SANTA ROSA ROAD DEBRIS BASIN NO. 2
DEBRIS BASIN MODIFICATION
PRELIMINARY DESIGN STUDY
JUNE 2016

Photo: Santa Rosa Road No. 2 Debris Basin, looking upstream from crest

Prepared for:

VENTURA COUNTY
WATERSHED PROTECTION DISTRICT

Prepared by:

WEST CONSULTANTS, INC.

Santa Rosa Road Debris Basin No. 2
Debris Basin Modification
Preliminary Design Study

June 2016

Prepared for:

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EXECUTIVE SUMMARY

Santa Rosa Road No. 2 Debris Basin, located on the Arroyo Santa Rosa Tributary, was constructed by the U.S. Soil Conservation Service (SCS) in 1957. The basin has a watershed area of 1,101 acres and a 100-year peak inflow of 1,274 cubic feet per second. Investigations by Ventura County Watershed Protection District (VCWPD) indicate that the basin was designed solely for the purpose of debris collection. Over the 59 years of operation, the basin has been cleaned out eight times with a total approximate sediment removal of 18,500 cubic yards and an average annual debris production of 314 cubic yards.

A 2004 study by GEI Consultants concluded the basin is below current VCWPD standards and modification or removal was recommended. A 2007 study by WEST Consultants, Inc. (WEST) recommended that removal of the basin could be beneficial. The current study investigates rehabilitation and removal scenarios based on the functionality of the basin considering upstream land use changes, historical precipitation, frequency of emergency spillway overtopping, and debris storage and detention functions.

Hydraulic modeling using HEC-RAS was conducted to evaluate flood inundation extents for the 10-, 50-, and 100-year events as well as the 1997 event when the emergency spillway was briefly overtopped. Each event was modeled for existing conditions, basin rehabilitation conditions, basin removal, and basin breach assuming the basin is full prior to the breach. Sediment transport modeling downstream of the basin was also conducted for the 100-year event for basin removal.

Approximate cost estimates were developed for five alternatives addressing basin deficiencies. To provide a recommended course of action, the five alternatives and two additional alternatives were evaluated using a priorities matrix with five criteria: (1) potential cost, (2) improvements to safety, (3) changes to possible flood extent, (4) downstream effects on debris/sediment, and (5) anticipated public perception.

Study results are summarized as follows:

- Santa Rosa Debris Basin No. 2 provides minimal or no flood protection to the area downstream for the 10-, 50-, or 100-year events.
- A basin breach would likely overtop Santa Rosa Road by potentially up to seven feet of water.
- Downstream channel sediment deposition from a 100-year event without the basin is generally less than a foot in most reaches.
- Basin outlet works and the earthen spillway need substantial rehabilitation to bring the facility into compliance with current District standards.
- Basin removal is the most cost effective alternative.

After evaluating basin alternatives using the aforementioned criteria, the recommended course of action for Santa Rosa Debris Basin No. 2 is removal.

1 INTRODUCTION

The Santa Rosa Road Debris Basin No. 2 was constructed approximately six decades ago by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) now known as the USDA Natural Resources Conservation Service (NRCS). The basin was determined to be below current Ventura County Watershed Protection District (VCWPD) standards in 2004 by GEI Consultants (GEI, 2004) and modification or removal was recommended. VCWPD has requested a review of current basin functionality and recommendations for potential modifications to the basin (including possible removal).

1.1 STUDY OVERVIEW

The Santa Rosa Road Debris Basin No. 2 is located in Santa Rosa Valley, an unincorporated area of Ventura County as presented in Figure 1-1. The basin is located approximately 100 feet north of Santa Rosa Road as shown in Figure 1-2.

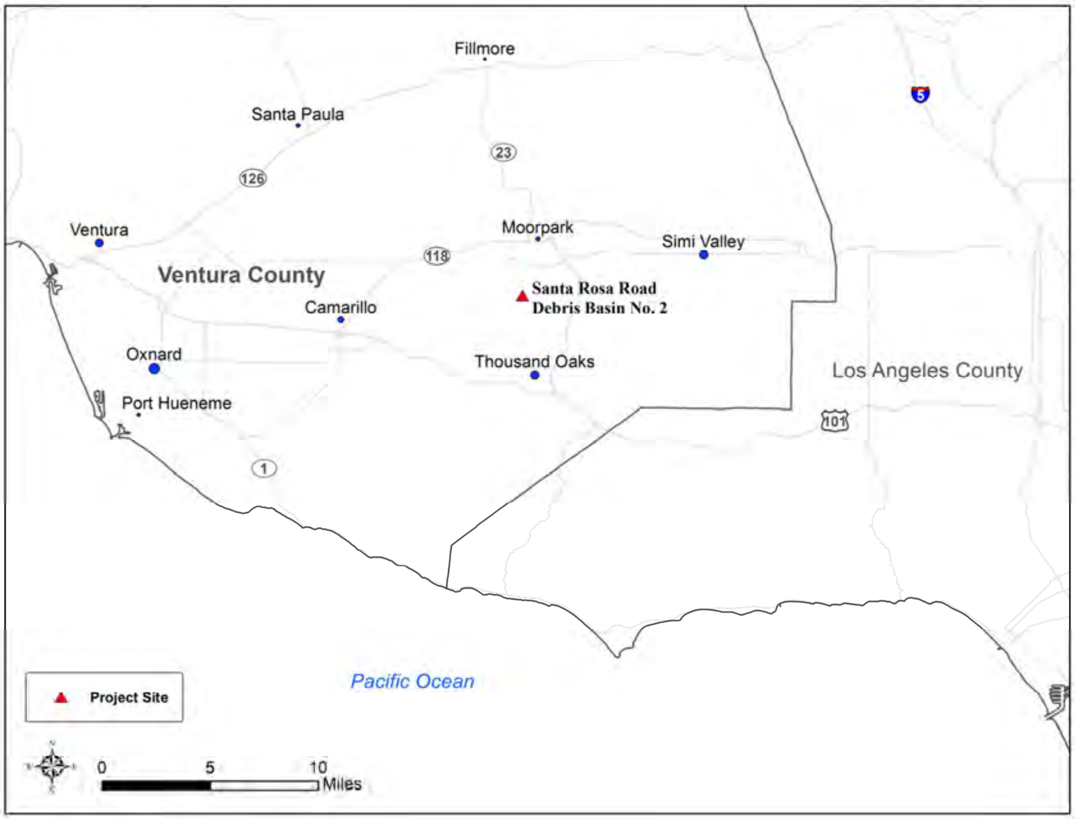

Figure 1-1. Project Vicinity Map

Figure 1-2. Project Location Map

The basin is located in Zone 3 of the VCWPD's four districts. Zone 3 encompasses the Calleguas Creek watershed and its tributaries. The basin's approximate location within the VCWPD Zone system is presented in Figure 1-3.

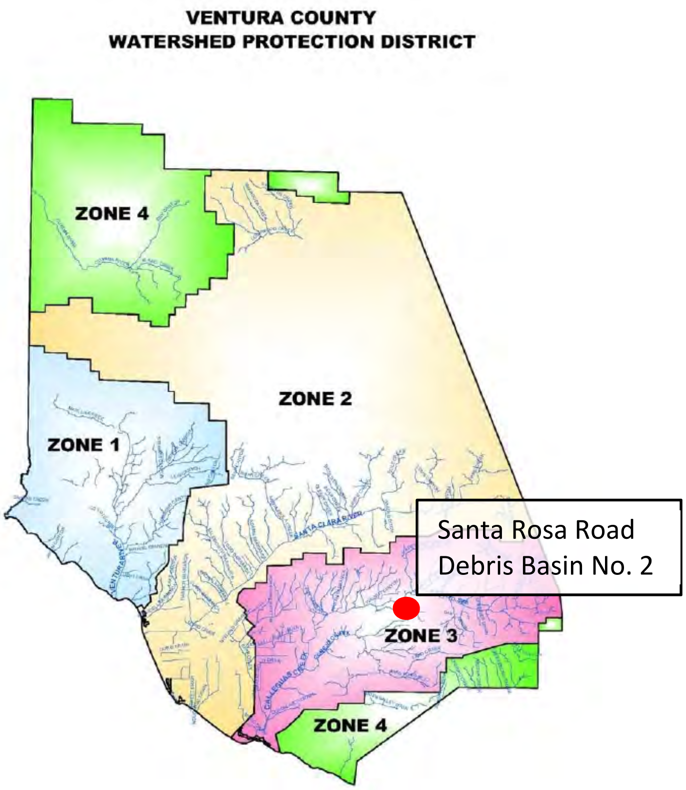

Figure 1-3. Basin VCWPD Zone Location (VCWPD 2005)

1.2 PREVIOUS STUDIES

The Santa Rosa Road Debris Basin No. 2 has been evaluated in multiple previous studies. Two alternative designs were created by VCWPD to update the basin outlet works and vehicle access in 1993. In 2004 GEI Consultants "evaluated the condition and structural integrity, functionality and remaining service life, safety, and [VCWPD] proposed retrofit concepts and cost estimates for each dam and basin" (GEI Consultants 2004). The basin was included in the VCWPD *Debris and Detention Basins* (2005) summary of technical and hydrologic characteristics of detention and debris basins owned and maintained by VCWPD. In 2007, WEST Consultants conducted the Ventura County Debris Basins and Sedimentation Analyses, and in March, 2015, a Design Hydrology Update Draft Report was completed by VCWPD.

1.3 ACKNOWLEDGMENTS

Mr. David S. Smith, P.E., CFM, D.WRE, of WEST Consultants, Inc. was the project manager for this study assisted by Mr. Cameron Jenkins, P.E., who performed the majority of the 1D and 2D hydraulic model development and analysis. Mr. Bryan Scholl, Ph.D., E.I.T., conducted the functionality review, alternatives analysis and cost estimates. Mr. Martin J. Teal, P.E., P.H., D.WRE, provided quality assurance reviews.

Dr. Zia Hosseinipour served as project manager for Ventura County Watershed Protection District.

2 DATA REVIEW AND SYNTHESIS

2.1 DATA REVIEW

Multiple documents were reviewed for information pertinent to the construction and functionality of the basin. The documents reviewed were:

- *Earth Fill Dam – Fle 14.1.: Calleguas Creek W.P.P, "As-Built" Drawings* (USDA SCS, 1956)
- *Design Manual: Detention Basin Criteria* updated 6/28/1991 (Ventura County Flood Control District, 1968)
- *Recording Gage Intensity Report: Lake Bard, Water Year 1998* (VCWPD, 2015)
- *Investigation of Detention Dams and Debris Basins* (GEI Consultants, 2004)
- *Debris and Detention Basins* (VCWPD, 2005)
- *Ventura County Debris Basins Sedimentation Analyses Final Report* (WEST Consultants, 2007)
- *Santa Rosa Road Debris Basin No. 2 – Design Hydrology Update* (VCWPD, 2015).

Key findings are summarized in Table 2-4 and the sections below.

2.2 SITE VISIT

A site visit in April 2015 included observations of the Santa Rosa Road Debris Basin No. 2 as well as culvert locations/sizes in the reach downstream. Accessible culvert dimensions were measured for use in the HEC-RAS model and are presented in Table 2-1. Representative photographs from the 2015 site visit are included in Appendix A.

Table 2-1. Culverts Downstream of Santa Rosa Road Debris Basin No. 2

Street Name	HEC-RAS Station	Culvert Geometry	Culvert Width (ft.)	Culvert Height (ft.)
un-Named Farm Rd.	3520	elliptical, CMP	6	4
un-Named Farm Rd.	3520	circular CMP	3	3
un-Named Farm Rd.	5100	rectangular, concrete	7.5	4
un-Named Farm Rd.	7600	rectangular, concrete	16	6
un-Named Farm Rd.	8000	rectangular, concrete	12	6
un-Named Farm Rd.	8560	rectangular, concrete	12	6
Andalusia Dr.	10600	rectangular, concrete	12	6
Santa Rosa Rd.	10900	rectangular, concrete	12	6

The reach upstream of the debris basin includes heavy vegetation; however, no debris was noted in the basin itself.

2.3 BASIN CAPACITY AND DEBRIS STORAGE

As-built drawings of the debris basin were reviewed (see Appendix B). The drawings provide construction dimensions and quantities but do not provide design parameters, such as design debris storage capacity, anticipated sediment volume, or spillway capacity.

Stage-discharge and stage-storage curves for flood storage and a debris stage-storage curve are located in *Debris and Detention Basins* (VCWPD, 2005) and presented here as Figure 2-1 and Figure 2-2.

In Figure 2-1, "Spillway Elevation - 396.0'" refers to the emergency spillway (Figure 2-3) crest elevation. "Top of Riser - 387.0'" refers to the primary spillway and debris bleeder elevations (all elevations are NGVD29). The spillway and bleeder are shown in Figure 2-4 and Figure 2-5. Discharge is given in cubic feet per second (cfs). The spillway and riser elevations differ by 9 feet in the stage-storage and debris-storage curves. The "as-built" drawings indicate the emergency spillway elevation is 126.0 feet and the spillway and riser elevations are 116.0 feet (local benchmark elevation values), a difference of 10.0 feet The spillway and riser elevations of 396.0 and 387.0 (NGVD29) from stage-storage and debris-storage curves were used for the hydraulic modeling.

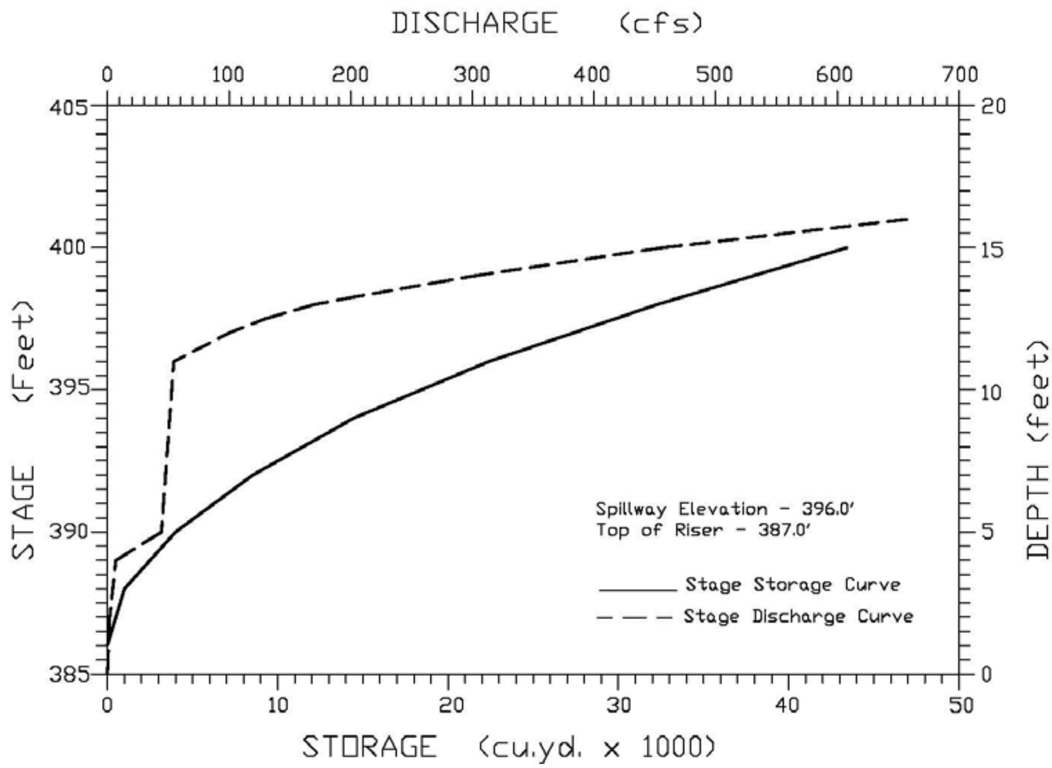

Figure 2-1. Stage-Discharge and Stage-Storage Curve (VCWPD, 2005)

