Folsom Sphere of Influence (SOI)

Storm Drainage Masterplan
Volume 1 of 2

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Introduction and Background

This report summarizes the hydrologic analysis for the master-planned area within the City of Folsom's Sphere of Influence. A proposed annexation concept plan has been created for the 3,600 acre study area. The plan outlines future residential/commercial development. The study area is located south of the City of Folsom bounded by Highway 50, Prairie City Road, White Rock Road and the Sacramento/El Dorado County line (see Figure 1).

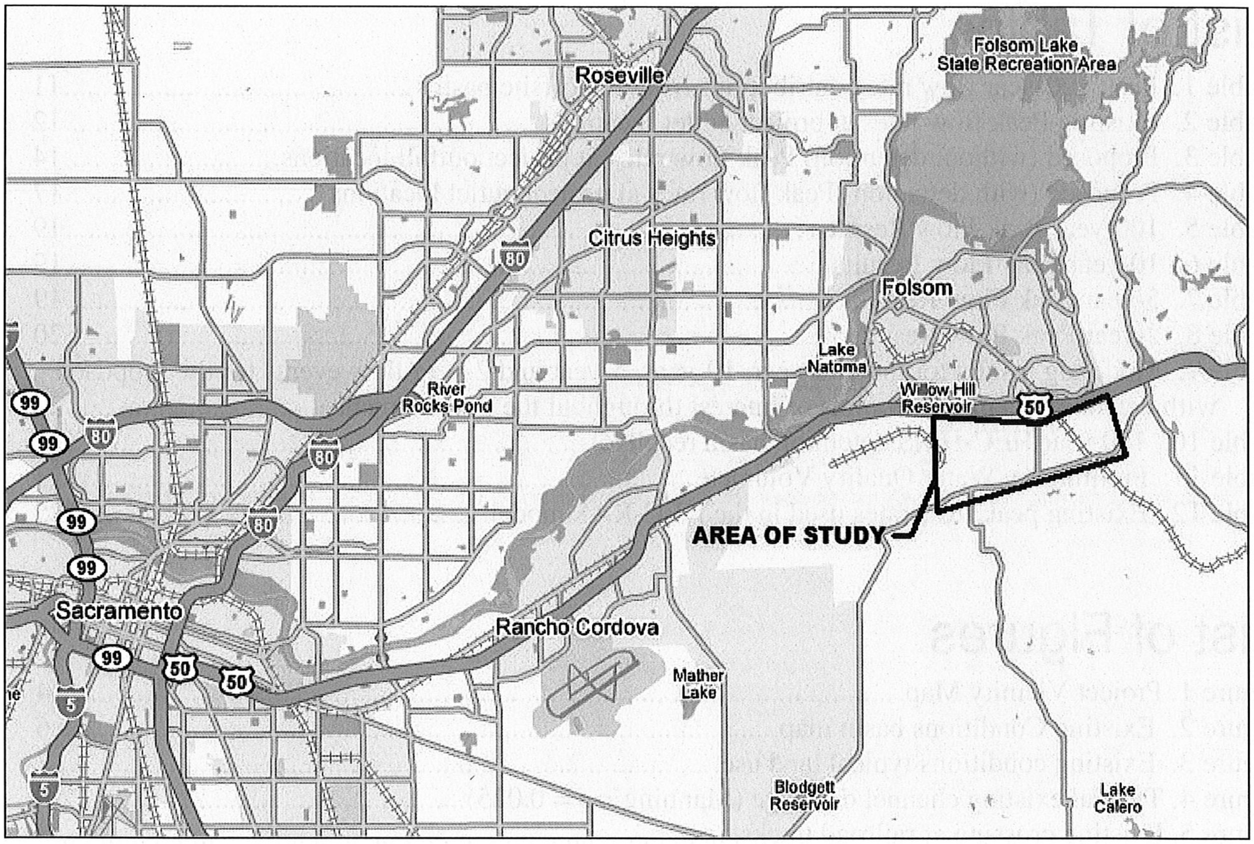


Figure 1. Project Vicinity Map.

The majority of the runoff from the study area flows into the headwaters of Alder Creek, which mainly flows east to west and eventually joins the American River three miles east of Prairie City Road at Lake Natoma. There are also offsite watersheds that contribute flow to Alder Creek. These watersheds include the recent Broadstone and Willow Springs developments located north of Highway 50. There are sub-basins within and along the project boundary that contribute flow to neighboring creeks. Runoff from the southwest corner of the study area flows across Prairie City Road and eventually joins Buffalo Creek. An area along the southern boundary flows offsite to Coyote Creek. Runoff from the east side of the study area flows offsite to Carson Creek in El Dorado County.

MacKay and Somps Civil Engineers, Inc. contracted with Domenichelli and Associates (D&A) to complete the hydrologic analysis of the master-planned area. The efforts defined in this analysis include the following: 1) existing and proposed conditions hydrology, 2) locating and sizing detention facilities and water quality ponds, 3) floodplain mapping and (4) sizing of major storm drain trunk lines.

Hydrologic Modeling

The hydrologic analysis in this study is based on procedures outlined in the Sacramento City/County Drainage Manual. Methodology from this Manual was used to develop a HEC-HMS (version 3.1.0) model for the project.

The Sacramento Hydrologic Calculator (SacCalc) pre-processor was used to create a HEC-1 input file that contained watershed properties rainfall data and pipe/channel routing information. The HEC-1 input file was then imported into HEC-HMS to determine the peak flows for the 2-year, 5-year, 10-year, and 100-year 24-hour design storms. Within the models, the following three scenarios were created:

1. **Existing Conditions:** A model of the existing study area was created to establish base flow conditions.

2. **Proposed Conditions without Detention:** This scenario includes the developed area without onsite detention.

3. **Proposed Conditions with Detention:** The scenario includes the developed area with the addition of onsite detention basins to mitigate for increased flows.

Existing Conditions

Watershed boundaries were determined based on existing aerial topography provided by MacKay and Somps. Offsite basins (located outside of the limits of the aerial topography) were determined using USGS topographic maps for the area. Figure 2 shows existing watershed basin boundaries.

