Canada de San Joaquin
Pre-Design Study Report

Ventura Avenue to Highway 33

Prepared for:

Advance Planning Section
Planning & Regulatory Division
Ventura County Watershed Protection District

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1. EXECUTIVE SUMMARY

The purpose of the Pre-Design Study for Canada de San Joaquin was to:

A. Develop and evaluate economically viable and environmentally responsible channel improvement alternatives
B. Prepare a complete Pre-Design (30% design) Report for the selected alternative

This study was conducted to determine the current level of protection the drainage system provides, to calculate flood damage estimates under present condition, to identify alternatives to provide 100-year flood protection, and to evaluate environmental concerns, and recommend a preferred alternative.

Canada de San Joaquin (CDSJ) is a local tributary channel to Ventura River flowing east to west draining a 1.5-square mile watershed, and it is located at the western end of the City of Ventura. The channel system is under the jurisdiction of the Ventura County Watershed Protection District (District), and sections of it are owned and or maintained by the District. Please see Figure 1 Location Map below.

For analysis and discussion purposes, the channel system is separated into Study Reaches 1 through 4. Starting at the downstream end; Reach 0, where no change is proposed, consists of the Ventura River confluence and the existing double box culvert under Highway 33; Reach 1 is from Highway 33 to 930 feet upstream; Reach 2 is a natural earthen channel approximately 270 feet long, Reach 3 is District's Reinforced Concrete Box (RCB) and the culvert under Ventura Avenue, approximately 540 feet long, and Reach 4 is a natural earthen channel upstream of Ventura Avenue. The confluence of CDSJ with Ventura River and the Highway 33 culvert (Reach 0) are not being altered, therefore Reach 1 starts upstream of Highway 33.

The existing 100-year floodplain boundary studied as part of this project is the basis for the flood damage assessment calculations. FEMA's preliminary (and unofficial) floodplain study models dated February and June 2010 were revised and corrected using new additional topographic survey in Reach 2 and new hydrology. The best available commercial property values were researched and estimated for the structures within the present 100-year floodplain.

Five (5) preliminary channel improvement Alternatives were analyzed within the lower Reaches 1, 2, and 3 from Highway 33 to Ventura Avenue.

Reach 4 upstream of Ventura Avenue will be generally considered adequate to carry the 100-year flow, if and when the downstream reaches are improved, including the Ventura Avenue culvert, inlet, and the dangling pipelines and other oil and gas transport facilities.

Reach 4 requires some routine Operation & Maintenance and erosion control measures. Discussions were held with several District staff on February 23, 2012. Their decision is to

repair the existing rock riprap at the upstream end, but not to do a major bank protection project along the entire 2200' reach. The reason being that due to lack of funding and relatively low benefit/cost ratio, this project will not rank very high.

For the reaches downstream of Ventura Avenue (Reaches 1 through 3), the preliminary alternatives are evaluated and compared in District's "Alternative Evaluation Matrix" format. The evaluations also include an "order of magnitude" engineering cost estimate for each preliminary alternative. An estimated Benefit/Cost (B/C) Ratio is developed for each preliminary alternative by comparing the estimated 100-year flood damage cost of $640,000 (as project Benefit) determined earlier, with the estimated construction Costs shown below.

The preliminary alternatives studied include various combinations of Reinforced Concrete Channels (RCC), Reinforced Concrete Boxes (RCB), Rock Riprap, and a Bypass Detention Basin concept as follows:

Alternative 0 – Do Nothing – Present Condition (current flooding situation)

Alternative 1 – Reach 1 – RCC and 4 RCB crossings
Reach 2 – Rock Riprap
Reach 3 – RCB in existing alignment plus new inlet/outlet

Alternative 2 – Reach 1 – RCC and 4 RCB crossings
Reach 2 – Rock Riprap
Reach 3 – Parallel RCB and existing 8'x8' RCB combination, plus new inlet/outlet

Alternative 3 – Reach 1 – RCC and 4 RCB crossings
Reach 2 – New RCB to bypass existing natural channel
Reach 3 – New RCB to replace existing 8'x8' RCB

Alternative 4 – Reach 1 – Smaller RCC and 4 RCB crossings
Reach 2 – New RCC within existing natural channel
Reach 3 – Bypass Det. Basin & New RCB to replace existing 8'x8' RCB

Alternative 5 – Reach 1 – RCC mostly along the northerly OST property line & 2 RCB crossings
Reach 2 – RCC along the northerly Ramirez property line & a 48" RCP from the existing natural channel, and Junction
Reach 3 – New RCB through VUSD property along the Head Start Structures, and new culvert and inlet at Ventura Avenue

The following table summarizes the results of the study, including the cost opinion, environmental ranking, and the overall rank and letter grade.

The order of magnitude engineer's cost estimate includes a 20 percent contingency, as well as a 25 percent increase for environmental permitting and monitoring, engineering design, and construction administration and inspection.

Alternative 5 has the highest overall rank among the studied alternatives.

ALTERNATIVE	PROJECT DESCRIPTION	COST ($M)	B/C Ratio	Environmental Rank	Alternative Evaluation Matrix Score	Overall Rank
0	No Project				133	
1	Channelization, Existing Alignment	2.3	0.28	1	251	C
2	Channelization, Existing Alignment, Existing 8x8 RCB, Parallel RCB thru VUSD property	2.0	0.33	1	257	B
3	Channelization, Existing Alignment, Abandon Existing 8x8 RCB, New Parallel RCB thru VUSD property	2.0	0.33	3	247	D
4	Detention Basin Concept, Channelization, Existing D/S Alignment	2.8	0.23	5	214	E
5	Channelization, Northerly Alignment, Abandon Existing 8x8 RCB	2.1	0.33	2	268	A

CONCLUSIONS & RECOMMENDATIONS

1. Only projects that provide a meaningful level of flood protection to the public, that are environmentally responsible, and are economically feasible deserve the expenditure of public funds in these difficult economic times.

   In this particular case, the biggest beneficiaries of this project appear to be a small number of private commercial or industrial properties at the downstream end of the CDSJ between Ventura Avenue and the Highway 33.

   Due to the high cost of construction and relatively minimal public benefit, this project is not recommended as a public works Capital Improvement Project, unless substantial funds are collected or assessed from the local project beneficiaries, or other sources.

2. Aside from funding issues and unforeseen utility or construction challenges, Alternative 5 is the highest ranked amongst the alternatives studied.

3. Due to the 2-dimensional nature of the overflow floodplain along CDSJ, and hydrograph timing and volume, a standard 1-dimensional Steady-State Peak Flow analysis is deemed inappropriate. A hydrologic and hydraulic evaluation of the 100-year flood presented in this report indicates that the peak flood ponding stage along the Highway 33 will be lower than what FEMA's recent studies show.

4. Based on the above findings, failing the levee extension parallel to CDSJ (mathematical failure for flood insurance purposes) is inappropriate. It is recommended that District approach FEMA about a volume-based 2-dimensional analysis to confirm the above findings. This is critical, as the Benefit/Cost ratio of the project is a direct function of the extent of inundation, and the projected number of affected properties.

5. The stop-log opening walls within the levee extension are approximately 8.2' high. However, the I-beam slide for the logs is only 6' high. To get credit for the full height of the levee extension, the slide height will need to be raised so that more logs could be inserted to the top of the levee extension.

6. The existing retaining wall along Henderson's northerly property line is not a typical retaining wall with proper structural foundation and components. Therefore, it is vulnerable to floods. Any potential channel improvement (during construction or after) in Reach 2 might affect the existing wall, since its structural integrity is unknown.

7. During the Final Design phase of the project, hydrology will also need to account for any runoff that might reach this location from Shell Road and surrounding watersheds east of Ventura Avenue north of CDSJ.

2. PROJECT OVERVIEW

CDSJ is a tributary of Ventura River, which flows in an east-west direction draining a 1.5 square mile drainage area. It is located at the western end of the City of Ventura. The channel system is under the jurisdiction of the Ventura County Watershed Protection District (District), and sections of it are owned and/or maintained by the District. Please see the Location Map below.

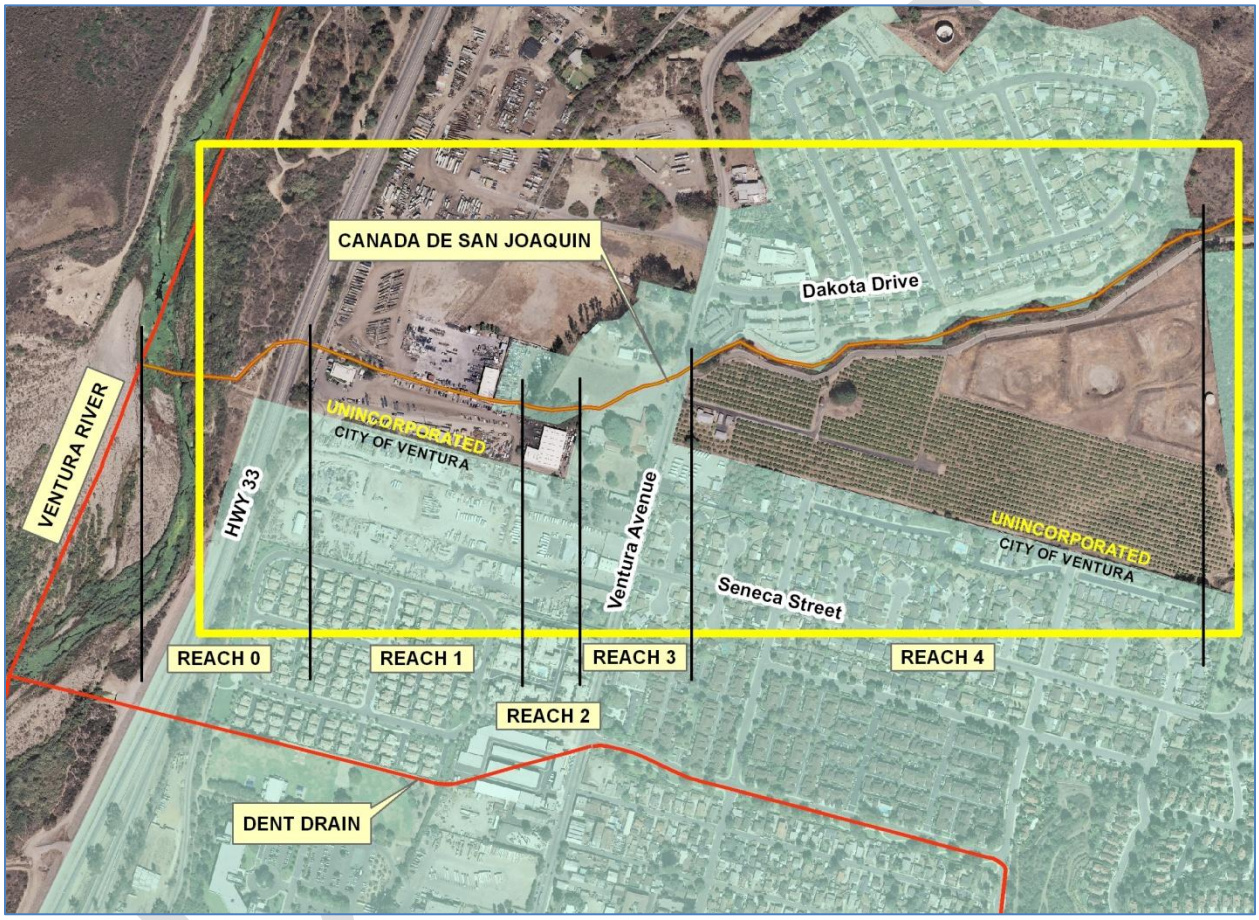


Figure 1 Location Map

This study was conducted to determine the current level of protection the drainage system provides, to calculate flood damage estimates under present condition, to identify alternatives to provide 100-year flood protection, and to evaluate environmental concerns, and recommend a preferred alternative.

It is imperative that the preferred alternative provides meaningful public benefit, and it is economically viable and environmentally responsible.

2.1 Existing Drainage Facilities

The existing drainage facilities consist of natural channel with or without armor and protection, underground RCBs, man-made open channels and RCCs. See the small-scale exhibit below and the large-scale copy of the exhibit at the end of the study report.

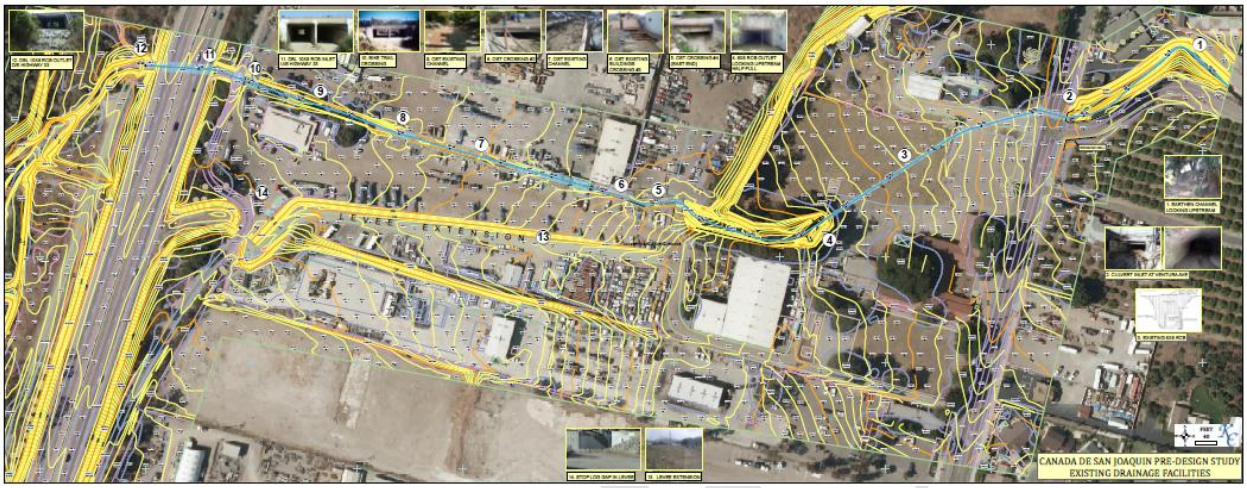
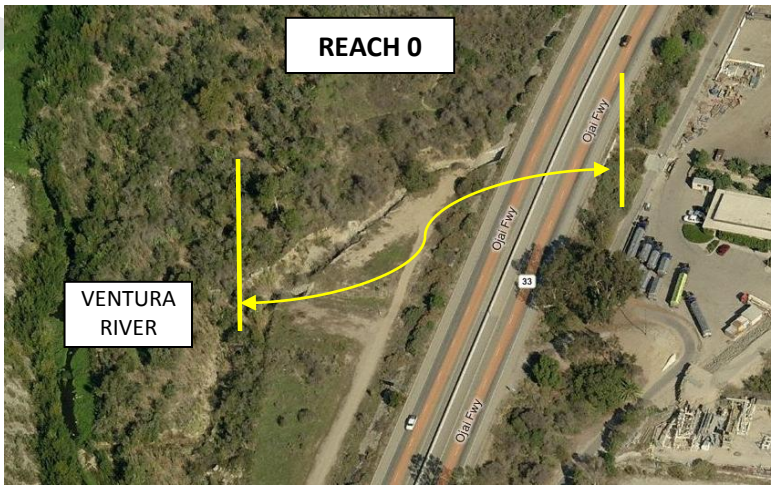


Figure 2 Existing Drainage Facilities

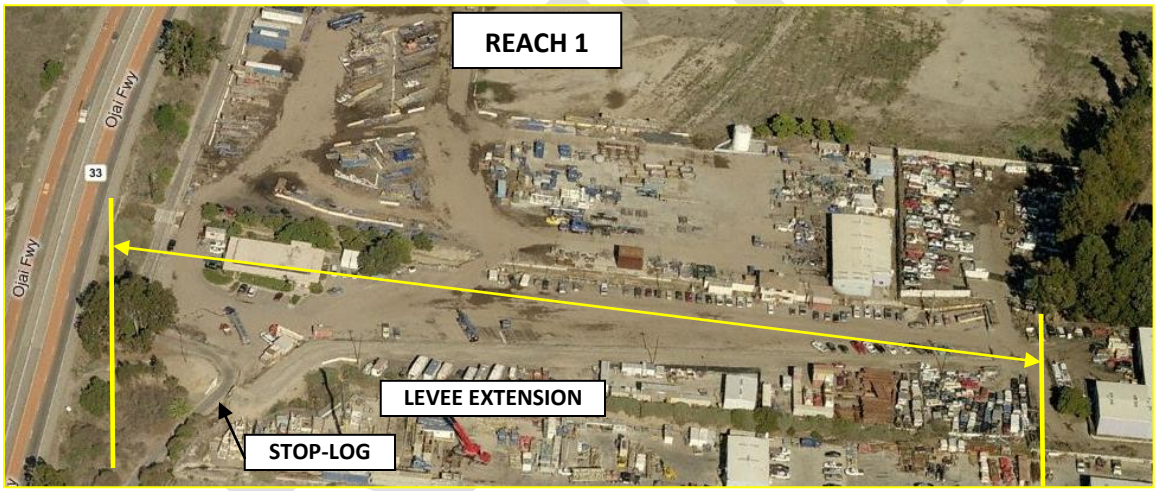
For analysis and discussion purposes, the channel system is divided into Reaches 1 through 4. Reach 0 is referred to the downstream confluence of CDSJ with the Ventura River, where no change or discussion is provided. Please see Figure 1 Location Map. The channel system flows through private properties for the most part. Please see the following property ownership and rights of way section of the report and the accompanying map below. Starting at the downstream end:

1. Study Reach 0 is the downstream end of CDSJ at Ventura River. There is a Double 10'x8' RCB culvert crossing under Highway 33, with a 9" center pier. The highway elevation is approximately 3.5' higher than the culvert soffit elevation at the upstream face, and 4' at the downstream face. The local Caltrans office provided some general construction plans and record drawings, but no structural



details. No change is proposed within Reach 0, therefore it was not included as a study reach.

2. Study Reach 1 is from east of Highway 33 to 930 feet upstream. It consists of a shallow varying rectangular open channel with several crossings. The base width varies from 11' to 20' and the height varies from 2.5' to 4.5'. Parts of the channel are concrete-lined, with concrete columns, and pipes acting as channel walls. There is evidence of erosion and deposition within this reach. Ventura River Bike Trail Double 10'x5.5' RCB crosses the CDSJ just upstream of Highway 33. Construction plans and other permitting data are enclosed in the Technical Appendix. OST has two crossings within this reach. No construction plans were found for these crossings or the channel system. OST has built their dispatch office buildings on top of the CDSJ within this reach. They have indicated that they might move these structures at some point in the future. There is also another crossing at the upstream end of this reach, which accesses the Ramirez property.