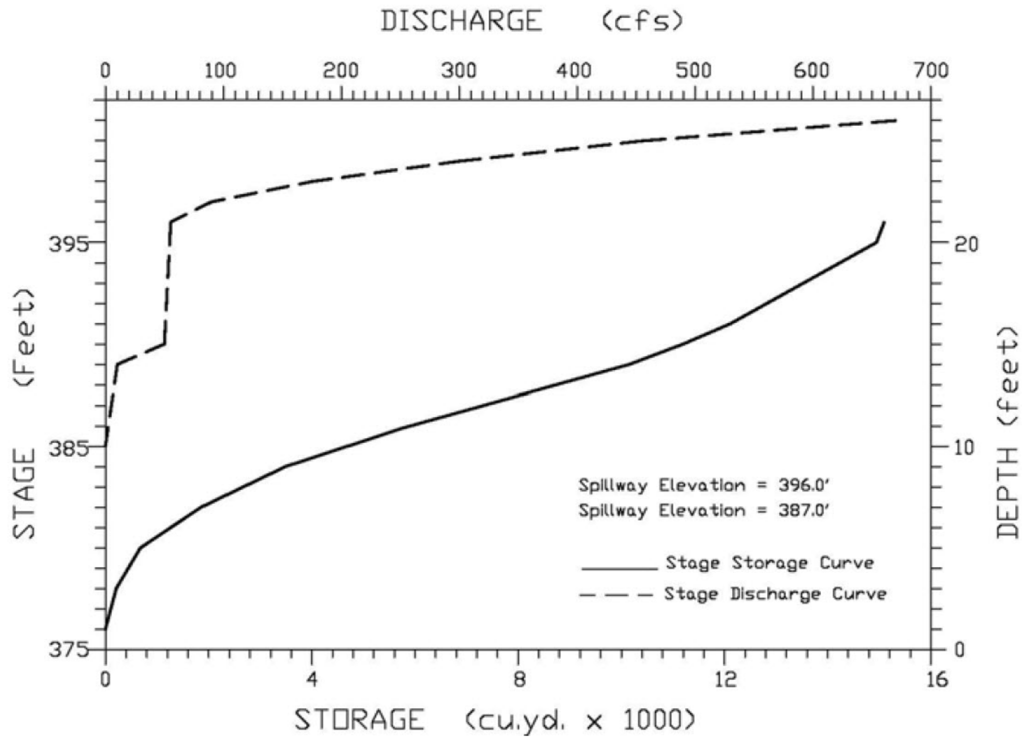

Figure 2-2. Basin Storage Debris Storage Curve, Debris Slope = 0.013 (VCWPD, 2005)

Figure 2-3. Emergency Spillway, Looking Downstream

Figure 2-4. Primary Spillway

Figure 2-5. Debris Bleeder/Riser

Debris and Detention Basins (VCWPD, 2005) states that 1,250 cubic yards (CY) is 10% of the 100-year debris yield indicating 12,500 cubic yards is the anticipated 100-year debris yield in this document. The emergency spillway elevation of 396.0 feet corresponds to a maximum storage volume of 15,000 cubic yards according to Figure 2-2. This is 120% of the 100-year debris volume of 12,500 cubic yards.

Current VCWPD guidelines require 125% of the 100-year debris volume at the spillway crest based on sloped capacity storage. The *Santa Rosa Road Debris Basin No. 2 Design Hydrology Update* (VCWPD, 2015) provides a current estimate of the 100-year debris volume of 5,424 cubic yards, which is less than half of the original design value of 12,500 cubic yards.

Historical basin clean-out and capacity records were obtained from the VCWPD *Debris and Detention Basins* (2005). Basin clean-out records from July 2000 through March 2015, were provided directly from VCWPD. Since construction in 1957, 18,461 cubic yards of documented material has been removed for an average annual debris accumulation of 318 cubic yards. Basin clean-out and capacity history is provided in Table 2-2.

Table 2-2. Santa Rosa Road No. 2 Debris Basin Clean-out and Capacity History

Date	Debris Volume Removed (Cubic Yards)	Basin Capacity (Cubic Yards)
Oct. 1971		6,614
Sep. 1980	2,600	
Sep. 1980		9,200
Nov. 1982		10,914
Aug. 1990	7,700	
Dec. 1990		14,957
Aug. 1991		14,889
May 1992		13,350
Jul. 1992	1,650	

Date	Debris Volume Removed (Cubic Yards)	Basin Capacity (Cubic Yards)
Jul. 1993	2,290	
Jul. 1993		15,000
Jul. 1994	288	
Jul. 1995	1,573	
May 1997		13,900
Jul. 1998		12,500
Mar. 2004	1,560	
Oct. 2004	800	

Debris accumulation rates were determined using VCWPD basin maintenance records. Historical basin clean-out records indicate the basin has been cleaned out eight times since 1957. Basin capacity has been determined by VCWPD using aerial surveying multiple times since construction. Using clean-out and survey records, the average debris accumulation rate between surveys was determined and is presented in Table 2-3.

Table 2-3. Average Annual Debris Accumulation Rate

	Time Period									
	1971-1980	1980-1982	1982-1990	1990-1991	1991-1992	1992-1993	1993-1997	1997-1998	1998-2015	1957-2015(1)
Debris Accum. Rate (CY/year)	2	-791(2)	452	102	2,050	1,962	772	1,200	-8(2)	318

(1) 2015 debris basin volume estimated during site visit.

(2) Negative value indicates debris basin gained capacity through means other than documented VCWPD debris removal.

The average debris accumulation rate is 318 cubic yards per year from 1957 to 2015. Incremental average debris accumulation rates between surveys varies from accumulating 2,050 cubic yards per year to *losing debris* at 791 cubic yards per year.

Key findings of the document review are summarized in Table 2-4.

Table 2-4. Document Review Key Findings Summary

Source	Work Completed By	Date	Key Findings
Site visit	WEST	2015	• channel roughness estimation for hydraulic modeling • culvert types and dimensions for hydraulic modeling • inadequate emergency spillway erosion protection • excessive vegetation on dam face • downstream slope of dam is steeper than current standards allow
"as-built" drawings	NRCS	1956	• initial basin design
Debris and Detention Basins	Ventura County Watershed Protection District	2005	• drainage area is 1,101 acres (1.72 sq. mi.) • required storage volume is 125% of debris from 100-year storm (sloped capacity) • historical 100-year anticipated debris is 12,500 CY • level capacity is 7,300 CY at emergency spillway elevation • sloped debris capacity is 15,000 CY • basin clean-out and available debris capacity history • emergency spillway capacity w/out sufficient freeboard is 610 cfs • highly variable debris accumulation rates
Santa Rosa Road Debris Basin No. 2 – Design Hydrology Update Draft Report	Ventura County Watershed Protection District	2015	• current 100-yr debris yield is 5,424 CY • 100-yr peak storm inflow, 1,274 cfs
Design Manual	Ventura County Flood Control District	1968 (rev. 1991)	• current basin design criteria
Ventura County Debris Basins Sedimentation Analyses	WEST Consultants	2007	• basin removal does not require grade control structures • removal could result in sediment deposition downstream
Investigation of Detention Dams and Debris Basins	GEI Consultants	2004	• recommended as High Priority for retrofit or abandonment

2.4 RAINFALL DATA

An evaluation of daily rainfall amounts from 1957 to present was conducted to determine the largest known rainfall event of record affecting the basin and to estimate the inflowing discharge. Rain gage data was obtained from the VCWPD website: http://www.vcwatershed.net/hydrodata/gmap.php?param =rain. Gages used for the evaluation are presented in Table 2-5.

Two gages, Moorpark-Everett and Santa Rosa Valley-Worthington Ranch, were evaluated beginning from the debris basin construction in 1957. The remaining five stations were evaluated beginning in 1990 to coincide with a documented debris basin cleanout. 24-hour rainfall events were selected with at least one inch of precipitation. In the case of recorded amounts greater than one inch from two or more gages in the same 24-hour period, the greater rainfall amount was selected. In this manner, multiple values greater than one inch occurring on the same day were eliminated.

The approximate 24-hour rainfall return interval for events greater than one inch near the debris basin was determined using a logarithmic regression of NOAA 14 rainfall return amounts (NOAA 2015) in the vicinity of the Santa Rosa and Moorpark Road intersection, an identifiable landmark relatively close to the watershed center. NOAA 14 return interval precipitation amounts are presented in Table 2-6. Figure 2-6 summarizes rainfall events greater than 1 inch, the approximate return interval of key precipitation depths, and documented cleanouts since basin construction.

The maximum recorded 24-hour rainfall in the area since 1928 when records begin occurred January 26, 1956, when 5.07 inches were recorded. This event was likely the impetus for the construction of Santa Rosa Road Debris Basin No. 2 because the as-built drawings were completed that same year in November 1956. The three highest recorded 24-hour rainfall events since basin construction are:

1) 4.85 inches during the 24 hours ending at 8am on December 6, 1997 at Moorpark County Fire Station (Site Id: 141A);
2) 4.75 inches during the 24 hours ending at 8am on January 10, 2005 at Moorpark County Fire Station (Site Id: 141A);
3) 4.63 inches during the 24 hours ending at 8am on February 11, 1992 at Thousand Oaks County Fire Station (Site Id: 128B).

Table 2-5. Available Rain Gage Information Near Debris Basin

STA No.	STA Name	Latitude	Longitude	Data Start Date	Data End Date
192	Moorpark-Everett	34 15 23.0	118 50 52.0	9/30/1955	10/1/1980
192A	Moorpark-Everett	34 15 02.0	118 50 36.0	9/30/1980	9/30/2008
049	Santa Rosa Valley - Worthington Ranch	34 14 10.0	118 56 01.0	9/30/1928	9/30/1977
049A	Santa Rosa Valley - Worthington Ranch	34 14 54.0	118 56 25.0	9/30/1977	9/30/2008
502	Santa Rosa Valley Basin 2	34 14 35.7	118 53 05.8	9/30/2007	9/30/2014
128B	1000 Oaks - County Fire Station	34 13 06.6	118 52 01.7	10/01/1990	10/1/2009
141A	Moorpark-County Fire Station	34 17 14.0	118 52 52.0	10/01/1990	10/1/2008
227	Lake Bard	34 14 34.7	118 49 43.6	10/01/1990	9/30/2014
128C	Thousand Oaks APCD	34 12 36.5	118 52 13.7	10/1/2008	12/31/2014

Table 2-6. NOAA 14 24-hour Rainfall Near Santa Rosa Rd and Moorpark Rd Intersection

		Return Interval (years)									
		1	2	5	10	25	50	100	200	500	1000
Precipitation (in.)	Lower 90% Bound	1.72	2.31	3.03	3.57	4.15	4.57	4.93	5.25	5.60	5.82
	Expected Value	1.94	2.61	3.44	4.08	4.91	5.51	6.10	6.68	7.42	7.97
	Upper 90% Bound	2.24	3.01	3.98	4.76	5.92	6.79	7.69	8.66	10.00	11.2

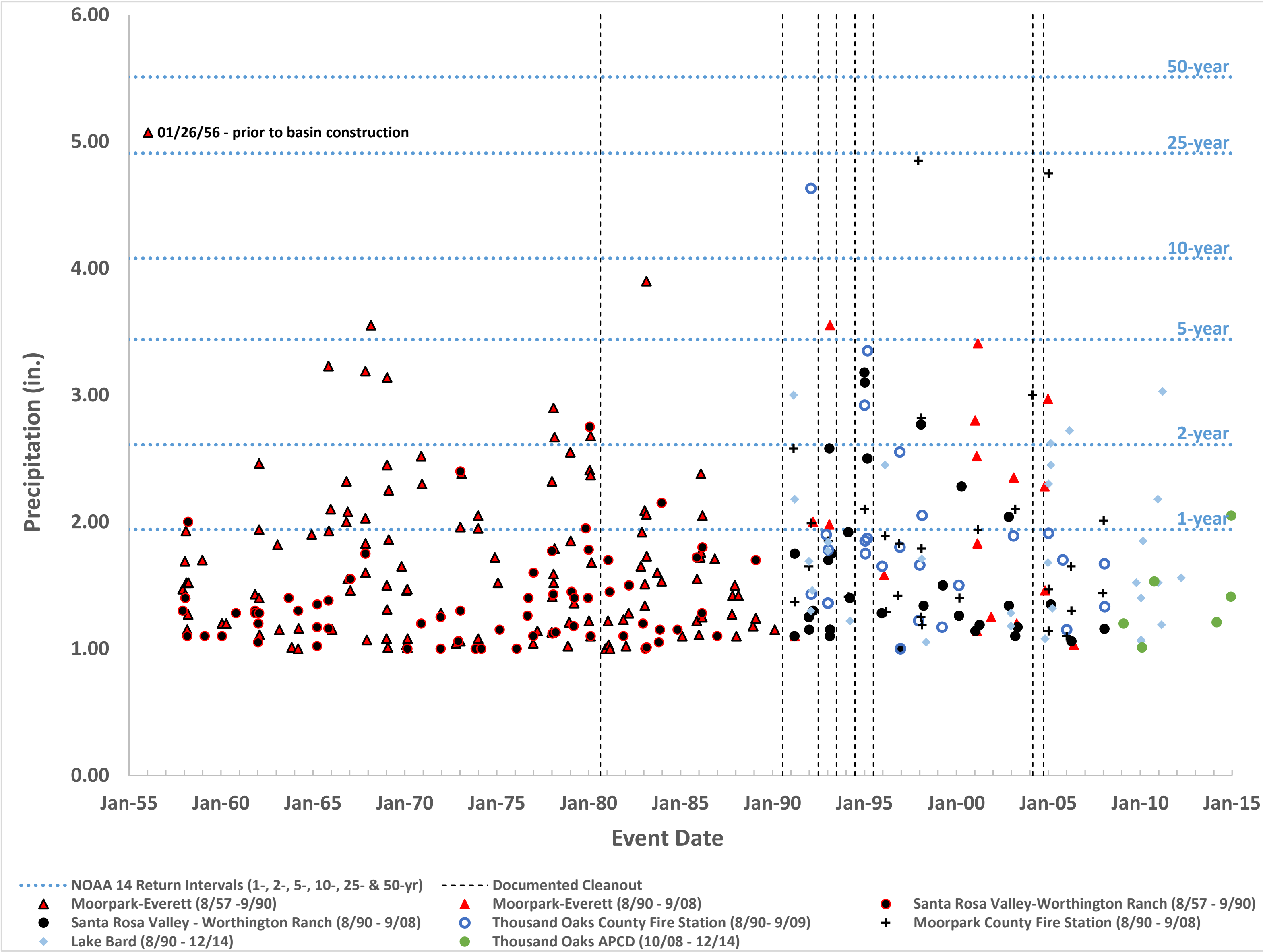

Figure 2-6. 24 hour Rainfall Events Greater Than 1 inch, 1957 – 2014

Hourly rainfall measurements are not recorded at the Moorpark County Fire Station gage. The nearest hourly rainfall data is the Lake Bard gage located approximately 3 miles from the debris basin. The highest three 24-hour rainfall event records were evaluated by VCWPD for cumulative rainfall totals and peak rainfall intensity using the Lake Bard hourly rainfall gage data. Cumulative hourly rainfall totals for the three events are presented in Figure 2-7.