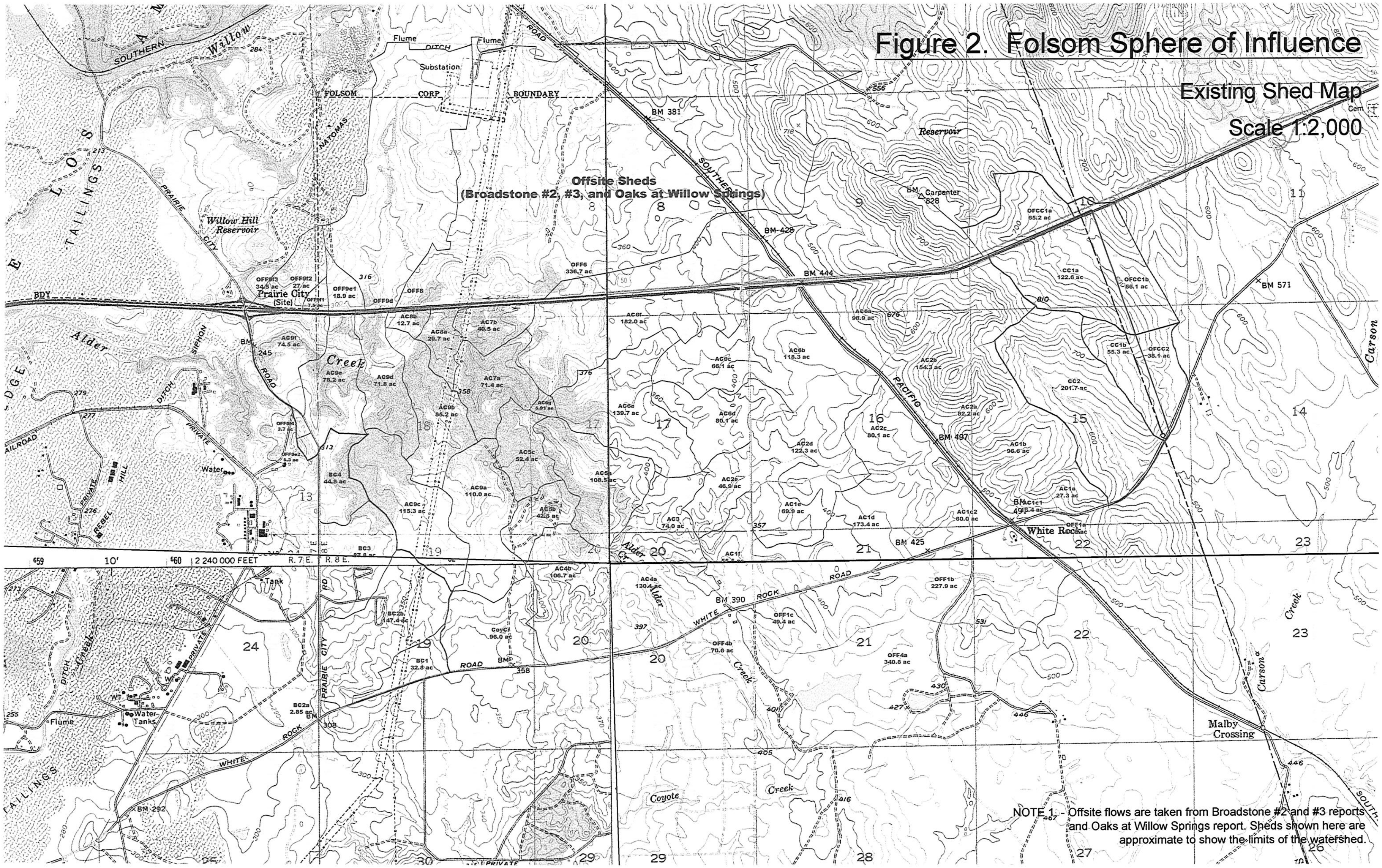


Figure 2. Folsom Sphere of Influence

Existing Shed Map

Scale 1:2,000

NOTE 1. - Offsite flows are taken from Broadstone #2 and #3 reports and Oaks at Willow Springs report. Sheds shown here are approximate to show the limits of the watershed.

Existing Conditions Modeling Criteria

The following modeling criteria were used during development of the existing conditions model:

1. Basin "n" method for computing lag times
2. Muskingum-Cunge for channel routing
3. Precipitation Zone 3
4. Storage-discharge rating curves for existing detention
5. Natural Resources Conservation Service (NRCS) soil surveys for runoff loss data

The basin "n" method was used to compute lag times. Parameters that were required for this method include the following: 1) slope of main channel, 2) length of main channel, 3) length to basin centroid, and 4) basin "n" coefficient. The basin "n" value is dependent on the basin land use and the condition of the main drainage course. Existing land use was determined from site visits and existing topography. Figure 3 shows the existing land use.

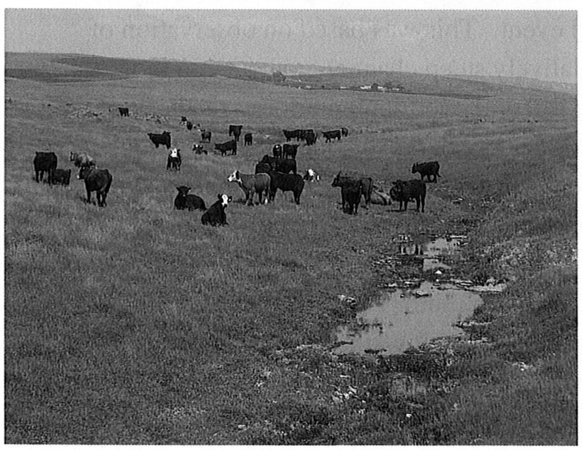


Figure 3. Existing conditions typical land use.

The Muskingum-Cunge method was used for channel routing. The existing model contains primarily natural open channel routing reaches. Manning's "n" values of 0.025, 0.03, and 0.035 were used for channel roughness factors. Figure 4 shows an example of typical channel drainage within the project boundaries.

Figure 4. Typical existing channel drainage (Manning's n = 0.025).

Precipitation Zone 3 was chosen based on the study area location found on the SacCalc map that shows the precipitation zones for the Sacramento HEC-1 method.

Storage-discharge rating curves were developed at existing roadways. During several site visits and analysis of the existing topographic maps it was determined that the detention available at most of the existing crossings would be minor during the 100-year flood event. This was based on observation of narrow channel sections, low roadway embankments and relatively steep channel gradients. In most cases, any ponding that may occur at the crossings would be full and overtopping prior to the peak of the 100-year flood event. However, at the two locations where Alder Creek crosses the Railroad east of Placerville Road it was determined that some ponding would occur which slightly reduces downstream flows. Storage-rating curves for these two locations were developed based on Caltrans nomographs for culvert flow and topographic mapping of the area. During the existing 100-year flood event these locations provide approximately 5.3 acre-feet of storage, which has a minor effect on the overall peak flow in the system. Figure 5 shows an example of one of the crossings along the railroad that was modeled.

Figure 5. Existing crossing at railroad tracks.

Additionally several irrigation/cattle water ponds exist on the project site. These ponds generally contain water throughout the year. It was assumed that these ponds would be full prior to the 100-year, 24-hour event and therefore were not modeled as providing detention under the existing or proposed conditions.

Soils information was obtained from the NRCS. Soils in the study area are mostly group "D" hydrologic soils with some "B" and "C" groups. Group "D" soils consist mostly of clays and have slow infiltration rates and slow rates of water transmission. Figure 6 shows the study area soils map.

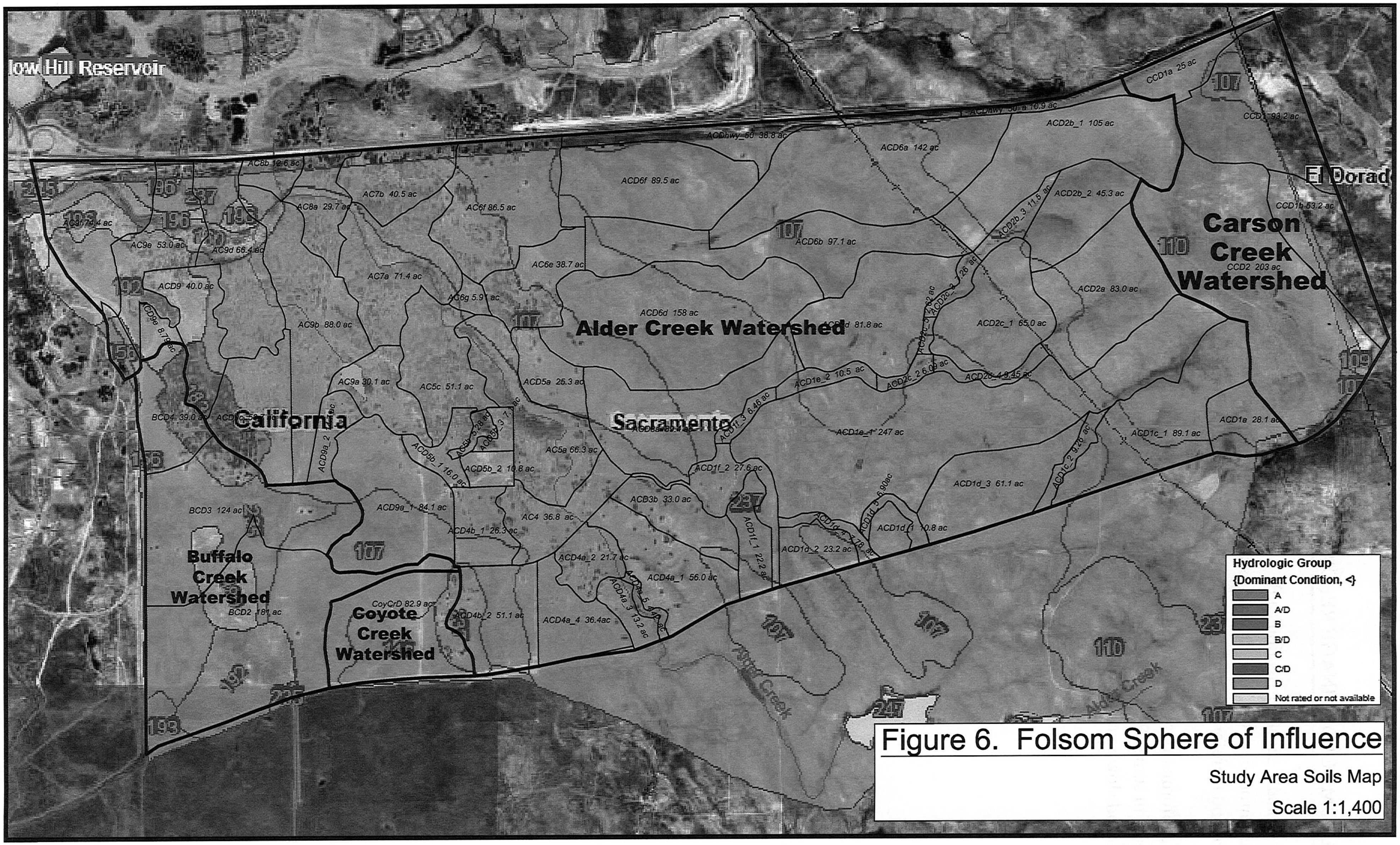


Figure 6. Folsom Sphere of Influence

Study Area Soils Map

Scale 1:1,400

Offsite Flows

In order to determine existing conditions flows in the project area, flows entering the project limits from offsite were added to the model. There are three offsite developments north of Highway 50 that contribute flow to Alder Creek. These developments have previously been analyzed to determine the impacts of the developments and to determine the detention requirements for each development. These projects currently have detention basins that detain flows back to pre project conditions. In order to model the outflow from these detention basins the appropriate drainage studies were obtained from the City of Folsom. The information for these offsite watersheds and detentions basins were found in the following drainage studies:

1. Broadstone Unit #2 (Spink Corporation, September 1997), and the drainage studies. The associated detention basins were also included using the storage/discharge relationships found in the studies.
2. Broadstone Unit #3 (Spink Corporation, July 1999).
3. Oaks at Willow Springs, (Wood Rodgers, Inc., November 2005).

