

Fairview Avenue Widening & Bridge Replacement

Santa Ana, CA 91203

River Hydraulics Analysis

Submitted to:

City of Santa Ana

20 Civic Center Plaza

Santa Ana, CA 92702

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INTRODUCTION

Fairview Street is classified as a north-south Major Arterial per the City's General Plan Circulation Element (GPCE) and the County of Orange's Master Plan of Arterial Highway (MPAH). The City is proposing to widen Fairview Street between 9th Street and 16th Street from a 4-lane street to a 6-lane arterial to provide adequate vehicular capacity within the City's northern limits.

The project includes the replacement of the bridge over the Santa Ana River. A new pier configuration is proposed within the Santa Ana River channel. The Santa Ana River is under the Army Corps of Engineers (USACE) jurisdiction and as-built plans (Reference 3) have been obtained and reviewed. The Santa Ana River baseline hydraulic model from the Corps of Engineers (Reference 4) has also been obtained and is used to model the proposed conditions and assess the impact of the new piers to the water surface profile.



Vicinity Map

HYDRAULIC MODEL

Existing Conditions

A baseline HEC-RAS (Reference 4) model was provided by the Corps of Engineers. This model was used to represent the existing conditions.

An existing analysis by HNTB Corporation in June 2017 prepared for the OC Streetcar, Santa Ana / Garden Grove Project (Reference 2). The report analyses a proposed bridge, downstream of the Fairview Street Bridge, just upstream of the existing OCTA Railroad Bridge. Review of the results of this analysis shows that the proposed Streetcar Bridge does not impact the hydraulics of the river near the Fairview Bridge.

Vertical Datum

The vertical datum used by the Corps of Engineers' baseline model is based on the National Geodetic Vertical Datum of 1929 (NGVD29). The mapping and survey information used for the Fairview project is based on the North American Vertical Datum of 1988 (NAVD88) which is approximately 2.4 feet higher. Therefore, 2.4 feet has to be added to the hydraulic model results to correlate with the project plans.

Proposed Hydraulic Model

The US Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System, HEC-RAS 5.0.6. November 2018 (Reference 1) was used to model the proposed improvements to replace the existing bridge. Four new piers will replace the eight existing piers. The bridge will be wider and, therefore, the piers longer. The pier modeling includes debris loading of 2 feet on both sides of each pier, to a depth of 6 feet (see cross sections in appendix).

Modeling Parameters

- Flow Regime - Mixed flow was modeled as both subcritical and supercritical flows are anticipated within the study reach.
- Design Discharge - The design discharge of 46,000 cubic feet per second (cfs) is used at the proposed crossing as provided in USACE HEC-RAS model.
- Roughness values - Roughness values used in the Baseline Model; are 0.014 for the portion of the reach that is a concrete channel.
- Boundary Conditions – The Baseline Model uses critical depth at the upstream and downstream boundary conditions.
- Coefficients of Contraction/Expansion – no change in channel shape occurs within the reach of interest; therefore the current baseline model contraction and expansion coefficients of 0.1 and 0.3 are used.
- Bridge Modeling Method – Highest Energy solution between (1) Energy Only (Standard Step) and (2) Momentum.

Summary of Results

The hydraulic analyses were performed using the mixed flow computation scheme. The boundary conditions of the models and design flow rates were set the same as USACE HEC-RAS model (Baseline) with critical depth at the upstream and downstream boundary conditions and design flow of 46,000 cfs at the project site.

The hydraulic model under both existing and proposed condition shows a supercritical flow regime, in this reach of the river, downstream of Fairview Avenue Bridge. The regime becomes subcritical upstream of the bridge. A hydraulic jump occurs further upstream and flow transitions to supercritical regime. As shown on the profile provided in appendix, the new bridge improves the river hydraulics upstream of the bridge by lowering the water surface elevation and reducing the length of subcritical regime by

approximately 300 feet.

In conclusion, the results show no impact to upstream and downstream structures and confirm that the proposed Fairview Avenue bridge provides some improvement to the local hydraulics.

REFERENCES

1. US Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System, HEC-RAS 5.0.6. November 2018.
2. OC Streetcar, Santa Ana / Garden Grove Project, Santa Ana River Hydraulics Study Memo, submitted by HNTB Corporation, to Orange County Transportation Authority, June 2017.
3. U.S. Army Engineer District Los Angeles Corps of Engineers, Lower Santa Ana River Channel, District File No.239/798-890 As-built, March 1993.
4. HEC-RAS Baseline Model (BlowPrdoSIAM02)