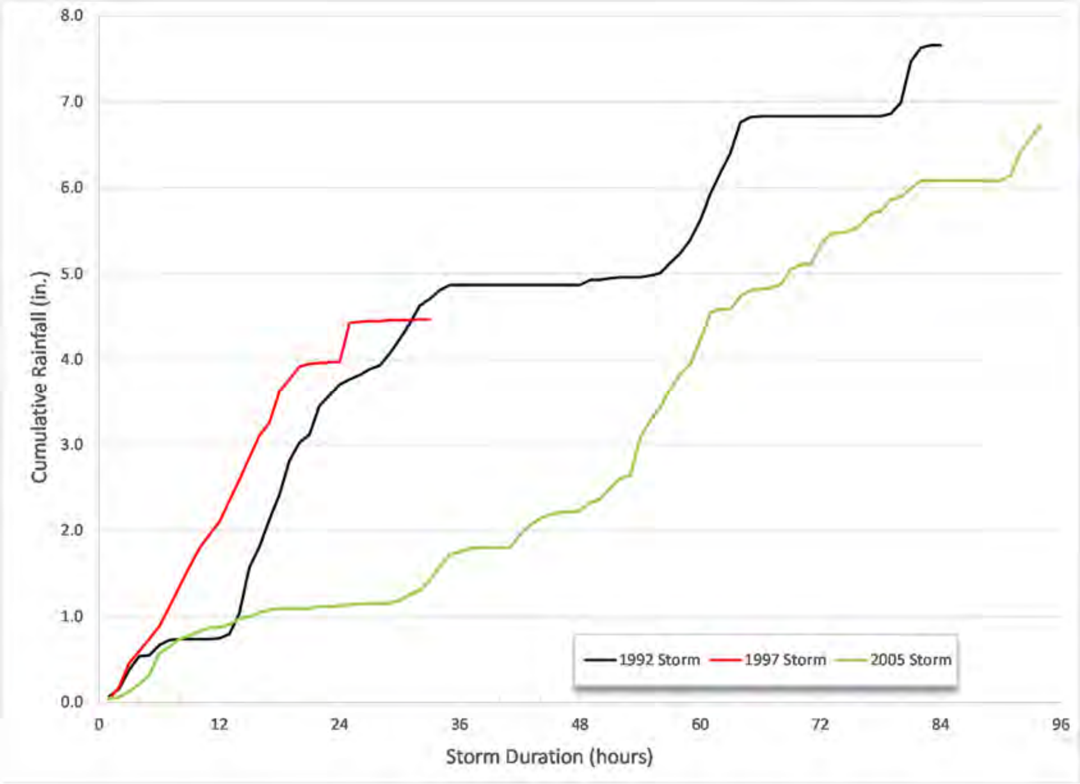

Figure 2-7. Cumulative Hourly Rainfall Totals, Lake Bard Rainfall Gage

Table 2-7 presents the documented debris volume between survey periods in which the three largest recorded rainfall events occurred. The survey periods including the February, 1992, and December, 1997, events measured deposits of 1,539 and 1,400 cubic yards, respectively, with few other events occurring during the same time period. The survey period with the January, 2005, event had negligible amounts of debris in spite of multiple events greater than the 1-year precipitation occurring during this time period. The quantity of debris removed and the time period between necessary clean-outs is heavily dependent on intermittent rainfall events in the watershed.

Table 2-7. Rainfall Events vs. Clean-out Volume

Rainfall Event Date	Rainfall Amount (in.)	Prior Basin Volume Survey Date	Subsequent Basin Volume Survey Date	Rainfall Events >1 year During Survey Period				Documented Debris (CY)
				1-2 yr	2-5 yr	5-10 yr	10+yr	
Feb. 1992	4.63	Aug. 1991	May 1992	2	0	0	1	1,539
Dec. 1997	4.85	May 1997	Jul. 1998	1	2	0	1	1,400
Jan. 2005	4.75	Jul. 1998	Apr. 2015	11	7	0	1	~ 0[1]

(1) 2015 debris basin volume estimated during site visit.

2.5 UPSTREAM LAND USE CHANGES

The *Santa Rosa Road Debris Basin No. 2 Design Hydrology Update* (VCWPD, 2015) includes a brief discussion of how land use in the basin has changed since construction. At the time of basin construction, there was very little development and most of the watershed was expected to provide sediment to the debris basin. Land use in the watershed has changed, and currently a significant portion of the watershed that was previously undeveloped can now be classified as rural or low density residential. Remaining undeveloped areas are not directly connected to the basin and thus do not contribute sediment to it. The change in land use is documented by the lack of developed structures in the 1971 aerial photo presented in Figure 2-8 compared with the structures in the existing condition aerial photo shown in Figure 2-9. Based on a land use evaluation by VCWPD, usage changes have not been significant enough to appreciably alter hydrologic response. The 100-year debris yield estimate, however, is now much lower (5,424 cubic yards, which is less than half of the original design value of 12,500 cubic yards).

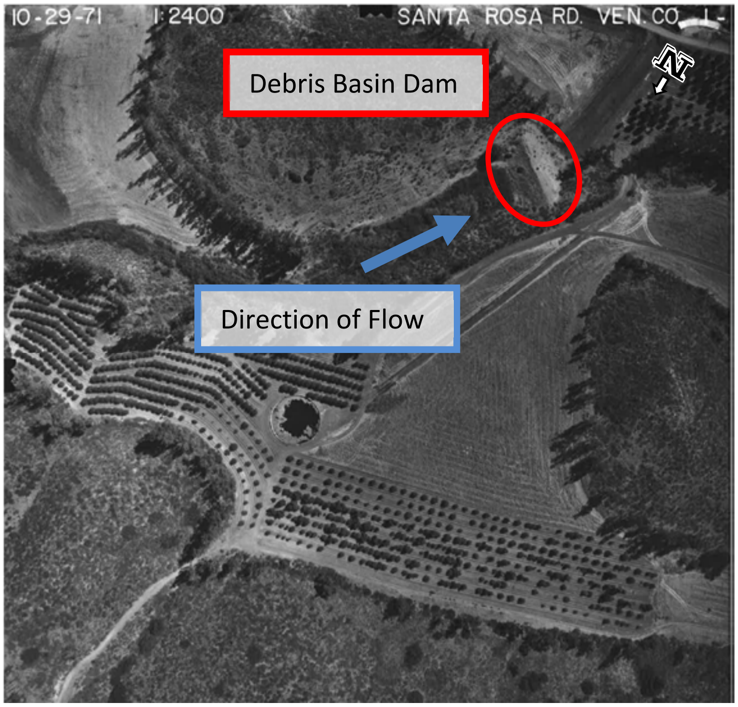

Figure 2-8. Debris Basin Aerial Photo, 1971

Figure 2-9. Debris Basin Aerial Photo, 2015

2.6 FREQUENCY OF EMERGENCY SPILLWAY OVERTOPPING

Based on rainfall records and VCWPD's knowledge of the small amount of emergency spillway flow in 1997, the emergency spillway would likely be activated during a storm in the range of a 5- to 10-year event. The emergency spillway is an unprotected earthen structure and could potentially fail from erosion and scour with virtually any sustained flow. In 1997, the rainfall recorded *approximately 3 miles away at Lake Bard* corresponded to a 20- to 25-year event. Rainfall is highly variable and the precipitation over the watershed in 1997 was likely not equal to that recorded at Lake Bard. Without rainfall data in the watershed during the event, it is impossible to directly correlate the hydrologic response return interval with the rainfall return interval.

3 HYDRAULIC ANALYSIS

3.1 MODEL DISCHARGES

Inflow hydrographs for the 1997 event as well as the 10-, 50- and 100-year events were provided by VCWPD as presented in Table 3-1 and Figure 3-1.

Table 3-1. Event Hydrograph Data Summary

	Design Event			
	1997	10-year	50-year	100-year
Peak Flow (cfs)	213	607	1,000	1,274
Time to Peak (min.)	1,178	1,171	1,170	1,168
Flood Volume (ac-ft)	102	151	248	283

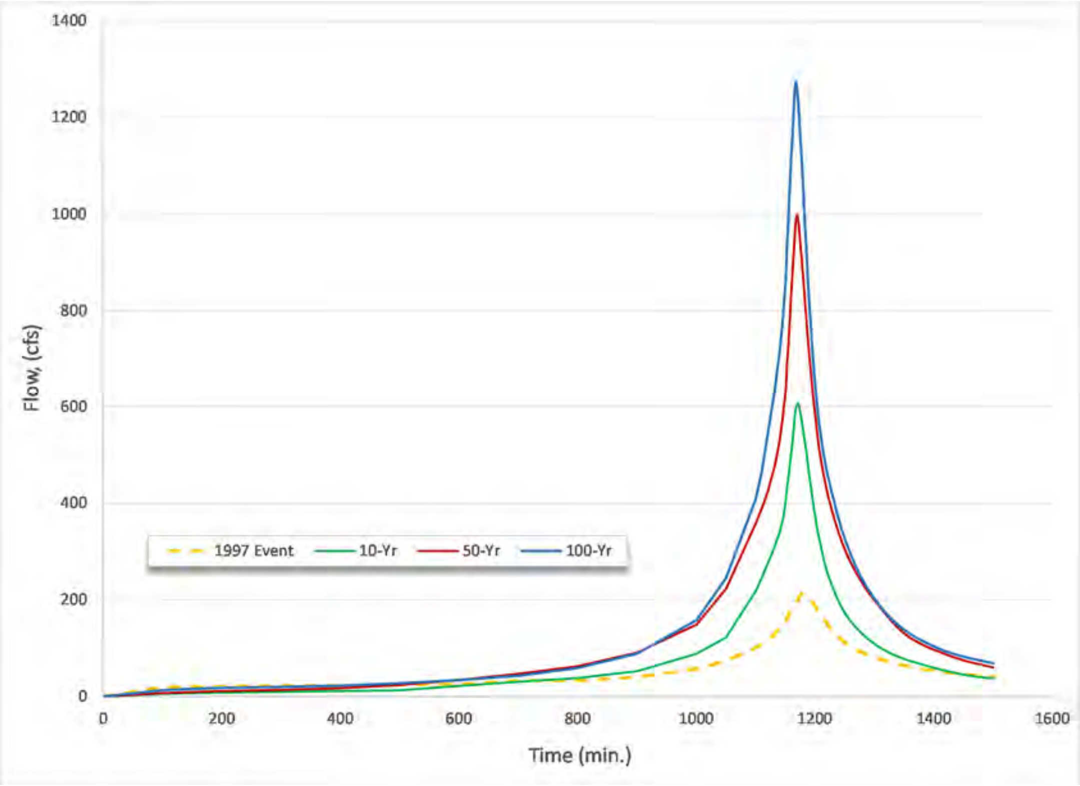

Figure 3-1. Event Hydrographs

Basin routing and dam break discharges were evaluated in HEC-HMS version 4.0 (USACE 2013). A stage-storage curve was generated from LiDAR data provided by VCWPD. A stage-discharge curve for existing conditions was generated from the scanned stage-discharge curve in *Debris and Detention Basins* (VCWPD 2005) and extrapolated for dam crest overtopping using the broad-crested weir equation. The resulting stage-storage-discharge curves are presented in Figure 3-2.

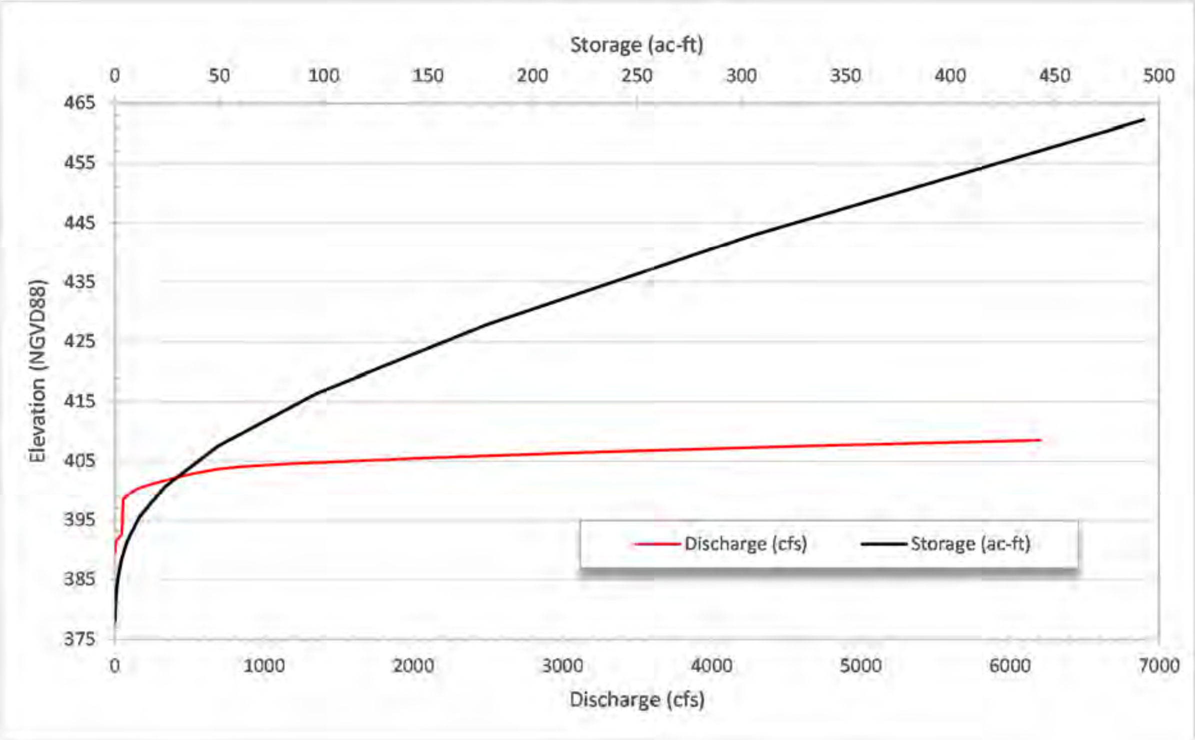

Figure 3-2. Stage-Storage-Discharge Curves

HEC-HMS was used to route event hydrographs through the basin. The resulting outflow hydrographs were input to the HEC-RAS hydraulic model (see Appendix F). All elevations in HEC-HMS are NAVD 88.

Dam breach scenario runs were based on the conservative Froehlich (2008) breach parameters presented in Table 3-2.

Table 3-2. Dam Breach Parameters

	Design Event		
	10-year	50-year	100-year
K_o (failure type)	overtopping	overtopping	overtopping
Breach Side Slope (H:1V)	1.0	1.0	1.0
Average Breach Width (ft.)	37	39	40
Breach Bottom Width (ft.)	6	7	8
Time to Breach (hrs.)	0.1	0.1	0.1

3.2 MODIFICATIONS TO HEC-RAS MODEL

The HEC-RAS model (USACE, 2010a, 2010b) developed by WEST in 2007 was converted to a HEC-RAS 2D model with 1D elements in the channel and 2D elements in the overbanks. The HEC-RAS model was configured for unsteady analysis with added interpolated cross sections for model stability. Overbank area roughness were modeled using previously defined Manning's *n* values. All elevations in HEC-RAS are NAVD 88.

WEST previously approximated the basin outflow rating curve by modifying the cross section at the Santa Rosa basin. The modification was applicable only to events smaller than a 10-year event. Larger events would overtop the earthen emergency spillway, likely resulting in dam failure. For this reason, the elevation-storage-outflow relationship was modeled in HEC-HMS (instead of taking the cross section approach in HEC-RAS) and the 10-, 50- and 100-year events were modeled assuming that the dam would breach in each case. Table 3-3 presents the HEC-RAS model runs completed for existing conditions—the dam was assumed to breach when the earthen emergency spillway was overtopped by more than 1 foot. The 10-year event overtops the spillway by 4 feet while the 50- and 100-year events overtop the spillway crest by 6 feet.

The reoperation scenario modeled is one of several reoperation alternatives considered in this study (see additional discussion in Section 4). The emergency spillway crest was lowered from 396 to 391.5 feet (NGVD29)—391.5 represents the approximate elevation required to store 100% of the design debris volume (5,424 cubic yards) at a level capacity. The spillway width of 16 feet was determined by trial and error such that 3 feet of freeboard to the dam crest is available for the 100-year event. The primary spillway pipe and bleeder tower capacity were assumed unchanged in this reoperation scenario. The discharge capacity of this low flow outlet is negligible compared to the emergency spillway (which technically functions as a primary spillway for large events).

Table 3-3. HEC-RAS Model Runs Completed

	Design Event			
	1997	10-year	50-year	100-year
Existing Conditions	✓	✓	✓	✓
Dam Breach	n/a	✓	✓	✓
Dam Removed	✓	✓	✓	✓
Reoperation	n/a	✓	✓	✓

3.3 MODELING RESULTS

A listing of HEC-RAS input and output files are included in Appendix H. The inundation limits for each model run were mapped downstream of the dam to the confluence with Conejo Creek. These results are used to compare Santa Rosa Road Debris Basin No. 2 alternatives, and are not intended for establishing floodplain limits or for other purposes. The number of buildings inundated for each model run was approximated based on georeferenced hydraulic model results (see Table 3-4). Hydraulic model results are presented as the maximum extent and depth of inundation during the event in Appendix D, Figure D-1 through Figure D-14.

