Watermark Engineering, Inc.

DATE: April 8, 2019

TO: Luis Rodriguez, Michael Durkee, Archie Wright
CC: Nick (Mykola) Parashchak, Tim Wong, Lyle Campbell

FROM: Patrick Stiehr, PE

RE: Revised LID and WQ Treatment at Verde Cruz Townhomes, Carmichael, CA

This technical memorandum (TM) provides additional information to support three excel LID Credits Worksheets and a Drawing that shows the development site and the proposed LID and WQ facilities. The LID/WQ facilities are described as follows.

Rooftops

Two adjoining town homes will be designed to drain to a common planter that will include a bioretention area. The bioretention configuration that meets LID and WQ requirements will have eight inches of available ponding and an underdrain 24 inches deep. The planters vary in length but all but one will be ten feet wide. The planter walls will be six inches thick so the bioretention area will be nine feet wide. The required bioretention areas will be 13 feet in length. All planters will actually be 15 feet in length or longer as shown on Drawing 1. The additional length will be used to plant trees to help meet shade requirements. See the two parcel excel worksheet, entitled , Table 1, and Drawing 1.

Impervious Areas

The inside impervious area is 0.56 acres and the impervious area outside the property lines is 0.32 acres. Two excel worksheets were used to determine the worse-case condition of (a): LID requirements for combined inside and outside impervious areas of 0.88 acres, and (b): LID and water quality requirements for the inside impervious area (0.56 acres).

The worse-case criteria to satisfy the requirements will be to have a bioretention area of 2,000 square feet, a ponding depth of ten inches, and an underdrain 24 inches deep. See Table 1 for a comparison of the facilities of the two criteria.

Note that the bioretention area is shown as a rectangle area only. The configuration will meet the area and ponding depth requirements, but the actual configuration has not been determined. The reason is that this "natural" area must also be used to meet shade requirements. The likely approach will be to maximize shade trees and then fit the bioretention area as efficiently as possible.

Also note that the outfall location may be at an existing culvert just upstream of Manzanita Avenue or at a vertical concrete structure near the upstream end of the property as shown on Drawing 1. It is believed either of these locations would not trigger instream approval because both are at manmade structures that would be modified only.

The attached two excel worksheets show the requirement for the two conditions.

Table 1. Summary of Bioretention Facilities								
Site	Ac	Treatment Area	∑ Area (ac)	LID	WQ	Area (sf)	Subdrain D (in)	Ponding D (in)
Parcel 1	0.015	Planter 1	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 2	0.015	Planter 1						
Parcel 3	0.015	Planter 2	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 4	0.015	Planter 2						
Parcel 5	0.015	Planter 3	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 6	0.015	Planter 3						
Parcel 7	0.015	Planter 4	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 8	0.015	Planter 4						
Parcel 9	0.015	Planter 5	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 10	0.015	Planter 5						
Parcel 11	0.015	Planter 6	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 12	0.015	Planter 6						
Parcel 13	0.015	Planter 7	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 14	0.015	Planter 7						
Parcel 15	0.015	Planter 8	0.03	Bio retn	Bio retn	9x13=117	24	8
Parcel 16	0.015	Planter 8						
Parcel 17	0.015	Planter 9	0.02	Bio retn	Bio retn	4.5x13= 58.5	24	8
			0.26					
All impervious w/in P/L	0.56	Open space area	0.56	Bio retn	Bio retn	2,000	24	10
All impervious of Project	0.88	Open space area	0.88	Bio retn	Not included	2,000	24	8

Watermark Engineering, Inc.

DATE: November 26, 2018

TO: Luis Rodriguez
                   Mykola Parashchak
                   Tim Wong

FROM: Patrick L. Stiehr, PE

RE: Backwater Analysis of Verde Cruz Creek, Adjacent to Proposed Verde Cruz
                   Townhouses, 4904 Manzanita Avenue, Carmichael, CA, Submittal 2.

Overview

The proposed townhouse project is located at Parcel 236-0254-009, 1.75 acres. It is located adjacent to the left bank or south side of Verde Cruz Creek, just upstream of Manzanita Avenue in Carmichael. The original development plan called for encroachment into the flood plain but not into the floodway, consistent with and per FEMA guidelines for development along a regulated watercourse.

Additional County requirements are:
1. Floodplain can be filled only to with 0.5 feet of the 100-year water surface elevation (WSE).
2. WSE cannot be raised more than 0.10 feet as a result of the proposed encroachment fill.

The additional requirements prompted a backwater analysis, and this technical memorandum that summarizes the findings.