APPENDICES

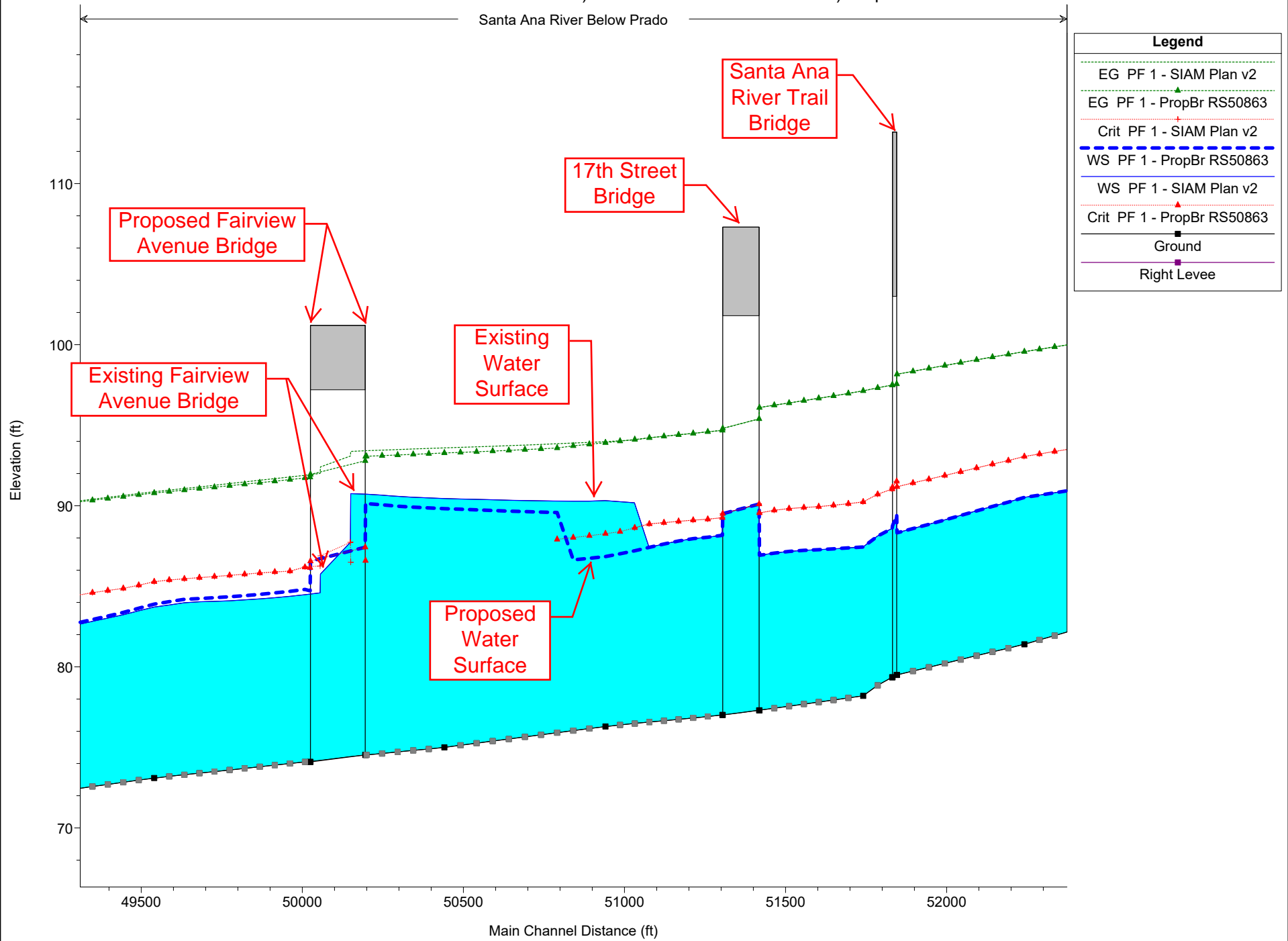
- Hydraulics Summary Table
- Water Surface Profiles
- Sections
- Improvement Plan

River Sta	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel (ft/s)	Froude #	W.S. Elev Difference
521+21	17th Street Bridge									
520+63	Existing	46000	77.01	88.17	89.26	94.68	0.00193	20.47	1.17	
520+63	Proposed	46000	77.01	88.17	89.26	94.68	0.001931	20.47	1.17	0.00
520+18	Existing	46000	76.92	88.05	89.17	94.59	0.001964	20.52	1.18	
520+18	Proposed	46000	76.92	88.05	89.17	94.59	0.001964	20.52	1.18	0.00
519+73	Existing	46000	76.83	87.96	89.11	94.49	0.001976	20.5	1.19	
519+73	Proposed	46000	76.83	87.96	89.11	94.49	0.001976	20.5	1.19	0.00
519+27	Existing	46000	76.74	87.81	89.03	94.4	0.00188	20.59	1.17	
519+27	Proposed	46000	76.74	87.81	89.03	94.4	0.00188	20.59	1.17	0.00
518+82	Existing	46000	76.65	87.62	88.95	94.31	0.001893	20.74	1.17	
518+82	Proposed	46000	76.65	87.62	88.95	94.31	0.001893	20.74	1.17	0.00
518+36	Existing	46000	76.57	87.42	88.87	94.22	0.001917	20.91	1.18	
518+36	Proposed	46000	76.57	87.42	88.87	94.22	0.001917	20.91	1.18	0.00
517+91	Existing	46000	76.48	90.18	88.63	94.09	0.000927	15.85	0.84	
517+91	Proposed	46000	76.48	87.21	88.63	94.12	0.001983	21.08	1.2	-2.97
517+46	Existing	46000	76.39	90.25		94.03	0.000883	15.6	0.82	
517+46	Proposed	46000	76.39	87.02	88.39	94.02	0.002038	21.22	1.21	-3.23
517+00	Existing	46000	76.3	90.32		93.98	0.000842	15.36	0.8	
517+00	Proposed	46000	76.3	86.84	88.27	93.91	0.002084	21.33	1.23	-3.48
516+50	Existing	46000	76.17	90.29		93.93	0.000818	15.32	0.79	
516+50	Proposed	46000	76.17	86.74	88.14	93.82	0.002073	21.34	1.22	-3.55
516+00	Existing	46000	76.04	90.29		93.89	0.000782	15.23	0.78	
516+00	Proposed	46000	76.04	86.64	88.03	93.72	0.002063	21.35	1.22	-3.65
515+50	Existing	46000	75.91	90.3		93.85	0.000749	15.12	0.76	
515+50	Proposed	46000	75.91	89.58	87.91	93.59	0.000883	16.06	0.83	-0.72
515+00	Existing	46000	75.78	90.31		93.81	0.00072	15.01	0.75	
515+00	Proposed	46000	75.78	89.61		93.53	0.000848	15.9	0.81	-0.70
514+50	Existing	46000	75.65	90.32		93.77	0.000694	14.89	0.74	
514+50	Proposed	46000	75.65	89.64		93.49	0.000816	15.74	0.8	-0.68
514+00	Existing	46000	75.52	90.35		93.73	0.000669	14.76	0.73	
514+00	Proposed	46000	75.52	89.67		93.44	0.000784	15.58	0.78	-0.68
513+50	Existing	46000	75.39	90.37		93.7	0.000645	14.62	0.71	
513+50	Proposed	46000	75.39	89.71		93.4	0.000753	15.4	0.77	-0.66
513+00	Existing	46000	75.26	90.4		93.66	0.000622	14.49	0.7	
513+00	Proposed	46000	75.26	89.75		93.36	0.000723	15.24	0.75	-0.65
512+50	Existing	46000	75.13	90.42		93.63	0.000601	14.36	0.69	
512+50	Proposed	46000	75.13	89.78		93.32	0.000696	15.08	0.74	-0.64
512+00	Existing	46000	75	90.45		93.59	0.000581	14.23	0.68	
512+00	Proposed	46000	75	89.82		93.28	0.00067	14.92	0.73	-0.63
511+52	Existing	46000	74.9	90.49		93.56	0.000564	14.05	0.67	
511+52	Proposed	46000	74.9	89.87		93.24	0.000647	14.72	0.72	-0.62