Table 3-4. Approximate Number of Inundated Structures

	Design Event			
	1997	10-year	50-year	100-year
Existing Conditions	1	2	9	12
Dam Breach	n/a	17	29	30
Dam Removed	1	2	12	12
Reoperation	n/a	2	9	12

In addition to structure inundation, Santa Rosa Road would be overtopped by greater than 7 feet of water during a dam breach (10-, 50- or 100-year event). This is a significant potential hazard to life.

3.4 DETENTION EFFECT OF BASIN

Model runs comparing downstream flooding with and without the basin are nearly identical for low and high flow scenarios. Comparing a 100-year event with the basin in place to a 100-year event without the basin (Figure D-11 and Figure D-12) shows that there is little change to the extent of inundation. Therefore, the detention function of the basin is negligible. This is easily confirmed without a hydraulic model when comparing the available storage volume of the basin (23,500 cubic yards at emergency spillway elevation capacity) with the volume of the inflow hydrograph (456,000 cubic yards for the 100-year event).

3.5 SEDIMENT TRANSPORT IMPLICATIONS

The WEST Consultants (2007) study included a sediment transport analysis downstream of the basin. There were three assumed sediment loads under exsiting conditions and under a proposed “Basin Removal” condition. Results indicated basin removal could be beneficial as minor erosion immediatley downstream of the basin had been observed. In addition, the downstream receiving stream, Conejo Creek, is erosive downstream of its confluence with Santa Rosa Creek and could benefit from an increased sediment supply. Sediment modeling result profiles are located in Appendix E.

As part of the current study, the District requested an edit to the 2007 sediment transport model to include the 100-year hydrograph following the long term simulation for the dam removal scenario. The purpose of this model run is to evaluate whether deposition is excessive for the 100-year event with dam removal. Several model changes were required to add the 100-year event hydrograph:

- The rating curve was modified to include flows up to 1,234 cfs (the 100-year peak flow),

- The inflowing sediment load was updated for Load A (Scott Method sediment yield, unburned condition minus wash load) and Load B (Scott Method sediment yield, burned condition 4.5 years after a fire minus wash load)
- The initial cross section geometry data were updated to reflect the final geometry results for the long term simulation.

Revised sediment modeling result profiles are located in Appendix I. There is more scour predicted downstream of culverts as would be expected with higher velocities due to the 100-year event. The locations of deposition along the stream are generally the same as for the long term simulation, and the amount of deposition due to the 100-year event is generally less than a foot in most reaches. These results suggest that the 100-year event would not produce areas of excessive deposition.

4 ALTERNATIVES ANALYSIS

4.1 GENERAL DESCRIPTION

Multiple alternatives for debris basin modification (including removal) were considered. Possible alternatives include:

- Continuing the current maintenance program with no major changes to the dam
- Modifying the dam and outlet works to meet current standards (also includes potential multi-purpose functions)
- Removing the dam

Given that the basin provides a negligible detention function and that a dam break could occur with the current basin deficiencies, the reoperation and removal alternatives are the two most reasonable options (the “do nothing” alternative is not recommended). Reoperation and removal options are discussed further below, including the approximate cost of each alternative.

4.2 REOPERATION ALTERNATIVES

VCWPD has previously developed two variations of a design (2A and 2B) for basin reoperation—this design data was provided by VCWPD and is included in Appendix G. The emergency spillway was redesigned to flow directly into a 6’x14’ (W x H) reinforced box culvert approximately 415 feet long that connects to the culvert passing beneath Santa Rosa Road. The VCWPD design also includes a new low flow outlet tower (replacing the current primary spillway and bleeder pipe). The two VCWPD designs differ in the location of the low flow outlet point—one connects directly to the emergency spillway culvert, and the other outlets to an open channel reach which then flows into a side opening of the emergency spillway culvert.

One of the alternatives evaluated was previously described in Section 3—lowering the emergency spillway to elevation 391.5 (NGVD29) and widening the spillway to 16 feet to provide adequate freeboard (see Figure 4-1). This alternative would also include paving the spillway with concrete, re-grading the downstream face of the dam to 3H:1V, covering the downstream face with rounded river stone, increasing the basin crest width to 20 feet, adding a 15-foot wide paved asphalt access road on the dam crest, constructing an access bridge for servicing outlet works, removing vegetation/trees from the dam, and constructing a stilling basin approximately 35 feet long with riprap downstream of the end sill. This alternative does not include upgrading the low flow outlet (primary spillway, bleeder, and culvert) but the VCWPD should include this improvement if a condition assessment reveals any deficiencies.

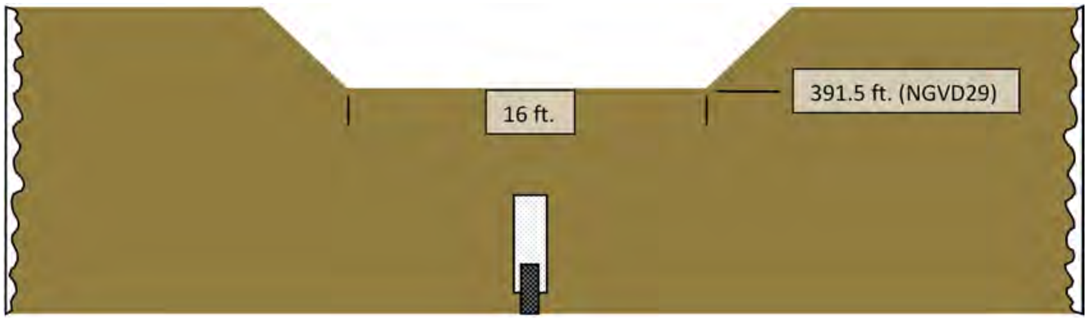

Figure 4-1. Lowered and Widened Spillway Alternative

This alternative would capture the design debris volume and provide for routing of the 100-year discharge through the basin with adequate spillway freeboard, which would significantly reduce the potential for dam breach.

Another similar alternative was considered which replaces the low flow spillway, bleeder and culvert with a 3-foot wide slot to provide open channel flow from the clean out elevation upstream of the embankment to the downstream toe of the embankment (see Figure 4-2). The intent of this "slot" option is to allow sediment to flow through the structure while still trapping larger debris. The slot width cannot be "calculated" and would be somewhat experimental in nature (WEST has assumed the slot width equal to 3 feet). The elevation and width of the spillway above the slot is recommended to have the same dimensions as previously calculated (width of 16 feet at elevation 391.5 (NGVD29)) to provide adequate freeboard for the 100-year event. A rating curve for the slot option was not explicitly calculated because the slot would likely provide more conveyance than the current low flow outlet and the dimensions of the emergency spillway are identical to the previous alternative.

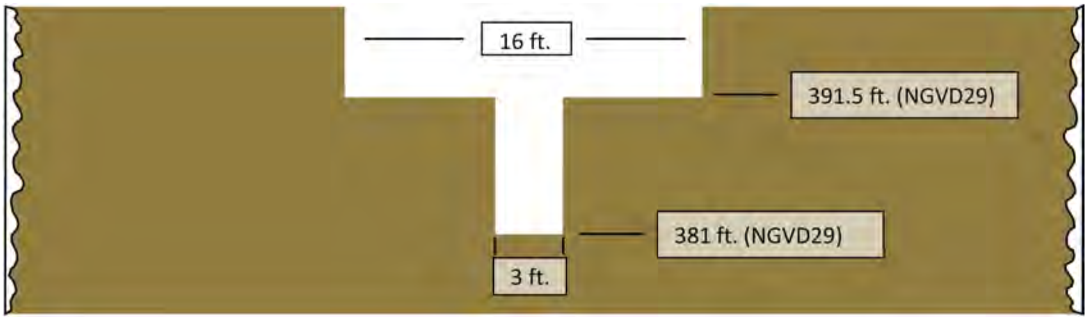

Figure 4-2. Lowered and Widened Spillway Alternative with Slot

4.3 POTENTIAL MULTI-PURPOSE FUNCTIONS

The basin could potentially be modified to provide a multi-purpose function. Potential multi-purpose uses might include environmental enhancement and recreational use, water supply or groundwater recharge. The basin covers over three acres and could be converted to a park or open space provided adequate measures were taken to accommodate the intermittent flows that would continue to pass through the area during the wet season.

As a water supply reservoir, the basin seems an unlikely candidate. The flows into the basin are highly intermittent resulting in an unreliable water supply. Due to vector control, long term storage would be an additional impediment. A raw water transmission facility would also need to be constructed for pumping and there does not appear to be a nearby end-user when the supply would be available.

Based on MWH Global's report (2013), a groundwater recharge function may be a possibility. The basin lies over the Santa Rosa Groundwater Basin and is located in an area described as "unconsolidated to moderately indurated clay, silt, sand [and] gravel". The site would need to be evaluated in detail by a hydrogeologist and/or geotechnical engineer to determine site suitability.

Any basin modification alternatives implemented would also need to address the dam deficiencies and update the facility to current VCWPD standards. As such, if a modification alternative were preferred, the cost would be in addition to the cost of reoperation.

4.4 REMOVAL ALTERNATIVE

The removal of the basin was evaluated in the WEST 2007 study which included sediment transport modeling. The results indicated that the basin removal may lead to some minor deposition downstream of the concrete channel reach (upstream of the Farm Road culvert). However, the current land use in this area is farming and the potential deposition is not expected to impact any structures.

The WEST 2007 study also addressed whether a drop structure would be required with basin removal. The conclusion was that a drop structure would not be required.

4.5 ESTIMATED ALTERNATIVES COST

An approximate cost for each alternative was developed based on earthwork volumes, debris removal, concrete work, riprap revetment quantities and other major expenses. Most item unit costs were provided by VCWPD. For cost categories not provided by VCWPD, references are provided in Appendix C.

Costs were developed for the following alternatives: (1) dam removal, (2) basin reoperation using VCWPD Design 2A, (3) basin reoperation using VCWPD Design 2B, (4) basin reoperation with a new concrete spillway, and (5) basin reoperation with a concrete slot for passing flow through the dam. For the dam removal alternative, channel stability was considered. In a previous sedimentation study, WEST Consultants, Inc. (2007) concluded that the channel would be relatively stable if the basin were removed. For this reason, grade control structures are not included in the cost of basin removal. Approximate costs are presented in Table 4-1. Cost breakdowns are presented in Appendix C.

Table 4-1. Approximate Cost of Basin Alternatives.

	Dam Removal	VCWPD Design 2A	VCWPD Design 2B	Reoperate w/ New Emergency Spillway	Reoperate w/ New Concrete Slot
Cost	$175,000	$1,044,000	$1,012,000	$714,000	$681,000

4.6 PREFERRED ALTERNATIVE

Based on the information reviewed (previous studies, historical records, and data provided by VCWPD), and hydraulic calculations performed in this evaluation, the Santa Rosa Road Debris Basin No. 2 has very limited functionality. The primary benefit of the basin is the ability to capture debris and sediment for a post-fire scenario. However, the Santa Rosa Road crossing itself would likely act as a de facto debris-capturing structure if the Santa Rosa Road basin was removed. As it stands now, the basin is a significant hazard for dam breach due to the potential for earthen spillway erosion.

To evaluate the alternatives, an alternatives analysis matrix was created in Microsoft Excel® to demonstrate how subjective criteria influence the choice of a "preferred alternative". Multiple alternatives were subjectively evaluated based on the following five decision criteria:

- Potential cost
- Improvement to safety
- Changes to possible flood extent
- Effect on debris/sediment
- Anticipated public perception

The seven alternatives evaluated were:

- Continue the current maintenance program ("do nothing")
- Lower and widen the spillway
- Lower and widen the spillway and incorporate a groundwater recharge aspect
- Lower and widen the spillway with a new low flow slot through the dam
- VCWPD designs 2A and 2B
- VCWPD designs 2A and 2B with a groundwater recharge aspect
- Basin removal

The alternatives analysis matrix provides a ranking of the alternatives using subjective user input. Initially, the user ranks the importance of each decision criteria (potential cost, improvement to safety, etc.) relative to the other decision criteria resulting in a "Priority Score" from 0 to 4. Based on user input, the most important criteria will have a Priority Score of 4 and the least important a score of 0. Final decision criteria values agreed upon with VCWPD are presented in Table 4-2.

Table 4-2. Subjective Decision Criteria Values.

	Relative Importance of Decision Criteria (0 is low, 4 is high importance)
Cost	1
Safety	4
Flood Damages	3
Debris/Sediment Issues	2
Anticipated Public Perception	0

Once the Priority Scores have been determined, the user must decide how much effect each alternative may have on the decision criteria, relative to other alternatives, and assign a value from 1 to 10. For example, the alternative "lower and widen the spillway" has an anticipated expense roughly in the middle of other alternatives so may be assigned a "Cost" value of 5. Safety is improved more than doing nothing, so this alternative would receive a higher value for effect on safety criteria. Individual decision criteria were ranked for each possible alternative based on the following:

- Cost - the alternative considered the most expensive (VCWPD Designs w/ Groundwater Recharge) would be assigned the highest value. The alternative considered the least expensive is assigned the lowest value. All other alternatives are ranked in between. If cost is no issue, then a low rating in the decision criteria ranking step would diminish the impact of any cost ranking.
- Improvement to safety - basin removal most notably improves safety by removing the potential of dam failure, so receives the highest value. Doing nothing leaves the potential of dam failure, so receives the lowest rating. All other alternatives are ranked in between, with groundwater recharge alternatives slightly lower due to standing water after a storm.
- Changes to possible flood extent – continuing the current maintenance program ranks the lowest since it perpetuates the greatest flood extent in the event of dam failure. Alternatives to "do nothing" were shown to have improved flood extents during the Hydraulic Modeling phase. The different alternatives were also demonstrated to have roughly equivalent flood extents, so were assigned equal values.
- Effect on debris/sediment - allowing sediment to proceed downstream was considered preferable to continuing basin cleanout activities. For this reason, the two alternatives allowing sediment to pass rank higher and other alternatives are considered equal.
- Anticipated public perception - it was assumed the public would not like the idea of dam failure and more extensive flooding, so "do nothing" received the lowest score. It was assumed the public would be equally ambivalent regarding other alternatives.

Final relative alternative comparisons in each criteria are presented in Table 4-3.

Table 4-3. Subjective Relative Alternative Comparisons.

Basin Alternative	Cost[(1)]	Safety[(2)]	Flood Damages/ Extent[(3)]	Debris/ Sediment/ Deposition[(4)]	Public Benefit/ Perception[(5)]
Continue current maintenance program	3	1	1	3	2
Lower & widen spillway	5	7	5	3	5
Lower & widen spillway w/ groundwater recharge	7	6	5	3	5
Lower & widen spillway w/ new low flow slot	5	7	5	8	5
VCWPD designs 2A & 2B	6	7	5	3	5
VCWPD designs 2A & 2B w/ groundwater recharge	8	6	5	3	5
Basin removal	4	10	5	7	5

(1) Cost 1 = low cost, 10 = high cost
(2) Is safety improved? 1 = no, 10 = yes
(3) Is the flood extent improved? 1 = no, 10 = yes
(4) Is there a positive debris/sediment outcome? 1 = no, 10 = yes
(5) Will the public generally like it? 1 = no, 10 = yes

The alternatives evaluation matrix produces a score (maximum of 100) for each alternative by weighting the effect of the alternative on the decision criteria while taking into consideration the importance of the decision criteria. For example, when comparing alternatives, a safety score of 1 will lower the overall score more than a sediment/debris score of 1 because safety was rated as more important than debris issues in Table 4-2. Final rankings of alternatives are presented in Table 4-4.

Table 4-4. Alternatives Ranking.

Basin Alternative	Raw Score	Score Out of 100
Continue current maintenance program	2.1	28
Lower & widen spillway	5.5	72
Lower & widen spillway w/ groundwater recharge	4.9	64
Lower & widen spillway w/ new low flow slot	6.5	86
VCWPD designs 2A & 2B	5.4	71
VCWPD designs 2A & 2B w/ groundwater recharge	4.8	63
Basin removal	7.6	100

Based on the alternatives evaluation matrix and the decision criteria of cost, safety, flood damages, sediment/debris issues and anticipated public perception, the removal option is the preferred alternative. Therefore, the removal alternative is recommended.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The evaluation of Santa Rosa Debris Basin No. 2 included rainfall data analysis, hydraulic modeling, cost estimation, and alternatives assessment. Based on available rainfall data in the area, the highest 24-hour rainfall amount since basin construction is 4.85 inches on December 6, 1997. This corresponds to approximately a 25-year rainfall return interval. Based on available records, the debris basin has never been subjected to peak flows as high as the 100-year peak inflow event equal to 1,274 cfs.