An existing levee extension is located along the left bank (south bank) of the study reach. The levee extension used to be a continuation of the Ventura River Levee constructed by the US Army Corps of Engineers in the late 1940's. California State Department of Transportation (Caltrans) constructed Highway 33 in the middle to late 1950's on top of the existing levee immediately downstream of the CDSJ and Ventura River confluence.

In our opinion, because the upper portion of the Ventura River Levee along CDSJ is now structurally and hydraulically separated from Ventura River, it is referred to as the "Levee Extension" throughout this study report. Furthermore, because the Ventura River floodplain no longer inundates its historical left overbank (currently Salsipuedes/OST properties), this levee extension is technically not providing flood protection from Ventura River. Therefore, there is no reason to refer to it as the Ventura River Levee.

Old railroad tracks used to go through the levee, therefore an opening or gap was constructed in the levee. Currently, the Ventura River Bike Trail has replaced the railroad tracks through the levee opening. During the rainy season the stop-logs, which are stock-piled at the site, are used to close the gap in the levee extension.

3. Study Reach 2 is currently a natural earthen channel approximately 270 feet long. This reach starts at the Ramirez access bridge at the downstream end, and it ends at the outlet of the existing 8'x8' RCB at the upstream end. The channel mostly has a soft bottom and vegetated right (north side) slope; although there is evidence of hard surfacing and protection as well as deposition at the upstream end and erosion at the downstream end. The left bank (south side) is a vertical retaining wall along the Henderson property, propped up by metal pipes. No design drawings could be found for this wall in the County, District, or City archives and permit applications. The upstream end of the reach is the downstream outlet of District's 8'x8' RCB as well as the City of Ventura's 48" RCP outlet. The channel bottom at the upper end has shown deposition of as much as 4 feet over the years. District's maintenance staff have a difficult time accessing this channel due to easement and location difficulties.

4. Study Reach 3 is District's Reinforced Concrete Box (RCB) and the culvert under Ventura Avenue, approximately 540 feet long. The 8'x8' RCB was built in 1960, and it is clear of debris at the upper end as it is a steep conduit. However, the lower end has silted up to 4 feet and the invert of the energy dissipator is completely buried. WSPG and HEC-RAS models indicate that the RCB capacity varies between 650 cfs with 4' of deposition and backwater condition to approximately 1200 cfs assuming clear 8'x8' RCB with no backwater condition or limitation.

The Ventura Avenue culvert is rather old and it is in need of repair or replacement. It appears to have been built by the State when Ventura Avenue was the State Highway before Highway 33 was constructed. It starts as a 15'x8' RCB at the inlet in front of an arched box conduit. The arched box conduit is made up of concreted masonry blocks, which are visible on the inside. The downstream end of the arched box conduit is a rectangular box, which drops and transitions to the 8'x8' RCB. District's Y-1-0004 record drawings start downstream of the Ventura Avenue culvert and end at the energy dissipator structure at the end of the 8'x8' RCB.

5. Study Reach 4 is a natural earthen channel upstream of Ventura Avenue parallel to School Canyon Road. The main channel is generally trapezoidal in shape (the left channel wall along the road is somewhat vertical), and it varies in depth from 10-20 feet (below the road elevation), and averages 40-50 feet wide from top of bank to top of bank. Trees, shrubs and numerous oil and gas pipelines extend within and across the channel in this reach. Reach 4 is believed to have adequate hydraulic capacity to carry the 100-year flood, so long as there is no backwater limitation at Ventura Avenue. That is to say that if and when the Ventura Avenue culvert is improved and enlarged, the 100-year flood will be conveyed safely. Under present condition, the 100-year flood will overtop its south bank approximately 150-300' upstream of the Ventura Avenue culvert. Slope protection has been placed along the channel in different places, but there is still evidence of erosion. Sediment transport within this reach may be out of balance as a result of upstream sediment traps and basins. Sedimentation analysis is not part of the current Scope of Work.

There are many oil pipelines within this reach; some are active and some may be inactive or abandoned. Some of these oil and gas pipelines are exposed without proper support. The pipes need to be identified, replaced, or relocated in order to prevent any blockage of the Ventura Avenue culvert and accumulation of debris during high flows.

2.2 Property Ownership & Rights of Way

The following Figure 3 shows the property ownership and District's Rights of Way within Reaches 1, 2, and 3. The ownership information is per 2010 Ventura County Assessor information.

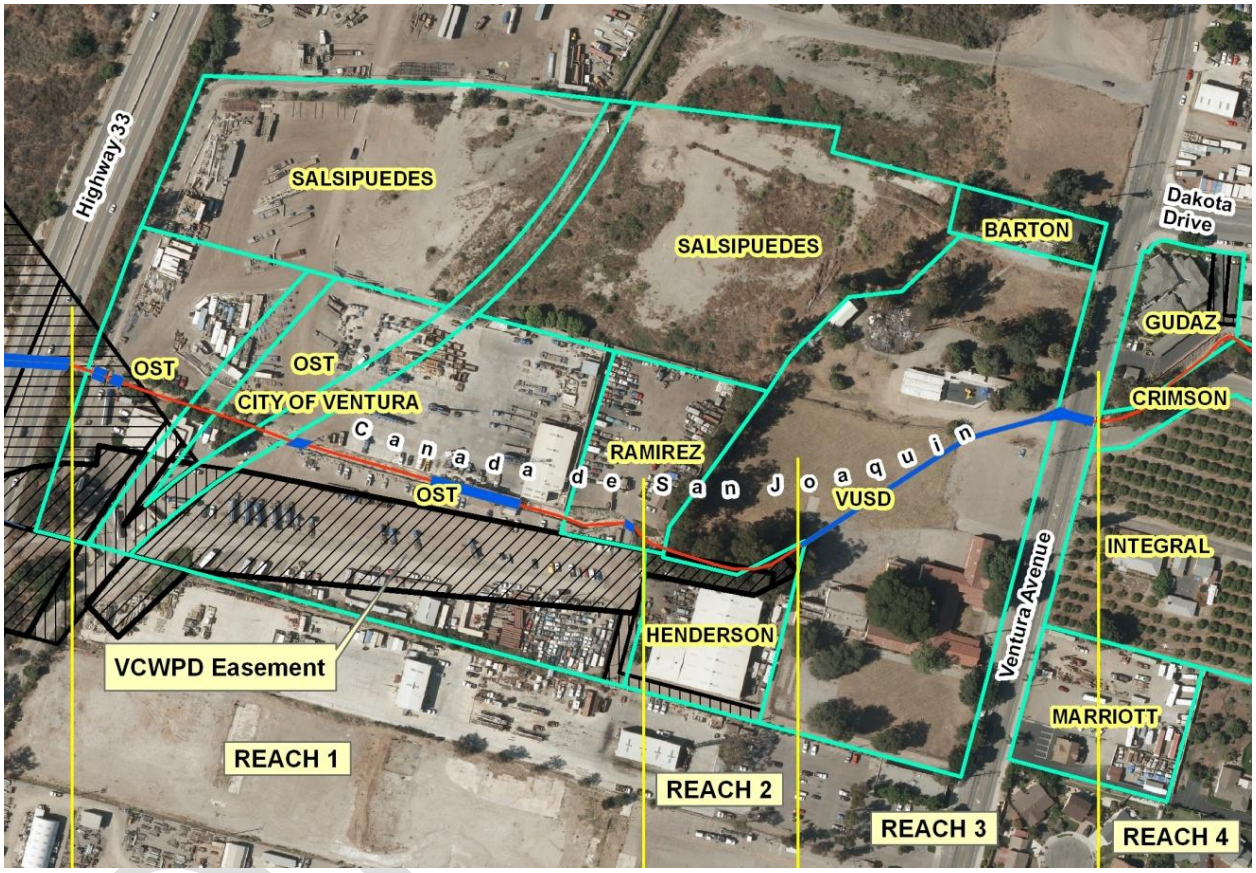


Figure 3 Property Ownership & Rights of Way

1. Study Reach 1 is primarily within the private industrial property of the Oilfield, Truck, & Service, Company (OST). The upstream 120' of the channel is within the Ramirez property. The old railroad right of way now belongs to the City of Ventura. The District has a permanent drainage easement over the levee extension for "all purposes of flood control and river protection including construction of a permanent levee and relocation of utilities and pipelines in conjunction with said levee". District also has an access and maintenance easements in this reach.

2. Study Reach 2 is within the Henderson property, where they have built a retaining wall. Even though the District has a flood control and water conservation easement in this reach to access the 8'x8' RCB outlet, Operations & Maintenance Division (O&M) staff indicate that they do not maintain the outlet structure because the banks alongside the channel are steep and heavily vegetated with large trees, etc.

Access would have to be from either along the channel from downstream, or from the top of the bank from the old Avenue School property. At the present time, there is no safe and manageable access to the RCB and outlet structure.

3. Study Reach 3 is within the Ventura Unified School District property, locally known as the old Avenue School property. This property has been abandoned and boarded up for many years.

4. Study Reach 4 is within several private properties. The District also owns two fee parcels X & Y of Tract 1458, which were accepted in 1963, after the tract was constructed that year.

2.3 Effective & Revised Flood Insurance Study

On January 20, 2010, the new Countywide Flood Insurance Study (FIS) and Digital Flood Insurance Rate Maps (DFIRM) became effective. Two DFIRM Panels 06111C0733E, and 06111C0740E cover the CDSJ ponding area and the confluence with the Ventura River. The Effective DFIRM shows overflow from Ventura River ponding north of the levee extension (discussed in Section 2.1.2 above) up to elevation 109.0. Please see figure below.

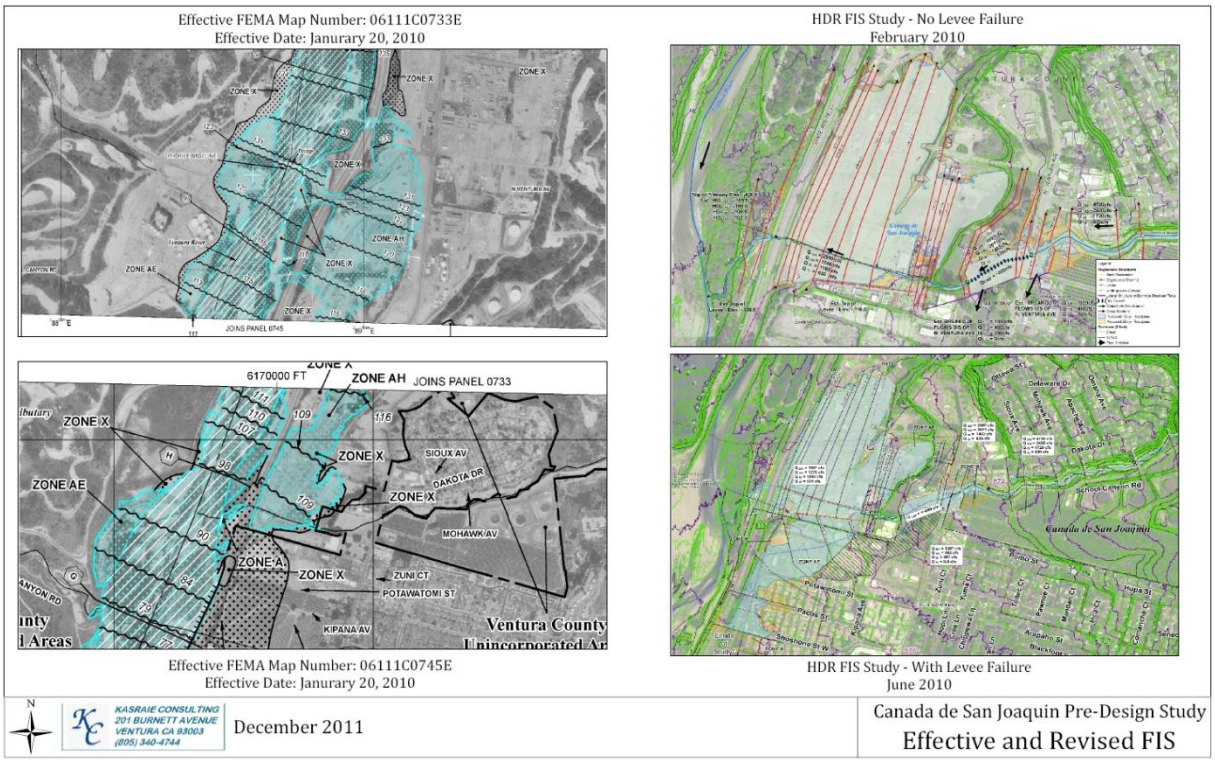


Figure 4 Effective & Revised Flood Insurance Study

HDR, Inc. conducted two studies commissioned by FEMA for CDSJ in February and June 2010. The studies indicate that the Ventura River will no longer overflow its left bank and inundate the OST property area. However, the area would still be subject to flooding from CDSJ as a result of existing inadequacies in the drainage system from Ventura Avenue to Highway 33. The first study assumes the levee extension does not fail; in the second study the levee extension was assumed to have failed. The peak water surface elevation for the "With Levee Failure" is 106.3' and 108.1' for the "Without Levee Failure" at the stop-log area. The effective DFIRM shows a water surface elevation of 109.0 Zone AH.

Both of these studies are based on Steady State Peak Flow hydrology and Q100 of 2,420 cfs at Ventura Avenue.

District published a revised hydrology study in August 2010, entitled "Ventura River Watershed Design Modeling – Addendum 1", which provided a reduce Present Condition Q_{100} value of 1870 cfs at Ventura Avenue. Please see Chapter 3.0 Hydrology for more detail.

For floodplain analysis purposes, it is imperative that the entire hydrograph volume be taken into account not only the peak flow. Furthermore, the overflow situation is of a 2-dimensional nature, and modeling the peak flow as a 1-dimensional flow system results in erroneous and misleading results.

Please see Section 4 for a discussion of the existing condition hydraulic analysis, as well as the "Present Condition 100-Year Floodplain Map" prepared by KC.

2.4 Utilities

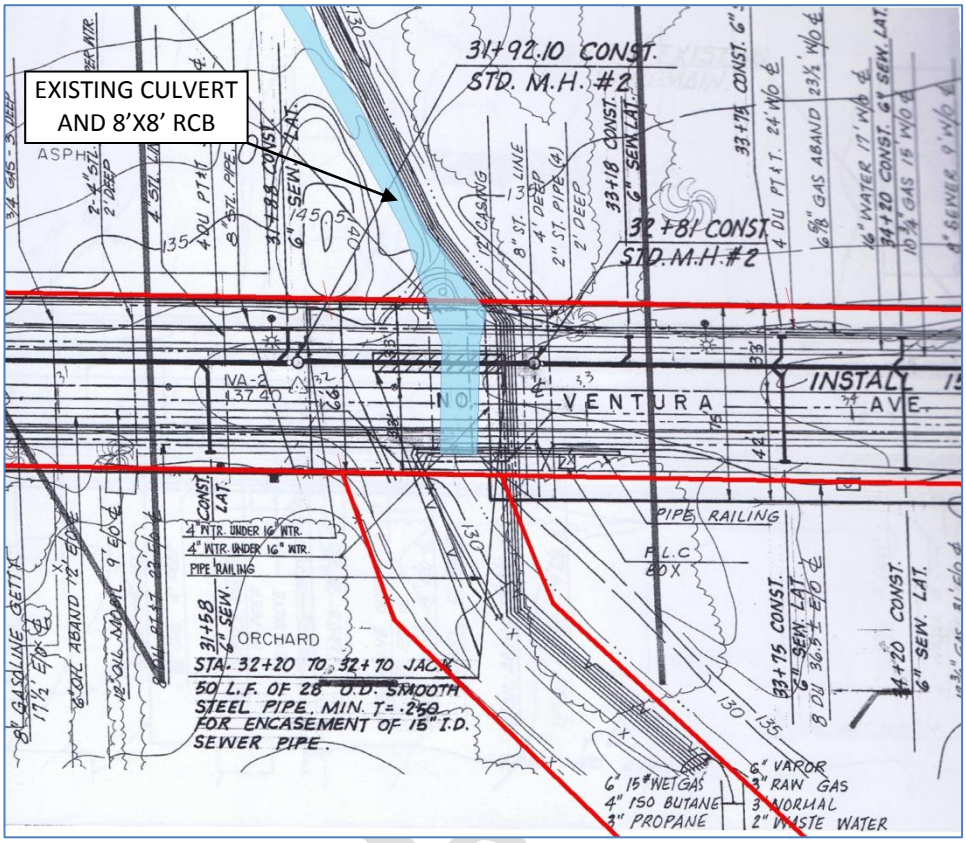
There are numerous utilities passing through the study area. The utility agencies listed below were contacted and advised of the Pre-Design Study ongoing within the CDSJ watershed. Any available as-built and/or Atlas maps of utility lines were requested from each agency and the status/result of those requests and contacts are contained in the summary table below. The documents provided by those agencies that responded can be found in the Technical Appendix – Utilities Section, in addition to the complete table of agency responses and actions taken to acquire the information. This task is ongoing, until all required data is collected.

Table 1 Utility Research

Name of Utility*	Contact Person	Address-Street	City-Zip	Phone Number	Utility Type / Size	Potential Conflict (Y / N)
Aera Energy, LLC	Louise Lampara	1800 School Canyon Road	Ventura, CA 93001	(805) 648-8382	N/A	No
Crimson Pipeline	Tony Valasques	210 N. 12th Street	Santa Paula, CA 93060	(805) 223-9602	No Response	No Response
Southern California Edison	Kim Gurule	PO Box 11982	Santa Ana, CA 92711	--	Poles and Electric Lines	Yes
City of Ventura	Chandra Chandra-shaker	PO Box 99	Ventura, CA 93002-0099	(805) 654-7714	8"/15" Swr 4"/12"/16"/ 24"/30" Wtr	Yes
Southern California Gas Company	Carlos Gaeta	9400 Oakdale Ave	Chatsworth, C A 91311	(818) 701-3225	2-16" HP 1-12" HP	Yes
Caltrans	Yan Moreles	157 South Garden Street	Ventura, CA 93001	(805) 654-4225	Dbl 10'x8' RCB-Hwy 33	No
United State Dept. of Transp.	Amy Nelson	1200 New Jersey Ave. SE	Washington, D.C. 20590	(202) 493-0591	Oil/Gas Database	Info. Only
Venoco, Inc.	Keith Wenal	5464 Carpinteria Ave	Carpinteria, CA 93013	(805) 745-2259	No Response	No Response

* The Phone and Cable TV companies have not been contacted, as their utilities are generally easier to move.

This sample utility plan shows the numerous utilities along (and crossing) Ventura Avenue, such as water, sewer, gas, cable, oil pipelines, telephone, etc. which will complicate future culvert constructions.