Data for the outflow from these detention basins along with information on the overall watersheds were used to simulate a runoff hydrograph through these basins. Additionally, there are offsite watersheds to the south of the project that also contribute flow to the Alder Creek system. These watersheds will remain undeveloped in the proposed condition. The parameters for these watersheds were taken from USGS topographic mapping.

The total peak flow from offsite sheds can be found in Table 1 below.

Table 1. Peak 100-year flow rate contributions from the offsite basins

Offsite Basin ID	Watershed Area (acres)	Peak flow rate (cfs)
OFF1A	55	100
OFF1B	228	190
OFF1C	49	74
OFF4A	341	236
OFF4B	71	69
OFF6	337	476
OFF8	1030	1160
OFF9D	371	444
OFF9E1	19	43
OFF9E2	5	14
OFF9F1	7	20
OFF9F2	27	51
OFF9F3	34	65
OFF9F4	4	8

Existing Flows at Outfall Locations

There are eight (8) main outfall locations where water leaves the boundaries of the project study area. The Alder Creek Watershed is the primary watershed in the study area with one main outfall location. Upper Buffalo Creek is located along the west project boundary. On the east side of Prairie City Road. There are three (3) outlet locations from the study area into the Buffalo Creek Watershed. Coyote Creek Watershed begins within the southwest project boundary. Runoff leaves this watershed at one location. A portion of the Carson Creek Watershed is located on the east side of the project. There are four (4) onsite sub basins and two (2) offsite sub basins of Carson Creek in the study area model. The Carson Creek Watershed has three (3) outfall locations from the study area.

All outfall locations are shown on Figure 7. Existing flows were established at these locations for comparison to proposed conditions results. A primary objective is to maintain proposed conditions flow at or below the existing peak flows at these locations.

Peak flows at the outfall locations for the 100-year flood event can be found in Table 2 below. Additional results from the existing conditions model are contained in the results section of this report.

Table 2. Existing Peak flow rates at project outlet locations.

FIGURE ID	Existing Conditions 100-Year Peak Flows (cfs)	MODEL ID DESCRIPTION
ALDER	4321	Alder Creek flow leaving the study area
BUFF 2	185	Peak flow leaving BCD2 to Buffalo Creek
BUFF 3	120	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	58	Runoff leaving BCD4 to Buffalo Creek
COY 1	122	Runoff leaving CoyCrD to Coyote Creek
CARS 1	276	Total flow leaving through CCD1
CARS 2	113	Runoff leaving CCD1b
CARS 3	205	Runoff leaving CCD2 to Carson Creek