Hydraulic models were used to evaluate flood inundation extents for 10-, 50-, and 100-year return interval events as well as the 1997 event when the emergency spillway was briefly overtopped. Inflow hydrographs for each event were supplied by VCWPD and entered into the hydraulic models. Four basin conditions were considered: (1) existing conditions, (2) basin rehabilitation conditions, (3) basin removal, and (4) basin breach assuming the reservoir is full to capacity prior to the breach. The flood inundation differences for each modeled condition were minimal, which means the basin does not provide a significant detention function. Basin breach scenarios indicate the potential to overtop Santa Rosa Road by as much as 7 feet which is a significant safety hazard.

In addition, the potential for sedimentation in the channel downstream of the basin was evaluated for the 100-year event. The purpose of the model run was to evaluate whether deposition could be excessive for the 100-year event with dam removal. Results indicate that the 100-year event does not create any areas of excessive deposition.

Approximate costs were developed for five reoperation and/or removal alternatives. The estimated lowest cost alternative is basin removal. The cost estimation results were used during the alternatives matrix evaluation. The matrix evaluation subjectively prioritized five basin criteria and ranked seven basin alternatives accordingly. Based on criteria including potential cost, safety, changes to flood extent, downstream sedimentation/debris effects and anticipated public perception, the highest ranked alternative is basin removal and the lowest is maintaining the status quo.

5.2 RECOMMENDATIONS

Based on study results, the recommended course of action is to remove Santa Rosa Debris Basin No.2.

6 REFERENCES

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APPENDIX A

SITE VISIT PHOTOGRAPHS

SANTA ROSA ROAD DEBRIS BASIN NO. 2

APRIL 7, 2015

SANTA ROSA ROAD DEBRIS BASIN NO. 2

APRIL 7, 2015

FIGURE A-1. DEBRIS BASIN AND UPSTREAM DAM FACE

FIGURE A-2. DOWNSTREAM DAM FACE, PRIMARY SPILLWAY OUTLET

FIGURE A-3. PRIMARY SPILLWAY ENTRANCE W/ TRASH RACK

FIGURE A-4. DEBRIS BLEEDER/RISER PIPE AT BOTTOM OF UPSTREAM DAM FACE

FIGURE A-5. DEBRIS BASIN, LOOKING UPSTREAM FROM TOP OF DAM

FIGURE A-6. TREE GROWING AT EMERGENCY SPILLWAY ENTRANCE

FIGURE A-7. EMERGENCY SPILLWAY ENTRANCE, LOOKING DOWNSTREAM

FIGURE A-8. EMERGENCY SPILLWAY, LOOKING DOWNSTREAM AT CHANNEL JUNCTION

FIGURE A-9. DOWNSTREAM CHANNEL, EMERGENCY SPILLWAY EXIT ON LEFT

FIGURE A-10. DOWNSTREAM CHANNEL, LOOKING UPSTREAM AT DAM

FIGURE A-11. UPSTREAM FACE OF SANTA ROSA ROAD CULVERT, LOOKING DOWNSTREAM

FIGURE A-12. DOWNSTREAM FACE OF SANTA ROSA ROAD, LOOKING UPSTREAM

FIGURE A-13. LOOKING DOWNSTREAM TOWARDS VISTA ARROYO DR./ANDALUSIA DR. CROSSING

FIGURE A-14. UN-NAMED FARM ROAD CULVERT CROSSING

FIGURE A-15. DOWNSTREAM FARM FIELDS

FIGURE A-16. UN-NAMED FARM ROAD CULVERT CROSSING AT 90-DEGREE BEND

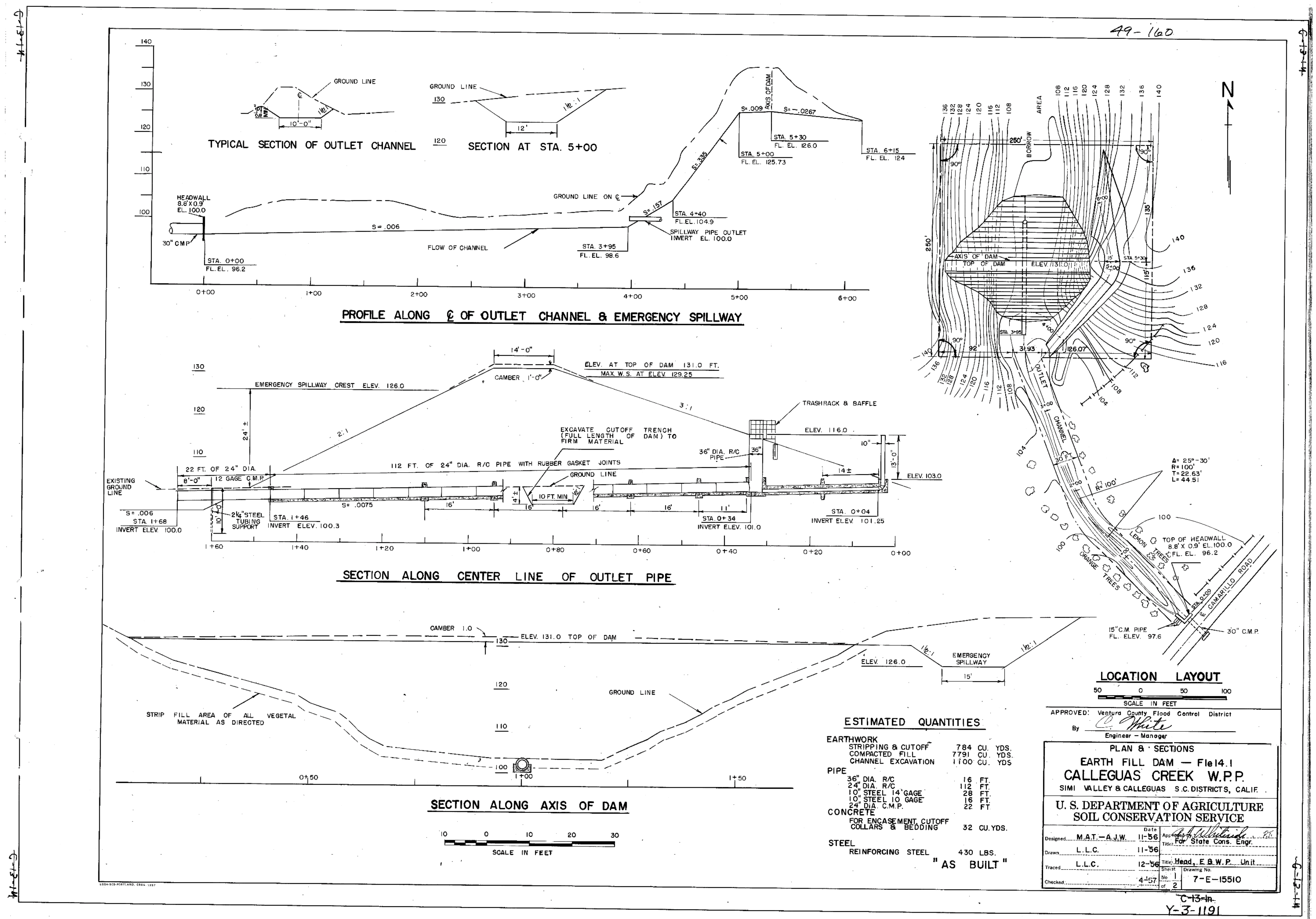
FIGURE A-17. DOWNSTREAM CONFLUENCE WITH CONEJO CREEK

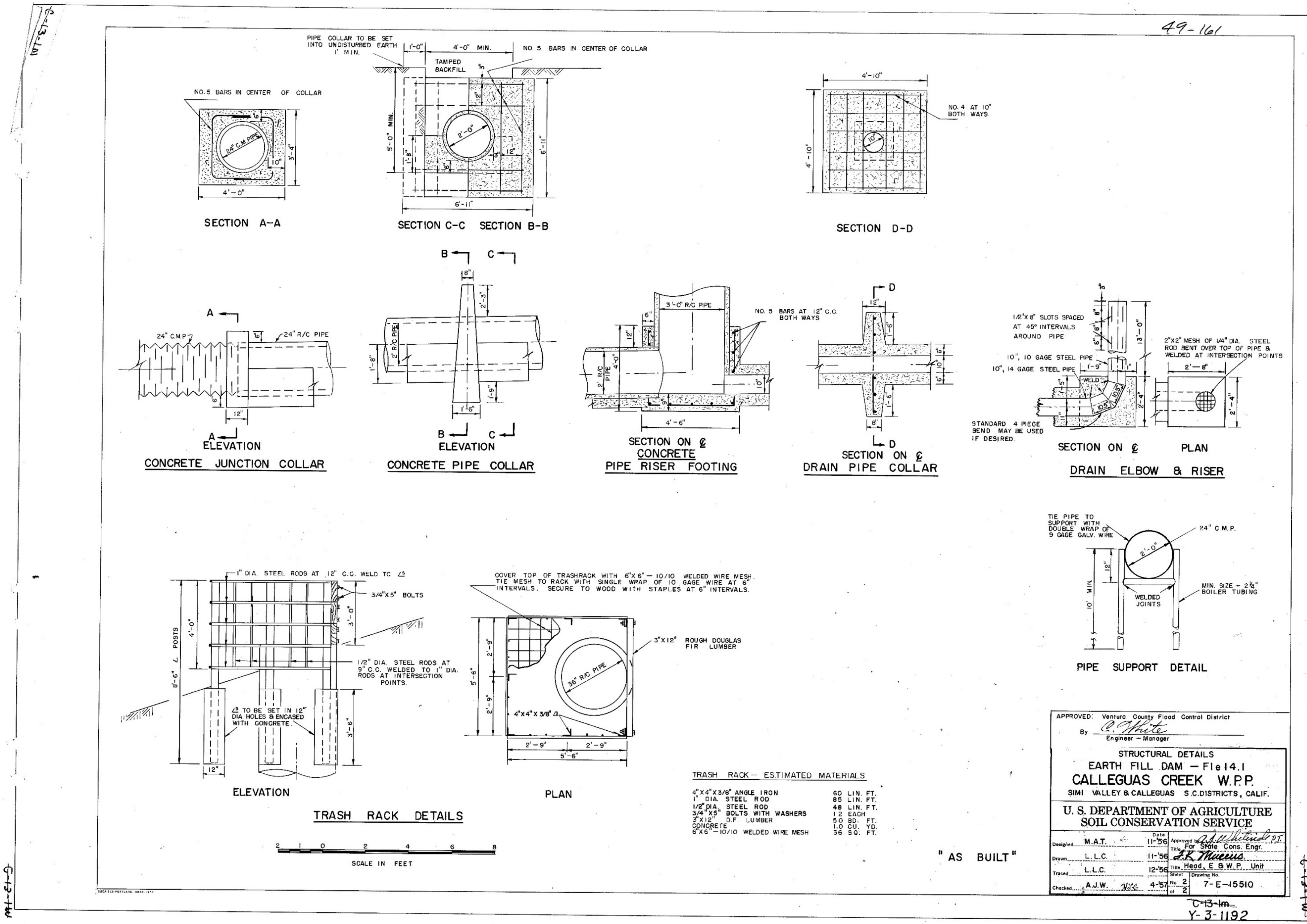
FIGURE A-18. CULVERT AT DOWNSTREAM CONFLUENCE WITH CONEJO CREEK

APPENDIX B

SANTA ROSA ROAD DEBRIS BASIN NO. 2

"AS-BUILT" DRAWINGS


49-160
TYPICAL SECTION OF OUTLET CHANNEL
SECTION AT STA. 5+00
GROUND LINE
PROFILE ALONG ℄ OF OUTLET CHANNEL & EMERGENCY SPILLWAY
HEADWALL 8.8'X 0.9' EL. 100.0
30" CMP
STA. 0+00 FL. EL. 96.2
S=.006
FLOW OF CHANNEL
STA. 3+95 FL. EL. 98.6
SPILLWAY PIPE OUTLET INVERT EL. 100.0
STA. 4+40 FL. EL. 104.9
GROUND LINE ON ℄
STA. 5+00 FL. EL. 125.73
STA. 5+30 FL. EL. 126.0
STA. 6+15 FL. EL. 124
AXIS OF DAM
SECTION ALONG CENTER LINE OF OUTLET PIPE
ELEV. AT TOP OF DAM 131.0 FT.
MAX W.S. AT ELEV. 129.25
EMERGENCY SPILLWAY CREST ELEV. 126.0
CAMBER 1'-0"
TRASHRACK & BAFFLE
ELEV. 116.0
EXCAVATE CUTOFF TRENCH (FULL LENGTH OF DAM) TO FIRM MATERIAL
36" DIA. R/C PIPE
112 FT. OF 24" DIA. R/C PIPE WITH RUBBER GASKET JOINTS
22 FT. OF 24" DIA. 12 GAGE C.M.P.
EXISTING GROUND LINE
2¼" STEEL TUBING SUPPORT
STA. 1+68 INVERT ELEV. 100.0
STA. 1+46 INVERT ELEV. 100.3
STA. 0+34 INVERT ELEV. 101.0
STA. 0+04 INVERT ELEV. 101.25
ELEV. 103.0
SECTION ALONG AXIS OF DAM
CAMBER 1.0
ELEV. 131.0 TOP OF DAM
EMERGENCY SPILLWAY
ELEV. 126.0
STRIP FILL AREA OF ALL VEGETAL MATERIAL AS DIRECTED
SCALE IN FEET
LOCATION LAYOUT
BORROW AREA
OUTLET CHANNEL
LEMON TREES
ORANGE TREES
CAMARILLO ROAD
TOP OF HEADWALL 8.8' X 0.9' EL. 100.0 FL. EL. 96.2
15" C.M. PIPE FL. ELEV. 97.6
30" C.M.P.
Δ= 25°-30' R=100' T=22.63' L=44.51
ESTIMATED QUANTITIES
EARTHWORK
STRIPPING & CUTOFF 784 CU. YDS.
COMPACTED FILL 7791 CU. YDS.
CHANNEL EXCAVATION 1100 CU. YDS.
PIPE
36" DIA. R/C 16 FT.
24" DIA. R/C 112 FT.
10" STEEL 14 GAGE 28 FT.
10" STEEL 10 GAGE 16 FT.
24" DIA. C.M.P. 22 FT.
CONCRETE
FOR ENCASEMENT, CUTOFF COLLARS & BEDDING 32 CU. YDS.
STEEL
REINFORCING STEEL 430 LBS.
"AS BUILT"
APPROVED: Ventura County Flood Control District
By C. White
Engineer – Manager
PLAN & SECTIONS
EARTH FILL DAM — Fle14.1
CALLEGUAS CREEK W.P.P.
SIMI VALLEY & CALLEGUAS S.C. DISTRICTS, CALIF.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed M.A.T.–A.J.W. 11-56
Drawn L.L.C. 11-56
Traced L.L.C. 12-56
Checked 4-57
For State Cons. Engr.
Head, E.&W.P. Unit
Sheet No. 1 of 2
Drawing No. 7-E-15510
C-13-In
Y-3-1191


