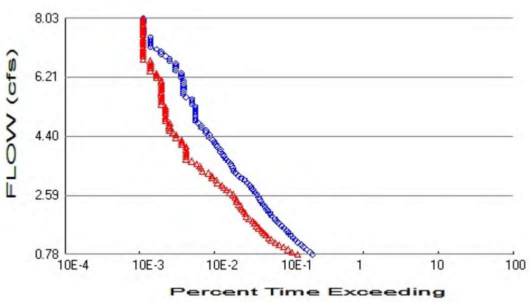
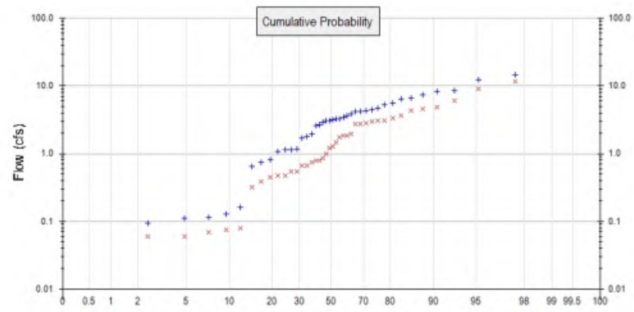
35.0912	4	3	75	Pass
35.4144	4	3	75	Pass

Water Quality

POC 5





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #5	
Total Pervious Area:	20.62
Total Impervious Area:	0.42

Mitigated Landuse Totals for POC #5	
Total Pervious Area:	20.62
Total Impervious Area:	0.42

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #5

Return Period	**Flow(cfs)**
2 year	3.10028
5 year	5.498146
10 year	8.02812
25 year	12.62681

Flow Frequency Return Periods for Mitigated. POC #5

Return Period	**Flow(cfs)**
2 year	1.1965
5 year	3.267036
10 year	4.762675
25 year	9.591948

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #5

Year	**Pre-Project**	**Mitigated**
1964	3.276	1.488
1965	2.579	0.849
1966	0.095	0.068
1967	8.194	6.141
1968	0.809	0.317
1969	7.497	3.107
1970	4.296	2.780
1971	4.164	1.760
1972	0.162	0.059
1973	8.544	4.573
1974	1.158	0.536
1975	0.112	0.059
1976	0.116	0.079
1977	0.068	0.034
1978	3.852	1.842

1979	3.474	1.197
1980	3.088	0.995
1981	0.128	0.074
1982	4.738	3.112
1983	6.675	3.634
1984	3.658	2.771
1985	0.734	0.446
1986	5.620	4.822
1987	1.677	0.660
1988	1.135	0.544
1989	3.100	0.776
1990	2.642	0.784
1991	1.960	0.738
1992	3.255	1.864
1993	3.158	1.935
1994	1.138	0.471
1995	14.556	11.798
1996	6.355	2.850
1997	12.173	9.073
1998	4.487	4.329
1999	4.190	3.384
2000	5.335	2.967
2001	1.070	0.476
2002	1.781	0.663
2003	0.652	0.387
2004	2.901	1.264

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #5

Rank	Pre-Project	Mitigated
1	14.5555	11.7979
2	12.1730	9.0729
3	8.5441	6.1406
4	8.1942	4.8220
5	7.4967	4.5729
6	6.6750	4.3289
7	6.3551	3.6339
8	5.6203	3.3836
9	5.3353	3.1116
10	4.7382	3.1072
11	4.4868	2.9667
12	4.2959	2.8501
13	4.1901	2.7803
14	4.1643	2.7711
15	3.8523	1.9351
16	3.6579	1.8642
17	3.4738	1.8418
18	3.2760	1.7599
19	3.2553	1.4882
20	3.1583	1.2643
21	3.1003	1.1965
22	3.0881	0.9951
23	2.9009	0.8492
24	2.6416	0.7837
25	2.5789	0.7764
26	1.9596	0.7377
27	1.7808	0.6628
28	1.6768	0.6603

29	1.1581	0.5436
30	1.1375	0.5364
31	1.1349	0.4762
32	1.0704	0.4712
33	0.8092	0.4456
34	0.7341	0.3869
35	0.6519	0.3166
36	0.1615	0.0787
37	0.1285	0.0740
38	0.1156	0.0677
39	0.1123	0.0593
40	0.0946	0.0592
41	0.0681	0.0340