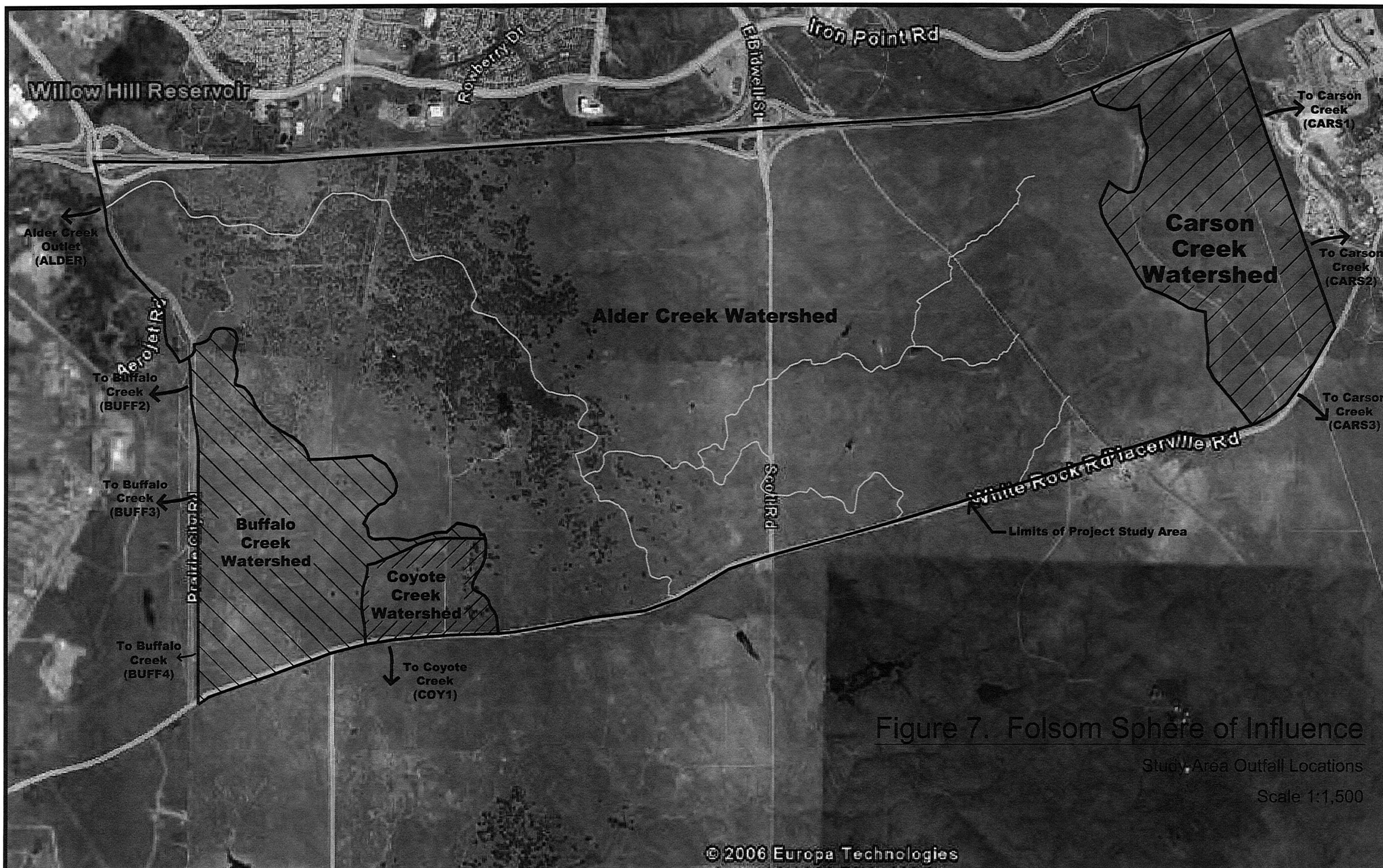


Figure 7. Folsom Sphere of Influence

Study Area Outfall Locations

Scale 1:1,500

Proposed Conditions Without Detention

Proposed Conditions Modeling Criteria

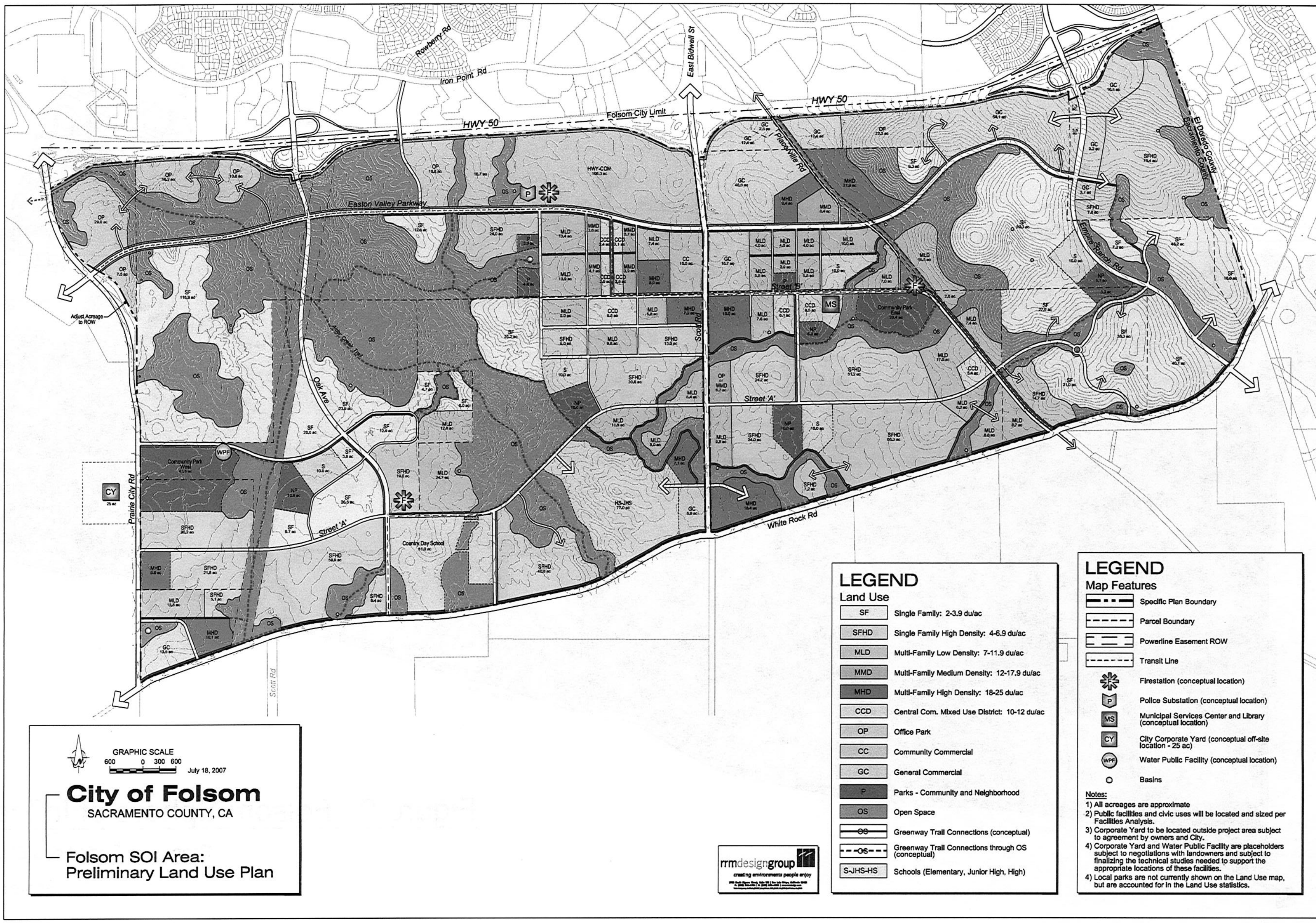
Basic modeling criteria for the proposed condition model were similar to the existing conditions model with minor changes. MacKay and Somps provided proposed land use for the entire study area to assist in creating the proposed conditions models. The proposed land use plan for the Folsom SOI area and the proposed conditions drainage basins can be found in Figures 8 and 9 respectively. The drainage basins are based on proposed mass grading of the site. The study area contains mixed land use and varying characteristics of the main drainage courses so the basin "n" values have been weighted per the Drainage Manual. Table 7-1 from the Drainage Manual provided basin "n" values for each land use type. Proposed basin n-value calculations can be found in Appendix A. The rainfall, soils data and routing methods remained the same as the existing conditions model with adjustment for new conveyance systems under the proposed condition. A Manning's n-value of 0.011 was used for pipe flow routing.

Proposed Flows at Outfall Locations

In general, the drainage flow paths remained similar under the proposed conditions with some changes based on proposed grading and roadways. While individual drainage basin drainage patterns may have changed, the overall flow path to the eight major outlets from the project boundaries did not change. The unmitigated flow rate at each outfall increased due to the proposed development. Table 3 shows the proposed peak flow rates at the eight major outfall locations without onsite detention.

Table 3. Proposed (without detention) Peak flow rates at project outfall locations.

FIGURE ID	Proposed Conditions without Detention 100 -Year Peak Flows (cfs)	MODEL ID DESCRIPTION
ALDER	4854	Alder Creek flow leaving the study area
BUFF 2	299	Runoff leaving BCD2 to Buffalo Creek
BUFF 3	152	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	86	Runoff leaving BCD4 to Buffalo Creek
COY 1	139	Runoff leaving CoyCrD to Coyote Creek
CARS 1	327	Total flow leaving through CCD1
CARS 2	132	Runoff leaving CCD1b
CARS 3	317	Runoff leaving CCD2 to Carson Creek


GRAPHIC SCALE
600 0 300 600
July 18, 2007
City of Folsom
SACRAMENTO COUNTY, CA
Folsom SOI Area:
Preliminary Land Use Plan
LEGEND
Land Use
SF Single Family: 2-3.9 du/ac
SFHD Single Family High Density: 4-6.9 du/ac
MLD Multi-Family Low Density: 7-11.9 du/ac
MMD Multi-Family Medium Density: 12-17.9 du/ac
MHD Multi-Family High Density: 18-25 du/ac
CCD Central Com. Mixed Use District: 10-12 du/ac
OP Office Park
CC Community Commercial
GC General Commercial
P Parks - Community and Neighborhood
OS Open Space
Greenway Trail Connections (conceptual)
Greenway Trail Connections through OS (conceptual)
S-JHS-HS Schools (Elementary, Junior High, High)
LEGEND
Map Features
Specific Plan Boundary
Parcel Boundary
Powerline Easement ROW
Transit Line
Firestation (conceptual location)
Police Substation (conceptual location)
Municipal Services Center and Library (conceptual location)
City Corporate Yard (conceptual off-site location - 25 ac)
Water Public Facility (conceptual location)
Basins
Notes:
1) All acreages are approximate
2) Public facilities and civic uses will be located and sized per Facilities Analysis.
3) Corporate Yard to be located outside project area subject to agreement by owners and City.
4) Corporate Yard and Water Public Facility are placeholders subject to negotiations with landowners and subject to finalizing the technical studies needed to support the appropriate locations of these facilities.
4) Local parks are not currently shown on the Land Use map, but are accounted for in the Land Use statistics.
rrmdesigngroup
creating environments people enjoy
HWY 50
Folsom City Limit
East Bidwell St
Iron Point Rd
Rowberry Rd
Placerville Rd
Empire Ranch Rd
El Dorado County
Sacramento County
Easton Valley Parkway
Scott Rd
Street 'A'
Street 'B'
White Rock Rd
Oak Ave
Prairie City Rd
Adjust Acreage to ROW
Country Day School