49-161
SECTION A-A
SECTION C-C SECTION B-B
SECTION D-D
NO. 5 BARS IN CENTER OF COLLAR
PIPE COLLAR TO BE SET INTO UNDISTURBED EARTH 1' MIN.
TAMPED BACKFILL
NO. 4 AT 10" BOTH WAYS
ELEVATION
CONCRETE JUNCTION COLLAR
ELEVATION
CONCRETE PIPE COLLAR
SECTION ON ℄
CONCRETE
PIPE RISER FOOTING
NO. 5 BARS AT 12" C.C. BOTH WAYS
SECTION ON ℄
DRAIN PIPE COLLAR
1/2"X 8" SLOTS SPACED AT 45° INTERVALS AROUND PIPE
10", 10 GAGE STEEL PIPE
10", 14 GAGE STEEL PIPE
STANDARD 4 PIECE BEND MAY BE USED IF DESIRED.
2"X2" MESH OF 1/4" DIA. STEEL ROD BENT OVER TOP OF PIPE & WELDED AT INTERSECTION POINTS
SECTION ON ℄
PLAN
DRAIN ELBOW & RISER
TIE PIPE TO SUPPORT WITH DOUBLE WRAP OF 9 GAGE GALV. WIRE
24" C.M.P.
WELDED JOINTS
MIN. SIZE - 2¼" BOILER TUBING
PIPE SUPPORT DETAIL
1" DIA. STEEL RODS AT 12" C.C. WELD TO ∠s
3/4"X5" BOLTS
1/2" DIA. STEEL RODS AT 9" C.C. WELDED TO 1" DIA. RODS AT INTERSECTION POINTS.
∠s TO BE SET IN 12" DIA. HOLES & ENCASED WITH CONCRETE.
ELEVATION
COVER TOP OF TRASHRACK WITH 6"X6" — 10/10 WELDED WIRE MESH. TIE MESH TO RACK WITH SINGLE WRAP OF 10 GAGE WIRE AT 6" INTERVALS. SECURE TO WOOD WITH STAPLES AT 6" INTERVALS.
3"X12" ROUGH DOUGLAS FIR LUMBER
36" R/C PIPE
4"X4"X3/8" ∠
PLAN
TRASH RACK DETAILS
TRASH RACK — ESTIMATED MATERIALS
4"X4"X3/8" ANGLE IRON 60 LIN. FT.
1" DIA. STEEL ROD 85 LIN. FT.
1/2" DIA. STEEL ROD 48 LIN. FT.
3/4"X5" BOLTS WITH WASHERS 12 EACH
3"X12" D.F. LUMBER 50 BD. FT.
CONCRETE 1.0 CU. YD.
6"X6" — 10/10 WELDED WIRE MESH 36 SQ. FT.
SCALE IN FEET
"AS BUILT"
APPROVED: Ventura County Flood Control District
Engineer — Manager
STRUCTURAL DETAILS
EARTH FILL DAM — Fle 14.1
CALLEGUAS CREEK W.P.P.
SIMI VALLEY & CALLEGUAS S.C. DISTRICTS, CALIF.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed M.A.T. 11-'56
Drawn L.L.C. 11-'56
Traced L.L.C. 12-'56
Checked A.J.W. 4-'57
For State Cons. Engr.
Head, E & W.P. Unit
7-E-15510
C-13-1m
Y-3-1192

APPENDIX C

SANTA ROSA ROAD DEBRIS BASIN NO. 2

ALTERNATIVES COST APPROXIMATION

Santa Rosa Road No. 2 Debris Basin Modification

Alternatives Matrix Approximate Costs

for

Ventura County Watershed Protection District

Removal

Assumed Design Conditions

- complete dam structure removal

Item	Unit	Unit Cost		Quantity	Extended Cost	Notes
Mobilization	% of total	5.5%			6,688	
Bond	% of total	3%			3,648	
Clear and grub	$$ per acre	4,000				
Grading	$$ per sq. yd	1				
Excavation	$$ per cu. yd	6.5		4,889	31,779	calculated from volume of four tetrahedrons
Fill	$$ per cu. yd	7.5				
Reinforced Concrete	$$ per cu. yd	425				
Catwalk	$$	25,000				
Intake riser	$$	8,500				
Cobble stone	$$ per cu. yd	100				
Light riprap (200#)	$$ per cu. yd	100				
1/4 ton concrete rock riprap	$$ per cu. yd	125				
Grouted riprap	$$ per cu. yd	165				
18 & 24" RCP jct w/ RC box	$$	5,000				
24" D-1500 RCP	$$ per LF	90				
Debris Removal	$$ per cu. yd	15		5,083	76,245	existing structure and earth disposal
AC Hot Mix + PMB	$$ per sq. yd	32				
CMB road base	$$ per cu. yd	67.5				
Construction Contingency	% of total	15%			18,241	
Final Design	% of total	20%			24,321	
Demolish Existing Structures	$$ per cu. yd	70		194	13,580	194 ft. of 24 in. pipe
25 year cleanout cost	$$ per year	8,870				
Total Cost					$174,501	

(1) Cost Sources: Ventura County Watershed Protection District Advanced Planning Division, Unit Price for APS 2013 projects and USACE Los Angeles River Ecosystem Restoration Feasibility Study, Cost Appendix, August 2013 unless otherwise noted.

Reoperate w/ Ventura County Design 2A, primary spillway closed conduit downstream

Assumed Design Conditions

- Ventura County supplied preliminary drawings

Item	Unit	Unit Cost	Quantity	Extended Cost	Notes
Mobilization	% of total	5.5%		31,515	
Bond	% of total	3%		17,190	
Clear and grub	$$ per acre	4,000	3.4	13,600	based on disturbed area from design drawings
Grading	$$ per sq. yd	1	16,521	16,521	designated area from design drawings
Excavation	$$ per cu. yd	6.5	1,965	12,772	estimated for RC Box construction (used for fill)
Fill	$$ per cu. yd	7.5	4,387	32,899	for 3:1 dam face and closed conduit coverage
Reinforced Concrete	$$ per cu. yd	425	766	325,686	RC Box, 16” floor, 12” other
Catwalk	$$	25,000	1	25,000	$$ based on educated guess for custom steel
Intake riser	$$	8,500	1	8,500	$$ based on educated guess for custom steel
Cobble stone	$$ per cu. yd	100	324	32,407	dam face, $$ educated guess based on riprap
Light riprap (200#)	$$ per cu. yd	100			
1/4 ton concrete rock riprap	$$ per cu. yd	125			
Grouted riprap	$$ per cu. yd	165	218	35,952	RC Box intake
18 & 24" RCP jct w/ RC box	$$	5,000	2	10,000	cost is WAG
24" D-1500 RCP	$$ per LF	90	266	23,940	plans call for D-2000 class pipe, cost is D-1500
Debris Removal	$$ per cu. yd	15			
AC Hot Mix + PMB	$$ per sq. yd	32	448	14,350	area based on drawings
CMB road base	$$ per cu. yd	67.5	317	21,374	AC and CMB area, 6 in. placement depth
Construction Contingency	% of total	15%		85,950	
Final Design	% of total	20%		114,600	
Demolish Existing Structures	$$ per cu. yd	70			
25 year cleanout cost	$$ per year	8,870	25	221,750	CPI adjusted 2004 cost, avg. cleanout rate
Total Cost				$1,044,008	

(1) Cost Sources: Ventura County Watershed Protection District Advanced Planning Division, Unit Price for APS 2013 projects and USACE Los Angeles River Ecosystem Restoration Feasibility Study, Cost Appendix, August 2013 unless otherwise noted.

Reoperate w/ Ventura County Design 2B, primary spillway open channel downstream

Assumed Design Conditions

- Ventura County supplied preliminary drawings

Item	Unit	Unit Cost	Quantity	Extended Cost	Notes
Mobilization	% of total	5.5%		30,280	
Bond	% of total	3%		16,516	
Clear and grub	$$ per acre	4,000	2.0	8,112	based on disturbed area from design drawings
Grading	$$ per sq. yd	1	9,816	9,816	designated area from design drawings
Excavation	$$ per cu. yd	6.5	1,965	12,772	estimated for RC Box construction (used for fill)
Fill	$$ per cu. yd	7.5	1,238	9,288	3:1 dam face
Reinforced Concrete	$$ per cu. yd	425	766	325,686	RC Box, 16” floor, 12” other
Catwalk	$$	25,000	1	25,000	$$ based on educated guess for custom steel
Intake riser	$$	8,500	1	8,500	$$ based on educated guess for custom steel
Cobble stone	$$ per cu. yd	100	503	50,333	dam face, $$ educated guess based on riprap
Light riprap (200#)	$$ per cu. yd	100			
1/4 ton concrete rock riprap	$$ per cu. yd	125			
Grouted riprap	$$ per cu. yd	165	305	50,243	RC Box intake
18 & 24" RCP jct w/ RC box	$$	5,000	2	10,000	cost is WAG
24" D-1500 RCP	$$ per LF	90			
Debris Removal	$$ per cu. yd	15			
AC Hot Mix + PMB	$$ per sq. yd	32	754	24,117	area based on drawings
CMB road base	$$ per cu. yd	67.5	247	16,678	AC and CMB area, 6 in. placement depth
Construction Contingency	% of total	15%		82,582	
Final Design	% of total	20%		110,109	
Demolish Existing Structures	$$ per cu. yd	70			
25 year cleanout cost	$$ per year	8,870		221,750	CPI adjusted 2004 cost, avg. cleanout rate
Total Cost				$1,011,783	

(1) Cost Sources: Ventura County Watershed Protection District Advanced Planning Division, Unit Price for APS 2013 projects and USACE Los Angeles River Ecosystem Restoration Feasibility Study, Cost Appendix, August 2013 unless otherwise noted.

Reoperate w/ Concrete Emergency Spillway

Assumed Design Conditions

- 100-year debris volume is 5,424 yd^3 (Santa Rosa Road Debris Basin #2 - Design Hydrology Update Draft Report, March 2015)
- riprap at intake and outfall
- entrance condition: 27 ft., broad rectangular weir
- weir contracts to 15 ft. wide spillway before dam face

Item	Unit	Unit Cost	Quantity	Extended Cost	Notes
Mobilization	% of total	5.5%		18,866	
Bond	% of total	3%		10,291	
Clear and grub	$$ per acre	4,000	0.3	1,174	area from design drawings
Grading	$$ per sq. yd	1	9,816	9,816	area from design drawings
Excavation	$$ per cu. yd	6.5	457	2,968	cut notch in dam at lower debris elevation
Fill	$$ per cu. yd	7.5	2,747	20,600	for dam face
Reinforced Concrete	$$ per cu. yd	425	245	104,190	spillway 15x6 ft. (WxH), + 35 ft. stilling basin
Catwalk	$$	25,000	1	25,000	$$ based on educated guess for custom steel
Intake riser	$$	8,500	1	8,500	$$ based on educated guess for custom steel
Cobble stone	$$ per cu. yd	100	284	28,385	dam face, $$ educated guess based on riprap
Light riprap (200#)	$$ per cu. yd	100	820	82,000	channel lining downstream
1/4 ton concrete rock riprap	$$ per cu. yd	125			
Grouted riprap	$$ per cu. yd	165	218	35,952	spillway entrance, similar to Ventura 2A
18 & 24" RCP jct w/ RC box	$$	5,000			
24" D-1500 RCP	$$ per LF	90			
Debris Removal	$$ per cu. yd	15			
AC Hot Mix + PMB	$$ per sq. yd	32	448	14,350	based on Ventura design drawings
CMB road base	$$ per cu. yd	67.5	149	10,090	AC and CMB area, 6 in. placement depth
Construction Contingency	% of total	15%		51,454	
Final Design	% of total	20%		68,605	
Demolish Existing Structures	$$ per cu. yd	70			
25 year cleanout cost	$$ per year	8,870	25	221,750	CPI adjusted 2004 cost, avg. cleanout rate
Total Cost				$713,991	

(1) Cost Sources: Ventura County Watershed Protection District Advanced Planning Division, Unit Price for APS 2013 projects and USACE Los Angeles River Ecosystem Restoration Feasibility Study, Cost Appendix, August 2013 unless otherwise noted.

Reoperate w/ Concrete Slot

Assumed Design Conditions

- 100-year debris volume is 5,424 yd^3 (Santa Rosa Road Debris Basin #2 - Design Hydrology Update Draft Report, March 2015)
- keyhole slot cut through dam
- bottom is 3 ft. wide, slot top portion is 16 ft. wide, variable heights
- riprap lining downstream
- stilling basin necessary

Item	Unit	Unit Cost	Quantity	Extended Cost	Notes
Mobilization	% of total	5.5%		17,606	
Bond	% of total	3%		9,603	
Clear and grub	$$ per acre	4,000	0.3	1,174	area from design drawings
Grading	$$ per sq. yd	1	9,816	9,816	area from design drawings
Excavation	$$ per cu. yd	6.5	509	2,402	cut notch in dam at riser elevation
Fill	$$ per cu. yd	7.5	2,694	21,253	for dam face
Reinforced Concrete	$$ per cu. yd	425	199	114,692	keyhole slot and stilling basin as described
Catwalk	$$	25,000			
Intake riser	$$	8,500			
Cobble stone	$$ per cu. yd	100	284	28,385	dam face, $$ educated guess based on riprap
Light riprap (200#)	$$ per cu. yd	100	820	82,000	channel lining downstream
1/4 ton concrete rock riprap	$$ per cu. yd	125			
Grouted riprap	$$ per cu. yd	165	218	35,952	slot entrance, similar to Ventura 2A
18 & 24" RCP jct w/ RC box	$$	5,000			
24" D-1500 RCP	$$ per LF	90			
Debris Removal	$$ per cu. yd	15			
AC Hot Mix + PMB	$$ per sq. yd	32	448	14,350	based on Ventura design drawings
CMB road base	$$ per cu. yd	67.5	149	10,090	6 in. placement depth
Construction Contingency	% of total	15%		48,017	
Final Design	% of total	20%		64,023	
Demolish Existing Structures	$$ per cu. yd	70			
25 year cleanout cost	$$ per year	8,870	25	221,750	CPI adjusted 2004 cost, avg. cleanout rate
Total Cost				$681,114	

(1) Cost Sources: Ventura County Watershed Protection District Advanced Planning Division, Unit Price for APS 2013 projects and USACE Los Angeles River Ecosystem Restoration Feasibility Study, Cost Appendix, August 2013 unless otherwise noted.

APPENDIX D

Hydraulic Model Inundation Extents

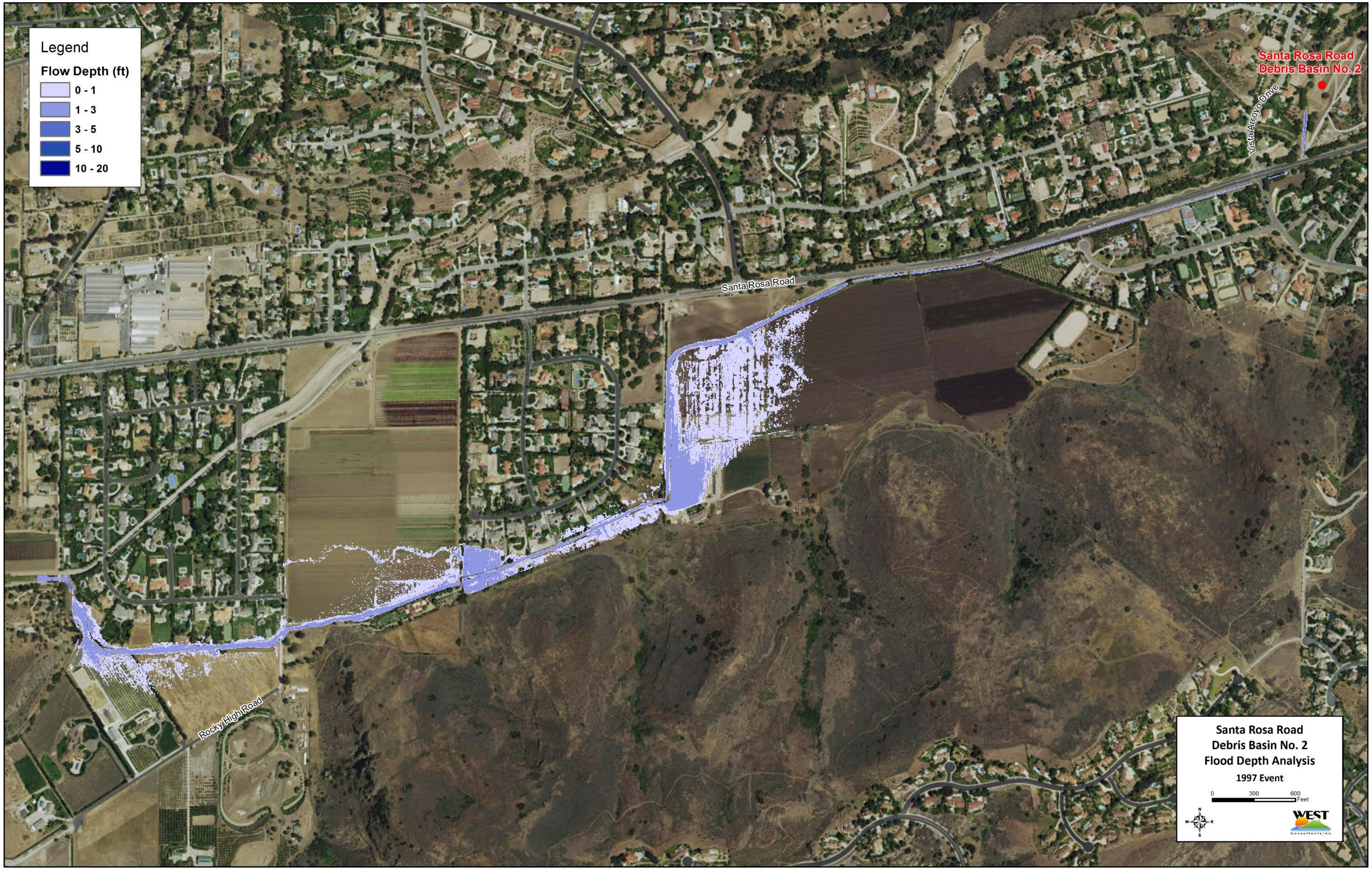


Figure D-1. 1997 Event Inundation Extent.