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.7751	735	470	63	Pass
0.8483	681	393	57	Pass
0.9216	614	353	57	Pass
0.9949	563	304	53	Pass
1.0681	517	264	51	Pass
1.1414	469	234	49	Pass
1.2146	438	209	47	Pass
1.2879	410	190	46	Pass
1.3612	376	176	46	Pass
1.4344	353	164	46	Pass
1.5077	333	155	46	Pass
1.5810	309	142	45	Pass
1.6542	284	133	46	Pass
1.7275	261	124	47	Pass
1.8008	242	118	48	Pass
1.8740	231	105	45	Pass
1.9473	213	96	45	Pass
2.0205	201	93	46	Pass
2.0938	189	89	47	Pass
2.1671	179	83	46	Pass
2.2403	171	81	47	Pass
2.3136	161	76	47	Pass
2.3869	151	71	47	Pass
2.4601	147	71	48	Pass
2.5334	140	68	48	Pass
2.6066	133	65	48	Pass
2.6799	127	58	45	Pass
2.7532	119	52	43	Pass
2.8264	112	48	42	Pass
2.8997	106	45	42	Pass
2.9730	99	40	40	Pass
3.0462	91	38	41	Pass
3.1195	82	33	40	Pass
3.1928	76	33	43	Pass
3.2660	69	30	43	Pass
3.3393	65	25	38	Pass
3.4125	64	24	37	Pass
3.4858	61	23	37	Pass
3.5591	59	21	35	Pass
3.6323	55	18	32	Pass
3.7056	52	15	28	Pass
3.7789	48	15	31	Pass
3.8521	47	15	31	Pass
3.9254	43	15	34	Pass
3.9986	43	15	34	Pass
4.0719	39	15	38	Pass
4.1452	38	13	34	Pass
4.2184	36	13	36	Pass
4.2917	34	13	38	Pass
4.3650	31	11	35	Pass
4.4382	31	11	35	Pass
4.5115	28	10	35	Pass
4.5848	28	9	32	Pass

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5.1709	20	8	40	Pass
5.2441	20	8	40	Pass
5.3174	20	8	40	Pass
5.3906	18	7	38	Pass
5.4639	18	7	38	Pass
5.5372	18	7	38	Pass
5.6104	15	7	46	Pass
5.6837	14	7	50	Pass
5.7570	14	7	50	Pass
5.8302	14	7	50	Pass
5.9035	14	7	50	Pass
5.9768	14	7	50	Pass
6.0500	14	7	50	Pass
6.1233	14	7	50	Pass
6.1965	13	6	46	Pass
6.2698	13	6	46	Pass
6.3431	13	6	46	Pass
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6.4896	11	5	45	Pass
6.5629	11	5	45	Pass
6.6361	11	5	45	Pass
6.7094	9	5	55	Pass
6.7826	9	4	44	Pass
6.8559	8	4	50	Pass
6.9292	7	4	57	Pass
7.0024	7	4	57	Pass
7.0757	6	4	66	Pass
7.1490	5	4	80	Pass
7.2222	5	4	80	Pass
7.2955	5	4	80	Pass
7.3688	5	4	80	Pass
7.4420	5	4	80	Pass
7.5153	4	4	100	Pass
7.5885	4	4	100	Pass
7.6618	4	4	100	Pass
7.7351	4	4	100	Pass
7.8083	4	4	100	Pass
7.8816	4	4	100	Pass
7.9549	4	4	100	Pass
8.0281	4	4	100	Pass