2.5 Topography

In addition to the 2005 Light Detection & Ranging (LiDAR) Bare Earth data set available for the study area, 2010 aerial survey and topography prepared as part of District's Ventura River Levee project was also used. However, some inconsistencies were noticed in our Study Reaches 2 and 3 due to heavy vegetation. District agreed that additional field survey be performed to augment and expand the available topography.

Additional field survey was acquired in July 2011 by Hovell & Pilarski Engineering, Inc. with cooperation of Central Coast Aerial Mapping. This information is enclosed in the Technical Appendix.

For hydraulic analysis purposes, a composite topographic surface was created by merging the above data layers.

A composite topographic surface ("State Plane California V FIPS 0405 Feet" projection, horizontal datum NAD 1983, NAVD 88 vertical datum) representing existing ground conditions was created from two different topographic data sets:

- Starting just upstream of Ventura Avenue to the downstream study extent, elevations in the main channel and overbanks (approximately within 100 feet north and 300 feet south of the channel) are based on the available aerial survey.
- All other areas not listed above are based on the 2005 countywide Light Detection and Ranging (LIDAR) elevation points in NAVD88.

2.6 Vertical & Horizontal Datum

The above LiDAR and aerial survey and topographic maps are based on State Plane Coordinate System North American Datum (NAD) 1983 Zone V, Feet. The vertical datum is based on North American Vertical Datum (NAVD) 1988, Feet. Construction record drawings from the District and the City of Ventura are in National Geodetic Vertical Datum (NGVD) 1929, Feet. The NAVD 1988 elevations are higher than the NGVD 1929 elevations by a vertical datum shift of approximately 2.58 feet.

2.7 Field Visits

Several field site visits were conducted with District staff on October 21, 2010, February 4, 2011, February 8, 2011, May 11, 2011, and June 7, 2011. Over 130 photographs, and 25 video clips were taken during these site visits. This information is electronically cataloged in the Technical Appendix.

2.8 Record Drawings & As-Builts

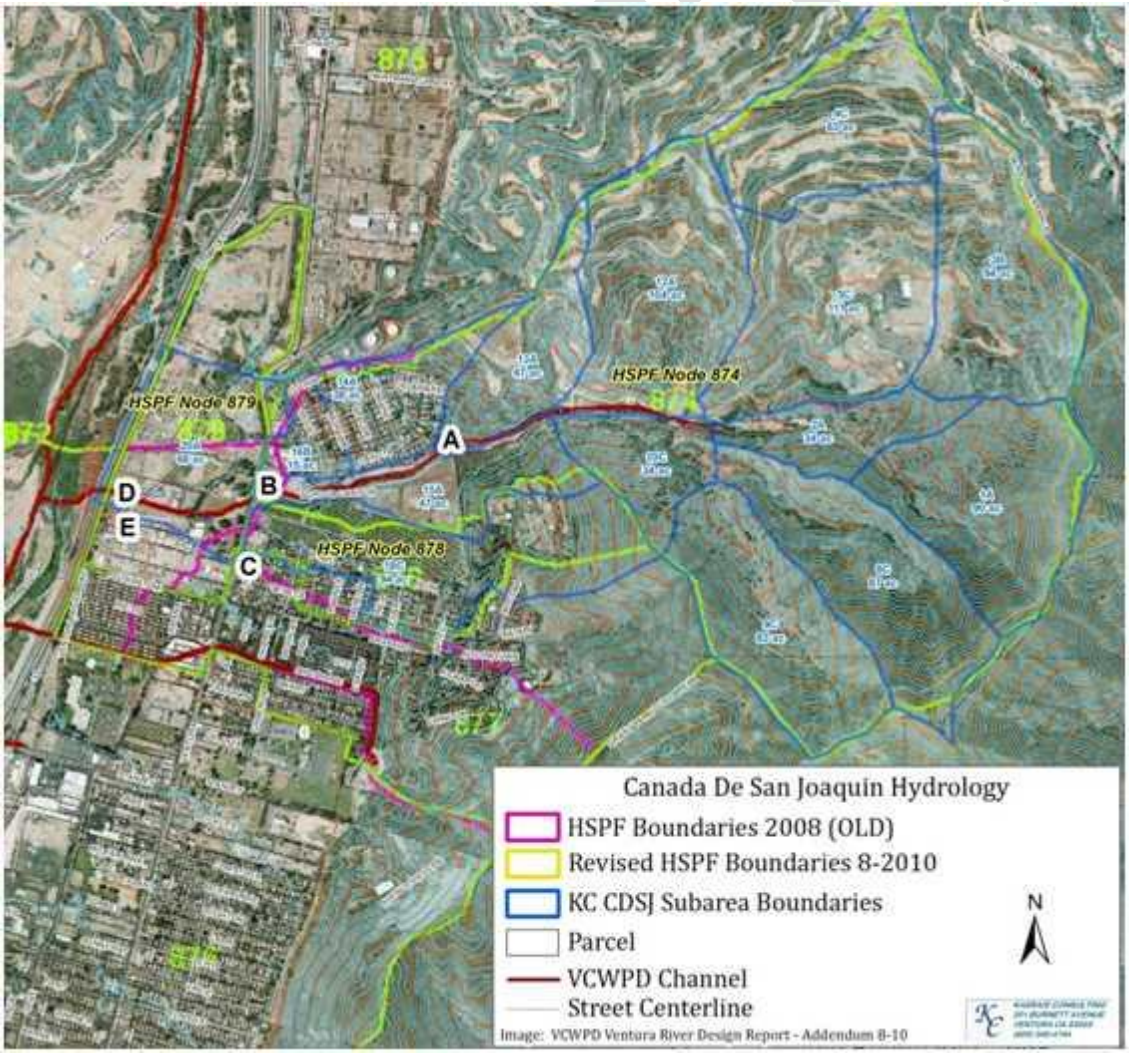
Record drawings available for District's 8'x8' RCB (Y-1-0004), along with several City of Ventura storm drain and water / sewer plans have been acquired and utilized for the project. This information is electronically cataloged in the Technical Appendix.

3. HYDROLOGY

3.1 General Watershed Description

Canada de San Joaquin (CDSJ) has a total drainage area of 1.5 square miles (point D) at its confluence with the Ventura River. Please see figure below. The upper portions of the watershed are undeveloped areas with some oil production facilities, while the lower portion of the watershed upstream of Ventura Avenue consist of a mix of existing and planned single family residential units. Downstream of Ventura Avenue, the watershed land use consists of an abandoned school property, industrial and maintenance yards for the various oil related facilities in the area.

The following hydrologic modeling section explains what the project hydrology is based on.



3.2 Hydrologic Modeling

Hydrologic conditions for the Ventura River Watershed were originally analyzed using the Hydrologic Simulation Program-FORTRAN (HSPF) model. The approach involved identifying a storm that caused saturated conditions in the model and then applying 100-yr design storm balanced hyetographs for each rain gage used in the HSPF model. Flood Frequency Analysis (FFA) results of stream data from gaged tributaries were used to calibrate the model in the modeling. Ungaged tributary HSPF results were verified by comparing the HSPF results to previous studies. Details and results are contained in the District Report entitled "Ventura River Watershed Design Storm Modeling" (February 2010).

Based on site-specific studies done since the release of the above "Ventura River Watershed Design Storm Modeling" (February 2010) report, District has updated the HSPF model for the CDSJ watershed. This updated information is included in their report "Ventura River Watershed Design Storm Modeling – Addendum 1" (August 2010), which can be found in the Technical Appendix. The model was adjusted by redelineating the Canada de San Joaquin watershed boundary based on other consultant feedback and field visits to the watershed. The watershed contributing flow to the culvert under Ventura Avenue was revised from 1,020 acres as shown in the original HSPF model (Tetra Tech, 2009) to 842 ac. in the revised model. Another 91 ac. of the of the original watershed (HSPF subarea 878 on hydrology map) drains to the downstream end of the CDSJ culvert under Ventura Avenue. In addition, a 121 ac. watershed (HSPF subarea 879) has been created from the portions of the two mainstem subareas to more accurately model the storage effects of the lower CDSJ in the vicinity of the OST Inc. yard. The original and revised HSPF boundaries are shown on the above Hydrology Map.

The resulting present land use condition 100-year peak discharge from the HSPF model at Ventura Avenue for HSPF subarea 874 decreased from 2,420 cfs to 1,870 cfs. The 100-year discharge for subarea 878 is 331 cfs. The outflow from HSPF subarea 879 after routing has a 100-year peak of 980 cfs. The hydrology results from the August 2010 Addendum were used for the present land use condition in this Pre-Design Study with some minor modification described below. Please see the above Hydrology Map and the following table of Present Land Use Condition Peak Flows.

Within the CDSJ watershed, the "Ventura River Watershed Design Storm Modeling – Addendum 1" (August 2010) provided peak flows at 4 locations. These locations are CDSJ above Ventura Avenue (Node 874), CDSJ Tributary above Ventura Avenue (Node 878), Lower CDSJ after routing (Node 879) and Lower CDSJ local inflow (Node 879).
After investigation of the local drainage network and subarea boundaries in addition to the planned and existing housing developments adjacent to the channel, Kasraie Consulting (KC) requested an additional flow location point upstream of Ventura Avenue at KC Subarea ID 13A (Map ID-A) as shown on the above Hydrology Map. To get the peak flow at this location District modified the HSPF model by adjusting the subarea boundary to match those provided by KC at this location. The estimated acreage at this point was 745 acres.

Using the USGS regression equation, a 100-year peak flow was estimated and the undeveloped ratios (Table 2) were applied to get the flows as shown on Table 3 - Present Land Use Condition Peak Flows and Table 4 – Future Land Use Condition Peak Flows.

Design storm ratios from "Table 12 - Ventura River Watershed Design Storm Modeling - Final Report" (February 2010) were used to convert the 100-year peak flows to other recurrence intervals. These ratios are listed below in Table 2.

Table 2 Design Storm Ratios from Multiple Gages – Undeveloped

Storm	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr
Design Storm Ratio from Multiple Gages	0.043	0.144	0.262	0.484	0.711	1.000	1.952

Table 3 Present Land Use Condition Peak Flows

Location	Map ID	HSPF Node	DA (ac)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Intermediate Point, Upper CDSJ*	**A**	874	746	73	243	443	818	1,202	**1,690**	3,300
CDSJ above Vta. Ave.	**B**	874	842	80	269	490	905	1,330	**1,870**	3,650
CDSJ Trib above Vta. Ave.	**C**	878	na	14	48	87	160	235	**331**	646
Lower CDSJ after routing	**D**	879	na	42	141	256	474	696	**979**	1,911
Lower CDSJ local inflow**	**E**	879	na	41	137	250	461	678	**953**	1,860

* Intermediate Point A 100-yr peak flow calculated by USGS regression equation. Other Frequencies for Point A calculated by using Design Storm Ratios shown in Table 2.

** Present Land Use Peak flow (Lower CDSJ local inflow) not used in analysis, due to inconsistencies with model results. Future Condition Land Use Peak Flow for the Lower CDSJ local inflow was used. See Table 4 below.

To acquire future condition peak flows, it was decided that District would adjust the land use within the existing HSPF model to reflect future land use conditions and the resultant future condition peak flows. The City of Ventura General Plan Land Use GIS layer was used to determine future land uses within the watershed (See Figure below). For the area upstream of Ventura Avenue, the main changes are from the orchard to medium residential and some open space in the hillsides that changed to low residential. No changes in land use type were noted for the lower portion of the watershed. See Table 4 – Future Condition Land Use Peak Flows.

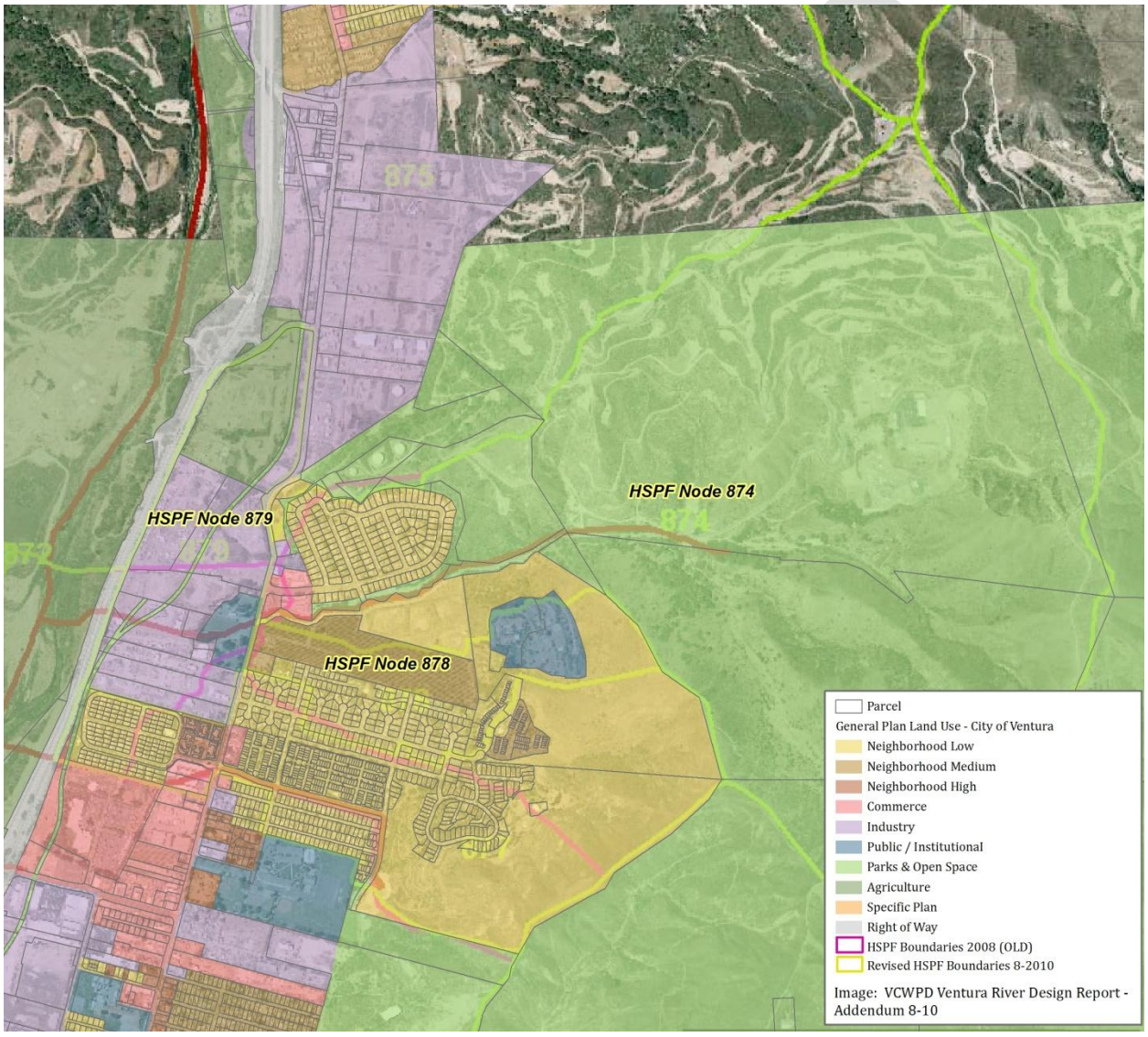


Figure 6 Future Condition Land Use Map

Table 4 Future Land Use Condition Peak Flows

Location	Map ID	HSPF Node	DA (ac)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Intermediate Point, Upper CDSJ*	**A**	874	746	73	246	448	827	1,215	**1,709**	3,335
CDSJ above Vta. Ave.	**B**	874	842	81	272	495	915	1,344	**1,890**	3,689
CDSJ Trib above Vta. Ave.	**C**	878	94	13	43	78	144	211	**297**	580
OST local inflow	**D**	879	68	4	14	25	45	67	**94**	183
Total Flow at Hwy 33 With Channel Improvement**	**E**	-	1,004	93	313	569	1,052	1,545	**2,173**	4,242
Total Flow at Hwy 33 With No Channel Improvement+	**E**	-	1,004	PONDED CONDITION OUTFLOW AND PEAK STAGE OVER THE OST AREA, WITH EXISTING INADQUATE FACILITIES					**1,121 (Peak Stage 104.1)**	N/A

* Intermediate Point A 100-yr peak flow calculated by USGS regression equation. Other Frequencies for Point A were calculated by using Design Storm Ratios shown in Table 2.

** HMS Model Results for Future Condition hydrology for Preliminary Alternative and Preferred Alternative design purposes through the OST property.

+ HMS Model Results assuming no channel improvements are made within the OST property. This also simulates the current condition ponding over the OST property.

3.3 Bulking

Due to the possible erosive nature of the upstream watershed areas and natural channel in addition to the recent wild fires within the watershed, bulking of the peak flows was considered.

However, based on the information that the District has gathered on historical sediment deposition, or the lack of it, in the watershed after the 2005 storms and fires, it was their conclusion that no bulking factor adjustment needed to be applied to the peak flows or hydrographs for this study.

3.4 Ponding over the OST Property

To more accurately determine the floodplain storage effects on the depth and extent of ponding area over the OST property, a level-pool "reservoir routing" procedure was performed using the provided hydrographs from the District. US Army Corps of Engineers Hydrologic Modeling System (HEC-HMS) version 3.1.0 was used for this purpose. Polygons were digitized using the 2005 LiDAR contours within this lower area and a stage storage discharge relationship was determined. It was noted during this investigation of the lower watershed (HSPF Node 879) the provided HSPF boundaries included areas that did not directly drain to the CDSJ channel. KC provided a revised boundary for this area (See the Hydrology Map) to the District. They reviewed the proposed boundary changes in the lower watershed and confirmed that engineering judgement could be used to pro-rate the hydrograph and peak flow for the local inflow due to the complex nature of the flow patterns and the fact that flow patterns in this area are affected more by the hydraulics than the topography (See Correspondence dated 3-22-2011 in Technical Appendix).

For reservoir routing purposes over the OST property, the stage-storage relationship was developed using the 2005 LiDAR, as mentioned earlier. The stage-discharge relationship at the inlet of Highway 33 Double 10'x8' RCB was based on a detailed WSPG hydraulic model, which will be explained in the next section of the Report.

Treating the floodplain storage and ponding over the OST property as a "reservoir" is in effect an unsteady (time-dependent) hydrograph analysis, which more accurately predicts the extent and depth of ponding over the area.

The effective FIS and FIRM date January 20, 2010 show a Zone AH ponding area up to Static Elevation 109. The preliminary revised FIS shows the ponding elevation to be in the 106-107 range. However, none of the above models took the volume and timing of hydrograph into account. The analysis presented in the report has taken this approach, and the resulting ponding elevation is calculated to be 103.9-104.5 feet (depending on outlet condition assumption at Highway 33), which is approximately 3' below the top of the levee extension at the stop-log location.