Analysis

A HEC-RAS static backwater file was prepared for Vera Cruz Creek based on HEC-2 information provided by the county, 15 cross-sections and topography prepared by Wong and Associates, and 100-year flow information from the recently approved Flood Insurance Study for Sacramento County.

The downstream portion of the backwater model consisted of two cross-sections downstream of Manzanita Avenue taken from the Flood Insurance Study (FIS) HEC-2 input file. The cross-sections were shortened (they were 1000+ feet wide), and elevations were adjusted +2.4 feet based on datum differences from the NGVD 29 to NAVD 88.

The road profile and the 10'w x 5'h RCB were surveyed by Wong and added to the model. An additional 13 cross-sections were surveyed at approximately 25 feet spacing and added to the model. Two additional cross-section were added upstream of the subject property based on lydar topography and the most upstream cross-section on the property. The upstream cross-section was at the eastern property boundary of the proposed development.

The 100-year flow of 780 cfs was taken from the HEC 2 files. The starting water surface elevation was based on the floodway table from the most recent FIS. Note that the starting water surface elevation shown in the FIS is 2.4 feet higher compared to the original HEC model results.

Findings

The high level of detail available from the closely spaced cross-sections provided information similar but slightly different compared to the FIS water surface profile. The new model indicated most of the water flowed over Manzanita Avenue. The more detailed topographic information indicated that at the upstream end, the overbank flow was mostly on the south side, on the development site. About 100± feet downstream from the eastern property boundary, the flow transitions to the north or right bank side and continues along the north side an additional 200± feet where it overtops Manzanita Avenue. The ground on the south side of the creek is above the 100-year WSE for at least 100 feet upstream of Manzanita Avenue.

Note that the initial backwater comparison between existing and proposed conditions indicated more than a 0.10 foot increase at the eastern portion of the development site. As a result, the site plan was revised with less encroachment into the flood plain at the eastern portion. The parking configuration was modified and mostly removed from the floodplain. Figure 1 provides the revised site plan and cross-section locations. A pdf of Figure 1 is provided as a separate document for more detail.

There were three scenarios analyzed. They were existing conditions and proposed-project conditions where the encroachment was set horizontally at the edge of the proposed improvements, and the elevation at that defied edge was set at 0.5 feet below the existing-conditions WSE. The third scenario was complete blockage at the land side of the proposed development. This would be worse-case if there was a desire to completely remove the improved area from the floodplain.

Table 1 provides a comparison of water elevations at each cross-section. The maximum increase of water elevations was 0.02 feet for the limited encroachment up to 0.5 feet below the existing 100-year WSE and 0.03 feet for the full encroachment scenario.

Based on several site visits, there are no structures on the right bank in the vicinity of the proposed project that could be impacted by the development of the left bank.

Attachment B provides additional information related to the HEC-RAS analysis.

Please note there is a solid board fence at the upstream eastern boundary of the development site. It is not known whether that fence will remain competent during a 100-year storm. The analysis is based on the assumption the fence is compromised, which is the worst case at this site. If the fence remains competent, then less water will be on the south overbank area which means less impact from the proposed development.

The area that will remain in the floodplain may be improved, but ground elevations will be respected such that the comparative analysis remains valid.

Comments have been addressed within this document with additional responses provided within the Initial Submittal Comments document.