Water Quality

POC 6

POC #6 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 7

POC #7 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

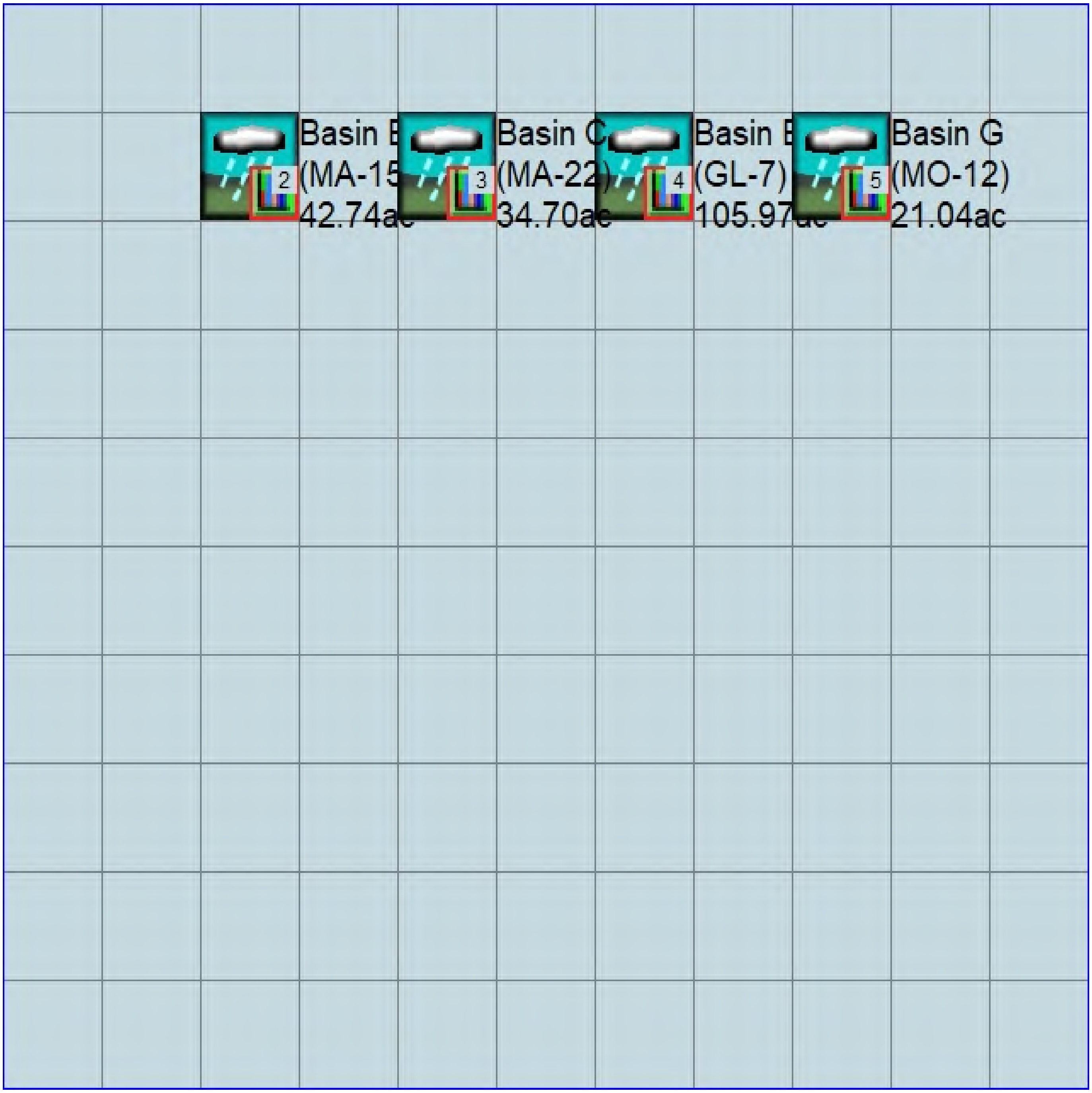
PERLND Changes

No PERLND changes have been made.