River Sta	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel (ft/s)	Froude #	W.S. Elev Difference
511+04	Existing	46000	74.81	90.53		93.52	0.000549	13.89	0.66	
511+04	Proposed	46000	74.81	89.91		93.2	0.000628	14.54	0.71	-0.62
510+55	Existing	46000	74.72	90.59		93.49	0.000545	13.66	0.66	
510+55	Proposed	46000	74.72	89.97		93.16	0.000621	14.32	0.7	-0.62
510+07	Existing	46000	74.62	90.66		93.45	0.00051	13.4	0.64	
510+07	Proposed	46000	74.62	90.06		93.11	0.000584	14.01	0.68	-0.60
509+59	Existing	46000	74.53	90.72		93.42	0.000484	13.17	0.62	
509+59	Proposed	46000	74.53	90.14		93.07	0.000552	13.75	0.66	-0.58
509+56	Proposed	46000	74.53	90.17	86.59	93.06	0.000538	13.64	0.65	
509+10	Existing	46000	74.43	90.75	86.49	93.37	0.000462	12.98	0.61	-0.58
508+63	Fairview Avenue Bridge									
508+15	Existing	46000	74.2	84.59	86.26	92	0.002204	21.84	1.25	0.13
507+84	Proposed	46000	74.1	84.72	86.16	91.77	0.002168	21.3	1.24	
507+68	Existing	46000	74.1	84.48	86.22	91.89	0.002224	21.84	1.26	
507+68	Proposed	46000	74.1	84.81	86.18	91.73	0.001998	21.1	1.2	0.33
507+22	Existing	46000	74	84.38	85.94	91.79	0.00224	21.83	1.26	
507+22	Proposed	46000	74	84.69	85.94	91.63	0.002024	21.13	1.21	0.31
506+75	Existing	46000	73.9	84.29	85.9	91.69	0.002249	21.81	1.26	
506+75	Proposed	46000	73.9	84.59	85.9	91.53	0.002036	21.12	1.21	0.30
506+28	Existing	46000	73.8	84.22	85.82	91.58	0.00225	21.76	1.27	
506+28	Proposed	46000	73.8	84.5	85.82	91.43	0.002051	21.13	1.21	0.28
505+81	Existing	46000	73.7	84.16	85.75	91.48	0.002246	21.71	1.26	
505+81	Proposed	46000	73.7	84.42	85.75	91.34	0.002056	21.1	1.21	0.26
505+34	Existing	46000	73.6	84.1	85.68	91.38	0.002237	21.65	1.26	
505+34	Proposed	46000	73.6	84.35	85.68	91.25	0.002055	21.06	1.21	0.25
504+88	Existing	46000	73.5	84.07	85.61	91.27	0.00221	21.54	1.25	
504+88	Proposed	46000	73.5	84.29	85.61	91.16	0.002048	21.01	1.21	0.22
504+41	Existing	46000	73.4	84.04	85.54	91.17	0.002177	21.42	1.25	
504+41	Proposed	46000	73.4	84.24	85.54	91.06	0.002035	20.95	1.21	0.20
503+94	Existing	46000	73.3	83.98	85.47	91.07	0.002032	21.37	1.21	
503+94	Proposed	46000	73.3	84.19	85.47	90.97	0.002016	20.89	1.2	0.21
503+47	Existing	46000	73.2	83.84	85.39	90.97	0.002053	21.42	1.22	
503+47	Proposed	46000	73.2	84.05	85.39	90.88	0.001923	20.97	1.18	0.21
503+00	Existing	46000	73.1	83.71	85.29	90.87	0.002071	21.47	1.22	
503+00	Proposed	46000	73.1	83.89	85.29	90.79	0.001955	21.07	1.19	0.18
502+52	Existing	46000	72.97	83.48	85.07	90.76	0.002136	21.65	1.24	
502+52	Proposed	46000	72.97	83.64	85.07	90.68	0.002029	21.29	1.21	0.16
502+04	Existing	46000	72.83	83.24	84.87	90.64	0.002202	21.83	1.26	
502+04	Proposed	46000	72.83	83.38	84.87	90.57	0.002102	21.51	1.23	0.14
501+57	Existing	46000	72.7	83.03	84.74	90.53	0.002255	21.97	1.27	