4. EXISTING FACILITIES HYDRAULIC ANALYSIS

In order to accurately analyze the hydraulics of the existing drainage facilities, both the Los Angeles County Department of Public Works Water Surface Pressure Gradient (WSPG) and the US Army Corps of Engineers River Analysis System (HEC-RAS) software were utilized. The following sections explain what was accomplished and what the results are. Because of differences in these two software programs (such as lack of overflow/split flow in WSPG), the calculated capacities are not necessarily the same, however there are a lot of similarities especially for small flows. Please see Figure 2 the Existing Drainage Facilities drawing in the Technical Appendix.

The following table summarizes the approximate capacities of the existing culverts and crossings based on the WSPG analyses:

Table 5 Culvert Crossing Capacities

ID	LOCATION	SIZE	CAPACITY (CFS)
1	At Highway 33	10'W x 8'H DBL Box Culvert	1,300
2	Ventura River Bike Trail Crossing	10'W x 5.5'H DBL Box Culvert	1,000
3	OST Downstream Crossing	18'W x 2.25'H Culvert	300
4	OST Upstream Crossing	16'W x 3.5'H Culvert	350
5	OST Buildings	Varies,15.75'W x 4.25'H to 13'W x 4'H	425
6	Ramirez Crossing	11.5'W x 3'H (avg.) Culvert	300
7	District RCB & Ventura Avenue Culvert (Current condition & with sediment deposit inside the box)	8'W x 8'H Box Culvert & 15'Wx8'H Box and Arch Culverts	650 - 800
8	District RCB & Ventura Avenue Culvert (Original design invert slope (no sediment) per Y-1-0004 Record Drawings)	8'W x 8'H Box Culvert & 15'Wx8'H Box and Arch Culverts	1,250
9	District RCB & Ventura Avenue Culvert (Gas Line 5.75' above Invert at Upstream Face of Culvert Obstructing the Flow)	8'W x 8'H Box Culvert & 15'Wx8'H Box and Arch Culverts	1,100

4.1 WSPG Models

The entire CDSJ drainage system from 300' upstream of Ventura Avenue to the confluence with Ventura River downstream of the Highway 33 was analyzed using WSPG. The model input and output files are enclosed in the Technical Appendix.

Because the channel system in the lower Study Reach 1 has several inadequate crossings, the existing condition WSPG model was rerun many times in order to determine the above channel system capacities.

4.2 HEC-RAS Models

Hydraulic characteristics were analyzed using the US Army Corps of Engineers Hydraulic Engineering Center's River Analysis System (HEC-RAS) version 4.1.0 software package. Multiple peak flow recurrence intervals were evaluated. Geometry data for the study area was derived from varying sources. ESRI's ArcMap, Spatial Analyst, 3D Analyst Geographical Information Systems (GIS) software and Hydrologic Engineering Center's Geo-RAS extension for ArcMap were used to evaluate each data source as well as create the base geometry used within the HEC-RAS model. Additional WSPG hydraulic model runs were created to analyze the capacity of the Ventura Avenue conduit as well as provide a quality control check for the HEC-RAS modeling.

Previous hydraulic modeling generated by HDR Engineering Inc, as part of the 2010 Ventura County Flood Insurance Study (FIS) was used as the initial base for the flood hazard assessment modeling along CDSJ. As part of this analysis, flood flows above and through the Ventura Avenue conduit were modeled as one. Resulting overflows were modeled leaving the channel in the vicinity of the conduit and continuing west and south along the levee extension. A second run assuming the levee failing was also generated, however it did not result in significant additional outflow to the south (69 cfs, <3% of the FIS 100-year peak flow at the upstream channel extent).

After review by KC staff, several adjustments were made for this project. Refinements include:

- Revised 100-year inflows.
- Accounting for flood storage modeled in HEC-HMS upstream of State Highway 33 on the OST property.
- Updating cross-section geometry and adding additional cross-sections based on the July 2011 aerial survey
- Updating structure geometry to included current field conditions (compacted sedimentation and transitions within the Ventura Avenue conduit)
- Defining separate reaches for the excess flow due to the lack of capacities of the Ventura Avenue conduit and the OST Property channel
- Creating a Manning's "n" GIS layer to better reflect field conditions

(a) Channel Geometry

The existing VCWPD jurisdictional channels shapefile was modified for CDSJ to better reflect the plans, aerial topography and photography. Resulting alignments were used as the basis for the hydraulic modeling.

A composite topographic surface ("State Plane California V FIPS 0405 Feet" projection, horizontal datum NAD 1983, NAVD 88 vertical datum) representing existing ground conditions was created from two different topographic data sets:

- Starting just upstream of Ventura Avenue to the downstream study extent, elevations in the main channel and overbanks (approximately within 100 feet north and 300 feet south of the channel) are based on the available aerial survey.
- All other areas not listed above are based on the 2005 countywide Light Detection and Ranging (LIDAR) elevation points in NAVD88.

Using HEC-GeoRAS, initial channel cross-sections at the same locations previously used by HDR Engineering Inc. were extracted from the surface. Additional cross-sections were added and the initial cross-sections in the overbank areas were refined to better define the Ventura Avenue conduit as well as the two new overflow areas.

(b) Manning's n-Values Roughness Factors

Available GIS land use planning boundaries were overlaid on the 2010 aerial photography. General land use categories were created based on this information. Manning's n-values were assigned to each category consistent with the District Design Manual and are listed in Table 6.

Table 6 Manning's "n" Values by Land Use Category

Land Use Category	Description	n-Value
Channel	Pipes in and across channel, shrubs and trees	**0.045**
Commercial	Larger value represents building effects on flow	**0.011**
Dense Trees and Schrubs		**0.045**
Engineered Channel	Sediment/silt bottom	**0.030-0.032**
Grass and Shrubs		**0.045**
Industrial	Asphalt, numerous trailers, and pipes	**0.040**
Large Stream Channel	Ventura River	**0.045-0.047**
Orchard		**0.070**
Public Institutional (School)	Includes large open area adjacent to school	**0.030**
RCB		**0.015**
Residential (< 0.25 acre lots)	Larger value represents building effects on flow	**0.110**
State Highway (and right of way)		**0.025**

(c) Ineffective Flow Areas/Contraction-Expansion Coefficients

Areas of ineffective flow were defined in large parts of the northern portions of the OST Property as well as along the levee near the downstream study extent. They reflect the estimated flow transition from the modeled right overbank (ROB) flow to the culvert flowing beneath State Highway 33.

Standard contraction/expansion coefficients of 0.1/0.3 were used for the majority of the cross-sections. For culvert/bridge crossings as well as internal transitions within the Ventura Avenue conduit, 0.3/0.5 was used.

(d) Levee Extension

As mentioned in Section 2.1.2, a levee extends approximately 1000 feet from the Ventura River to the most upstream OST /Ramirez Property crossing. There is a 20-foot wide opening in the levee extension for the Ventura River Bike Trail for the stop-logs. The bike path opening was modeled as being closed. The HMS model result concluded that the maximum 100-year ponding condition water surface elevation within the OST property would be 104.1 (to 104.5 depending on the outlet condition). Considering the top of the levee extension at the stop-log location is 107.19 (or higher), there is approximately 3' of freeboard. Therefore, the levee extension was not assumed to have failed, and the stop-log was assumed to be closed.

Even though the stop-log does not extend to the top of the levee, the District may be able to repair and raise it relatively easily and inexpensively. The stop-log opening walls within the levee extension are approximately 8.2' high. However, the I-beam slide for the logs is only 6' high. To get credit for the full height of the levee extension, the slide height will need to be raised so that more logs could be inserted to the top of the levee extension.

Due to the 2-dimensional nature of the overflow floodplain along CDSJ, and hydrograph timing and volume, a standard 1-dimensional Steady-State Peak Flow analysis is deemed inappropriate.

Even if different modeling renders a less than 3' freeboard, FEMA allows for a minimum freeboard of 2 feet with the appropriate documentation. So this may be another avenue that can be pursued in lieu of failing the levee extension.

This finding presents a smaller floodplain compared to FEMA's effective or recently revised Flood Insurance Studies.

4.3 HEC-RAS ANALYSIS RESULTS

A total of six reaches were used to model the existing condition hydraulics along CDSJ. Each are described below:

(a) Can San Joaquin Main 2

(Existing Creek Upstream of Ventura Avenue)

This reach extends from the upstream side of the Ventura Avenue conduit to the upstream extent of the study. 100-year flows are contained within the channel and do not affect any adjacent properties. Flows downstream of this section are split using a junction in HEC-RAS into two distinct flow paths representing the flow in the Ventura Avenue conduit (Can San Joaquin Main 2a) and overflow heading through the school property (Ventura Ave). They recombine at the downstream end of the conduit, forming a looped system.

(b) Can San Joaquin Main 2a

(Flow through Existing Ventura Avenue Culvert & District's 8'x8' RCB)

The Ventura Avenue conduit consists of multiple sections, each are listed below as well as the plan used if available:

- 5' long single cell 14.66'x8' RCB (no plan, invert defined by aerial topography)
- 37' long 14.66'x8' masonry arch (no plan)
- 50' long double RCB, cell width and height varies as you move downstream providing a transition to the 8'x8' RCB (County of Ventura Department of Public Works [CVDPW] plans Y-1-8 and Y-1-9)
- 425' 8'x8' RCB (CVDPW plans Y-1-8 and Y-1-9)

Each section within the conduit was modeled in HEC-RAS using a lidded cross-section to reflect the changes in geometry. Pressure flow can be determined within HEC-RAS using lids as long as the top is not exceeded by the hydraulic grade line (HGL). Since we are modeling the overflow on top of the conduit separately, the top of the lid was artificially increased in the model to maintain correct pressure calculations. A significant amount of sediment has settled and compacted at the downstream end of the conduit (approximately 3.9' deep based on field measurements and the aerial topography). It is represented in the model using a blocked obstruction along the bottom of the channel. Using this methodology the upstream junction balances the water surface elevations of the conduit and overflow resulting in 936 cfs through the conduit (the remaining 954 cfs flows above the conduit). Flows within the reach recombine with the overflow (Ventura Avenue) downstream of the conduit outlet.

(c) Ventura Avenue

(Overflow above Existing Ventura Avenue Culvert & District's 8'x8' RCB)

Cross-sections were extracted along the top of the Ventura Avenue conduit representing the excess flows from the conduit. A calculated overflow of 954 cfs results in a fairly wide floodplain that is contained within the extent of the cross-sections. Although some minor flow not shown in the model may occur down Ventura Avenue itself, the original outflow to the south defined by HDR Engineering Inc. in the submitted FIS model was not used since the majority will run along the top of the conduit and eventually free falling, combining with the main channel.

(d) Can San Joaquin Main 2b

(Flow along Existing Alignment from 8'x8' RCB Outlet to Middle of OST Property)

Cross-sections along the apron/outlet structure of the Ventura Avenue conduit are covered by sediment. This was modeled in HEC-RAS using blocked obstructions based on the aerial topography (the original invert is based on the CVDPW plans). From the downstream end of the Ventura Avenue conduit to approximately 40 feet the most upstream OST / Ramirez Property crossing, flows are contained due to the high embankment elevations formed by the School Canyon Road to the south and the adjacent bluff to the north. The bluff on the north side ends at this point (turns north).

Downstream of the bluff, lack of structure flow capacity and the decrease in right channel embankment results in the flows no longer being contained. Excess flow leaves the channel to the north (to the reach defined as *Can San Joaquin2 Overbank*) and is modeled using lateral structures along the right embankment elevation. At the downstream end of the reach, only 655 cfs remains in the main channel.

(e) Can San Joaquin2 Overbank

(Overflow through Ramirez and OST Properties)

Outflows from the main channel require a quasi 2-dimensional approach using the 1-dimensional HEC-RAS model to accurately evaluate the potential flood hazards. A flow path heading north through the Ramirez Property, eventually turning westward parallel to the main channel was defined. Flows are eventually re-combined with the main channel approximately 330 feet downstream of the most upstream OST / Ramirez Property crossing.

(f) Can San Joaquin Main 1

(Flow Along Existing Alignment from Middle of OST Property to Ventura River Confluence)

The Double 10'x8' RCB under the Highway 33 form a significant constriction along the CDSJ floodplain creating a large storage area upstream of the inlet. A rating curve for the structure was developed using HEC-RAS and storage area/depth relationships were determined from the available topography. Both were used in HEC_HMS to determine a peak outflow of 970 cfs and water surface elevation of 104.5' (NAVD). Plugging the resulting 970 cfs back into the final HEC-RAS model containing all of the model reaches results in a water surface elevation 103.9' (NAVD), which is within acceptable tolerance of the HEC-HMS results.

5. FLOOD DAMAGE ASSESSMENT

5.1 Current Level of Protection

To alleviate flooding, it is imperative that the current level of flood protection be established. The following table summarizes the protection levels in the form of storm frequencies. The basis for this information is the hydraulic modeling results that were explained in Section 4 and presented in Table 5.

Table 7 Level of Protection of Existing Drainage Facilities

ID	LOCATION	Estimated Flow Capacity, cfs	Existing Level of Flood Protection (Years)
1	Highway 33 Culvert	1,340 - 2,200	30yr – 100yr*
2	Ventura River Bike Trail Crossing	970	25yr
3	OST & Ramirez Crossings	300 - 425	5-yr
4	District RCB & Ventura Avenue Culvert	650 - 1,250	15yr – 40yr

* Highway 33 Double 10'x8' RCB can convey more flow with improved inlet as super-critical flow.

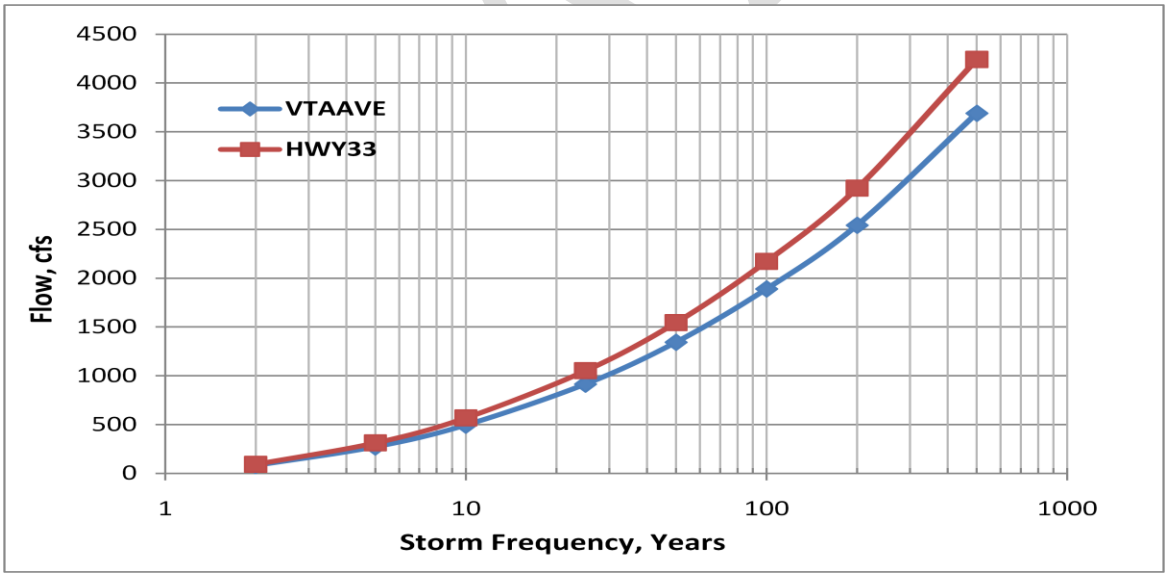


Figure 7 Level of Protection Storm Frequency

5.2 Flood Damage Costs

Because the existing drainage facilities upstream of Highway 33 only provide a 5-year to 40-year level of protection, during the 100-year storm event, the area adjacent to the stream will experience flooding. Exhibit 1, Present Condition 100-year Floodplain Map shows the predicted extent of flooding during a 100-year storm event. Due to inherent uncertainty of hydrologic modeling, sedimentation and blockage, the floodplain map also includes a wider advisory Shaded Zone X (average 100-year flood depths less than 1 foot) is also drawn just outside the computed 100-year floodplain.
District's Advance Planning Section provided a flood damage procedure based on the US Department of Housing and Urban Development (HUD) methods and parameters.
Flood damages to the affected structures were assessed by estimating an average 100-year flood depth at each of the 18 structures shown in the flood hazard map below.

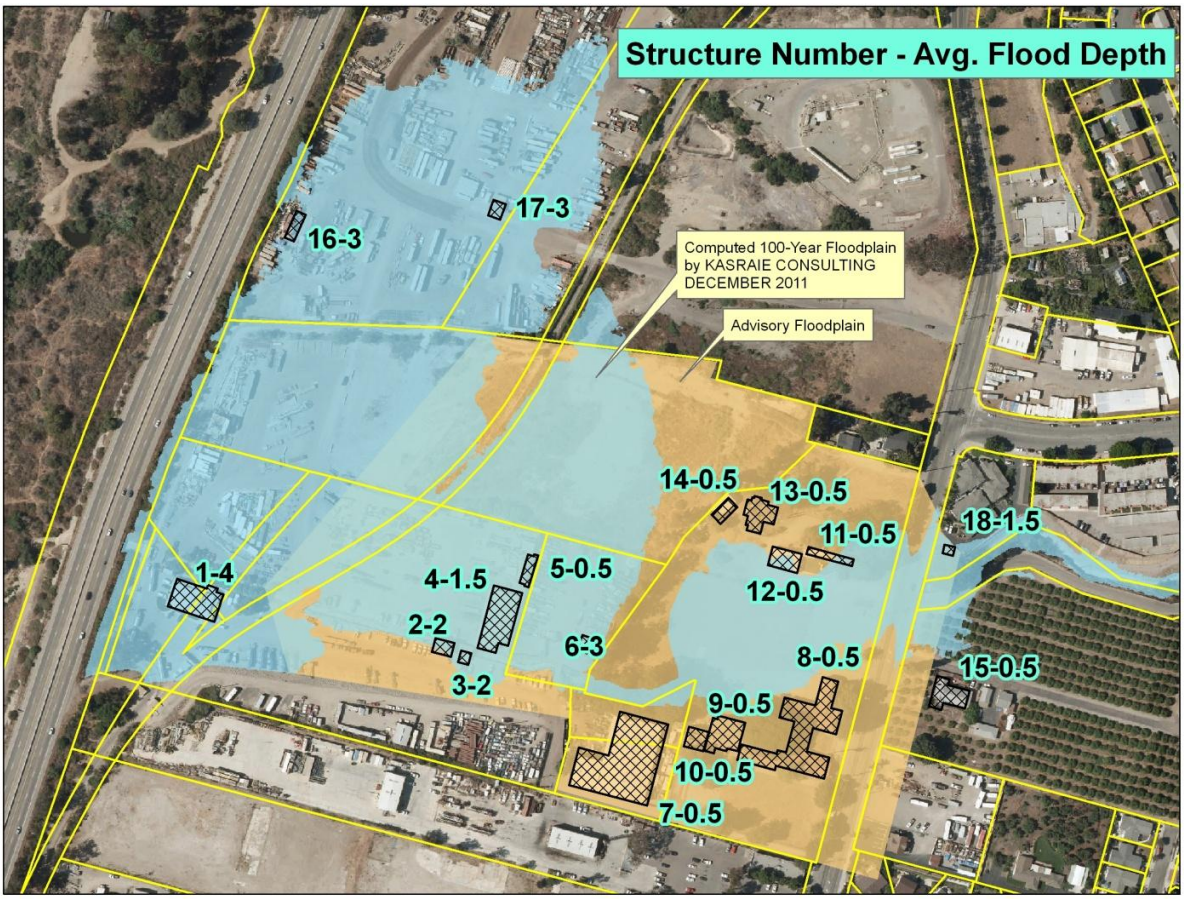


Figure 8 Flood Damage Assessment Map

Based on structure type, land use, and average 100-year flood depth at each structure, a HUD factor was determined. This factor is then applied to the replacement cost of the structure.