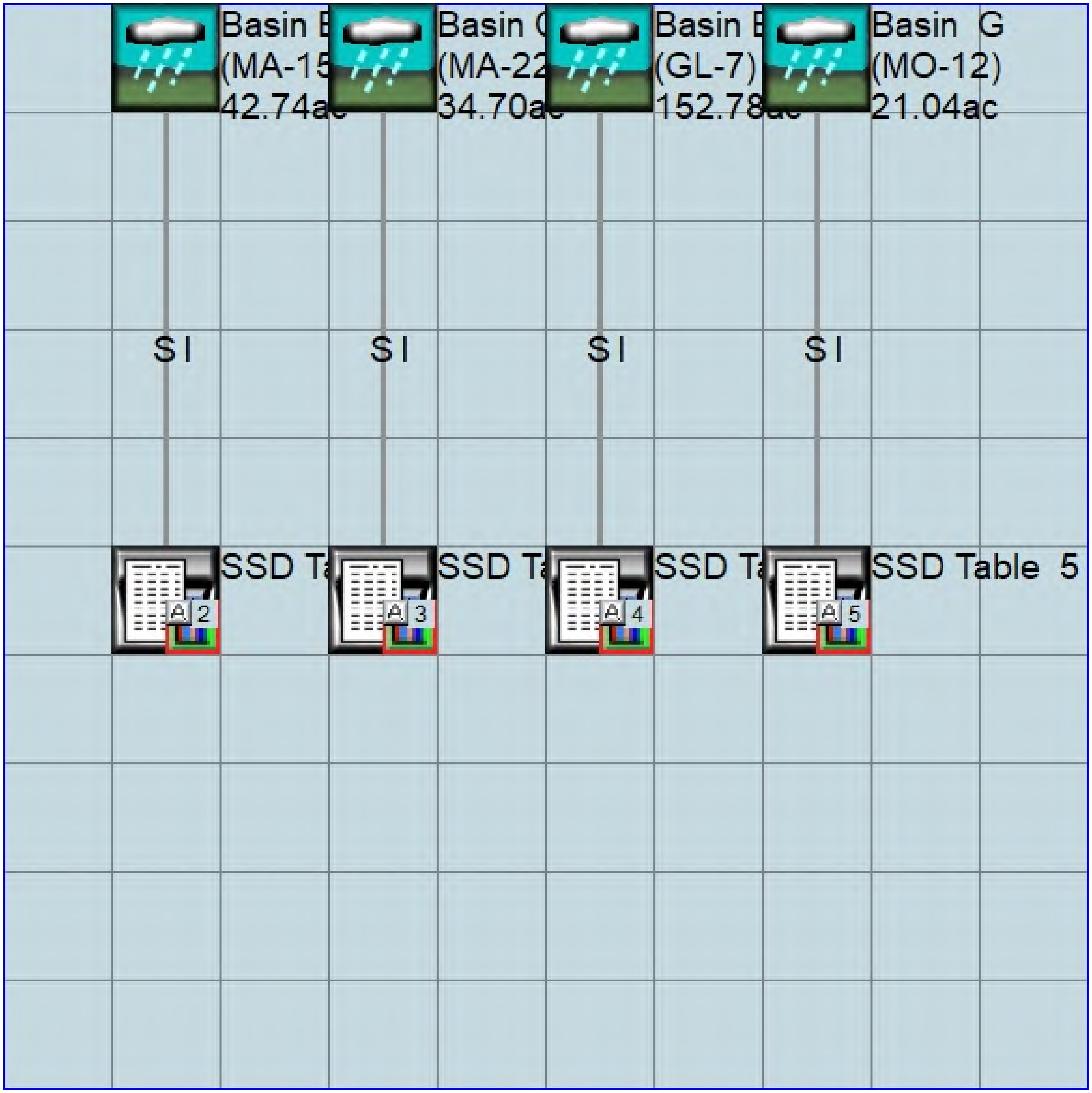
IMPLND Changes

No IMPLND changes have been made.

Appendix
Pre-Project Schematic



Mitigated Schematic



Pre-Project UCI File

Mitigated UCI File

```
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  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

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           27   MitUpdated Mahon_(Basins B,C,E,G)_Alternative B.L61
           28   MitUpdated Mahon_(Basins B,C,E,G)_Alternative B.L62
           31   POCUpdated Mahon_(Basins B,C,E,G)_Alternative B2.dat
           32   POCUpdated Mahon_(Basins B,C,E,G)_Alternative B3.dat
           33   POCUpdated Mahon_(Basins B,C,E,G)_Alternative B4.dat
           34   POCUpdated Mahon_(Basins B,C,E,G)_Alternative B5.dat
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      COPY       503
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      COPY       505
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END OPN SEQUENCE
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GENER
```

```
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out         ***
   53     D,Agric,Flat(0-1%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   53         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   53         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   53         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   53             0         5      0.03       400      0.01         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   53            40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   53             0       0.3       0.2       0.7       0.5         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53       0.5  0.5  0.5 0.55  0.6 0.65 0.65 0.65 0.65 0.65 0.55  0.5
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   53      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   53             0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND
```

```
IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    1     Imperv,Flat(0-1%)       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            100      0.01      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin B (MA-15)***
PERLND  53                        41.9     RCHRES   1      2
PERLND  53                        41.9     RCHRES   1      3
IMPLND   1                        0.84     RCHRES   1      5
Basin C (MA-22)***
PERLND  53                       24.47     RCHRES   2      2
PERLND  53                       24.47     RCHRES   2      3
IMPLND   1                       10.23     RCHRES   2      5
Basin E (GL-7)***
PERLND  53                      103.89     RCHRES   3      2
PERLND  53                      103.89     RCHRES   3      3
IMPLND   1                       48.89     RCHRES   3      5
Basin  G (MO-12)***
PERLND  53                       20.62     RCHRES   4      2
PERLND  53                       20.62     RCHRES   4      3
IMPLND   1                        0.42     RCHRES   4      5

******Routing******
PERLND  53                        41.9     COPY     2     12
IMPLND   1                        0.84     COPY     2     15
```

```
PERLND  53                        41.9     COPY     2     13
PERLND  53                       24.47     COPY     3     12
IMPLND   1                       10.23     COPY     3     15
PERLND  53                       24.47     COPY     3     13
PERLND  53                      103.89     COPY     4     12
IMPLND   1                       48.89     COPY     4     15
PERLND  53                      103.89     COPY     4     13
PERLND  53                       20.62     COPY     5     12
IMPLND   1                        0.42     COPY     5     15
PERLND  53                       20.62     COPY     5     13
RCHRES   1                           1     COPY   502     16
RCHRES   2                           1     COPY   503     16
RCHRES   3                           1     COPY   504     16
RCHRES   4                           1     COPY   505     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   12.1        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   12.1        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   12.1        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   12.1        DISPLY   5     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     SSD Table  1           1    1    1    1   28    0    1