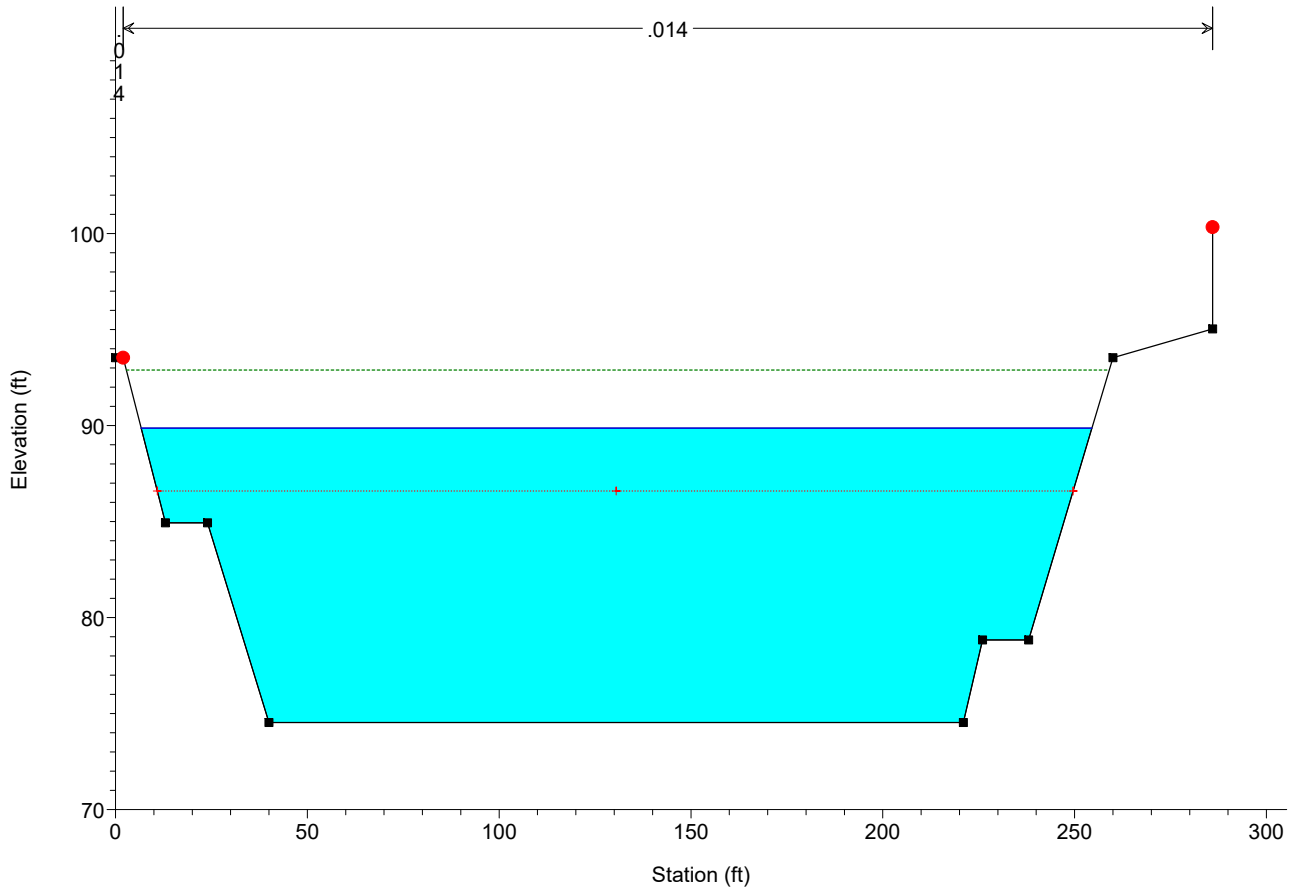
River Sta	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel (ft/s)	Froude #	W.S. Elev Difference
501+57	Proposed	46000	72.7	83.15	84.74	90.45	0.002161	21.67	1.25	0.12
501+09	Existing	46000	72.57	82.82	84.61	90.41	0.002303	22.09	1.28	
501+09	Proposed	46000	72.57	82.94	84.61	90.34	0.002215	21.81	1.26	0.12
500+61	Existing	46000	72.43	82.61	84.44	90.29	0.002354	22.23	1.3	
500+61	Proposed	46000	72.43	82.72	84.44	90.22	0.002272	21.97	1.28	0.11
500+13	Existing	46000	72.3	82.43	84.3	90.16	0.002387	22.3	1.3	
500+13	Proposed	46000	72.3	82.53	84.3	90.09	0.002307	22.05	1.28	0.10
499+65	Existing	46000	72.17	82.26	84.16	90.03	0.002419	22.37	1.31	
499+65	Proposed	46000	72.17	82.35	84.16	89.97	0.002342	22.14	1.29	0.09
499+17	Existing	46000	72.03	82.07	84.01	89.9	0.002454	22.45	1.32	
499+17	Proposed	46000	72.03	82.15	84.01	89.85	0.002389	22.26	1.3	0.08
498+69	Existing	46000	71.9	81.9	83.86	89.78	0.002482	22.51	1.33	
498+69	Proposed	46000	71.9	81.98	83.86	89.72	0.002419	22.32	1.31	0.08
498+21	Existing	46000	71.77	81.73	83.72	89.65	0.002508	22.57	1.33	
498+21	Proposed	46000	71.77	81.81	83.72	89.59	0.002448	22.38	1.32	0.08
497+73	Existing	46000	71.63	81.55	83.58	89.51	0.00254	22.63	1.34	
497+73	Proposed	46000	71.63	81.62	83.58	89.46	0.002481	22.46	1.33	0.07
497+25	Existing	46000	71.5	81.39	83.44	89.38	0.002563	22.68	1.35	
497+25	Proposed	46000	71.5	81.46	83.44	89.33	0.002506	22.51	1.33	0.07
496+77	Existing	46000	71.37	81.29	83.31	89.26	0.002544	22.65	1.34	
496+77	Proposed	46000	71.37	81.35	83.31	89.21	0.002489	22.49	1.33	0.06
496+30	Existing	46000	71.23	81.17	83.17	89.14	0.002535	22.66	1.34	
496+30	Proposed	46000	71.23	81.23	83.17	89.09	0.002478	22.49	1.33	0.06
495+82	Existing	46000	71.1	81.06	83.04	89.03	0.002518	22.64	1.34	
495+82	Proposed	46000	71.1	81.13	83.04	88.98	0.002464	22.48	1.32	0.07
495+34	Existing	46000	70.97	80.96	82.92	88.91	0.002502	22.62	1.33	
495+34	Proposed	46000	70.97	81.02	82.92	88.86	0.00245	22.46	1.32	0.06
494+86	Existing	46000	70.83	80.84	82.79	88.78	0.002491	22.61	1.33	
494+86	Proposed	46000	70.83	80.9	82.79	88.73	0.002437	22.45	1.32	0.06
494+38	Existing	46000	70.7	80.73	82.67	88.66	0.002478	22.6	1.33	
494+38	Proposed	46000	70.7	80.78	82.67	88.62	0.002432	22.46	1.32	0.05
493+90	Existing	46000	70.57	80.61	82.55	88.55	0.002474	22.61	1.33	
493+90	Proposed	46000	70.57	80.67	82.55	88.51	0.002426	22.47	1.31	0.06
493+42	Existing	46000	70.43	80.49	82.42	88.43	0.002461	22.59	1.32	
493+42	Proposed	46000	70.43	80.53	82.42	88.4	0.00243	22.5	1.32	0.04
492+94	Existing	46000	70.3	80.37	82.3	88.31	0.002456	22.6	1.32	
492+94	Proposed	46000	70.3	80.41	82.3	88.28	0.002424	22.51	1.31	0.04
492+46	Existing	46000	70.17	80.26	82.18	88.2	0.00245	22.61	1.32	
492+46	Proposed	46000	70.17	80.3	82.18	88.17	0.002417	22.51	1.31	0.04
491+98	Existing	46000	70.03	80.12	82.05	88.09	0.002455	22.65	1.32	
491+98	Proposed	46000	70.03	80.15	82.05	88.06	0.002424	22.55	1.31	0.03