Estimating existing commercial and industrial building replacement cost is rather difficult, due to geographic and economic variability. However, Oltmans Construction Company's May 2010 Unit Building Costs for "Tilt Up" structures was used in order to estimate building replacement costs. As can be seen in the Technical Appendix, since all the affected structures were less than 7,500 square feet in area, a constant $77.00 per square foot building cost was used for all structures. This is a conservative assumption, as there are steel industrial structures, an abandoned school property, and some other structures, which would cost less to replace. The following table summarizes the results of the Flood Damage Assessment calculations. The total replacement cost of the affected structures is $ 3.2M, with an estimated Flood Damage Cost of $ 640,000. It should be pointed out that the extent of flooding computed is smaller than what was assumed for these calculations. It is to say that some of the structures accounted for in the flood damage calculations may not be flooded, or they may be flooded at lower depths to be conservative.

Table 8 Flood Damage Cost

STR. ID NUMBER	STRUCTURE TYPE	AVG. FLOOD DEPTH	SURFACE AREA (SQFT)	AVERAGE GROUND ELEV.	OLTMANS COST ($/SQFT)	ESTIMATED REPLACEMNT COST	HUD FACTOR	ESTIMATED DAMAGE COST
1	OFFICE	4.0'	6,058	102.7	$77	$466,466	0.403	$187,753
2	OFFICE	2.0'	1,137	106.5	$77	$87,549	0.221	$19,305
3	OFFICE	2.0'	521	108.0	$77	$40,117	0.221	$8,846
4	INDUSTRIAL	1.5'	7,355	107.7	$77	$566,335	0.190	$107,604
5	INDUSTRIAL	0.5'	1,294	107.9	$77	$99,638	0.132	$13,182
6	INDUSTRIAL	3.0'	669	110.6	$77	$51,513	0.362	$18,622
7	INDUSTRIAL	0.5'	2,223	125.6	$77	$171,171	0.132	$22,646
8	SCHOOL	0.5'	1,622	132.8	$77	$124,894	0.132	$16,523
9	SCHOOL	0.5'	4,320	130.0	$77	$332,640	0.132	$44,008
10	SCHOOL	0.5'	1,642	128.9	$77	$126,434	0.132	$16,727
11	SCHOOL	0.5'	1,365	136.4	$77	$105,105	0.132	$13,905
12	SCHOOL	0.5'	2,428	134.7	$77	$186,956	0.132	$24,734
13	SCHOOL	0.5'	3,329	134.2	$77	$256,333	0.132	$33,913
14	SCHOOL	0.5'	1,256	130.9	$77	$96,712	0.132	$12,795
15	OFFICE	0.5'	3,393	140.6	$77	$261,261	0.132	$34,565
16	INDUSTRIAL	3.0'	1,229	103.7	$77	$94,633	0.362	$34,210
17	INDUSTRIAL	3.0'	880	104.3	$77	$67,760	0.362	$24,495
18	OFFICE	1.5'	397	141.2	$77	$30,569	0.190	$5,808
						$3,166,086		**$639,641**

6. PRELIMINARY ALTERNATIVES ANALYSES

Five Preliminary Alternatives have been studied as part of the CDSJ Pre-Design Study. Please see Exhibits 4 through 8 for the alignment and geometry of the various alternatives.

All the preliminary alternatives involve replacing the open channel through the Ramirez and OST properties in Reach 1 with a new RCC, along the same alignment. For Reach 2, several options are evaluated, such as replacing it with rock riprap, an RCC, or bypassing it altogether and keeping it natural. Reach 3 involves the existing 8'x8' RCB and the Ventura Avenue Culvert. Several options were looked at, which involve replacing the entire facility due to its age, adding a parallel RCB, as well as a bypass detention basin concept within the Avenue School property. No change to Reach 4 is anticipated other than constructing a new inlet structure and improving the approach channel just upstream of Ventura Avenue.

All the hydraulic modeling for the four alternatives is based on the WSPG software, which is routinely used by the District for projects of this sort. Hydrologic modeling for Alternative 4 is based on HMS, since it involves reservoir routing and hydrograph analysis.

Representative sample Freeboard Calculations are provided in Section 6.5. Order of Magnitude Engineer's Cost Estimates have been prepared, and discussed in Section 6.6

The four alternatives are as follows:

6.1 Alternative 1

Reach 1

A 20' wide RCC with a channel height varying from 4.5' to 6.5' is anticipated in this reach. There will be a total of 4 bridge crossings, Ventura River Bike Trail, two crossings within the OST property, and one for the Ramirez property. The channel will be built along the existing alignment. Bridge crossings will replace the existing crossings. No access road is deemed necessary since both sides of the channel are paved and accessible. The channel top of wall will be flush with the adjacent ground at the upper end, but it will be extruded above ground at the lower end due to flatter slopes. The overall channel slope in this reach will be in the range of 0.006 – 0.017.

Reach 2
This reach will be a grouted rock rip rap channel, 14' wide, 6'-8' high at 1:1 side slope. The flow velocity will be 13-20 fps. There will a warped transition structure at the downstream end and a wall exit at the upstream end of the reach. The overall slope in this reach will be 0.015.

Reach 3
The existing 8'x8' RCB in this reach will be replaced by a 14x8 RCB in the existing alignment plus new inlet/outlet structures. The Ventura Avenue Arch/Box culvert will be replaced by a single 18'x8' RCB, with the required inlet and transition structure. The Ventura Avenue culvert will need to be constructed in the same exact alignment and at the same invert profile as the existing culvert due to numerous utilities crossing the structure, especially gas lines and a major City sewer line.

6.2 Alternative 2

Reach 1
This will be the same as Alternative 1 for this reach.
A 20' wide RCC with a channel height varying from 4.5' to 6.5 is anticipated in this reach. There will be a total of 4 bridge crossings, Ventura River Bike Trail, two crossings within the OST property, and one for the Ramirez property. The channel will be built along the existing alignment. Bridge crossings will replace the existing crossings. No access road is deemed necessary since the channel depth is not deep. The channel top of wall will be flush with the adjacent ground at the upper end, but it will be extruded above ground at the lower end due to flatter slopes. The overall channel slope in this reach will be in the range of 0.006 – 0.017.

Reach 2
This will be the same as Alternative 1 for this reach.
This reach will be a grouted rock rip rap channel, 14' wide, 6'-8' high at 1:1 side slope. The flow velocity will be 13-20 fps. There will a warped transition structure at the downstream end and a wall exit at the upstream end of the reach. The overall slope in this reach will be 0.015.

Reach 3

Assuming the existing 8'x8' RCB is structurally sound, and the District finds it safe to operate for many years to come, a parallel 9x6 RCB can be constructed along the existing 8'x8' RCB plus new inlet/bifurcation and outlet structures. The parallel box conduit will be at a slope of 0.008, with flow velocity in the range of 19-27 fps. The double box outlet structure will wall exit to the grouted rock rip rap channel.

The Ventura Avenue Culvert segment will be the same as Alternative 1. This Arch/Box culvert will be replaced by a single 18'x8' RCB, with the required inlet and transition structures. The Ventura Avenue culvert will need to be constructed in the same exact alignment and at the same invert profile as the existing culvert due to numerous utilities crossing the structure, especially gas lines and a major City sewer line.

6.3 Alternative 3

Reach 1

This will be the same as Alternative 1 for this reach.

A 20' wide RCC with a channel height varying from 4.5' to 6.5 is anticipated in this reach. There will be a total of 4 bridge crossings, Ventura River Bike Trail, two crossings within the OST property, and one for the Ramirez property. The channel will be built along the existing alignment. Bridge crossings will replace the existing crossings. No access road is deemed necessary since the channel depth is not deep. The channel top of wall will be flush with the adjacent ground at the upper end, but it will be extruded above ground at the lower end due to flatter slopes. The overall channel slope in this reach will be in the range of 0.006 – 0.017.

Reaches 2 & 3

A new 600' long 14x8 RCB will replace the existing 8'x8' RCB in Reach 3, and will go parallel the existing natural channel in Reach 2 within the Avenue School property. This box conduit will connect directly with the downstream Reach 1 20x4.5 RCB/RCC system at the Ramirez crossing. The flow velocity will be approximately 25-27 fps. The advantage of this alternative is that the 50-year old 8'x8' RCB will no longer be used and it may be abandoned in place. Furthermore, the natural channel reach in Reach 2 will be bypassed completely, except at the lower end where the 14x8 RCB will drop and transition to the downstream Reach 1. Because the City's 48" RCP will still be draining into the natural channel, an inlet/junction will need to be constructed as part of the transition structure at the upstream end of Reach 1.

6.4 Alternative 4

Reach 1
Similar to Alternative 1, a new RCC with 4 crossings will be constructed in this reach through the OST and Ramirez properties, however, this RCC will only be 14-16' wide and 4.5-6.5' high. Therefore, it will be smaller and less expensive than the previous alternatives.

Reach 2
The upper end of Reach 2 is where the outlet of the existing 8'x8' RCB, the City's 48" RCP, and the proposed bypass detention basin outlet will confluence. A new 14x6 RCC will connect the triple junction to the downstream Reach 1. Therefore, the natural channel will be replaced with a new RCC. This is also important in that the re-grading through this reach will further stabilize the retaining wall along the Henderson property.

Reach 3
If the Ventura Unified School District (VUSD) is agreeable to the sale or transfer of a part of their property, a new Bypass Detention Basin and bifurcation structure will be constructed in the open areas of the Avenue School property north of the existing school building. The detention basin will be approximately 20' deep and 1.25 acres in area.

A new 18'x8' RCB culvert will cross the Ventura Avenue transitioning to a bifurcation structure. This structure will split the flows above a 25-year event so that the existing 8'x8' RCB will carry Q25 flow (915 cfs) (bottom part of the hydrograph), and the balance (975 cfs, top part of the hydrograph) will spill into the bypass detention basin.

The detention basin will have an intake riser structure with a low-level 24" outlet pipe, which connects with the extension of the 8'x8' RCB and junctions with the City's 48" RCP and the new RCC in Reach 2.

Table 9 Bypass Detention Basin Parameters

BYPASS DETENTION BASIN & BIFURCATION STRUCTURE		
	Flow	Volume/Stage
Q100 Upstream of Bifurcation Structure D/S Ventura Ave.	1,890 cfs	300.4 ac-ft
Q100 to Existing 8'x8' RCB	915 cfs	286.9 ac-ft
Q100 Inflow to Bypass Detention Basin	975 cfs	13.6 ac-ft
Q100 Peak Outflow from Bypass Detention Basin	53 cfs	13.6 ac-ft
Peak Storage in Bypass Detention Basin	53 cfs	12.4 ac-ft
Peak Stage in Bypass Detention Basin	53 cfs	127.0 ft

6.5 Alternative 5

Reach 1

A 20' wide RCC with a channel height varying from 4.0' to 6.0' is anticipated in this reach. There will be a total of 2 bridge crossings; Ventura River Bike Trail, and one crossing within the OST property at the west end. The channel will be built along the north property line. Bridge crossings will replace the existing crossings. The channel top of wall will be flush with the adjacent ground at the upper end, but it will be extruded above ground at the lower end due to flatter channel slope. The overall channel slope in this reach will be in the range of 0.005 – 0.011. No access road is deemed necessary since both sides of the channel are paved and accessible. An access easement may be negotiated with the property owners for joint use. District may also consider having a moveable fence on top of the channel wall or long sliding gates. Land acquisition cost has not been added to the cost estimate, and it is assumed that a flood control easement would be granted to the District.

Reach 2

This reach will be a narrower 14' wide RCC with a channel height of 5.0' along the north property line. A 48" RCP will deliver water to the RCC from the existing natural channel (current alignment), mostly to convey runoff from the City's storm drain along the Henderson property.

Reach 3

The existing 8'x8' RCB in this reach will be abandoned in place or partially removed. A new 14'x7' RCB will run straight through from the Ventura Avenue culvert to Reach 2 parallel to the existing Head-Start classrooms. The Ventura Avenue Arch/Box culvert will be replaced by a single 18'x8' RCB, with the required inlet and transition structure. The Ventura Avenue culvert will need to be constructed in the same exact alignment and at the same invert profile as the existing culvert due to numerous utilities crossing the structure, especially gas lines and a major City sewer line. A sample utility plan is presented in Section 2.4, which shows the complexity of the existing utilities along Ventura Avenue, or crossing Ventura Avenue parallel to the existing culvert crossing.

6.6 Freeboard Calculations

For each of the hydraulic alternatives, the freeboard calculations were prepared using the VCWPD procedures, as follows:

Minimum Channel Height (MINHT) = Flow Depth +(H_1 + H_2 + H_3 +H_4)

H_1 = Air Entrainment
H_2 = Flow in the Unstable Zone
H_3 = Super-elevation
H_4 = Residual Freeboard

Typically, VCWPD freeboard requirement is based on the higher of the following two conditions:

1. 50-Year Flow Depth + Full Freeboard (H_1 + H_2 + H_3 +H_4) OR
2. 100-Year Flow Depth + Superelevation (H_3)

The only purpose behind these calculations is to estimate conservative channel heights for design and cost estimating purposes. These calculations currently do not apply to trapezoidal geometry, and not all the details such as transitions and some of the curvature data are taken into account. However, it is believed that the channel heights presented are conservative enough at the pre-design study (30%) level of detail. More detail will be taken into account during the final design phase of the project, or for the Preferred Alternative. Furthermore, during the final design phase, the hydraulic models will be fine-tuned and some of the calculated geometry might change.

The detailed freeboard calculations are provided in the Technical Appendix. However, summary tables are provided below.

ALTERNATIVE 1

			50-YEAR				100-YEAR				
	STA	BW	Q	DEPTH	MINHT	DIMENSION	Q	DEPTH	MINHT	DIMENSION	FINAL DIMENSIONS
REACH 1	1130.49	20.75	1537	4.20	5.12	20.8x5.1	2154	5.14	5.14	20.8x5.1	20'x4.5' TO 20'x5.5' RCC
	1170.00	20.00	1512	4.19	5.11	20.0x5.1	2120	5.13	5.13	20.0x5.1	
	1170.00	20.00	1512	4.19	5.11	20.0x5.1	2120	5.13	5.13	20.0x5.1	
	1300.00	20.00	1512	3.97	4.87	20.0x4.9	2120	4.88	4.88	20.0x4.9	
	1440.00	20.00	1512	3.68	4.55	20.0x4.6	2120	4.57	4.57	20.0x4.6	
	1795.00	20.00	1512	3.19	4.17	20.0x4.2	2120	4.12	4.12	20.0x4.1	
	2040.00	20.00	1512	3.12	4.13	20.0x4.1	2120	4.18	4.18	20.0x4.2	
	2065.00	20.00	1512	3.11	4.12	20.0x4.1	2120	4.18	4.18	20.0x4.2	
REACH 2	2125.00	14.00	1512	5.94	8.19	14.0x8.2	2120	7.04	7.04	14.0x7.0	ROCK RIPRAP TRAP BW=14 SS=1:1 HT=8'
	2325.00	14.00	1512	4.01	4.91	14.0x4.9	2120	4.79	4.79	14.0x4.8	
REACH 3	2335.00	14.00	1344	3.46	4.37	14.0x4.4	1890	4.22	4.22	14.0x4.2	14'x6' RCB
	2335.00	14.00	1344	4.46	5.41	14.0x5.4	1890	5.73	5.73	14.0x5.7	
	2550.00	14.00	1344	4.16	5.08	14.0x5.1	1890	5.43	5.43	14.0x5.4	
	2781.50	14.00	1344	3.68	4.77	14.0x4.8	1890	4.97	4.97	14.0x5.0	
VENTURA AVENUE CULVERT	2815.00	18.00	1344	5.57	8.02	18.0x8.0	1890	7.00	7.00	18.0x7.0	18'x8' RCB
	2870.00	18.00	1344	5.80	8.08	18.0x8.1	1890	7.32	7.32	18.0x7.3	
	2870.00	18.00	1344	5.80	8.07	18.0x8.1	1890	7.32	7.32	18.0x7.3	

ALTERNATIVE 2

			50-YEAR				100-YEAR				
	STA	BW	Q	DEPTH	MINHT	DIMENSION	Q	DEPTH	MINHT	DIMENSION	FINAL DIMENSIONS
REACH 1	1130.49	20.75	1537	4.20	5.12	20.8x5.1	2154	5.15	5.15	20.8x5.2	20'x4.5' TO 20'x5.5' RCC
	1170.00	20.00	1512	4.19	5.11	20.0x5.1	2120	5.14	5.14	20.0x5.1	
	1218.62	20.00	1512	4.11	5.02	20.0x5.0	2120	5.05	5.05	20.0x5.1	
	1300.00	20.00	1512	3.97	4.87	20.0x4.9	2120	4.89	4.89	20.0x4.9	
	1440.00	20.00	1512	3.68	4.55	20.0x4.6	2120	4.58	4.58	20.0x4.6	
	1463.66	20.00	1512	3.63	4.49	20.0x4.5	2120	4.53	4.53	20.0x4.5	
	1498.43	20.00	1512	3.55	4.41	20.0x4.4	2120	4.45	4.45	20.0x4.5	
	1980.59	20.00	1512	3.16	4.15	20.0x4.2	2120	4.20	4.20	20.0x4.2	
	2040.00	20.00	1512	3.15	4.14	20.0x4.1	2120	4.22	4.22	20.0x4.2	
	2065.00	20.00	1512	3.14	4.14	20.0x4.1	2120	4.24	4.24	20.0x4.2	
REACH 2	2125.00	14.00	1512	6.12	7.84	14.0x7.8	2120	7.43	7.43	14.0x7.4	ROCK RIPRAP TRAP BW=14 SS=1:1 HT=8'
	2315.00	14.00	1512	6.55	7.71	14.0x7.7	2120	7.88	7.88	14.0x7.9	
REACH 3	2335.00	12.00	1008	3.72	4.62	12.0x4.6	1400	4.72	4.72	12.0x4.7	PARALLEL 12'x5' RCB
	2781.50	12.00	1008	3.26	4.34	12.0x4.3	1400	4.29	4.29	12.0x4.3	
VENTURA AVENUE CULVERT	2815.00	18.00	1344	5.57	8.02	18.0x8.0	1890	7.00	7.00	18.0x7.0	18'x8' RCB
	2870.00	18.00	1344	5.80	8.08	18.0x8.1	1890	7.32	7.32	18.0x7.3	
	2870.00	18.00	1344	5.80	8.07	18.0x8.1	1890	7.32	7.32	18.0x7.3	