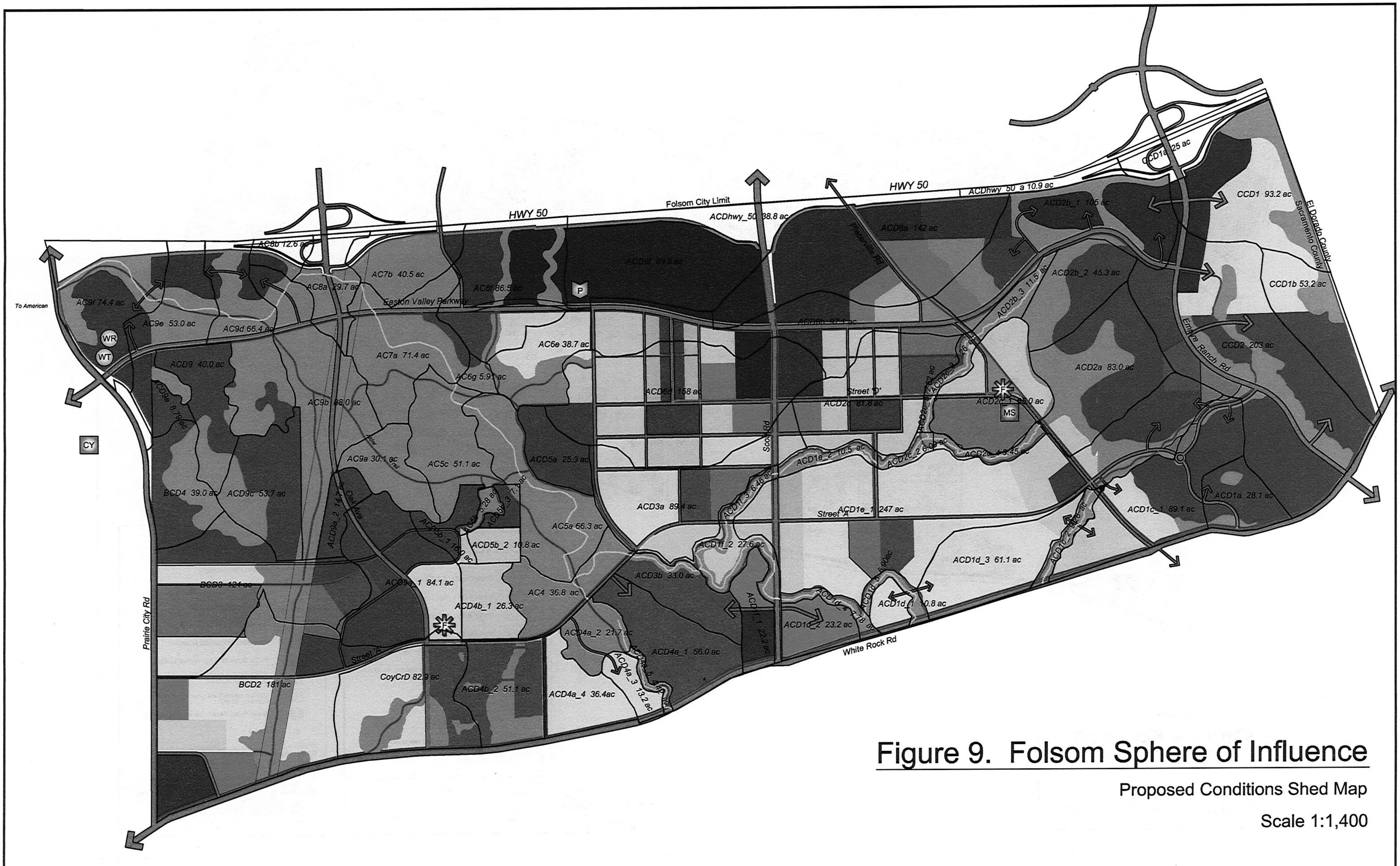


Figure 9. Folsom Sphere of Influence

Proposed Conditions Shed Map

Scale 1:1,400

Proposed Conditions With Detention

Modeling Criteria

Based on the results from the proposed condition modeling onsite detention facilities are necessary to mitigate for increased runoff leaving the project site. MacKay and Somps provided the location for proposed onsite detention basins. Storage-discharge rating curves were developed for each detention basin based on preliminary design layouts provided by MacKay and Somps. The discharge curves were developed using Caltran's hydraulic nomographs (Chart 5 Headwater Depth for C.M. Pipe Culverts with Inlet Control). A total of fourteen (14) detention basins were located and modeled. Additional detail on the development of the rating curves and the location of the detention can be found in the Proposed Detention Facilities section of this report. The location of the proposed detention facilities can be found in Figure 10.

Analysis showed that the proposed detention facilities can adequately mitigate for the increased flow rates due to the proposed development. Table 4 shows the resultant peak flows leaving the project site after detention facilities are added. A comparison of the three scenarios is provided in the results section of this report.

Table 4. Proposed (with detention) Peak flow rates at project outlet locations

FIGURE ID	Proposed Conditions with Detention 100-Year Peak Flows (cfs)	MODEL ID DESCRIPTION
ALDER	3866	Alder Creek flow leaving the study area
BUFF 2	140	Runoff leaving BCD2 to Buffalo Creek
BUFF 3	85	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	43	Runoff leaving BCD4 to Buffalo Creek
COY 1	67	Runoff leaving CoyCrD to Coyote Creek
CARS 1	185	Total flow leaving through CCD1
CARS 2	51	Runoff leaving CCD1b
CARS 3	104	Runoff leaving CCD2 to Carson Creek

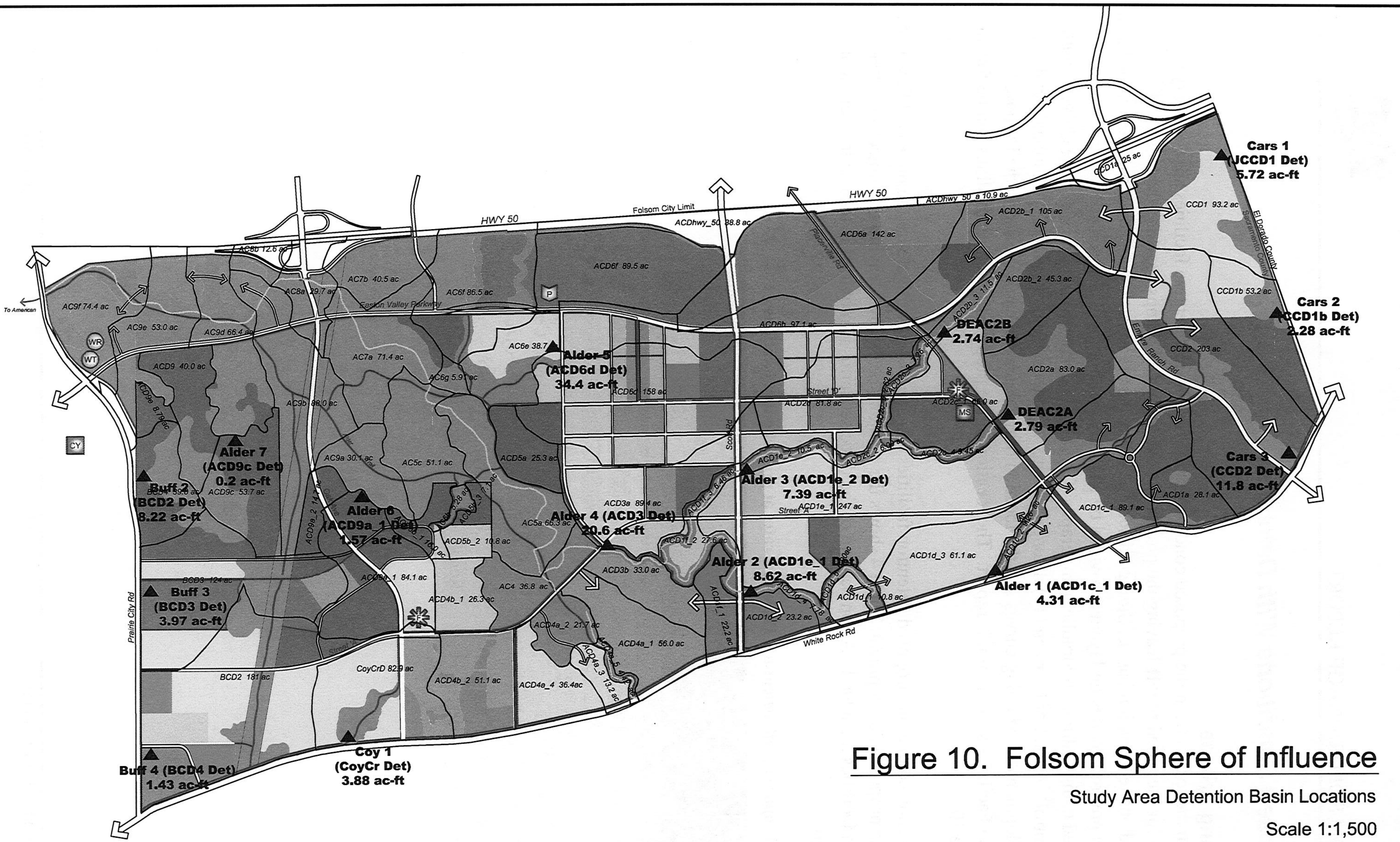


Figure 10. Folsom Sphere of Influence

Study Area Detention Basin Locations

Scale 1:1,500

Hydrologic Modeling Results

A comparison of the HEC-HMS peak flows at the eight (8) main outfall locations for the 100-year, 10-year, 5-year and 2-year flow events are shown in Tables 5 through 8.

Table 5. 100-year Peak Flow Results.

FIGURE ID	Existing Conditions (cfs)	Proposed Conditions without Detention (cfs)	Proposed Conditions with Detention (cfs)	MODEL ID DESCRIPTION
ALDER	4321	4854	3866	Alder Creek flow leaving the study area
BUFF 2	185	299	140	Runoff leaving BCD2 to Buffalo Creek
BUFF 3	120	152	85	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	58	86	43	Runoff leaving BCD4 to Buffalo Creek
COY 1	122	139	67	Runoff leaving CoyCrD to Coyote Creek
CARS 1	276	327	185	Total flow leaving through CCD1
CARS 2	113	132	51	Runoff leaving CCD1b
CARS 3	205	317	104	Runoff leaving CCD2 to Carson Creek

Table 6. 10-year Peak Flow Results.