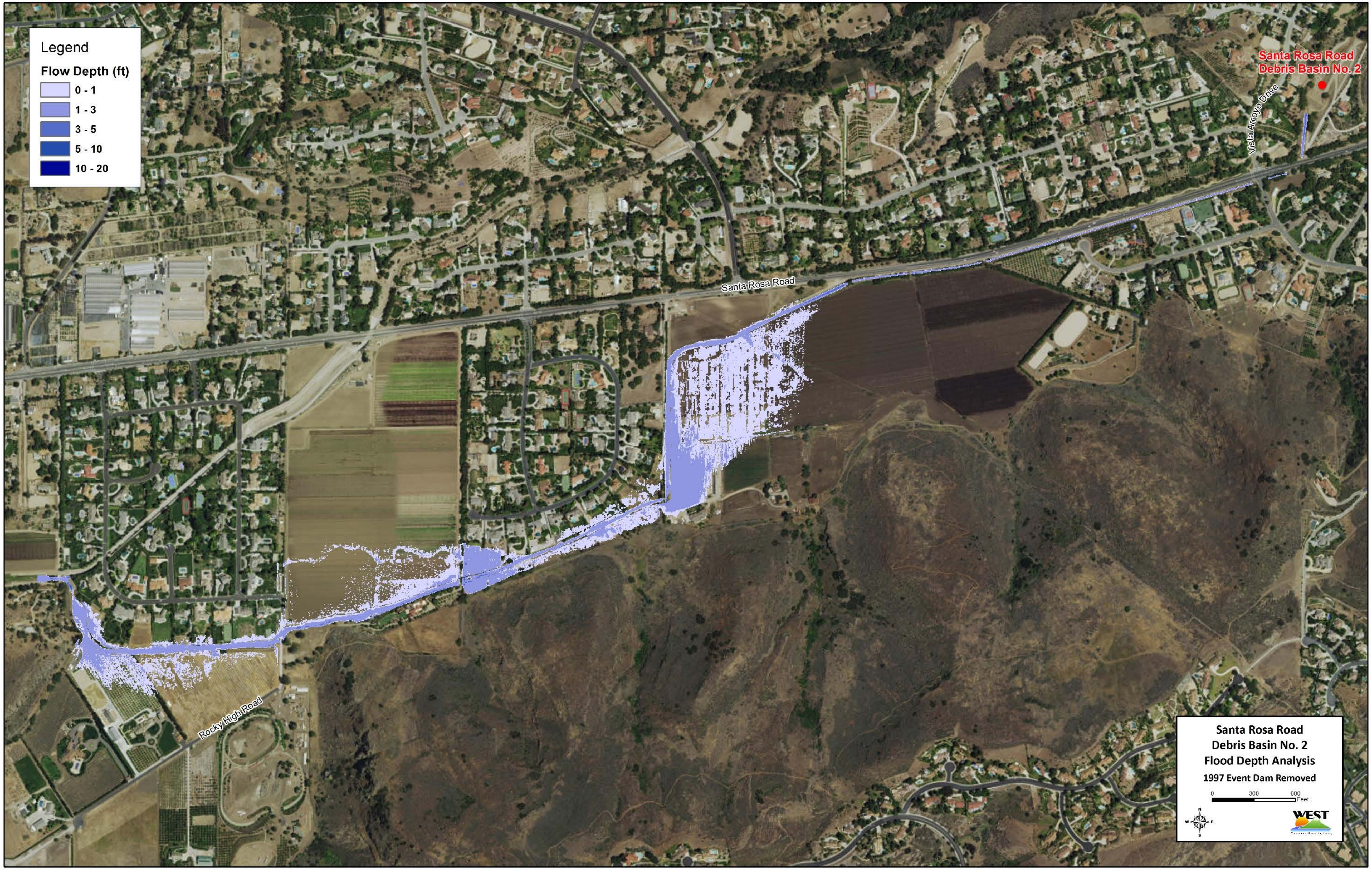


Figure D-2. 1997 Event Inundation Extent, Dam Removed.

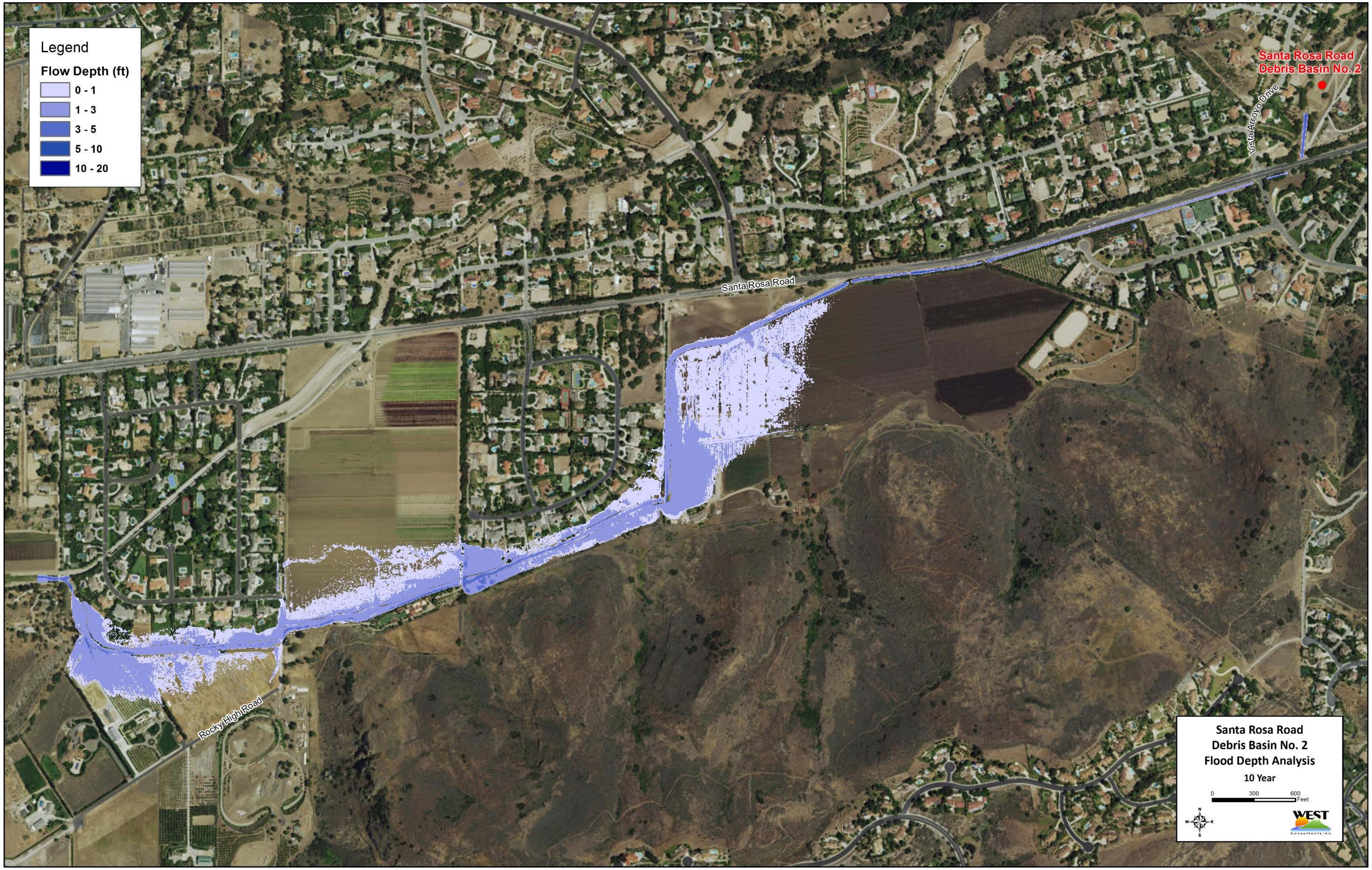


Figure D-3. 10-year Event Inundation Extent.

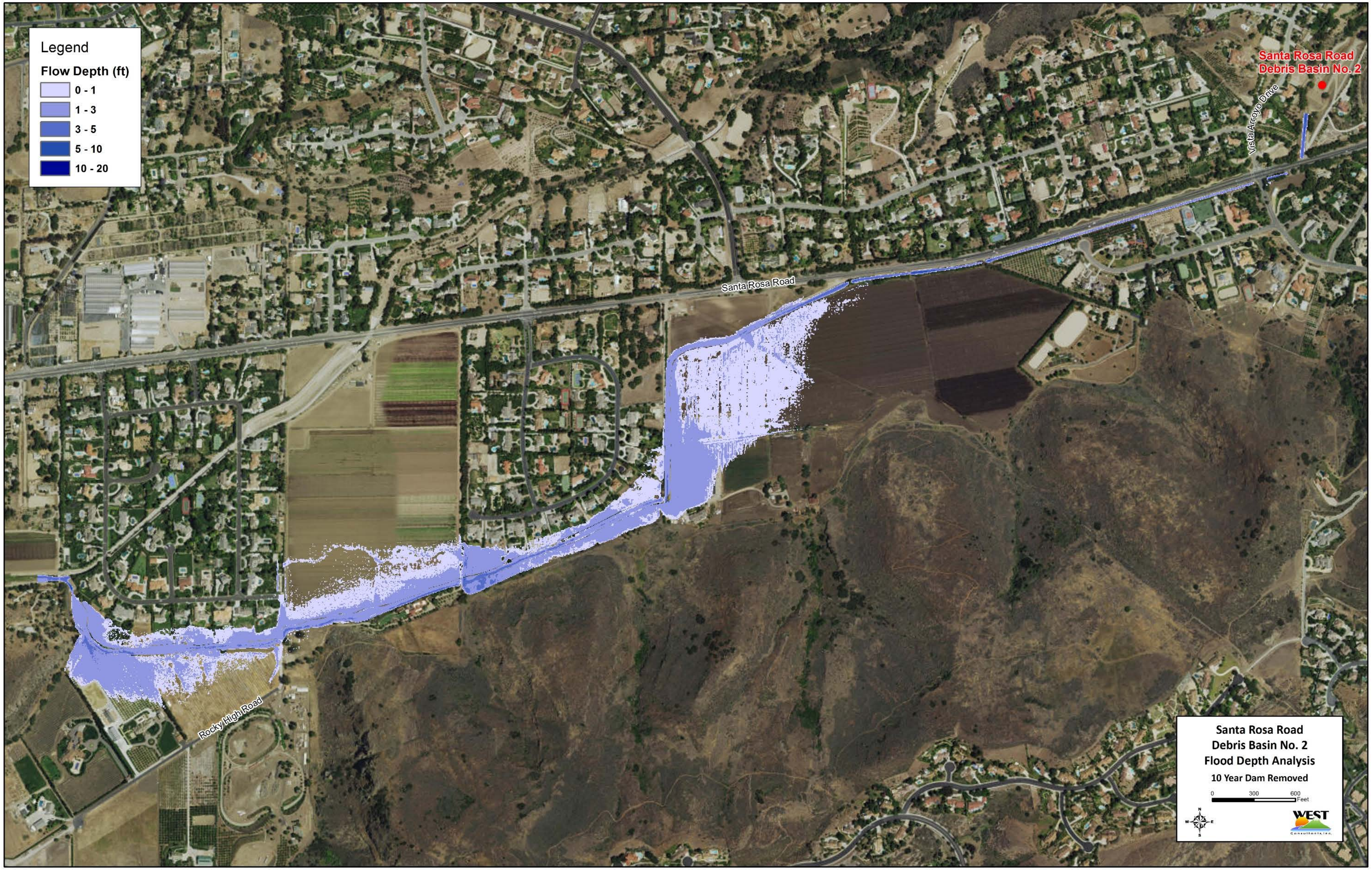


Figure D-4. 10-year Event Inundation Extent, Dam Removed.

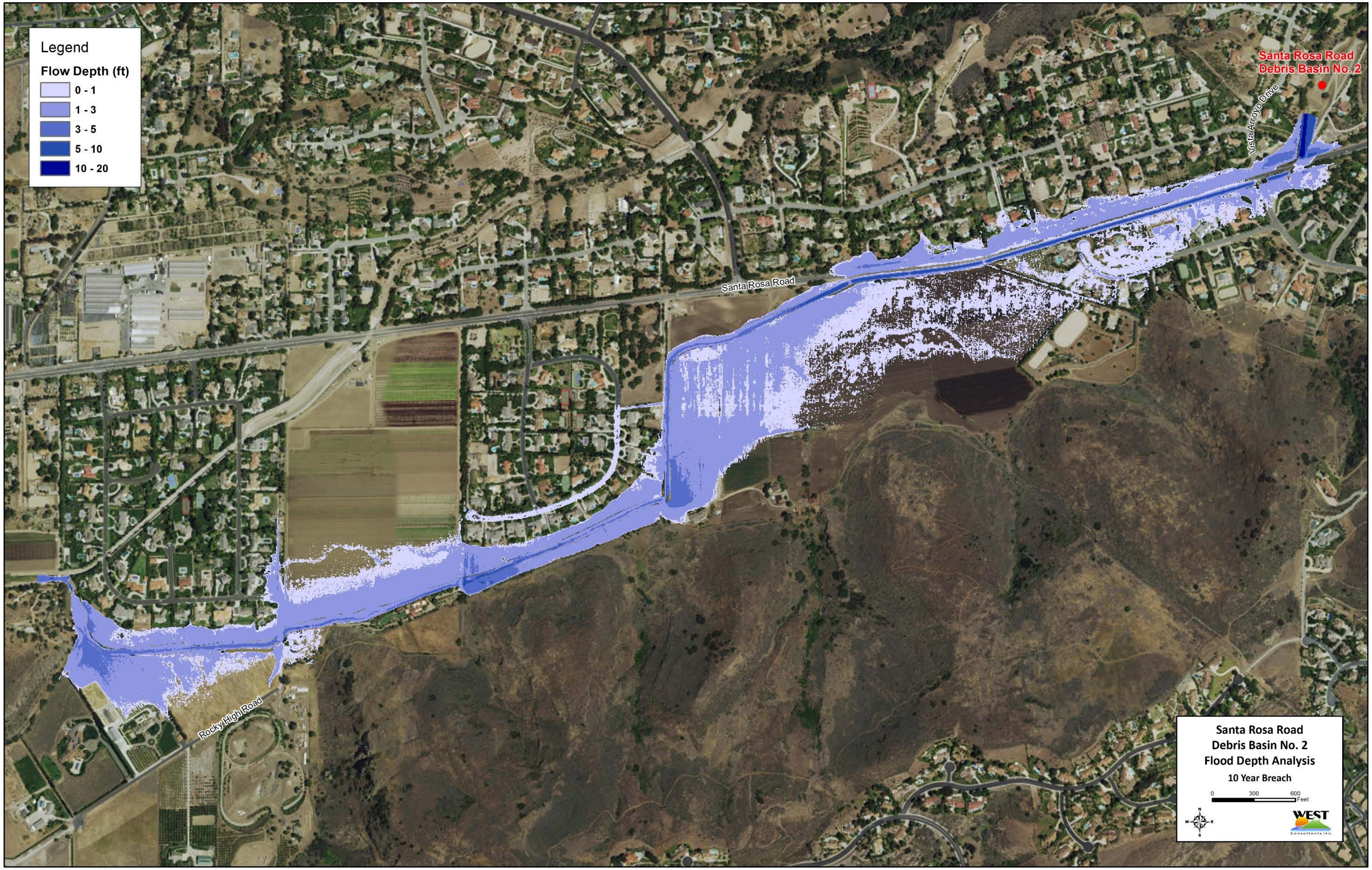


Figure D-5. 10-year Event Inundation Extent, Dam Breach.