Santa Ana River Below Prado



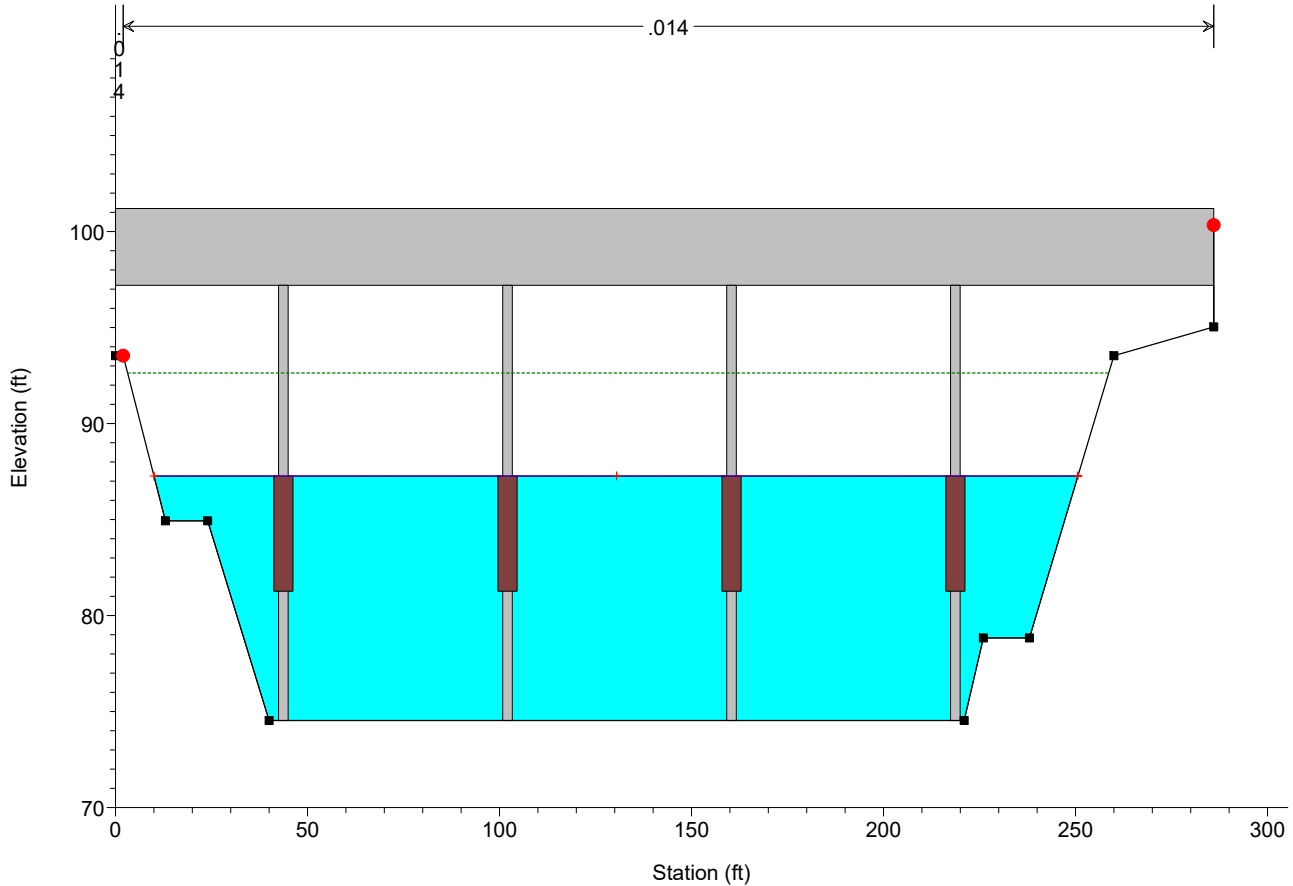
Legend	
EG PF 1 - SIAM Plan v2	(Green dashed line with triangles)
EG PF 1 - PropBr RS50863	(Red solid line with triangles)
Crit PF 1 - SIAM Plan v2	(Red dotted line with triangles)
WS PF 1 - PropBr RS50863	(Blue dashed line)
WS PF 1 - SIAM Plan v2	(Blue solid line)
Crit PF 1 - PropBr RS50863	(Red dotted line with triangles)