Figure 1. Cross-Sections and Proposed Development

Table 1. HEC-RAS Data Summary

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
us of Manz	1650	PF 1	Exist-R3	780	99.21	105.97	106.41	0.00826	5.33	147.0	38.0	0.46
us of Manz	1650	PF 1	Project-Enc	780	99.21	105.97	106.41	0.00823	5.32	147.1	38.0	0.46
us of Manz	1650	PF 1	Proj-Full Enc	780	99.21	105.97	106.41	0.00823	5.32	147.1	38.1	0.46
us of Manz	1500	PF 1	Exist-R3	780	97.81	104.96	105.33	0.00610	4.86	163.2	45.9	0.4
us of Manz	1500	PF 1	Project-Enc	780	97.81	104.97	105.34	0.00605	4.85	163.7	46.3	0.4
us of Manz	1500	PF 1	Proj-Full Enc	780	97.81	104.98	105.34	0.00605	4.84	163.8	46.3	0.4
us of Manz	1350	PF 1	Exist-R3	780	96.51	104.33	104.59	0.00374	4.16	204.3	83.4	0.32
us of Manz	1350	PF 1	Project-Enc	780	96.51	104.35	104.61	0.00369	4.14	205.9	85.3	0.32
us of Manz	1350	PF 1	Proj-Full Enc	780	96.51	104.35	104.61	0.00368	4.14	206.1	85.6	0.32
us of Manz	1325	PF 1	Exist-R3	780	96.52	104.25	104.48	0.00439	4.38	256.9	180.3	0.33
us of Manz	1325	PF 1	Project-Enc	780	96.52	104.27	104.50	0.00429	4.34	261.0	189.6	0.33
us of Manz	1325	PF 1	Proj-Full Enc	780	96.52	104.28	104.50	0.00427	4.34	261.7	191.2	0.33
us of Manz	1300	PF 1	Exist-R3	780	96.63	104.21	104.37	0.00314	3.81	331.6	236.1	0.28
us of Manz	1300	PF 1	Project-Enc	780	96.63	104.22	104.39	0.00332	3.92	324.2	236.7	0.29
us of Manz	1300	PF 1	Proj-Full Enc	780	96.63	104.23	104.39	0.00324	3.88	315.2	212.4	0.29
us of Manz	1275	PF 1	Exist-R3	780	97.17	104.07	104.26	0.00491	4.07	278.5	216.1	0.35
us of Manz	1275	PF 1	Project-Enc	780	97.17	104.08	104.28	0.00510	4.15	273.5	216.8	0.36
us of Manz	1275	PF 1	Proj-Full Enc	780	97.17	104.06	104.28	0.00530	4.23	253.8	178.8	0.37
us of Manz	1250	PF 1	Exist-R3	780	96.94	103.95	104.16	0.00366	4.21	283.4	202.7	0.31
us of Manz	1250	PF 1	Project-Enc	780	96.94	103.95	104.17	0.00375	4.26	279.3	203.9	0.32
us of Manz	1250	PF 1	Proj-Full Enc	780	96.94	103.95	104.17	0.00373	4.26	266.4	167.3	0.32
us of Manz	1225	PF 1	Exist-R3	780	95.91	103.92	104.07	0.00234	3.56	321.0	183.2	0.25
us of Manz	1225	PF 1	Project-Enc	780	95.91	103.92	104.08	0.00238	3.58	318.8	184.2	0.25
us of Manz	1225	PF 1	Proj-Full Enc	780	95.91	103.93	104.08	0.00234	3.56	308.6	158.1	0.25
us of Manz	1200	PF 1	Exist-R3	780	95.89	103.77	103.99	0.00324	4.11	259.0	164.6	0.29
us of Manz	1200	PF 1	Project-Enc	780	95.89	103.76	104.00	0.00335	4.17	251.4	164.3	0.3
us of Manz	1200	PF 1	Proj-Full Enc	780	95.89	103.75	104.00	0.00348	4.25	228.9	112.5	0.3
us of Manz	1175	PF 1	Exist-R3	780	96.16	103.61	103.89	0.00406	4.5	217.8	124.8	0.33
us of Manz	1175	PF 1	Project-Enc	780	96.16	103.62	103.90	0.00404	4.49	218.8	127.4	0.33
us of Manz	1175	PF 1	Proj-Full Enc	780	96.16	103.62	103.90	0.00404	4.49	218.3	121.2	0.33
us of Manz	1150	PF 1	Exist-R3	780	96.1	103.42	103.77	0.00537	4.86	186.5	112.9	0.37
us of Manz	1150	PF 1	Project-Enc	780	96.1	103.43	103.78	0.00532	4.84	187.9	113.2	0.37
us of Manz	1150	PF 1	Proj-Full Enc	780	96.1	103.43	103.78	0.00532	4.84	187.9	113.2	0.37
us of Manz	1125	PF 1	Exist-R3	780	95.82	103.33	103.62	0.00518	4.36	192.5	121.4	0.37
us of Manz	1125	PF 1	Project-Enc	780	95.82	103.34	103.63	0.00512	4.34	194.1	123.6	0.36
us of Manz	1125	PF 1	Proj-Full Enc	780	95.82	103.34	103.63	0.00512	4.34	194.1	123.6	0.36
us of Manz	1100	PF 1	Exist-R3	780	95.92	103.08	103.47	0.00633	5.22	193.0	158.1	0.39
us of Manz	1100	PF 1	Project-Enc	780	95.92	103.09	103.48	0.00630	5.21	194.9	158.2	0.39
us of Manz	1100	PF 1	Proj-Full Enc	780	95.92	103.09	103.48	0.00630	5.21	194.9	158.2	0.39
us of Manz	1075	PF 1	Exist-R3	780	95.48	103.19	103.28	0.00282	3.07	426.4	367.4	0.25
us of Manz	1075	PF 1	Project-Enc	780	95.48	103.18	103.29	0.00318	3.25	381.5	295.0	0.27
us of Manz	1075	PF 1	Proj-Full Enc	780	95.48	103.18	103.29	0.00318	3.25	381.5	295.0	0.27
us of Manz	1050	PF 1	Exist-R3	780	95.48	103.13	103.22	0.00206	3.18	486.2	399.7	0.22
us of Manz	1050	PF 1	Project-Enc	780	95.48	103.13	103.22	0.00206	3.18	486.2	399.7	0.22
us of Manz	1050	PF 1	Proj-Full Enc	780	95.48	103.13	103.22	0.00206	3.18	486.2	399.7	0.22
us of Manz	1000			Culvert								
us of Manz	950	PF 1	Exist-R3	780	94.7	102.73	103.20	0.00705	5.52	148.6	50.5	0.43
us of Manz	950	PF 1	Project-Enc	780	94.7	102.73	103.20	0.00705	5.52	148.6	50.5	0.43
us of Manz	950	PF 1	Proj-Full Enc	780	94.7	102.73	103.20	0.00705	5.52	148.6	50.5	0.43
us of Manz	829	PF 1	Exist-R3	780	94.3	101.2	101.98	0.01454	7.1	109.9	25.2	0.6
us of Manz	829	PF 1	Project-Enc	780	94.3	101.2	101.98	0.01454	7.1	109.9	25.2	0.6
us of Manz	829	PF 1	Proj-Full Enc	780	94.3	101.2	101.98	0.01454	7.1	109.9	25.2	0.6