FIGURE ID	Existing Conditions (cfs)	Proposed Conditions without Detention (cfs)	Proposed Conditions with Detention (cfs)	MODEL ID DESCRIPTION
ALDER	2579	2835	2532	Alder Creek flow leaving the study area
BUFF 2	100	160	94	Runoff leaving BCD2 to Buffalo Creek
BUFF 3	63	82	61	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	30	45	26	Runoff leaving BCD4 to Buffalo Creek
COY 1	65	74	41	Runoff leaving CoyCrD to Coyote Creek
CARS 1	150	177	135	Total flow leaving through CCD1
CARS 2	59	69	40	Runoff leaving CCD1b
CARS 3	113	172	96	Runoff leaving CCD2 to Carson Creek

Table 7. 5-year Peak Flow Results.

FIGURE ID	Existing Conditions (cfs)	Proposed Conditions without Detention (cfs)	Proposed Conditions with Detention (cfs)	MODEL ID DESCRIPTION
ALDER	2073	2265	2096	Alder Creek flow leaving the study area
BUFF 2	78	124	82	Runoff leaving BCD2 to Buffalo Creek
BUFF 3	48	64	54	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	23	34	21	Runoff leaving BCD4 to Buffalo Creek
COY 1	50	57	34	Runoff leaving CoyCrD to Coyote Creek
CARS 1	116	137	126	Total flow leaving through CCD1
CARS 2	45	53	35	Runoff leaving CCD1b
CARS 3	88	134	85	Runoff leaving CCD2 to Carson Creek

Table 8. 2-year Peak Flow Results.

FIGURE ID	Existing Conditions (cfs)	Proposed Conditions without Detention (cfs)	Proposed Conditions with Detention (cfs)	MODEL ID DESCRIPTION
ALDER	1332	1455	1395	Alder Creek flow leaving the study area
BUFF 2	46	74	53	Runoff leaving BCD2 to Buffalo Creek
BUFF 3	28	38	35	Runoff leaving BCD3 to Buffalo Creek
BUFF 4	12	19	13	Runoff leaving BCD4 to Buffalo Creek
COY 1	30	34	25	Runoff leaving CoyCrD to Coyote Creek
CARS 1	69	83	82	Total flow leaving through CCD1
CARS 2	26	31	25	Runoff leaving CCD1b
CARS 3	53	81	63	Runoff leaving CCD2 to Carson Creek

The above tables of results show that by providing detention facilities as proposed, the 100-year and 10-year flow events will remain at or below the existing conditions flows under the proposed condition scenario. During the 5-year and 2-year events flow rates do increase at some locations under proposed conditions. However, these increases are not considered significant. These minor increases in peak flow rates are not anticipated to affect any downstream facilities, however, during detailed design studies, modified outlet facilities can be provided to also mitigate for the more frequent events.

Figure 11 shows the proposed conditions results for the 100-year, 10-year, 5-year and 2-year flow events at key location throughout the proposed development. Table 9 summarizes these results. Detailed result tables from HEC-HMS are provided in Appendix B.

Table 9. Modeling results for the 100-year, 10-year, 5-year and 2-year flow events for the proposed with detention scenario at points of interest throughout the development.

FIGURE ID	100-year (cfs)	10-year (cfs)	5-year (cfs)	2-year (cfs)	MODEL ID DESCRIPTION
DEAC2B	253	151	118	71	Placerville Road, North
DEAC2A	87	58	50	30	Placerville Road, South
JAD2C3	263	155	121	72	Proposed road by M&S - Street D
JACD2C	456	274	214	127	Flow mergence of two Alder Creek tributaries and ACD2C1
JAD2C2	460	274	216	130	Proposed road by M&S
ALDER 3	463	311	256	157	Scott Road, North
JAD1F3	468	314	256	159	Proposed road by M&S - Street A
JOFF1B	413	247	195	123	Offsite Flow entering study area across Whit Rock Road
ALDER 2	718	466	376	228	Scott Road, South
JACD1F	1225	800	648	397	Flow mergence of Alder Creek tributaries
ALDER4	1156	821	671	421	Proposed road by M&S - Street A
JAC4	1468	1002	817	519	Flow mergence of Alder Creek tributaries
ALDER5	254	158	131	94	Proposed road by M&S
JAC6G	2254	1549	1281	848	Flow mergence
JAC7	2392	1593	1318	874	Proposed road by M&S -Oak Ave and Easton Valley Parkway

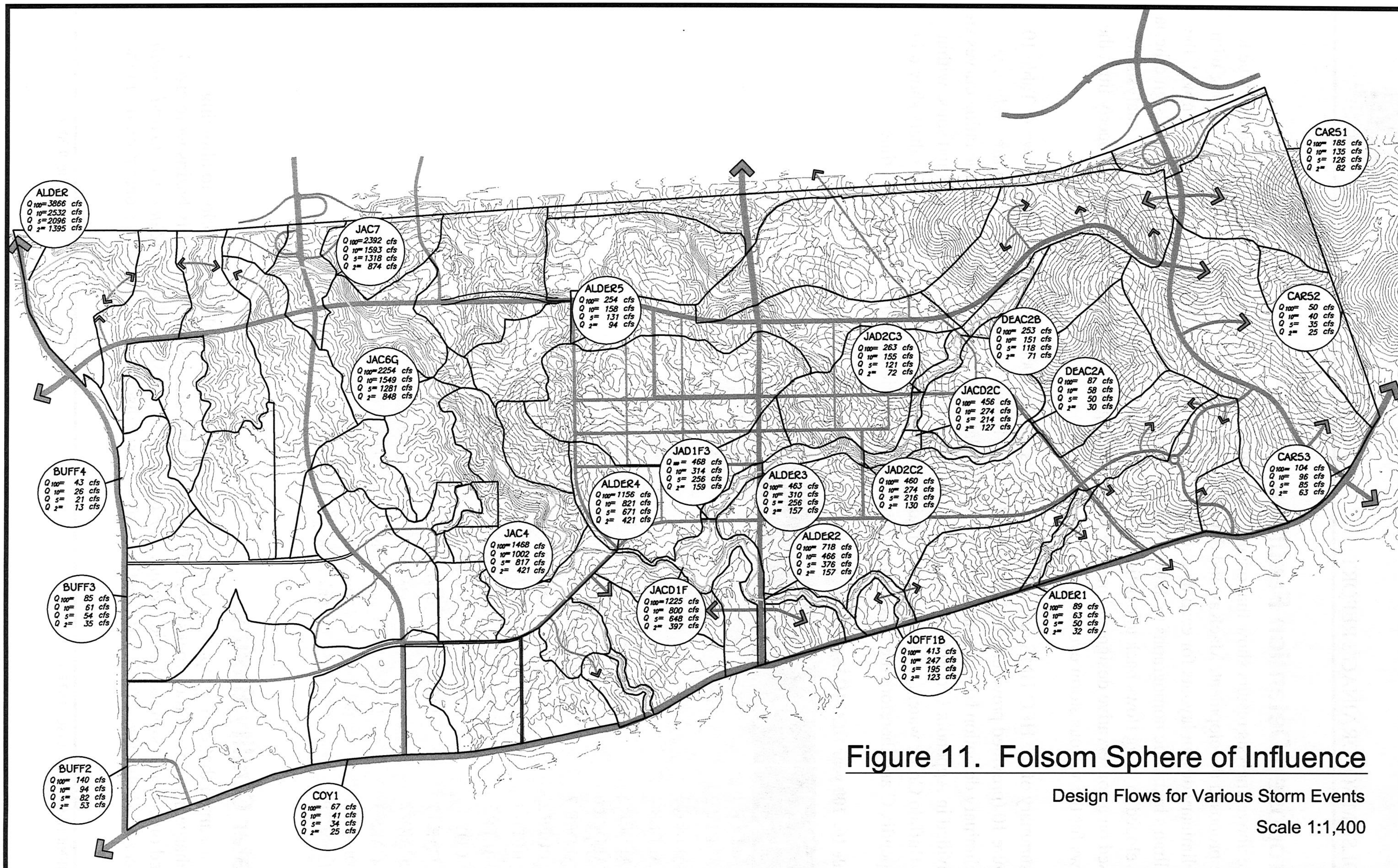


Figure 11. Folsom Sphere of Influence

Design Flows for Various Storm Events

Scale 1:1,400

Proposed Detention Facilities

The above analysis results show that onsite detention is necessary to mitigate flow rate increases due to the proposed development. MacKay and Somps provided elevation and volume staging data along with preliminary design layouts for each detention basin. D&A used that information in conjunction with the Caltran's hydraulic nomographs to develop rating curves for each detention basin based on design criteria developed to bring flows back to existing conditions. The outfall rating curves used in this analysis are based on a conservative design and may be revised during the design phase in order to properly limit the flows for the various storm events.