ALTERNATIVE 3

			50-YEAR				100-YEAR				
	STA	BW	Q	DEPTH	MINHT	DIMENSION	Q	DEPTH	MINHT	DIMENSION	FINAL DIMENSIONS
REACH 1	1130.49	20.75	1537	4.15	5.07	20.8x5.1	2154	5.01	5.01	20.8x5.0	20'x4.5' TO 20'x5.5' RCC
	1170.00	20.00	1512	4.12	5.03	20.0x5.0	2120	4.97	4.97	20.0x5.0	
	1170.00	20.00	1512	4.12	5.03	20.0x5.0	2120	4.97	4.97	20.0x5.0	
	1925.00	20.00	1512	2.87	3.98	20.0x4.0	2120	3.65	3.65	20.0x3.7	
	1980.59	20.00	1512	2.80	3.94	20.0x3.9	2120	3.59	3.59	20.0x3.6	
	1985.50	20.00	1512	2.79	3.93	20.0x3.9	2120	3.58	3.58	20.0x3.6	
	2040.00	20.00	1512	2.71	3.88	20.0x3.9	2120	3.52	3.52	20.0x3.5	
	2040.00	20.00	1512	2.71	3.88	20.0x3.9	2120	3.51	3.51	20.0x3.5	
	2040.10	20.00	1512	2.71	3.88	20.0x3.9	2120	3.52	3.52	20.0x3.5	
	2065.00	20.00	1512	2.67	3.86	20.0x3.9	2120	3.48	3.48	20.0x3.5	
	2065.10	20.00	1512	2.67	3.86	20.0x3.9	2120	3.48	3.48	20.0x3.5	
REACHES 2 & 3	2115.00	14.00	1344	4.18	5.10	14.0x5.1	1890	5.36	5.36	14.0x5.4	14'x6' RCB
	2115.10	14.00	1344	4.19	5.11	14.0x5.1	1890	5.36	5.36	14.0x5.4	
	2720.00	14.00	1344	3.68	4.77	14.0x4.8	1890	4.97	4.97	14.0x5.0	
VENTURA AVENUE CULVERT	2752.00	18.00	1344	5.57	8.02	18.0x8.0	1890	7.00	7.00	18.0x7.0	18'x8' RCB
	2820.00	18.00	1344	5.98	7.92	18.0x7.9	1890	7.51	7.51	18.0x7.5	
	2820.00	18.00	1344	5.98	7.91	18.0x7.9	1890	7.51	7.51	18.0x7.5	

ALTERNATIVE 4

			50-YEAR				100-YEAR				
	STA	BW	Q	DEPTH	MINHT	DIMENSION	Q	DEPTH	MINHT	DIMENSION	FINAL DIMENSIONS
REACH 1	1130.49	20.75	1097	2.84	3.62	20.8x3.6	1164	2.98	2.98	20.8x3.0	15'x4.5' TO 15'x5.5' RCC
	1170.00	15.00	1072	4.33	5.26	15.0x5.3	1130	4.47	4.47	15.0x4.5	
	1190.38	15.00	1072	4.30	5.23	15.0x5.2	1130	4.44	4.44	15.0x4.4	
	1530.66	15.00	1072	3.53	4.38	15.0x4.4	1130	3.66	3.66	15.0x3.7	
	1795.00	15.00	1072	3.26	4.16	15.0x4.2	1130	3.39	3.39	15.0x3.4	
	1880.00	15.00	1072	3.27	4.16	15.0x4.2	1130	3.40	3.40	15.0x3.4	
	1925.00	15.00	1072	3.28	4.17	15.0x4.2	1130	3.41	3.41	15.0x3.4	
	1980.59	15.00	1072	3.29	4.18	15.0x4.2	1130	3.42	3.42	15.0x3.4	
	2040.00	15.00	1072	3.31	4.19	15.0x4.2	1130	3.45	3.45	15.0x3.5	
REACH 2	2065.00	15.00	1072	3.31	4.18	15.0x4.2	1130	3.46	3.46	15.0x3.5	14'x6' TO 14'x8' RCC
	2125.00	15.00	1072	4.93	5.92	15.0x5.9	1130	5.13	5.13	15.0x5.1	
	2325.00	15.00	1072	5.41	7.80	15.0x7.8	1130	5.61	5.61	15.0x5.6	
REACH 3	EXISTING 8'x8' RCB, NEW BYPASS DETENTION BASIN, NEW TRANSITION STRUCTURE FROM VENTURA AVENUE CULVERT										DETENTION BASIN
VENTURA AVENUE CULVERT	NEW 18'x8' RCB CULVERT CROSSING										18'x8' RCB

ALTERNATIVE 5

			50-YEAR				100-YEAR				
	STA	BW	Q	DEPTH	MINHT	DIMENSION	Q	DEPTH	MINHT	DIMENSION	FINAL DIMENSIONS
REACH 1	1130.49	20.75	1537	4.25	5.18	20.8x5.2	2154	5.11	5.11	20.8x5.1	20'x6' RCC
	1160.00	20.00	1512	4.28	5.98	20.0x6.0	2120	5.13	6.19	20.0x6.2	
	1225.00	20.00	1512	4.21	5.93	20.0x5.9	2120	5.03	6.14	20.0x6.1	
	1350.00	20.00	1512	3.98	5.81	20.0x5.8	2120	4.75	6.03	20.0x6.0	
	1613.00	20.00	1512	3.36	4.28	20.0x4.3	2120	4.08	4.08	20.0x4.1	
	2075.00	20.00	1512	2.49	3.76	20.0x3.8	2120	3.18	3.18	20.0x3.2	
REACH 2	2094.00	14.00	1344	3.05	4.39	14.0x4.4	1890	3.97	3.97	14.0x4.0	14'x5' TO 14'x7' RCC
	2211.00	14.00	1344	2.67	4.19	14.0x4.2	1890	3.59	3.59	14.0x3.6	
	2291.00	14.00	1344	4.93	5.92	14.0x5.9	1890	6.40	6.40	14.0x6.4	
REACH 3	2291.00	14.00	1344	4.93	6.42	14.0x6.4	1890	6.40	6.98	14.0x7.0	14'x7' RCB
	2461.00	14.00	1344	4.97	6.46	14.0x6.5	1890	6.53	7.09	14.0x7.1	
	2656.00	14.00	1344	5.09	6.10	14.0x6.1	1890	6.86	6.86	14.0x6.9	
	2707.00	14.00	1344	5.14	6.15	14.0x6.2	1890	7.03	7.03	14.0x7.0	
	2747.00	18.00	1344	5.57	8.02	18.0x8.0	1890	7.00	7.00	18.0x7.0	
VENTURA AVENUE CULVERT	2747.00	18.00	1344	5.57	8.02	18.0x8.0	1890	7.00	7.00	18.0x7.0	18'x8' RCB
	2815.00	18.00	1344	5.86	8.04	18.0x8.0	1890	7.38	7.38	18.0x7.4	
	2815.00	18.00	1344	5.86	8.04	18.0x8.0	1890	7.38	7.38	18.0x7.4	

6.7 Engineer's Cost Estimates

An order of magnitude engineer's cost estimate was prepared for each of the above 5 Preliminary Alternatives. Costs include construction, engineering and design, and construction administration, and permitting. The following tables summarize the construction cost estimate results.

The Project Costs are 25% higher than the Construction Costs to include Environmental Permitting and Monitoring, Engineering Design, and Construction Administration. Traffic control, tree removal and other such items are included. However, a 20% Contingency has also been added due to the preliminary nature of the pre-design level of study.

The following table summarizes the construction and total project costs for the studied alternatives.

Table 10 Cost Estimates Summary Table

PRELIMINARY ALTERNATIVE	IMPROVEMENT TYPE	CONSTRUCTION COST (Million $)	PROJECT COST (Million $)
Alternative 1	CHANNELIZATION	$ 1.8 M	$ 2.3 M
Alternative 2	CHANNELIZATION	$ 1.6 M	$ 2.0 M
Alternative 3	CHANNELIZATION	$ 1.6 M	$ 2.0 M
Alternative 4	DETENTION & CHANNELIZATION	$ 2.2 M	$ 2.8 M
Alternative 5	CHANNELIZATION	$ 1.7 M	$ 2.1 M

Table 11 Cost Estimate for Preliminary Alternative 1

Item Number	Description	Unit Type	Quantity	Unit Price	Total
1	Mobilization @ 5% of Total Const. Cost	LS	1	$70,675	$70,675
2	Excavation Safety	LS	1	$10,000	$10,000
3	Diversion & Control of Water	LS	1	$5,000	$5,000
4	Clearing & Grubbing	LS	1	$20,000	$20,000
5	Removal of RC Structures	LS	1	$40,000	$40,000
6	Excavation	CY	8,000	$8	$64,000
7	Fill & Backfill	CY	8,100	$8	$64,800
8	Reinforced Concrete	CY	2,200	$400	$880,000
9	1/4 Ton Rock Rip Rap	CY	1,480	$80	$118,400
10	1/4 Ton Concreted Rock Rip Rap	CY	470	$110	$51,700
11	Misc. Reinforced Concrete Structures	LS	1	$10,000	$10,000
12	5' High Chain Link Fence	LF	1,330	$20	$26,600
13	15' Commercial Chain Link Gate	Each	4	$3,000	$12,000
14	Subdrain System for Reinforced Concrete Channel	LF	950	$20	$19,000
15	Misc. Side Drains	LS	1	$10,000	$10,000
16	Gravelled Access Road	SY	450	$20	$9,000
17	OVERPOUR	Each	2	$2,000	$4,000
18	Misc. Facilities	LS	1	$10,000	$10,000
19	Erosion Control	LS	1	$5,000	$5,000
20	Access Manholes	Each	2	$2,000	$4,000
21	Removal & Replacement of Ventura Road, including Traffic Control	LS	1	$50,000	$50,000
			Subtotal		**$1,484,175**
			Contingency @ 20%		**$296,835**
			Total		**$1,781,010**
			Rounded Total Project Cost		**$ 1.8 M**

Table 12 Cost Estimate for Preliminary Alternative 2

Item Number	Description	Unit Type	Quantity	Unit Price	Total
1	Mobilization @ 5% of Total Const. Cost	LS	1	$63,083	$63,083
2	Excavation Safety	LS	1	$10,000	$10,000
3	Diversion & Control of Water	LS	1	$5,000	$5,000
4	Clearing & Grubbing	LS	1	$20,000	$20,000
5	Removal of RC Structures	LS	1	$25,000	$25,000
6	Excavation	CY	5,750	$9	$51,750
7	Fill & Backfill	CY	5,800	$9	$52,200
8	Reinforced Concrete	CY	1,920	$400	$768,000
9	1/4 Ton Rock Rip Rap	CY	1,480	$80	$118,400
10	1/4 Ton Concreted Rock Rip Rap	CY	470	$110	$51,700
11	Reinforced Concrete Structures	LS	1	$10,000	$10,000
12	5' High Chainlink Fence	LF	1,330	$20	$26,600
13	15' Commercial Chain Link Gate	Each	4	$3,000	$12,000
14	Subdrain System for Reinforced Concrete Channel	LF	950	$20	$19,000
15	Misc. Side Drain	LS	1	$10,000	$10,000
16	Gravelled Access Road	SY	450	$20	$9,000
17	OVERPOUR	Each	2	$2,000	$4,000
18	Misc. Facilities	LS	1	$10,000	$10,000
19	Erosion Control	LS	1	$5,000	$5,000
20	Access Manholes	Each	2	$2,000	$4,000
21	Removal & Replacement of Ventura Road, including Traffic Control	LS	1	$50,000	$50,000
			Subtotal		**$1,324,733**
			Contingency @ 20%		**$264,947**
			Total		**$1,589,679**
			Rounded Total Project Cost		**$ 1.6 M**

Table 13 Cost Estimate for Preliminary Alternative 3

Item Number	Description	Unit Type	Quantity	Unit Price	Total
1	Mobilization @ 5% of Total Const. Cost	LS	1	$63,810	$63,810
2	Excavation Safety	LS	1	$10,000	$10,000
3	Diversion & Control of Water	LS	1	$5,000	$5,000
4	Clearing & Grubbing	LS	1	$20,000	$20,000
5	Removal of RC Structures	LS	1	$25,000	$25,000
6	Excavation	CY	10,500	$7	$73,500
7	Fill & Backfill	CY	9,000	$8	$72,000
8	Reinforced Concrete	CY	2,465	$380	$936,700
9	1/4 Ton Rock Rip Rap	CY	0	$0	$0
10	1/4 Ton Concreted Rock Rip Rap	CY	0	$0	$0
11	Reinforced Concrete Structures	LS	1	$10,000	$10,000
12	5' High Chainlink Fence	LF	1,000	$25	$25,000
13	15' Commercial Chain Link Gate	Each	2	$3,000	$6,000
14	Subdrain System for Reinforced Concrete Channel	LF	950	$20	$19,000
15	Misc. Side Drain	LS	1	$10,000	$10,000
16	Gravelled Access Road	SY	0	$20	$0
17	OVERPOUR	Each	0	$2,000	$0
18	Misc. Facilities	LS	1	$10,000	$10,000
19	Erosion Control	LS	0	$5,000	$0
20	Access Manholes	Each	2	$2,000	$4,000
21	Removal & Replacement of Ventura Road, including Traffic Control	LS	1	$50,000	$50,000
				Subtotal	**$1,340,010**
				Contingency @ 20%	**$268,002**
				Total	**$1,608,012**
				Rounded Total Project Cost	**$ 1.6 M**

Table 14 Cost Estimate for Preliminary Alternative 4

Item Number	Description	Unit Type	Quantity	Unit Price	Total
1	Mobilization @ 5% of Total Const. Cost	LS	1	$85,555	$85,555
2	Excavation Safety	LS	1	$15,000	$15,000
3	Diversion & Control of Water	LS	1	$5,000	$5,000
4	Clearing & Grubbing	LS	1	$30,000	$30,000
5	Removal of RC Structures	LS	1	$35,000	$35,000
6	Excavation-Channel & RCB	CY	7,000	$7	$49,000
7	Fill & Backfill-Channel & RCB	CY	8,100	$8	$64,800
8	Reinforced Concrete	CY	2,300	$400	$920,000
9	Basin Excavation	CY	25,000	$8	$200,000
10	Dam Fill	CY	5,700	$7	$39,900
11	1/4 Ton Concreted Rock Rip Rap	CY	600	$100	$60,000
12	Reinforced Concrete Structures	LS	1	$10,000	$10,000
13	5' High Chainlink Fence	LF	2,400	$18	$43,200
14	15' Commercial Chain Link Gate	Each	8	$2,500	$20,000
15	Subdrain System for Reinforced Concrete Channel	LF	1,400	$18	$25,200
16	Misc. Side Drain	LS	1	$10,000	$10,000
17	Gravelled Access Road	SY	2,400	$15	$36,000
18	OVERPOUR	Each	5	$2,000	$10,000
19	Misc. Facilities	LS	1	$10,000	$10,000
20	Erosion Control	LS	1	$20,000	$20,000
21	Access Manholes	Each	1	$3,000	$3,000
22	Removal & Replacement of Ventura Road, including Traffic Control	LS	1	$50,000	$50,000
23	Basin Outlet 24" RCP	LF	100	$150	$15,000
24	Intake Riser	LS	1	$40,000	$40,000
			Subtotal		**$1,796,655**
			Contingency @ 20%		**$359,331**
			Total		**$2,155,986**
			Rounded Total Project Cost		**$ 2.2 M**

Table 15 Cost Estimate for Preliminary Alternative 5

Item Number	Description	Unit Type	Quantity	Unit Price	Total
1	Mobilization @ 5% of Total Const. Cost	LS	1	$62,449	$62,449
2	Excavation Safety	LS	1	$10,000	$10,000
3	Diversion & Control of Water	LS	1	$5,000	$5,000
4	Clearing & Grubbing	LS	1	$20,000	$20,000
5	Removal of RC Structures	LS	1	$25,000	$25,000
6	Excavation	CY	10,500	$7	$73,500
7	Fill & Backfill	CY	9,000	$8	$72,000
8	Reinforced Concrete	CY	2,393	$380	$909,470
9	1/4 Ton Rock Rip Rap	CY	0	$0	$0
10	1/4 Ton Concreted Rock Rip Rap	CY	0	$0	$0
11	Reinforced Concrete Structures	LS	1	$10,000	$10,000
12	5' High Chainlink Fence	LF	1,000	$25	$25,000
13	15' Commercial Chain Link Gate	Each	2	$3,000	$6,000
14	Subdrain System for Reinforced Concrete Channel	LF	950	$20	$19,000
15	Misc. Side Drain	LS	1	$10,000	$10,000
16	Gravelled Access Road	SY	0	$20	$0
17	OVERPOUR	Each	0	$2,000	$0
18	Misc. Facilities	LS	1	$10,000	$10,000
19	Erosion Control	LS	0	$5,000	$0
20	Access Manholes	Each	2	$2,000	$4,000
21	Removal & Replacement of Ventura Road, including Traffic Control	LS	1	$50,000	$50,000
22	48" RCP through Ramirez Property	LF	250	$345	$86,250
23	48" RCP inlet and junction with RCC	Each	2	$7,000	$14,000
			Subtotal		**$1,411,669**
			Contingency @ 20%		**$282,334**
			Total		**$1,694,003**
			Rounded Total Project Cost		**$ 1.70 M**

7. ENVIRONMENTAL REVIEW

As part of the Pre-Design Study effort, a Preliminary Environmental Review Report has been prepared under a separate cover. Padre Associated, Inc. has prepared that report, which is currently stamped Draft, and it is dated February 2012.

The purpose of that report is to provide a preliminary environmental review of the proposed improvements to CDSJ. A Ventura County CEQA Initial Study Checklist has been completed for each of the alternatives considered to preliminarily identify the significance of potential environmental impacts.