Ground	(Black solid line with squares)
Right Levee	(Purple solid line with squares)

Prado RSM RAS Model-Levee 2a Plan: 1) PropBr RS50863 2/26/2019
 SAR 50956 U/S FAIRVIEW



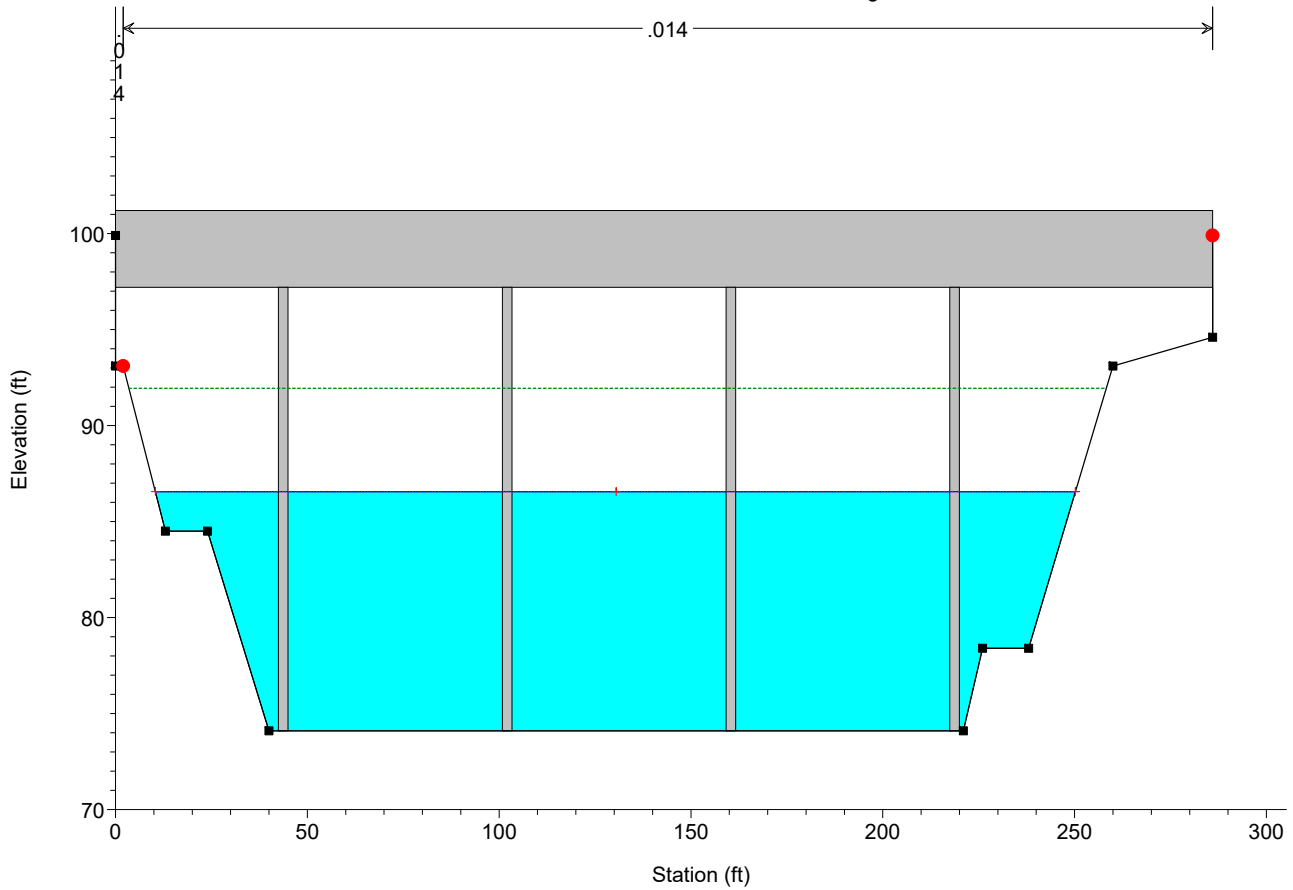
Legend	
EG PF 1	(Green dashed line)
WS PF 1	(Blue solid line)
Crit PF 1	(Red dashed line with cross)
Ground	(Black solid line with square)
Bank Sta	(Red solid circle)