A summary of the HEC-HMS detention basin results for the 100-year flow event are shown in Table 10. Figure 10 (provided previously) shows these detention basin locations relative to the entire study area. Preliminary detention basin layouts and area-volume data used in the development of the rating curves are provided in Appendix C of this report. The basins within the Carson Creek watershed and some within the Buffalo Creek watershed have not been laid out within the development as with the others shown in Appendix C and therefore the maximum water surface elevations are not known at this time.

Table 10. 100 year HEC-HMS detention basin results.

FIGURE ID	PEAK DISCHARGE (CFS)	MAXIMUM W.S. DEPTH (FT)	PEAK VOLUME (ACRE-FT)
ALDER 1	88	5.70	4.31
ALDER 2	718	10.0	8.62
ALDER 3	463	10.8	7.39
ALDER 4	1156	11.5	20.6
ALDER 5	254	11.7	34.4
ALDER 6	116	7.70	1.57
ALDER 7	94	4.90	0.20
BUFF 2	140	unknown	8.22
BUFF 3	85	7.50	7.50
BUFF 4	43	4.50	4.50
COY 1	67	3.80	3.80
CARS 1	185	unknown	5.72
CARS 2	51	unknown	2.28
CARS 3	104	unknown	11.8
DEAC2A	87	unknown	2.79
DEAC2B	253	unknown	2.74

Water Quality Basins

It is assumed that each proposed subbasin will require a water quality basin prior to allowing discharge into any of the creeks or off of the project boundaries. Water quality basins were sized based on criteria outlined in the *Stormwater Quality Design Manual for the Sacramento and South Placer Regions (May 2007)*. At locations where basin discharge directly into a detention basin the water quality volume may be added to the overall detention basin size. This will be determined during the final design stages. The following table shows the preliminary water quality basin sizing for each water shed. Additional sizing criteria (impervious areas) and water quality design guidelines from the Sacramento County Manual are provided in Appendix E.

Table 11. Preliminary Water Quality Volumes

Sub-Basin	Total area (acres)	Storage volume (48-hr drawdown) (in)	Storage volume (48-hr drawdown) (acre-ft)
ACD9	40.0	0.16	0.52
ACD9a_1	84.1	0.28	1.98
ACD9a_2	14.7	0.24	0.30
ACD9c	53.7	0.16	0.71
ACD9e	8.79	0.21	0.16
ACD6a	142	0.65	7.65
ACD6b	97.1	0.54	4.40
ACD6d	158	0.56	7.41
ACD6f	89.5	0.75	5.61
ACD5a	25.3	0.21	0.45
ACD5b_1	16.0	0.27	0.36
ACD5b_2	10.8	0.47	0.42
ACD5b_3	7.10	0.18	0.11
ACD4a_1	56.0	0.38	1.78
ACD4a_2	21.7	0.05	0.09
ACD4a_3	13.2	0.40	0.44
ACD4a_4	36.4	0.35	1.07
ACD4a_5	4.42	0.08	0.03
ACD4b_1	26.3	0.46	1.00
ACD4b_2	51.1	0.25	1.07
ACD3a	89.4	0.39	2.88
ACD3b	33.0	0.33	0.90
ACD2a	83.0	0.16	1.10
ACD2b_1	105.0	0.39	3.43
ACD2b_2	45.3	0.13	0.50
ACD2c_1	65.0	0.21	1.14
ACD2d	81.8	0.48	3.25
ACD1a	28.1	0.21	0.49
ACD1c_1	89.1	0.32	2.38
ACD1c_2	9.26	0.13	0.10
ACD1d_1	10.8	0.37	0.34
ACD1d_2	23.2	0.61	1.19

Sub-Basin	Total area (acres)	Storage volume (48-hr drawdown) (in)	Storage volume (48-hr drawdown) (acre-ft)
ACD1d_3	61.1	0.38	1.96
ACD1e_1	247	0.36	7.47
ACD1f_1	22.2	0.68	1.26
CCD1	93.2	0.36	2.81
CCD1a	25.0	0.86	1.80
CCD1b	53.2	0.22	0.97
CCD2	203	0.25	4.24
BCD2	181	0.39	5.81
BCD3	124	0.16	1.70
BCD4	39.0	0.13	0.42
ACDhwy_50	38.8	0.79	2.54
ACDhwy_50_a	10.9	0.86	0.78
CoyCrD	82.9	0.29	1.97
AC9a	30.1	0.05	0.12
AC9b	88.0	0.10	0.73
AC9d	66.4	0.15	0.81
AC9e	53.0	0.37	1.62
AC9f	74.4	0.51	3.18
AC8a	29.7	0.33	0.81
AC8b	12.6	0.67	0.70
AC7a	71.4	0.08	0.45
AC7b	40.5	0.20	0.67
AC6e	38.7	0.19	0.62
AC6f	86.5	0.45	3.28
AC6g	5.91	0.07	0.03
AC5a	66.3	0.05	0.27
AC5b	5.28	0.06	0.03
AC5c	51.1	0.05	0.21
AC4	36.8	0.08	0.26

Flood Plain Mapping

In order to determine the existing and proposed conditions flood plain limits a HEC-RAS model of Alder Creek was created. The HEC-RAS cross sections were taken from a surface topographic model created from the aerial topographic mapping. A site visit was used to determine the size and location of the existing crossings that may affect the water surface elevations. Flow rates used in the model were taken at various locations along the creek alignments from the existing and proposed HEC-HMS and SacCalc models. Tables 12 and 13 below show the existing and proposed flow rates at the appropriate station in the HEC-RAS model. Cross section and river station IDs used in the model can be found in Figure F-1 provided in Appendix F. The HEC-RAS model was run for the 100-year, 10-year, 5-year and 2-year flow frequencies.

Manning's n-values used in the existing and proposed conditions model were based on existing field conditions. The model assumes that proposed condition will be maintained to simulate the existing condition as closely as possible. The existing streams generally consist of short grasses without an abundance of brush or other growth that would indicate a high manning's n-value. For the purposes of this analysis a Manning's n-value of 0.03 was used throughout the project area.

Output from the HEC-RAS model for the existing and proposed 100-year flow were plotted on the existing topographic map based on the stationing provided in Figure F-1 to create the existing and proposed floodplains. Figures showing the 100-year floodplain limits for the existing and proposed conditions are provided in Appendix F.

The existing floodplain shows a relatively narrow floodplain with some backup of water at existing roadway crossings, which is typical of the steep slopes in this area. The proposed floodplain takes into account the proposed on-site detention facilities and locations where proposed drainage will be exclusively in storm drains and within the streets. A portion of Tributary A4 along Alder Creek will be cut off upstream of detention basin Alder 5 due to the proposed land use. Drainage will be conveyed in storm drain lines and the streets that will outlet to detention basin Alder 5.

The proposed floodplain also shows narrowing or changes to the floodplain to account for proposed roadway alignments and limits of fill. Proposed roadway locations that were not used to store water were not sized and were modeled as clear span bridges. As design progresses these crossings will be sized and their affects on the water surface elevations will be analyzed. Additional detailed HEC-RAS results for the 100-year, 10-year, 5-year and 2-year water surface elevations is provided in Appendix F.

Table 12. Existing peak flow rates used in the HEC-RAS model.

River	RS	EX 100YR (cfs)	EX 10YR (cfs)	EX 5YR (cfs)	EX 2YR (cfs)
ALDER (2)	17000	1202	644	515	334
ALDER (2)	15800	1202	644	515	334
ALDER (2)	14400	1681	927	738	470
ALDER (2)	13600	1681	927	738	470
ALDER (2)	11400	1681	927	738	470

ALDER (2)	9400	1766	980	779	495
ALDER (3)	8900	1766	980	779	495
ALDER (3)	8800	1766	980	779	495
ALDER (3)	6400	2807	1618	1289	819
ALDER (3)	5200	3730	2204	1767	1124
ALDER (3)	4600	3906	2304	1844	1170
ALDER (3)	3600	4190	2492	2003	1284
ALDER (3)	2600	4238	2524	2027	1302
ALDER (3)	1600	4238	2524	2027	1302
ALDER (3)	200	4321	2579	2073	1332
RIVER-1	23600	502	252	191	123
RIVER-1	21600	502	252	191	123
RIVER-1	19900	631	333	254	162
TRIB-A2	11750	181	74	64	45
TRIB-A2	5800	338	163	136	95
TRIB-A3	5200	62	46	39	28
TRIB-A4	9200	257	141	105	60
TRIB-A4	3600	399	220	168	97
RIVER-1 (CARSON)	5250	205	113	88	53

Table 13. Proposed peak flow rates used in the HEC-RAS model.