The following environmental constraints and opportunities, as required by the District, have been evaluated.

a) Historic Vegetation and Habitat Review
b) Sensitive Habitats and Sensitive Species
c) Urban Areas and Urban Constraints
d) Agricultural Issues and Constraints
e) Recreation Opportunities and Conflicts
f) Growth Inducement

A preliminary impact analysis has been presented to facilitate development of an alternative which best addresses improvements to CDSJ to accommodate a 100-year storm event. The following table lists the significance of environmental impacts for each alternative considered.

In summary, Alternatives 1 and 2 would have virtually the same environmental impacts, and fewer and lower magnitude impacts as compared to other alternatives. Alternative 5 would have slightly higher construction noise impacts, since the new box culvert would be closer to the Ventura Head Start preschool. Alternative 3 would have slightly higher biological and scenic resource impacts as compared to Alternatives 1 and 2, because more blue gum trees would be removed. Alternative 4 is ranked last because implementation would result in additional impacts as compared to the other alternatives, including scenic resources (incompatible visual element), cultural resources (impacts to the Avenue School property), coastal beaches (reduction in sediment transport), and community character (incompatible land use).

Table 16 Environmental Issues Matrix

ENVIRONMENTAL ISSUE AREA	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
OVERALL RANKING	**1**	**1**	**3**	**5**	**2**
1. AIR QUALITY	LS	LS	LS	LS	LS
2. WATER RESOURCES	LS	LS	LS	LS	LS
3. MINERAL RESOURCES	N	N	N	N	N
4. BIOLOGICAL RESOURCES	**PS-M**	**PS-M**	**PS-M+**	**PS-M**	**PS-M**
5. AGRICULTURAL RESOURCES	N	N	N	N	N
6. SCENIC RESOURCES	LS	LS	LS+	**PS-M**	LS
7. PALEONTOLOGICAL RESOURCES	N	N	N	N	N
8. CULTURAL RESOURCES	**PS-M**	**PS-M**	**PS-M**	**PS**	**PS-M**
9. COASTAL BEACHES AND SAND DUNES	N	N	N	LS	N
10. FAULT RUPTURE HAZARD	N	N	N	N	N
11. GROUND SHAKING HAZARD	LS	LS	LS	LS	LS
12. LIQUEFACTION HAZARDS	LS	LS	LS	LS	LS
13. SEICHE AND TSUNAMI HAZARDS	N	N	N	N	N
14. LANDSLIDE/MUDFLOW HAZARD	LS	LS	LS	LS	LS
15. EXPANSIVE SOILS HAZARDS	N	N	N	N	N
16. SUBSIDENCE HAZARD	N	N	N	N	N
17. HYDRAULIC HAZARDS	N	N	N	N	N
18. FIRE HAZARDS	N	N	N	N	N
19. AVIATION HAZARDS	N	N	N	N	N
20. HAZARDOUS MATERIALS/WASTE	N	N	N	N	N
21. NOISE AND VIBRATION	**PS**	**PS**	**PS**	**PS**	**PS+**
22. DAYTIME GLARE	N	N	N	N	N
23. PUBLIC HEALTH	N	N	N	N	N
24. GREENHOUSE GASES	LS	LS	LS	LS	LS
25. COMMUNITY CHARACTER	N	N	N	**PS**	N
26. HOUSING	N	N	N	N	N
27. TRANSPORTATION/CIRCULATION	LS	LS	LS	LS	LS
28. WATER SUPPLY	N	N	N	N	N
29. WASTE TREATMENT/DISPOSAL FACILITIES	LS	LS	LS	LS	LS
30. UTILITIES	N	N	N	N	N
31. FLOOD CONTROL FACILITIES/WATERCOURSES	N	N	N	N	N
32. LAW ENFORCEMENT/EMERGENCY SERVICES	N	N	N	N	N
33. FIRE PROTECTION SERVICES	N	N	N	N	N
34. EDUCATION	N	N	N	N	N
35. RECREATION	N	N	N	N	N

8. ALTERNATIVE EVALUATION MATRIX

In coordination with District staff, a preliminary Alternative Evaluation Matrix has been prepared for the studied alternatives. This tool helps to determine the most economically viable and environmentally responsible channel improvement alternative for CDSJ.

As can be seen in the following table, each studied alternative is ranked and evaluated for the following, with their prescribed weighting factors 1 through 6:

a) Public Health & Safety – 27.5%
b) Environmental Impacts – 25.0%
c) Community Components – 15.0%
d) Life Cycle Cost – 25.0%
e) Project Dependencies – 7.5%

For each component of the above five general categories, a category rank is assigned a value of 0 to 5. Category Score is calculated by multiplying the category rank by the corresponding weighting factor.

The following are special notes about each Alternative:

ALTERNATIVE 0	Existing facility's "benefits" are ranked, as if it is being built new. Therefore, there is limited environmental value now. Reach 2 appears to be stable at present, and therefore streambank protection and biological resources were ranked higher than any proposed alternative (except Alt 5).
ALTERNATIVE 1	Environmental Evaluations ranked highest with Alt 2.
ALTERNATIVE 2	Environmental Evaluations ranked highest with Alt 1.
ALTERNATIVE 3	Environmental Evaluations ranked 4th highest.
ALTERNATIVE 4	VUSD may charge land acquisition fee for their detention basin area. During large storm events, there may be more infiltration within the detention basin area. Environmental Evaluation ranked lowest.
ALTERNATIVE 5	OST may contribute more funding to get ALT 5 built, as it will increase their property value substantially. Environmental Evaluation ranked 3rd highest.

Table 17 Alternative Evaluation Matrix

Canada de San Joaquin Alternative Evaluation Matrix (Ventura Avenue to Highway 33)		ALTERNATIVE 0 No Project		ALTERNATIVE 1 Channelization Existing Alignment		ALTERNATIVE 2 Channelization Existing Alignment Existig 8x8 RCB Parallel RCB thru VUSD property		ALTERNATIVE 3 Channelization Existing Alignment Abandon Exist. 8x8 New Parallel RCB thru VUSD property		ALTERNATIVE 4 Detention Basin Channelization Existing D/S Alignment		ALTERNATIVE 5 Channelization Northerly Alignment Abandon Exist. 8x8	
Ranking Criteria	Weighting Factor (1 - 6)	Category Rank (0 - 5)	Category Score	Category Rank (0 - 5)	Category Score	Category Rank (0 - 5)	Category Score	Category Rank (0 - 5)	Category Score	Category Rank (0 - 5)	Category Score	Category Rank (0 - 5)	Category Score
PUBLIC HEALTH & SAFETY	**27.5%**												
Flooding of Public Right of Way	4	2	8	5	20	5	20	5	20	5	20	5	20
Flooding of Buildings	6	2	12	5	30	5	30	5	30	5	30	5	30
Flooding of Agricultural Resources	2	4	8	5	10	5	10	5	10	5	10	5	10
Frequency of Flooding	4	1	4	5	20	5	20	5	20	5	20	5	20
Rehabilitation of Existing District Facilities	6	0	0	5	30	5	30	5	30	5	30	5	30
	22		32		110		110		110		110		110
ENVIRONMENTAL	**25%**												
Streambank Protection	4	3	12	4	16	4	16	4	16	4	16	4	16
Habitat Improvement (BioResources)	4	3	12	2	8	2	8	1	4	2	8	2	8
Water Quality	3	0	0	1	3	1	3	1	3	1	3	1	3
Water Conservation	4	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory Issues (lack of)	3	5	15	5	15	5	15	3	9	2	6	4	12
Sediment Equilibrium	2	1	2	5	10	5	10	5	10	4	8	5	10
	20		41		52		52		42		41		49
COMMUNITY COMPONENTS	**15%**												
Construction Related Impacts	6	5	30	3	18	3	18	3	18	3	18	3	18
Recreation Opportunities	1	1	1	0	0	0	0	0	0	0	0	0	0
Socio-Economic Opportunities (Benefit to OST)	5	0	0	3	15	3	15	3	15	2	10	5	25
	12		31		33		33		33		28		43
LIFE CYCLE COST	**25%**												
Benefit/Cost	6	0	0	2	12	3	18	3	18	1	6	2	12
Maintenance Level	6	3	18	5	30	5	30	5	30	3	18	5	30
Property Acquisition	3	0	0	3	9	3	9	3	9	2	6	3	9
Project Agreements/Grant Funding	5	1	5	1	5	1	5	1	5	1	5	3	15
	20		23		56		62		62		35		66
PROJECT DEPENDENCIES	**7.5%**												
Project Coordination/Phasing	6	1	6		0		0		0		0		0
	6		6		0		0		0		0		0
PROJECT TOTAL	**80**		**133**		**251**		**257**		**247**		**214**		**268**

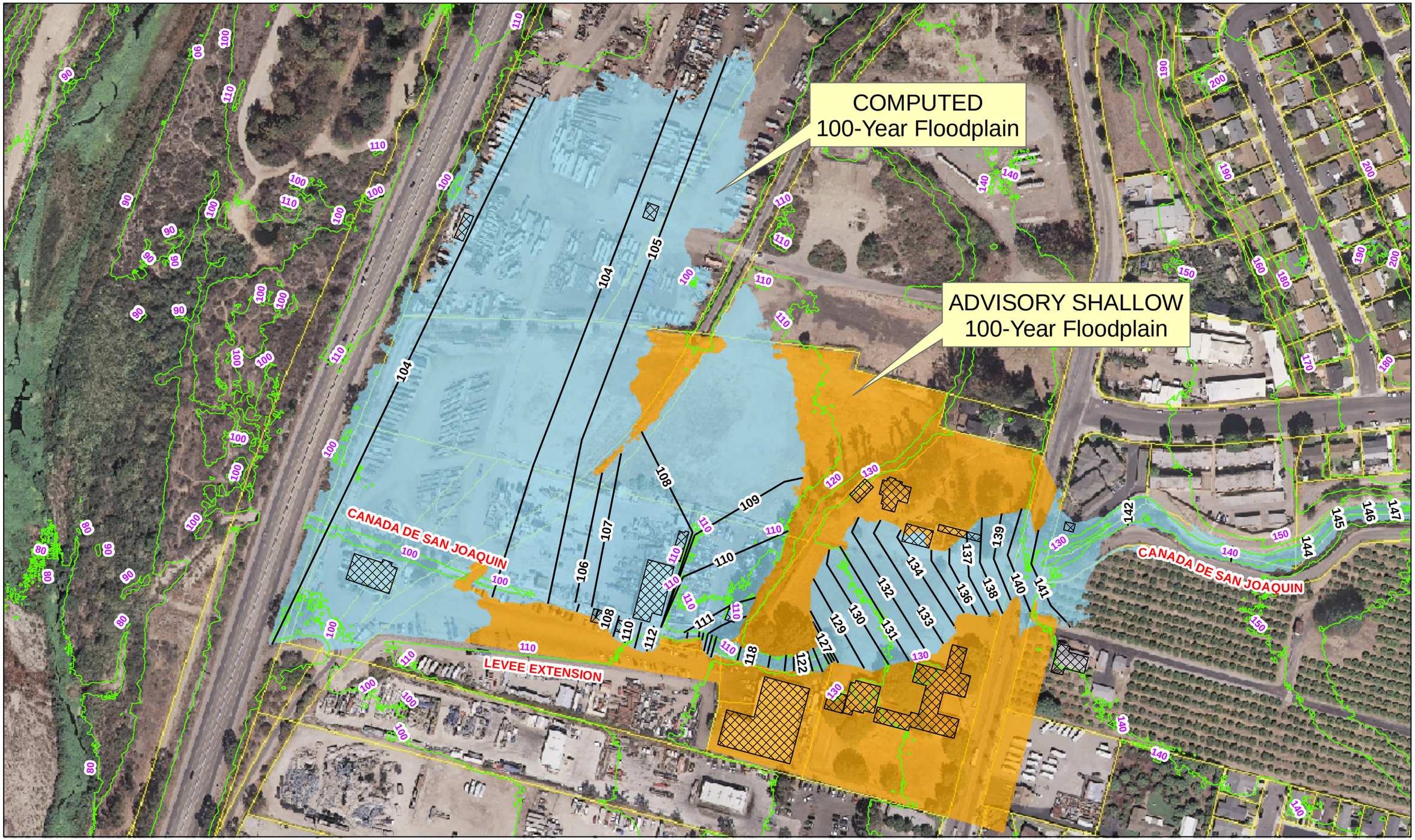
9. PREFERRED ALTERNATIVE

Depending on the Community or District's interests, a Preferred Alternative may be studied further. If so, the hydrologic and hydraulic analyses will be updated or refined as necessary, and 30% Pre-Design level engineering drawings (with Plan, Profiles and cross-sections) will be prepared. Also, the engineer's cost estimate will be updated.

Aside from funding issues, Alternative 5 ranks highest amongst the five alternatives studied. The following table summarizes the results of the Benefit/Cost Ratio analysis, Environmental Rank, District's Alternative Evaluation Matrix Score, and finally the Overall Rank with a letter grade.

Table 18 Preferred Alternative Selection

ALTERNATIVE	PROJECT DESCRIPTION	COST ($M)	B/C Ratio	Environmental Rank	Alternative Evaluation Matrix Score	Overall Rank
0	No Project				133	
1	Channelization, Existing Alignment	2.3	0.28	1	251	C
2	Channelization, Existing Alignment, Existing 8x8 RCB, Parallel RCB thru VUSD property	2.0	0.33	1	257	B
3	Channelization, Existing Alignment, Abandon Existing 8x8 RCB, New Parallel RCB thru VUSD property	2.0	0.33	3	247	D
4	Detention Basin Concept, Channelization, Existing D/S Alignment	2.8	0.23	5	214	E
5	Channelization, Northerly Alignment, Abandon Existing 8x8 RCB	2.1	0.33	2	268	A



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200
Feet
December 2011

Canada de San Joaquin Pre-Design Study

Present Condition Floodplain

N

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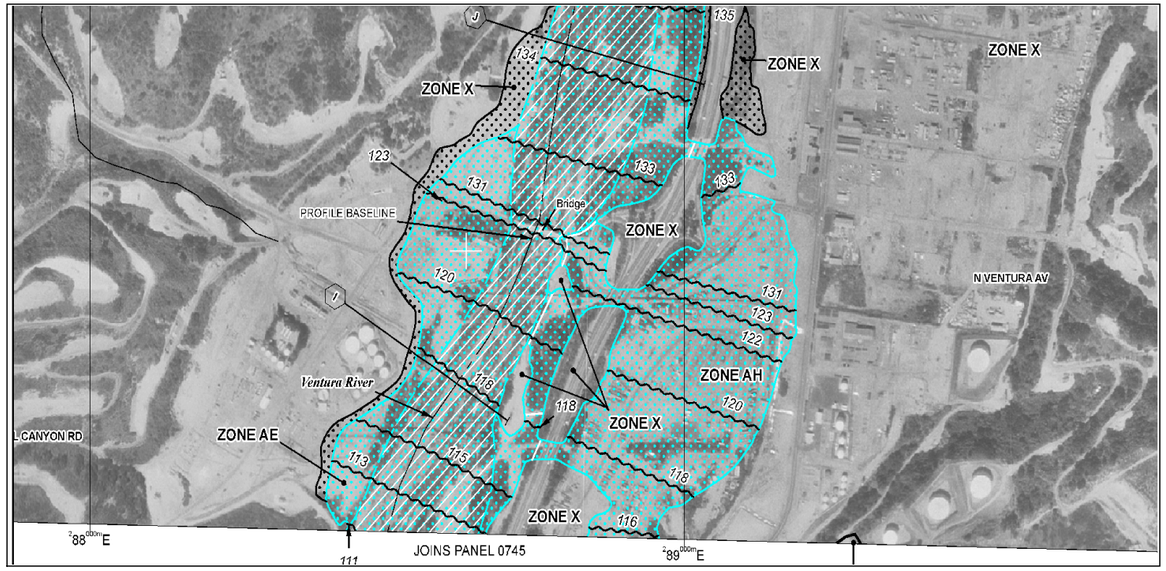
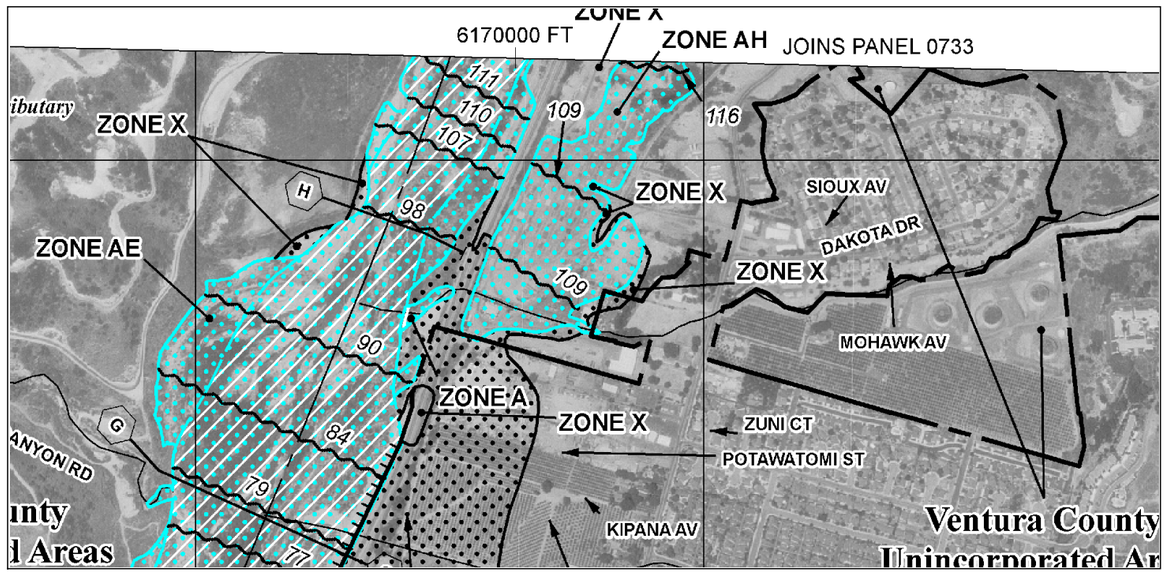
Note: Please see full sized Existing Drainage Facilities Exhibit in Technical Appendix