    2     SSD Table  2           1    1    1    1   28    0    1
    3     SSD Table  4           1    1    1    1   28    0    1
    4     SSD Table  5           1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
    4         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
    4         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    3        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    4        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1
```

```
  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1            1      0.01       0.0       0.0       0.5       0.0
    2            2      0.01       0.0       0.0       0.5       0.0
    3            3      0.01       0.0       0.0       0.5       0.0
    4            4      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                            ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1          0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2          0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3          0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    4          0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
    7    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.280000  0.000000  0.000000
  1.000000  0.340000  0.310000  0.494568
  2.000000  0.390000  0.670000  0.739304
  3.000000  0.450000  1.100000  0.921164
  4.000000  0.520000  1.580000  1.602421
  5.000000  0.580000  2.130000  4.331640
  6.000000  0.690000  2.770000  55.19165
  END FTABLE  1
  FTABLE      2
    7    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.280000  0.000000  0.000000
  1.000000  0.340000  0.310000  0.160901
  2.000000  0.390000  0.670000  0.233784
  3.000000  0.450000  1.100000  0.288827
  4.000000  0.520000  1.580000  0.334943
  5.000000  0.580000  2.130000  2.040437
  6.000000  0.690000  2.770000  28.31964
  END FTABLE  2
  FTABLE      3
    9    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  2.800000  0.000000  0.000000
  1.000000  2.930000  2.870000  0.846042
  2.000000  3.070000  5.870000  1.292350
  3.000000  3.210000  9.010000  1.620047
  4.000000  3.360000  12.30000  1.891807
  5.000000  3.510000  15.73000  3.461159
  6.000000  3.660000  19.31000  20.30737
  7.000000  3.810000  23.05000  65.45199
  8.000000  3.970000  26.93000  85.52613
  END FTABLE  3
  FTABLE      4
    9    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.040000  0.000000  0.000000
  1.000000  0.070000  0.060000  0.395565
  2.000000  0.110000  0.150000  0.587360
  3.000000  0.150000  0.280000  0.730419
```

```
  4.000000  0.190000  0.450000  1.379524
  5.000000  0.240000  0.660000  4.080676
  6.000000  0.280000  0.920000  49.10884
  7.000000  0.330000  1.230000  93.96486
  8.000000  0.390000  1.590000  114.8116
  END FTABLE  4
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.941          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.941          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.85           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.85           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     12.1      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     12.1      WDM    802 FLOW     ENGL      REPL
RCHRES   2 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1005 STAG     ENGL      REPL
COPY     3 OUTPUT MEAN   1 1     12.1      WDM    703 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     12.1      WDM    803 FLOW     ENGL      REPL
RCHRES   3 HYDR   RO     1 1        1      WDM   1010 FLOW     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1011 STAG     ENGL      REPL
COPY     4 OUTPUT MEAN   1 1     12.1      WDM    704 FLOW     ENGL      REPL
COPY   504 OUTPUT MEAN   1 1     12.1      WDM    804 FLOW     ENGL      REPL
RCHRES   4 HYDR   RO     1 1        1      WDM   1012 FLOW     ENGL      REPL
RCHRES   4 HYDR   STAGE  1 1        1      WDM   1013 STAG     ENGL      REPL
COPY     5 OUTPUT MEAN   1 1     12.1      WDM    705 FLOW     ENGL      REPL
COPY   505 OUTPUT MEAN   1 1     12.1      WDM    805 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16
```

```
END MASS-LINK

END RUN
```