Watermark Engineering, Inc.

DATE: June 11, 2018

TO: Mykola Parashchak
            Tim Wong

FROM: Patrick Stiehr, PE

RE: Drainage Information at Vera Cruz Town Homes Tentative Subdivision Map

This Technical Memorandum provides additional information concerning the floodplain and floodway of Vera Cruz Creek at the proposed project.

Wong and Associates has provided a map that shows the limits of 100-year floodplain and the designated floodway. Based on the Sacramento County Flood Insurance Study, the 100-year water surface elevation at Section K, at the upstream side of Manzanita Avenue is 103.2 feet. The floodway analysis shows the encroached 100-year water surface elevation to be 104 feet.

Based on the plot map, only a small portion of Lot 1 will encroach into the floodway. No grading is allowed within the floodway, so that portion of the north side yard must remain at the existing elevation.

The driveway, parking, and barbeque area encroach into the floodplain. Per information provided by Luis Rodriguez of Sacramento County, grading within the floodplain needs to be no lower than 0.5 feet below the FEMA floodplain elevation. Therefore, the minimum elevation of the development would then be elevation 104.5 feet at the western boundary and elevation 105.5 at the eastern boundary.

Attached are scanned excerpts from the Sac County FIS that are the basis of these recommendations.

Please call if there are questions or if additional information is needed.