Prado RSM RAS Model-Levee 2a Plan: 1) PropBr RS50863 2/26/2019
 SAR 50863 FAIRVIEW AVE. Bridge



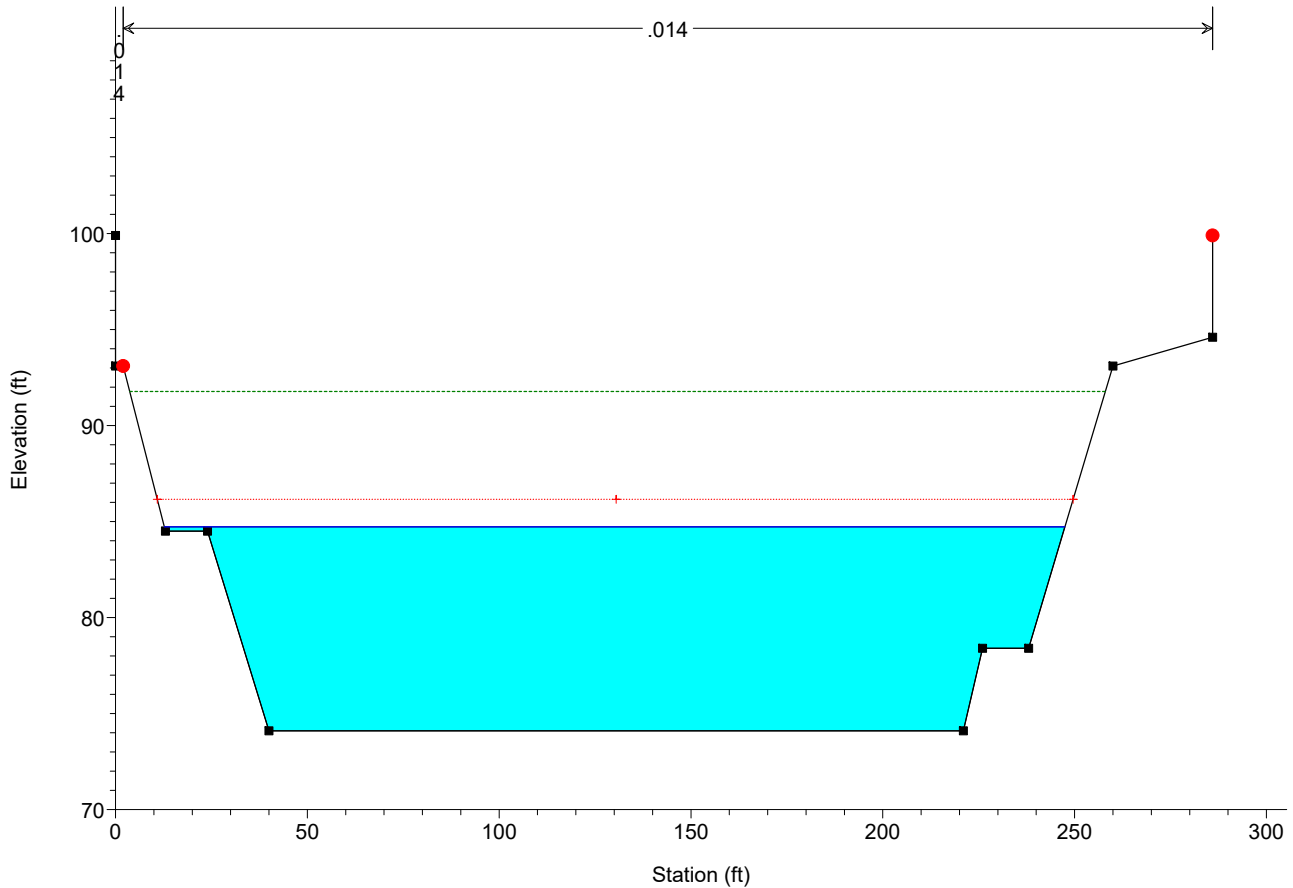
Legend	
EG PF 1	(Green dashed line)
WS PF 1	(Blue solid line)
Crit PF 1	(Red dashed line with cross)
Ground	(Black solid line with square)
Bank Sta	(Red solid circle)
Pier Debris	(Brown solid bar)

Prado RSM RAS Model-Levee 2a Plan: 1) PropBr RS50863 2/26/2019
 SAR 50863 FAIRVIEW AVE. Bridge