Pre-Project HSPF Message File

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1964/ 5/31 24: 0

RCHRES :    3

RELERR       STORS        STOR       MATIN      MATDIF
-4.804E-03     0.00000  0.0000E+00     0.00000  -2.252E-08

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
DATE/TIME: 1969/ 6/30 24: 0

RCHRES :    3

RELERR       STORS        STOR       MATIN      MATDIF
-3.410E-03     0.00000  0.0000E+00     0.00000  -3.079E-08

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR  is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR   is the storage of material in the processing unit (land-segment or
reach/reservior) at the end of the present interval.
STORS  is the storage of material in the pu at the start of the present
printout reporting period.
MATIN  is the total inflow of material to the pu during the present printout
reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the
present printout reporting period.
```

```
ERROR/WARNING ID:   238   1

The continuity error reported below is greater than 1 part in 1000 and is
therefore considered high.

Did you specify any "special actions"?  If so, they could account for it.

Relevant data are:
```

DATE/TIME: 1973/ 6/30 24: 0

RCHRES : 3

RELERR	STORS	STOR	MATIN	MATDIF
-5.159E-03	0.00000	0.0000E+00	0.00000	-2.037E-08

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

ERROR/WARNING ID: 238 1

The continuity error reported below is greater than 1 part in 1000 and is therefore considered high.

Did you specify any "special actions"? If so, they could account for it.

Relevant data are:
DATE/TIME: 1974/ 6/30 24: 0

RCHRES : 3

RELERR	STORS	STOR	MATIN	MATDIF
-2.612E-01	0.00000	0.0000E+00	0.00000	-2.296E-10

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.
REFVAL is the reference value (STORS+MATIN).
STOR is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

ERROR/WARNING ID: 238 1

The continuity error reported below is greater than 1 part in 1000 and is therefore considered high.

Did you specify any "special actions"? If so, they could account for it.

Relevant data are:
DATE/TIME: 1975/12/31 24: 0

RCHRES : 3

RELERR	STORS	STOR	MATIN	MATDIF
-3.503E-03	0.00000	0.0000E+00	0.00000	-3.212E-08

Where:

RELERR is the relative error (ERROR/REFVAL).
ERROR is (STOR-STORS) - MATDIF.

REFVAL is the reference value (STORS+MATIN).
STOR is the storage of material in the processing unit (land-segment or reach/reservior) at the end of the present interval.
STORS is the storage of material in the pu at the start of the present printout reporting period.