River	RS	PRO 100YR (cfs)	PRO 10YR (cfs)	PRO 5YR (cfs)	PRO 2YR (cfs)
ALDER (2)	17000	1225	800	648	397
ALDER (2)	15800	1225	800	648	397
ALDER (2)	14400	1468	1002	817	421
ALDER (2)	13600	1468	1002	817	421
ALDER (2)	11400	1468	1002	817	421
ALDER (2)	9400	1559	1080	885	568
ALDER (3)	8900	1559	1080	885	568
ALDER (3)	8800	1559	1080	885	568
ALDER (3)	6400	2392	1593	1318	874
ALDER (3)	5200	3245	2173	1798	1181
ALDER (3)	4600	3467	2281	1883	1233
ALDER (3)	3600	3686	2430	2013	1333
ALDER (3)	2600	3768	2473	2049	1361
ALDER (3)	1600	3768	2473	2049	1361
ALDER (3)	200	3866	2532	2096	1395
RIVER-1	23600	413	247	195	123
RIVER-1	21600	413	247	195	123
RIVER-1	19936	718	466	376	157
TRIB-A2	11750	253	151	118	71
TRIB-A2	5800	456	274	214	127
TRIB-A3	5200	87	58	50	30
TRIB-A4	2900	681	368	287	175

TRIB-A4	2461	254	158	131	94
RIVER-1 (CARSON)	5250	317	172	134	81
RIVER-1 (CARSON)	185	104	96	85	63

Major Storm Drain Trunk Lines

As part of this drainage analysis preliminary sizing of major storm drain trunk lines has been provided. MacKay and Somps provided approximate alignments for the major storm drain trunk lines based on proposed roadway alignments. The storm drain pipes were sized to convey the 10-year peak flow rate under gravity flow conditions (just flowing full with no pressure flow). Manning's equations was used to calculate the required size of the main pipelines to meet this criteria. The 10-year flows were taken from the proposed with detention HEC-HMS analysis. Major trunk lines were assumed to have a slope of 1% and a "n" value of 0.015 (based on City of Folsom and Sacramento County criteria). A 1% slope is considered a conservative assumption based on the generally steep slopes in the project area. This will generally oversize pipelines particularly on the east side of the project. A Manning's "n" value of 0.015 is also considered conservative and will account for minor losses in the system. During a 100-year storm event the storm drain pipes will flow under pressure and flow not conveyed in the pipes will be allowed to flow in the streets. Hydraulic Grade Lines have not been calculated at this time. Once alignments and detention facility locations are finalized HGL calculations for the 10-year and 100-year storm events can be performed and the trunk drainage pipeline sizes will be confirmed.

Table 14 shows pipe diameters and lengths and Figure 12 shows the pipe IDs and approximate pipeline alignments with its corresponding size. Appendix G provides back up pipe sizing calculations and flow rates used for each pipeline.

Table 14. Major storm drain pipe diameters and lengths.

SUB-BASIN	PIPE ID	PIPE DIA (in)	PIPE LENGTH (ft)
BCD2	A5	30	972
	A4	48	1672
	A3	30	1342
	A2	30	892
	A1	54	401
BCD3	B4	30	876
	B3	36	1137
	B2	42	1138
	B1	24	564
ACD9a_1	C7	24	716
	C6	30	425
	C5	18	971
	C4	18	728
	C3	42	803
	C2	18	245

	C1	42	711
ACD6a	D3	42	948
	D2	48	1481
	D1	54	1168
ACD6b	E6	30	845
	E5	36	1122
	E4	36	1103
	E3	60	1176
	E2	60	614
	E1	60	1083
ACD6d	F3	24	577
	F2	42	1675
	F1	54	1303
	F0	66	720
ACD2b_1	G3	36	1063
	G2	42	930
	G1	48	1855
ACD2c_1	H1	30	1553
ACD2d	I4	24	451
	I3	30	700
	I2	36	434
	I1	48	584
ACD3a	J4	18	681
	J3	24	1585
	J2	30	929
	J1	42	854
	J0	30	1559
ACD1c_1	K5	30	886
	K4	36	2189
	K3	30	658
	K2	42	793
	K1	48	420
ACD1d_3	L2	24	688
	L1	42	1549
ACD1e_1	M12	36	1069
	M11	42	919
	M10	24	702
	M9	42	1858
	M8	18	1549
	M7	24	776
	M6	48	1645
	M5	24	1794
	M4	24	565
	M3	60	1059
	M2	24	456
	M1	30	1129

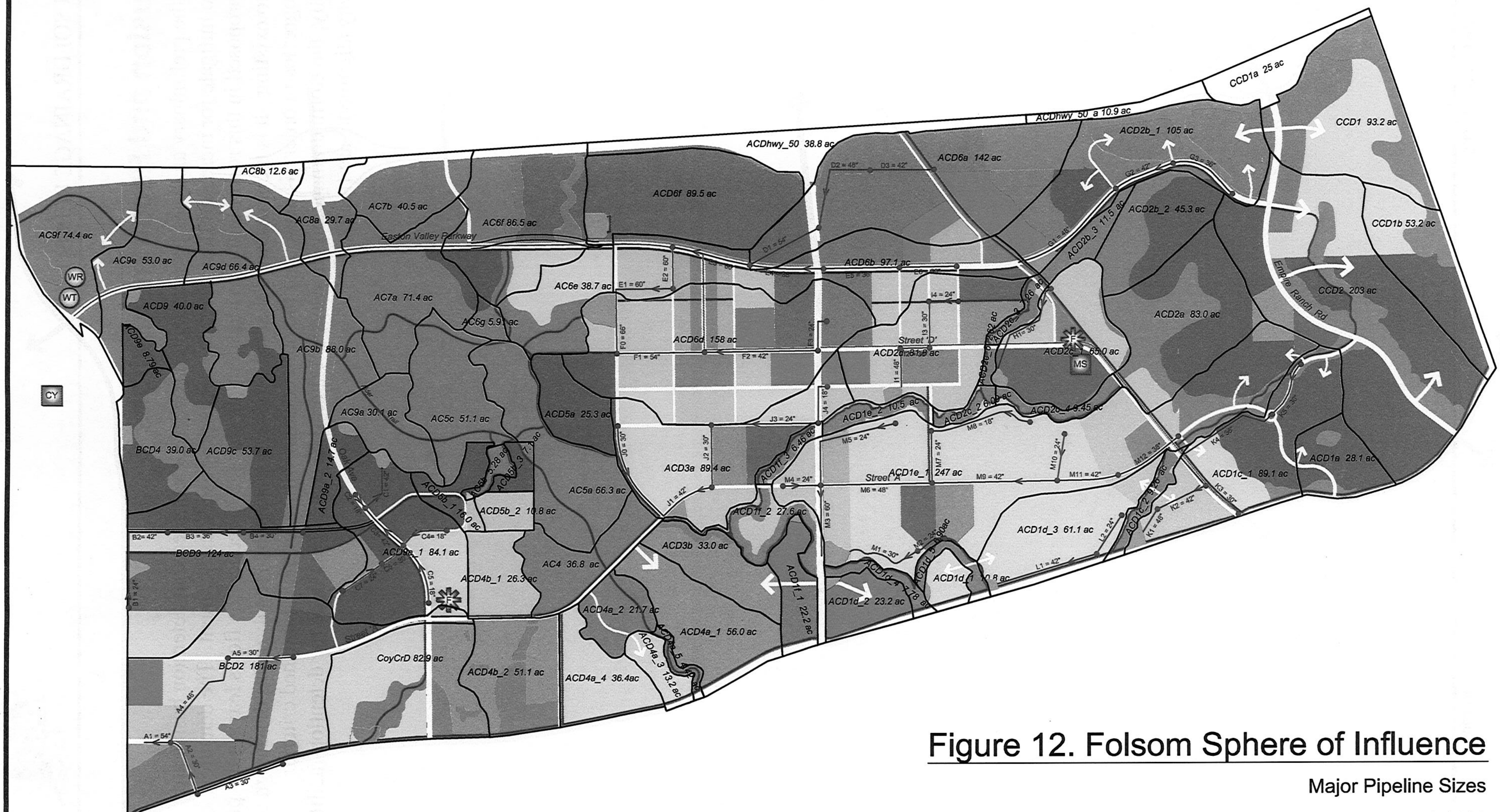


Figure 12. Folsom Sphere of Influence

Major Pipeline Sizes

Scale 1:1400

Conclusion and Recommendations

Based on the preliminary analyses performed it has been determined that detention basins are required to mitigate for increased flow rates due to the proposed development. The detention facilities proposed in this report will provide adequate storage to reduce the flows leaving the project site back to existing. It is recommended that the proposed storage be reanalyzed as the design of the system progresses in order to ensure that the outlet design will meet the established criteria. Additionally, the storm drainage pipeline system should be reanalyzed once the detention facilities and roadway alignments are finalized.