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JUN 11 2018
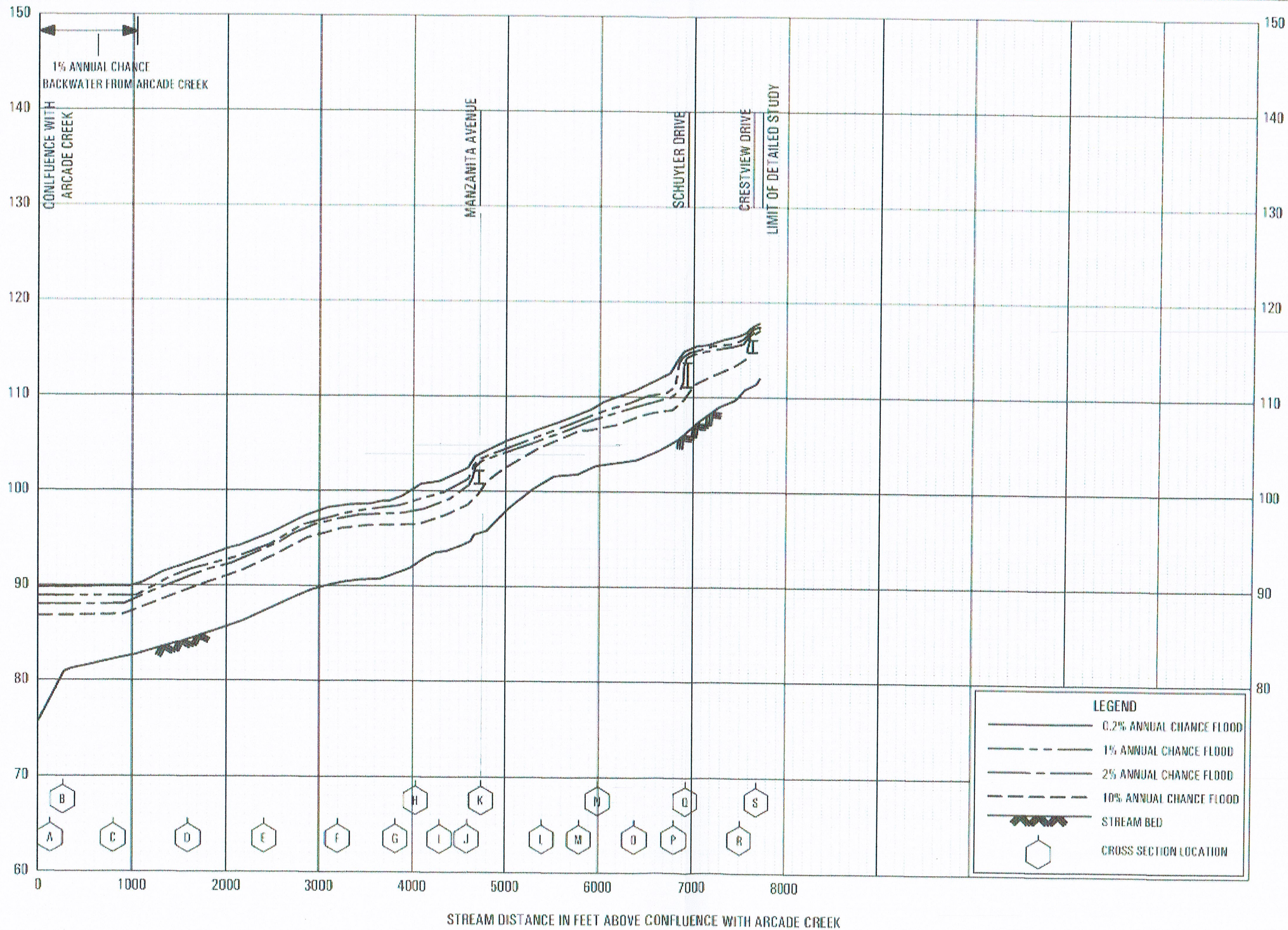
County of Sacramento
Department of Community Development
Planning and Environmental Review Division

3153 Jenna Court
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Table 24: Floodway Data (continued)

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/ SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	132	75	200	6.1	88.9	88.9	89.9	1.0
B	264	50	160	7.6	88.9	88.9	89.9	1.0
C	803	30	130	9.4	88.9	88.9	89.9	1.0
D	1,600	50	260	4.7	91.7	91.7	92.6	0.9
E	2,402	35	160	7.6	94.0	94.0	94.6	0.6
F	3,200	90	320	3.8	97.2	97.2	98.1	0.9
G	3,817	50	260	4.7	98.3	98.3	99.3	1.0
H	4,023	20	90	11.4	99.1	99.1	99.1	0.0
I	4,298	30	110	7.4	99.7	99.7	99.7	0.0
J	4,599	30	110	7.4	101.2	101.2	101.2	0.0
K	4,747	20	130	6.3	103.2	103.2	104.0	0.8
L	5,396	35	130	6.3	106.1	106.1	106.6	0.5
M	5,797	35	140	5.8	107.4	107.4	108.3	0.9
N	5,998	25	80	10.2	108.4	108.4	108.4	0.0
O	6,399	30	80	10.2	109.5	109.5	109.5	0.0
P	6,801	20	70	11.7	111.1	111.1	111.1	0.0
Q	6,933	30	130	6.3	114.4	114.4	115.4	1.0
R	7,519	20	70	10.8	115.9	115.9	115.9	0.0
S	7,698	35	130	8.0	117.3	117.3	118.3	1.0

[1]Feet above confluence with Arcade Creek

FEDERAL EMERGENCY MANAGEMENT AGENCY

SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: VERDE CRUZ CREEK

TABLE 24

FLOOD PROFILES
VERDE CRUZ CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
SACRAMENTO COUNTY, CA
AND INCORPORATED AREAS

LEGEND

0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION

STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH ARCADE CREEK

1% ANNUAL CHANCE
BACKWATER FROM ARCADE CREEK

CONFLUENCE WITH ARCADE CREEK

MANZANITA AVENUE

SCHUYLER DRIVE

CRESTVIEW DRIVE

LIMIT OF DETAILED STUDY

149P