MATIN is the total inflow of material to the pu during the present printout reporting period.
MATDIF is the net inflow (inflow-outflow) of material to the pu during the present printout reporting period.

The count for the WARNING printed above has reached its maximum.

If the condition is encountered again the message will not be repeated.

ERROR/WARNING ID: 341 6

DATE/TIME: 1995/ 1/10 8: 0

RCHRES: 2

The volume of water in this reach/mixed reservoir is greater than the value in the "volume" column of the last row of RCHTAB(). To continue the simulation the table has been extrapolated, based on information contained in the last two rows. This will usually result in some loss of accuracy. If depth is being calculated it will also cause an error condition. Relevant data are:

NROWS	V1	V2	VOL
7	9.2783E+04	1.2066E+05	1.2357E+05

ERROR/WARNING ID: 341 5

DATE/TIME: 1995/ 1/10 8: 0

RCHRES: 2

Calculation of relative depth, using Newton's method of successive approximations, converged to an invalid value (not in range 0.0 to 1.0). Probably ftable was extrapolated. If extrapolation was small, no problem. Remedy; extend ftable. Relevant data are:

A	B	C	RDEP1	RDEP2	COUNT
4.7916E+03	5.0530E+04	-6.109E+04	1.0953	1.0952E+00	3

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APPENDIX C
FEMA FIRM Mapping

drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was California State Plane Zone II (FIPSZONE 0402). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

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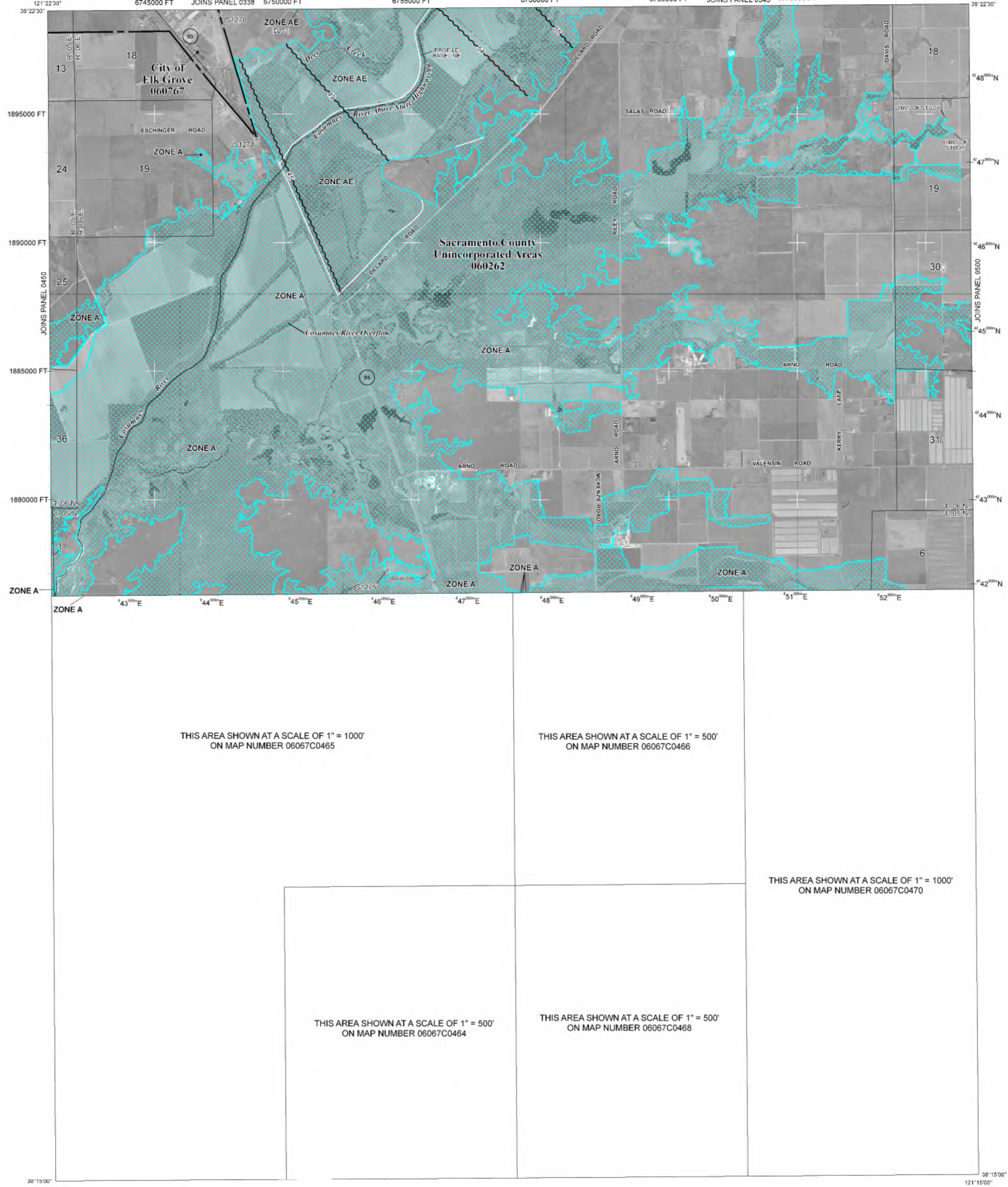

BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Limit of Moderate Wave Action

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)—(A)	Cross section line
(23)- - -(23)	Transect line
	Culvert, Flume, Penstock or Aqueduct
	Road or Railroad Bridge
	Footbridge
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
2476000mN	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid values: California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
AUGUST 16, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0475H

FIRM
FLOOD INSURANCE RATE MAP

SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 475 OF 705

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ELK GROVE, CITY OF	060767	0475	H
SACRAMENTO COUNTY	060262	0475	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06067C0475H

EFFECTIVE DATE

drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was California State Plane Zone II (FIPSZONE 0402). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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Silver Spring, Maryland 20910-3282
(301) 713-3242

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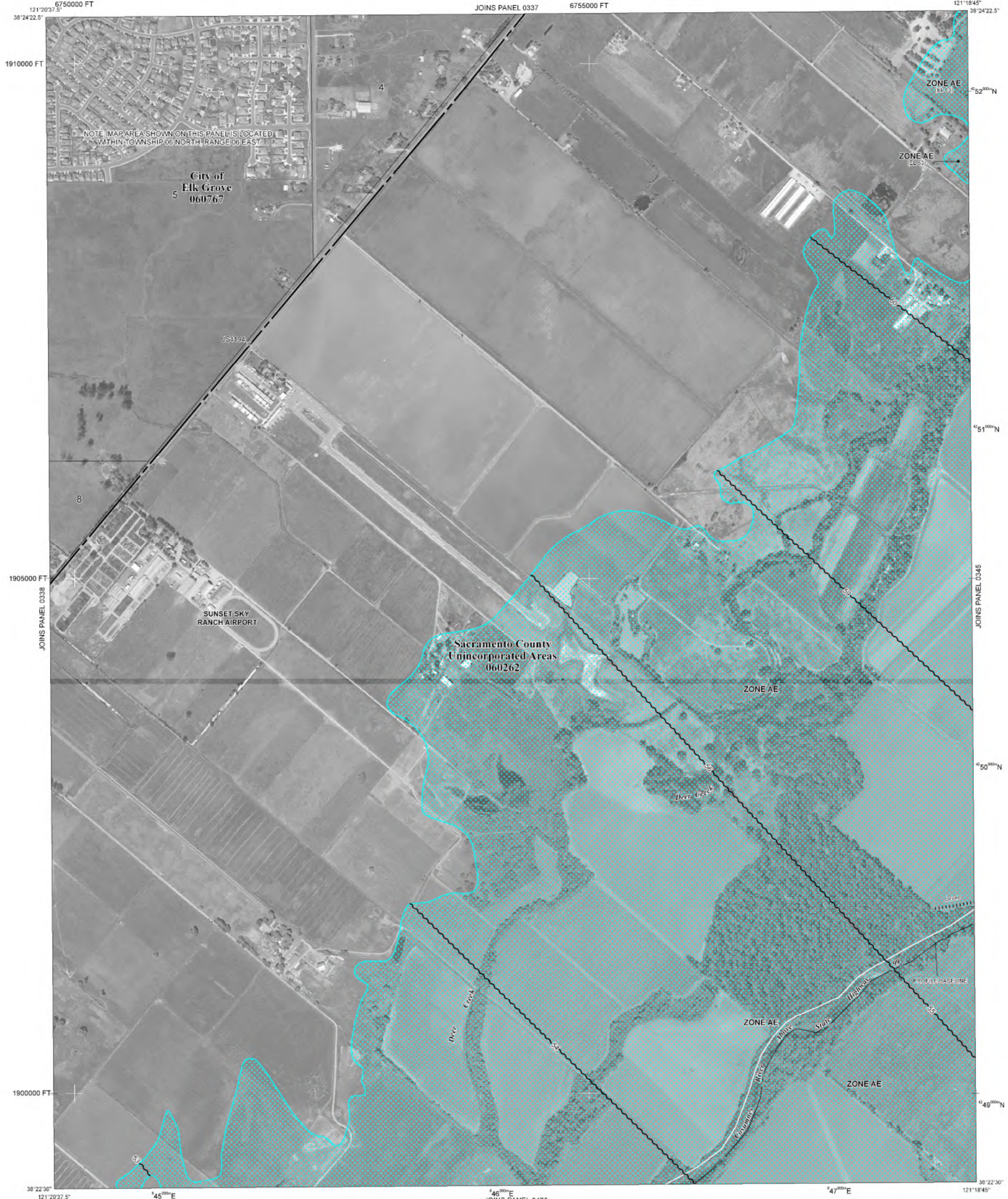

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
Limit of Moderate Wave Action

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)—(A)	Cross section line
(23)- - -(23)	Transect line
	Culvert, Flume, Penstock or Aqueduct
	Road or Railroad Bridge
	Footbridge
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
76 N	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid values: California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
AUGUST 16, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0339H

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 339 OF 705

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ELK GROVE, CITY OF	060767	0339	H
SACRAMENTO COUNTY	060262	0339	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06067C0339H

EFFECTIVE DATE

drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

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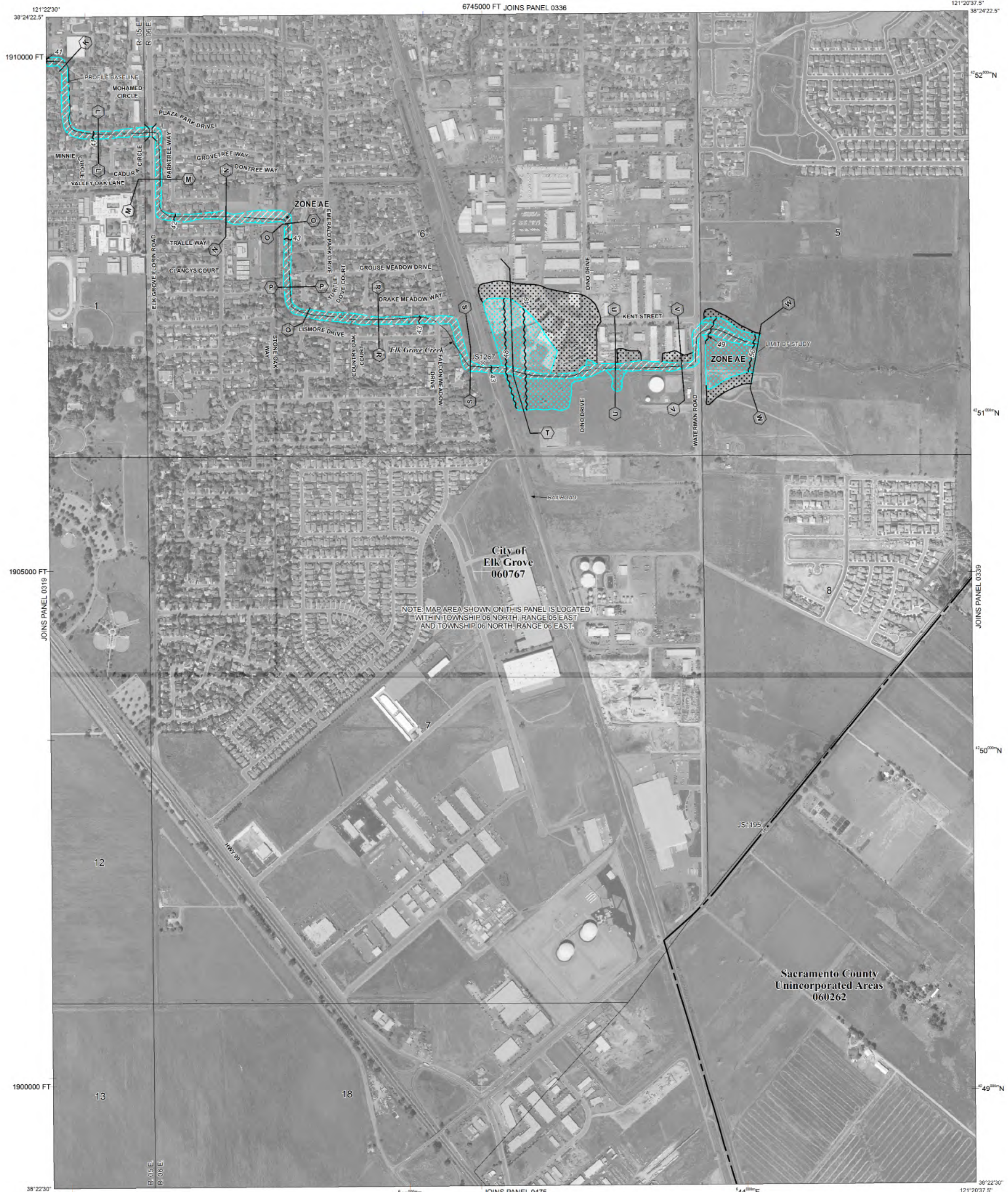

BY THE 1% ANNUAL CHANCE FLOOD

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ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
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ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

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OTHERWISE PROTECTED AREAS (OPAs)

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1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
Limit of Moderate Wave Action
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

Cross section line
Transect line
Culvert, Flume, Penstock or Aqueduct
Road or Railroad Bridge
Footbridge
87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
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600000 FT — 5000-foot grid values: California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection
DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
AUGUST 16, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0338H

FIRM

FLOOD INSURANCE RATE MAP

SACRAMENTO COUNTY, CALIFORNIA AND INCORPORATED AREAS

PANEL 338 OF 705

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ELK GROVE, CITY OF	060767	0338	H
SACRAMENTO COUNTY	060262	0338	H

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MAP NUMBER
06067C0338H

EFFECTIVE DATE
AUGUST 16, 2012