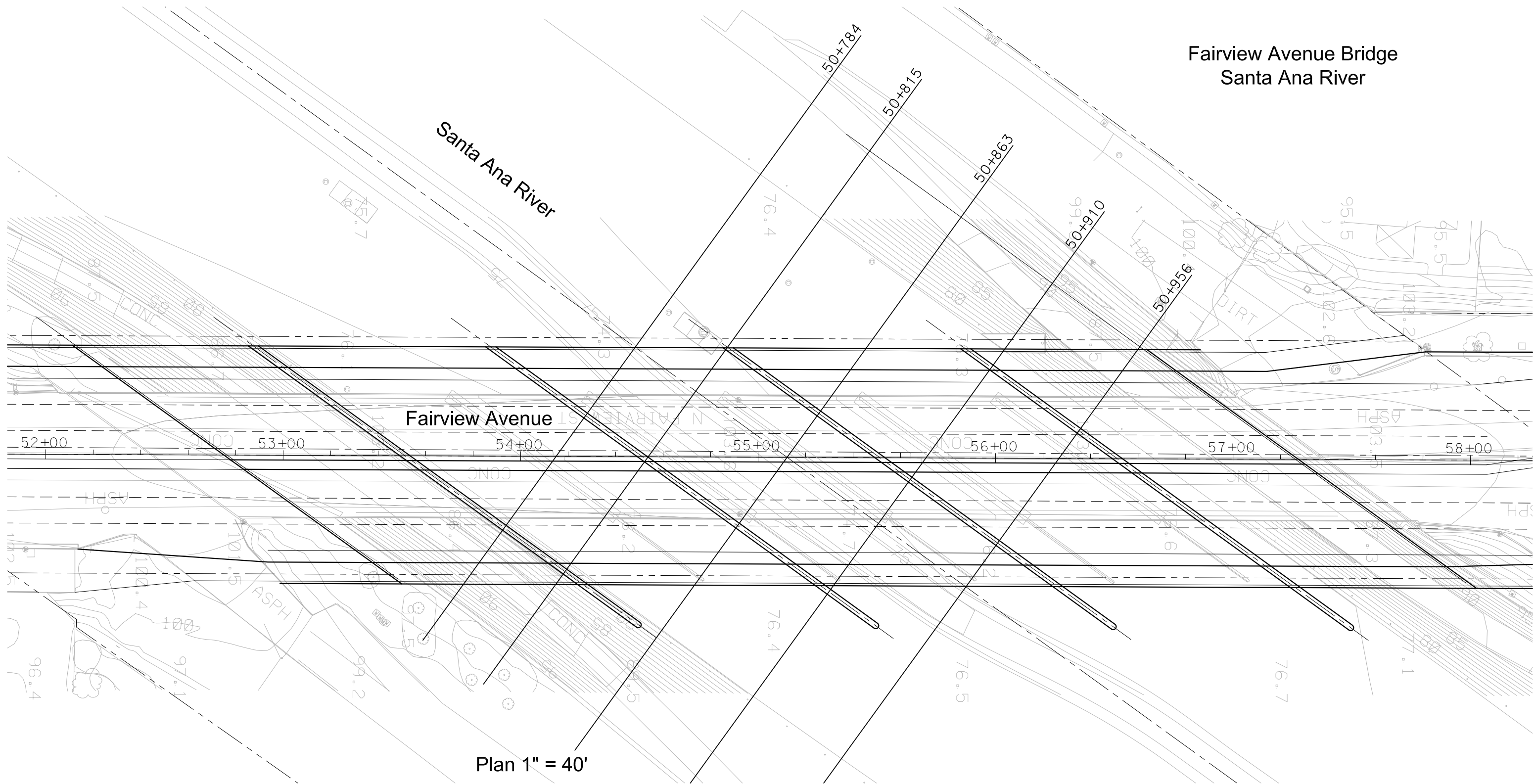
Legend	
EG PF 1	(Green dashed line)
WS PF 1	(Blue solid line)
Crit PF 1	(Red dotted line with cross)
Ground	(Black solid line with square)
Bank Sta	(Red solid line with circle)

Prado RSM RAS Model-Levee 2a Plan: 1) PropBr RS50863 2/26/2019
 SAR 50815 D/S FAIRVIEW.

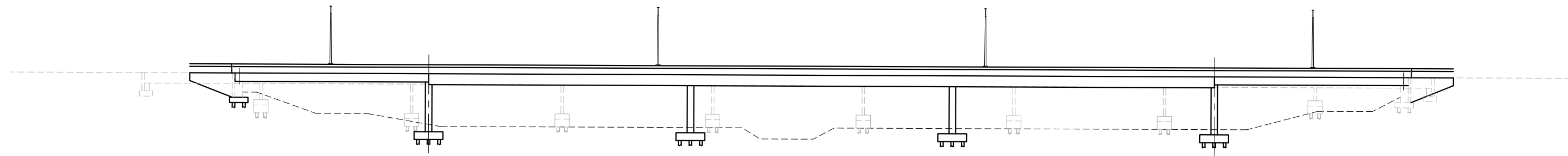


Legend	
EG PF 1	(Green dashed line)
Crit PF 1	(Red dotted line with cross)
WS PF 1	(Blue solid line)
Ground	(Black solid line with square)
Bank Sta	(Red solid line with circle)

Fairview Avenue Bridge
Santa Ana River



Plan 1" = 40'



Profile 1" = 40'