Canada de San Joaquin Pre-Design Study

Existing Drainage Facilities

Effective FEMA Map Number: 06111C0733E
Effective Date: Janurary 20, 2010





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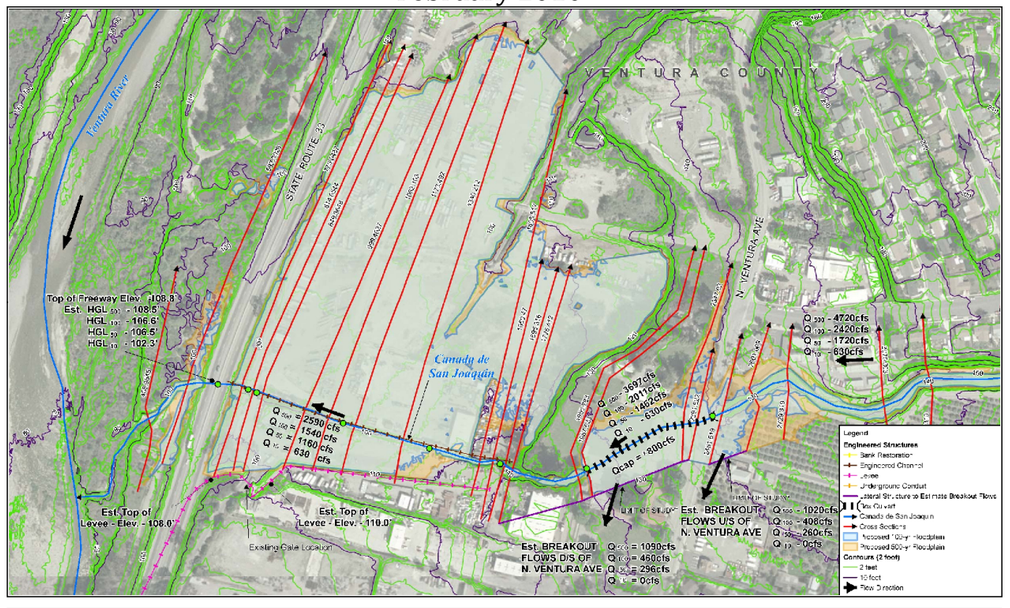
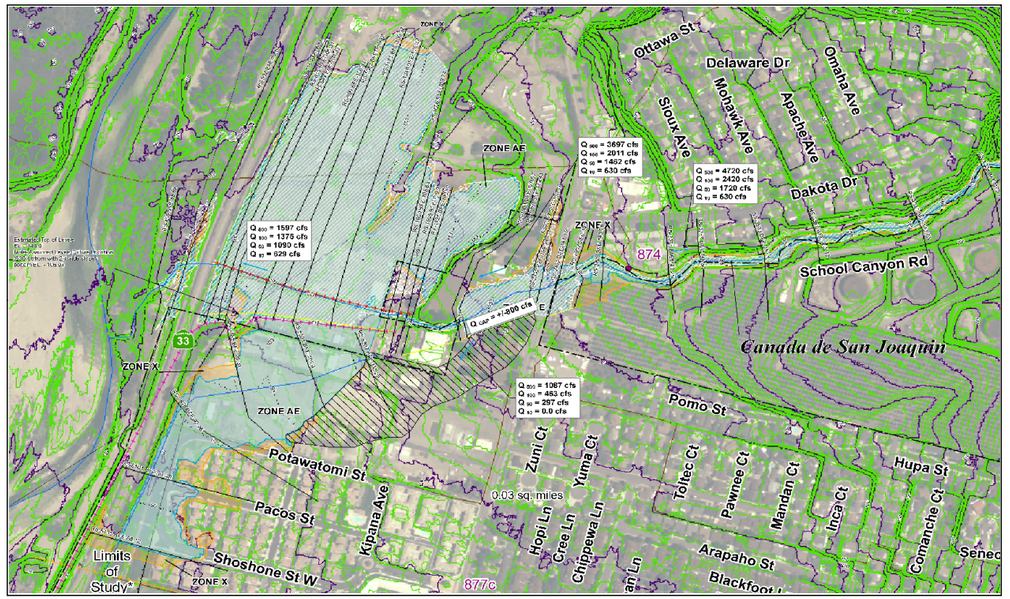
HDR FIS Study - No Levee Failure
February 2010





HDR FIS Study - With Levee Failure
June 2010

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Canada de San Joaquin Pre-Design Study

Effective and Revised FIS

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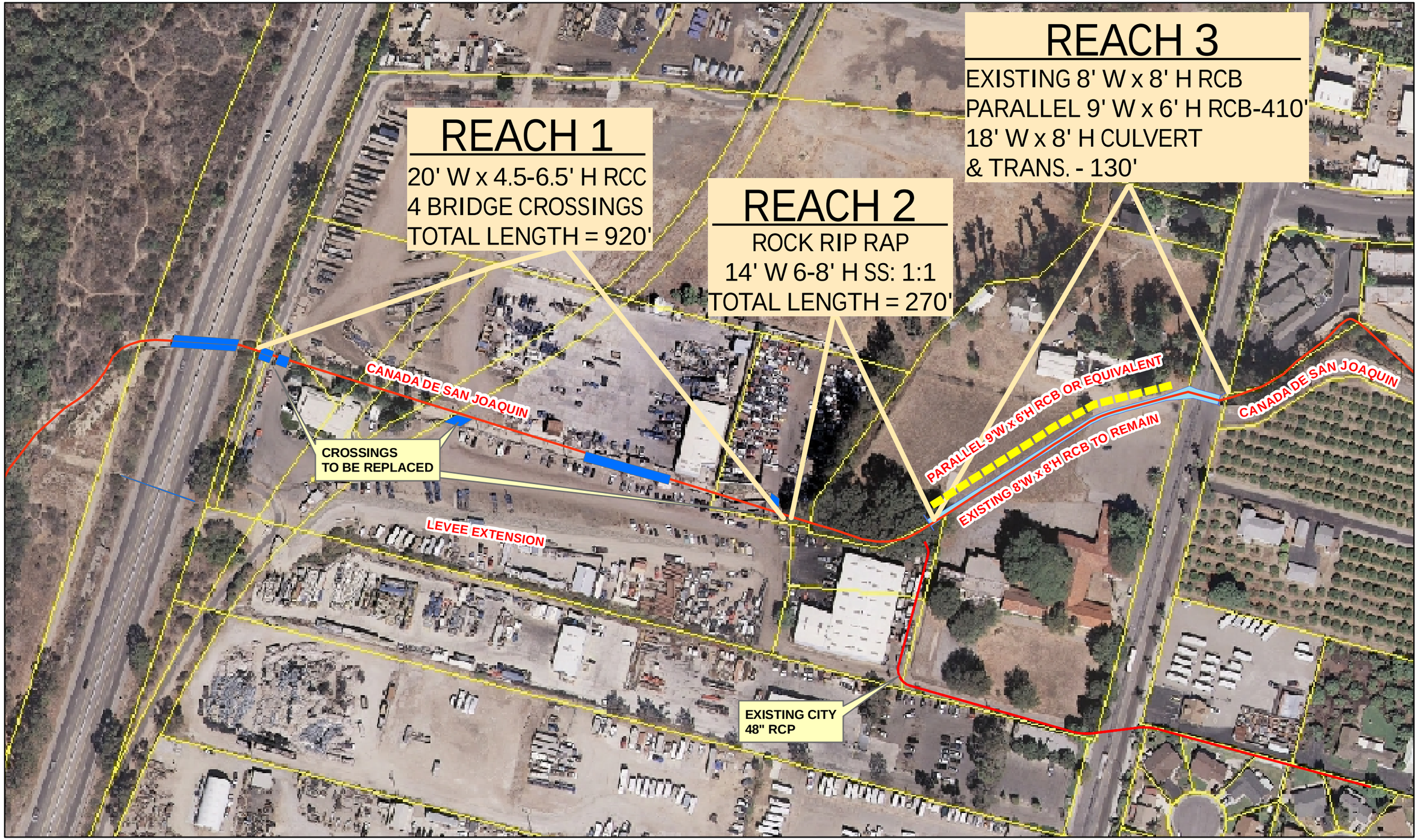
150 Feet

March 2012

Canada de San Joaquin Pre-Design Study

Preliminary Alternative 1



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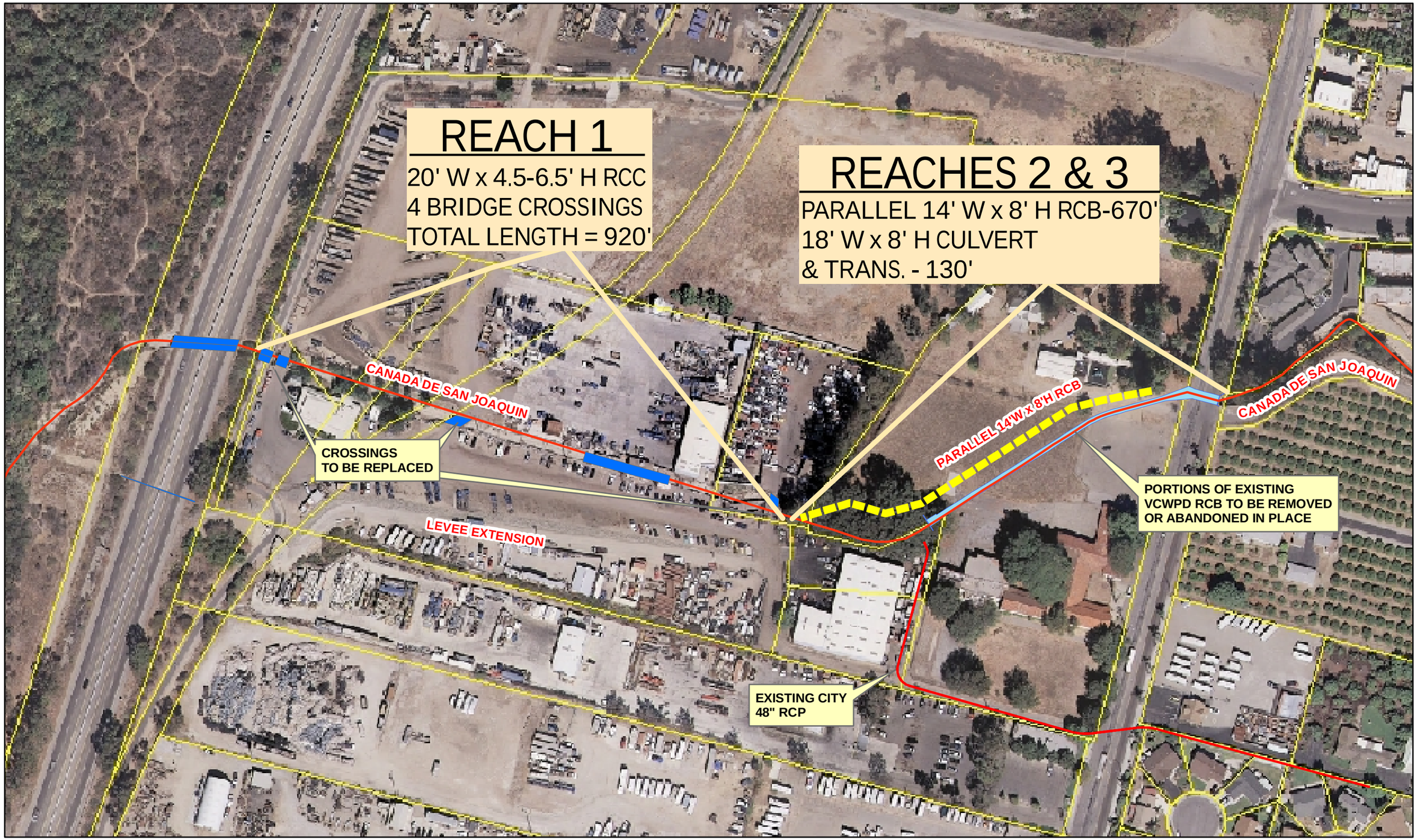
Preliminary Alternative 2



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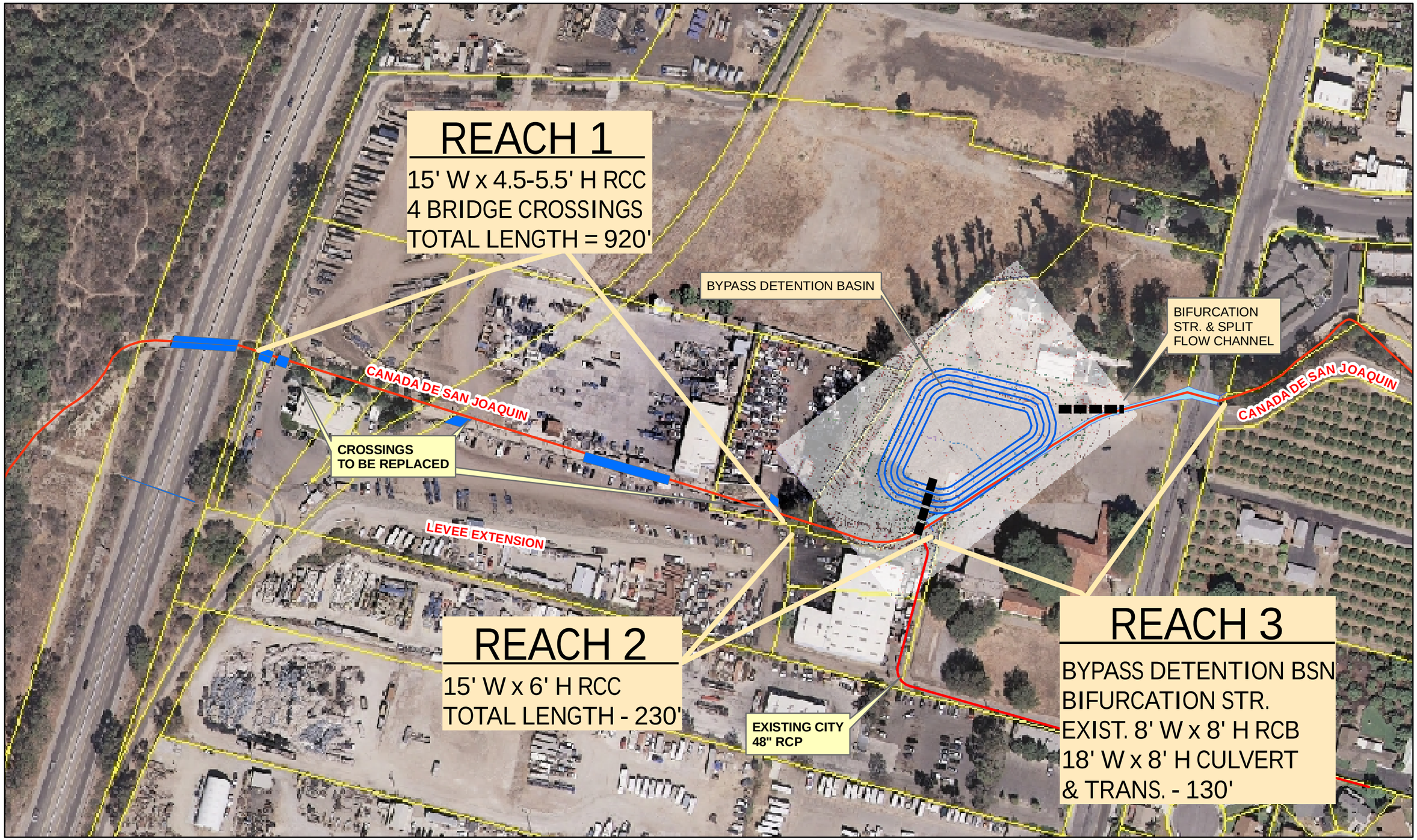
Preliminary Alternative 3



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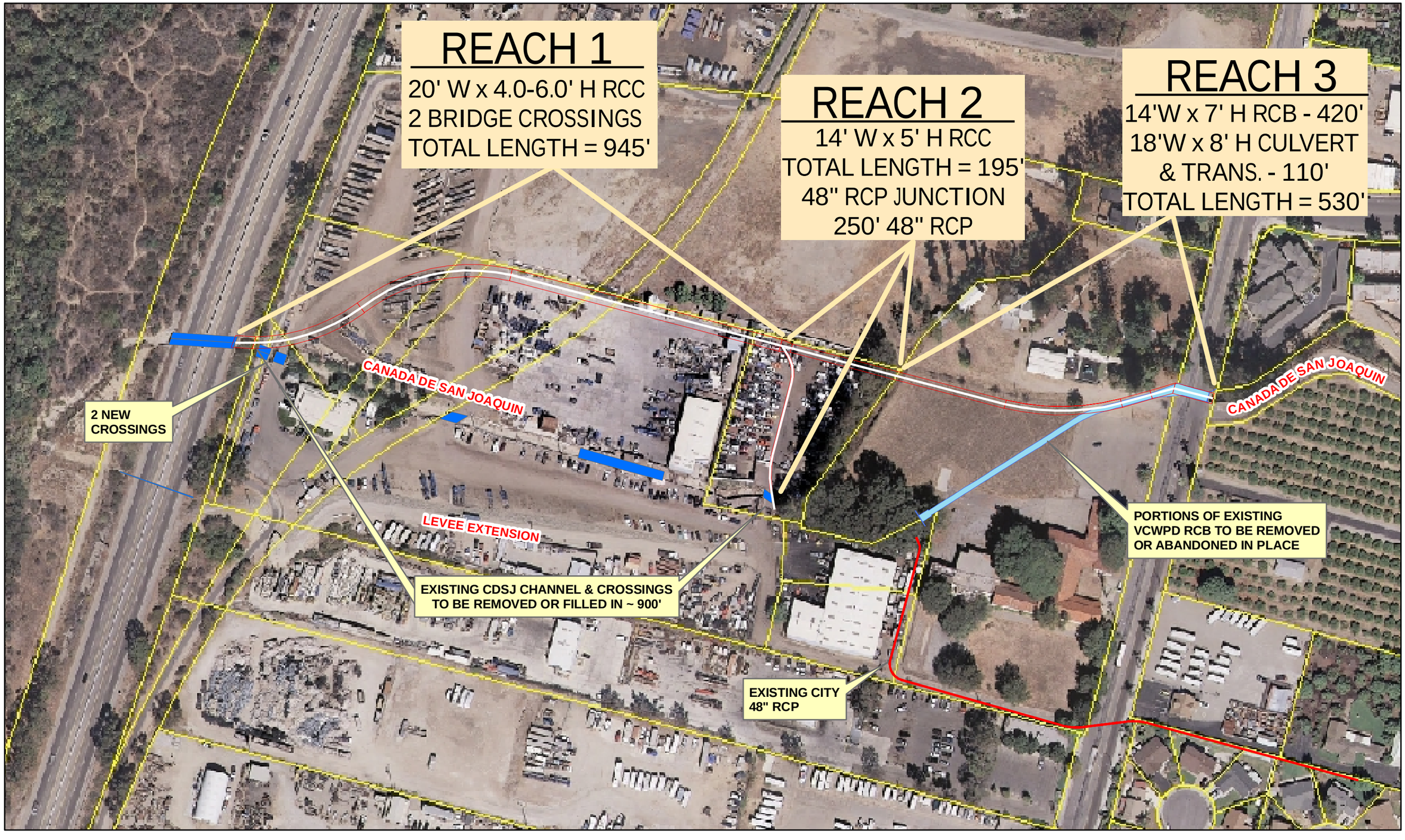
Preliminary Alternative 4



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Preliminary Alternative 5