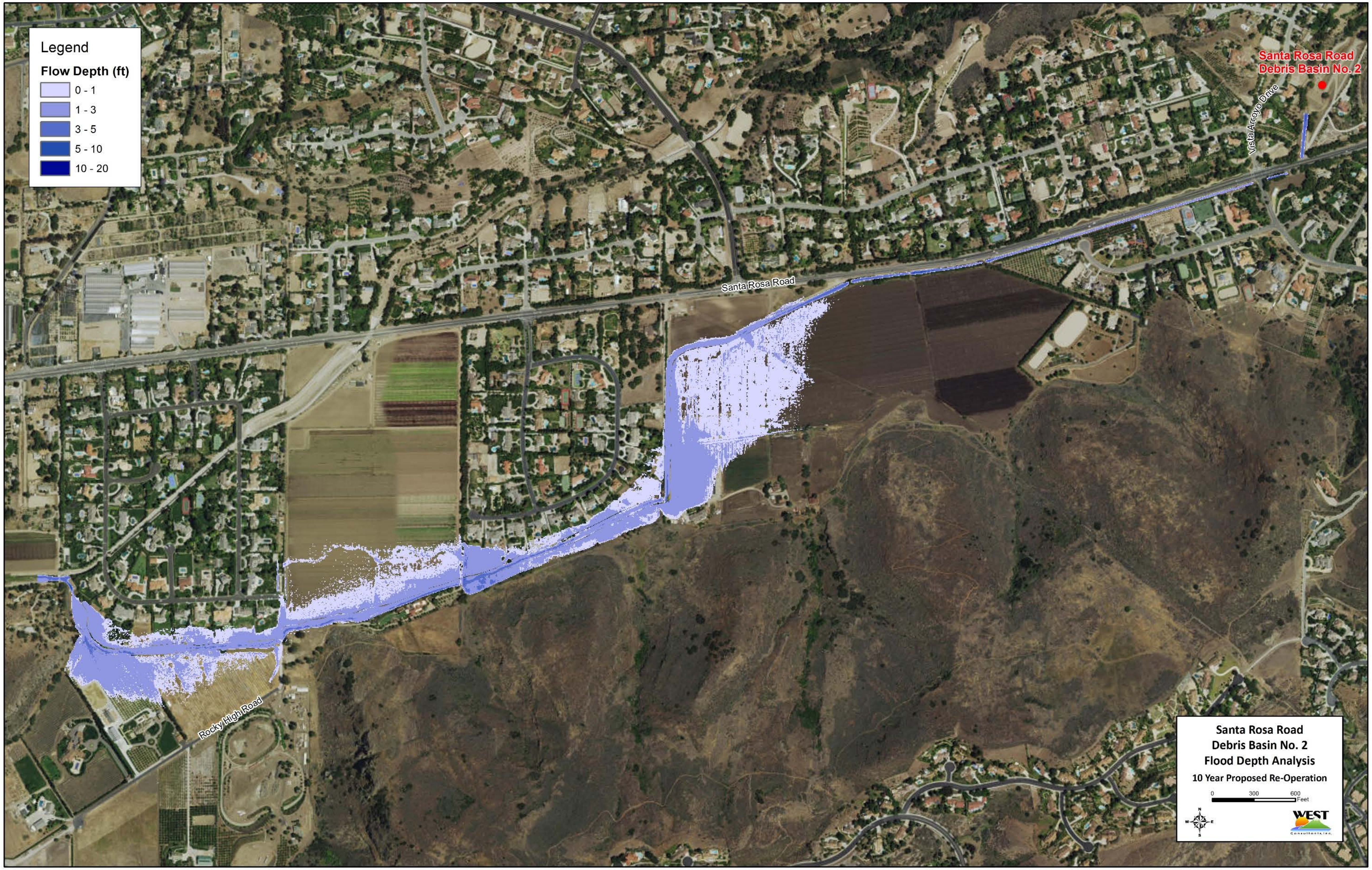


Figure D-6. 10-year Event Inundation Extent, Reoperation.

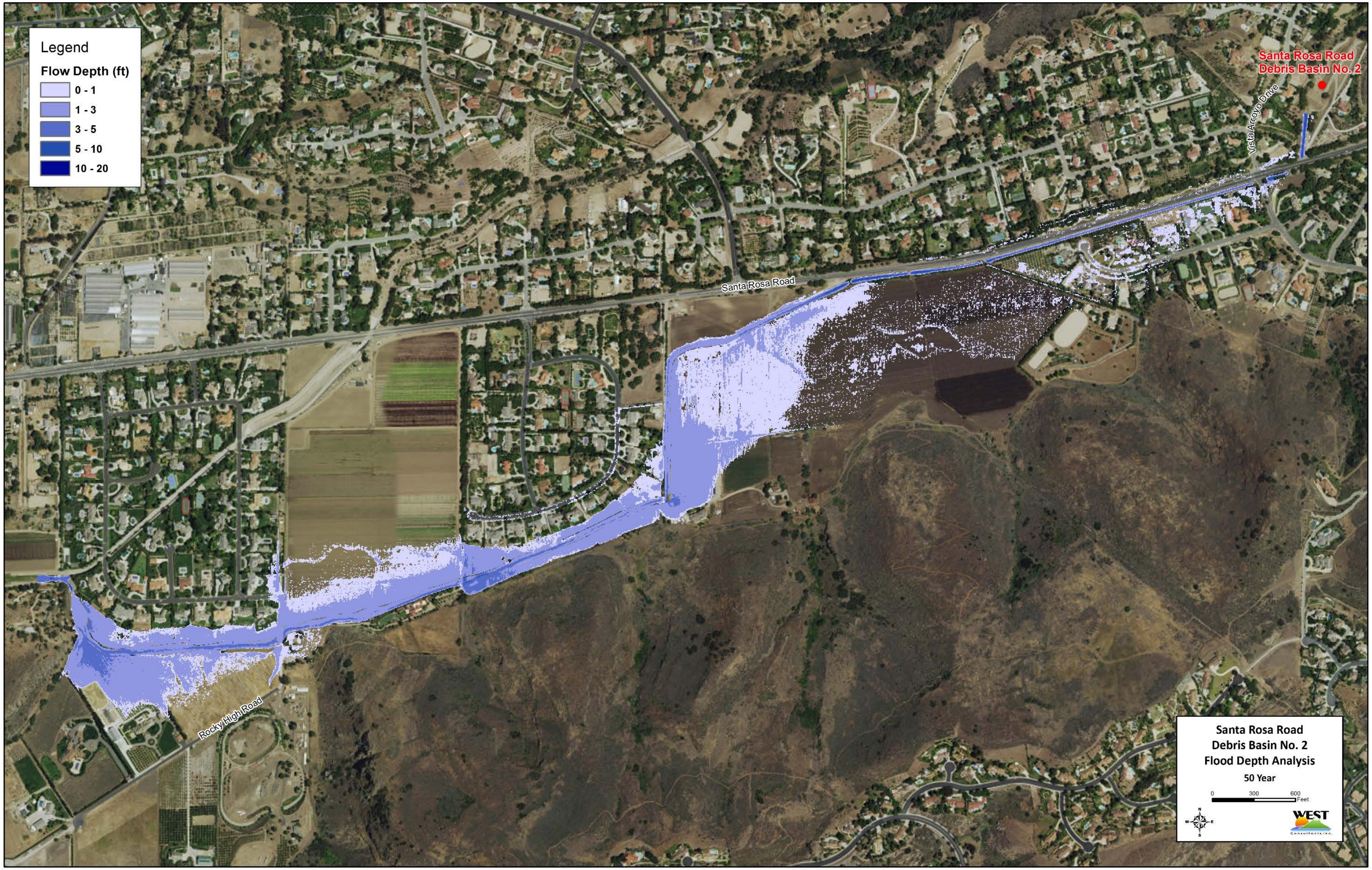


Figure D-7. 50-year Event Inundation Extent.

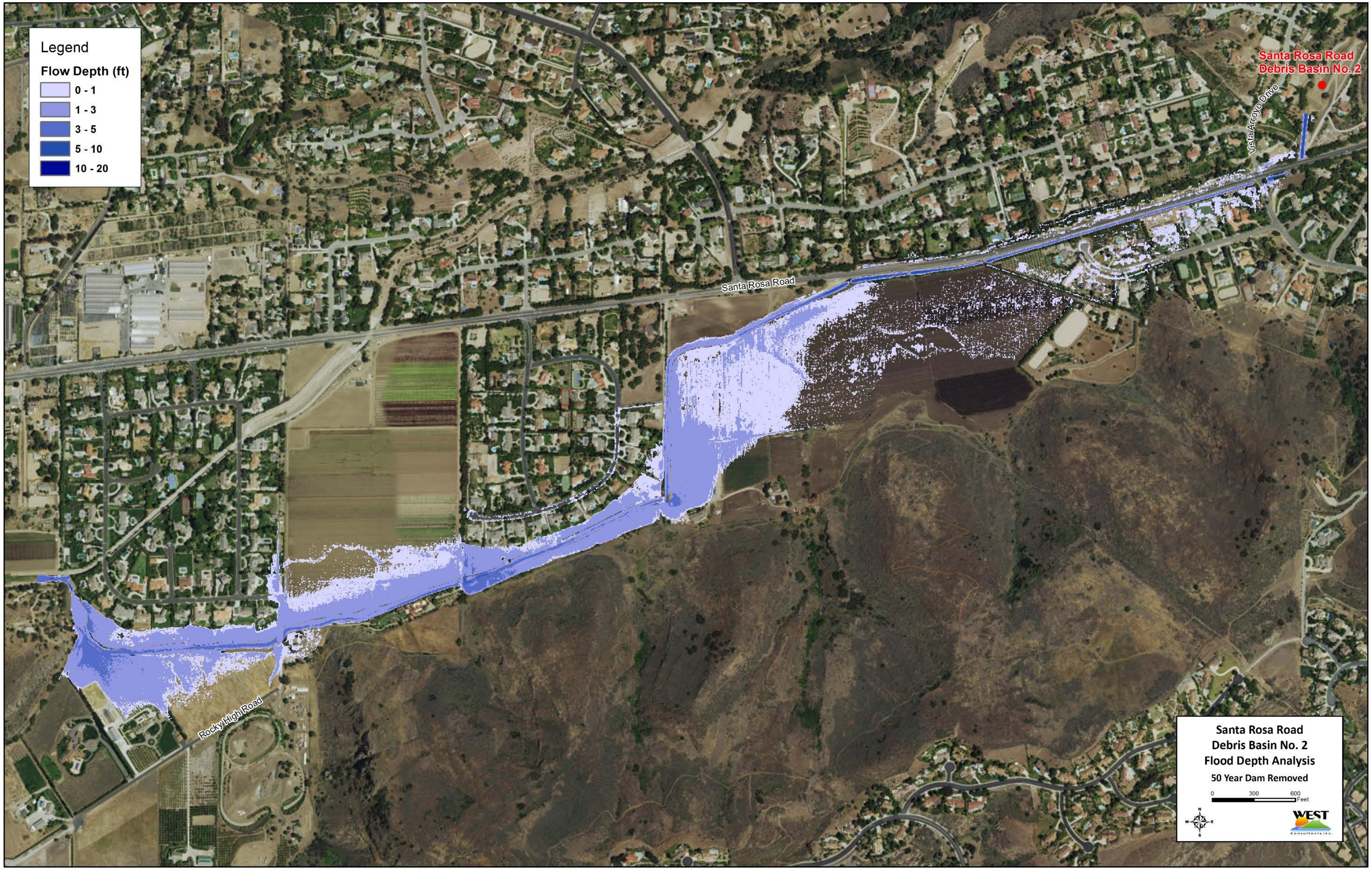


Figure D-8. 50-year Event Inundation Extent, Dam Removed.

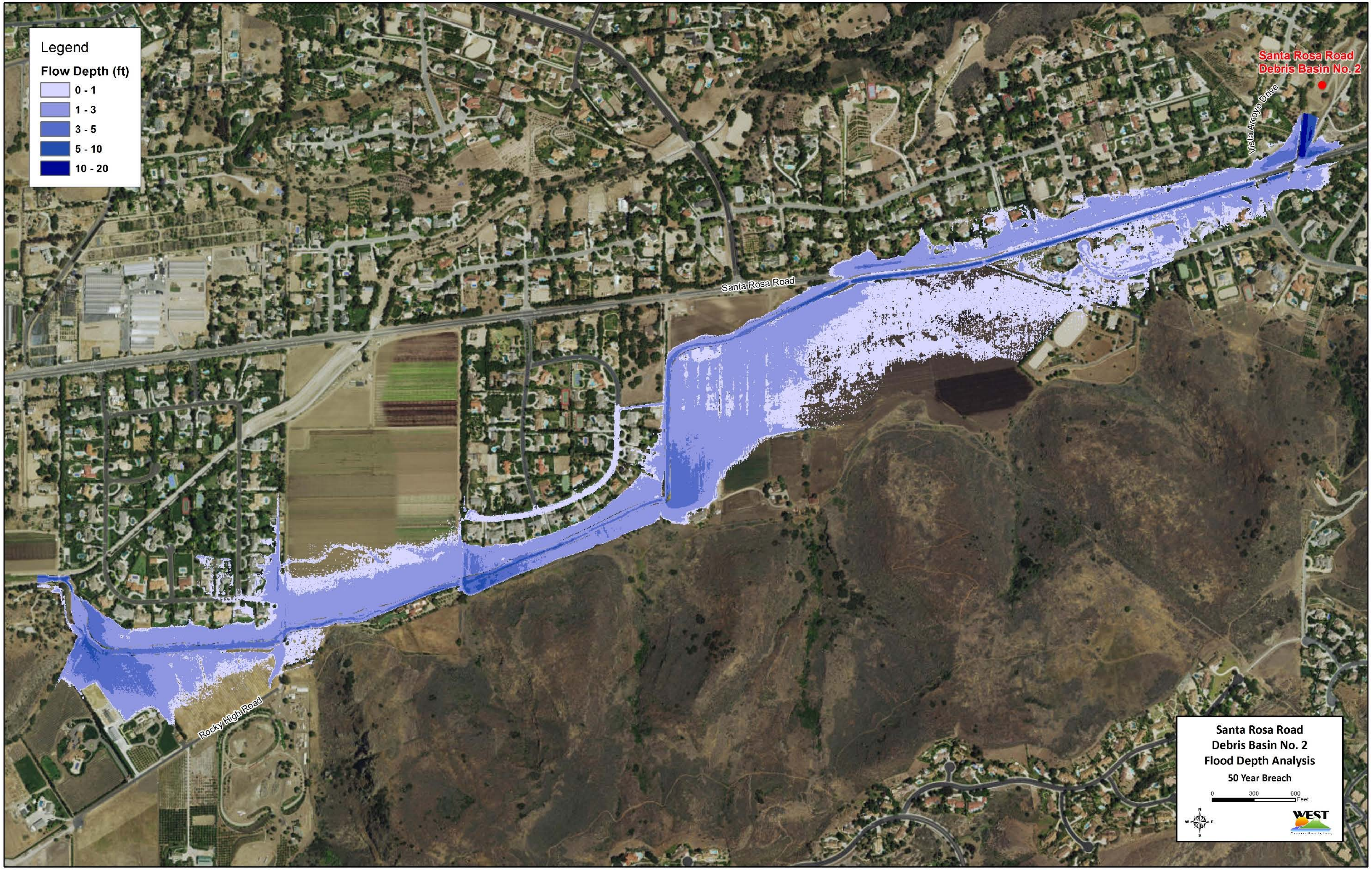


Figure D-9. 50-year Event Inundation Extent, Dam Breach.

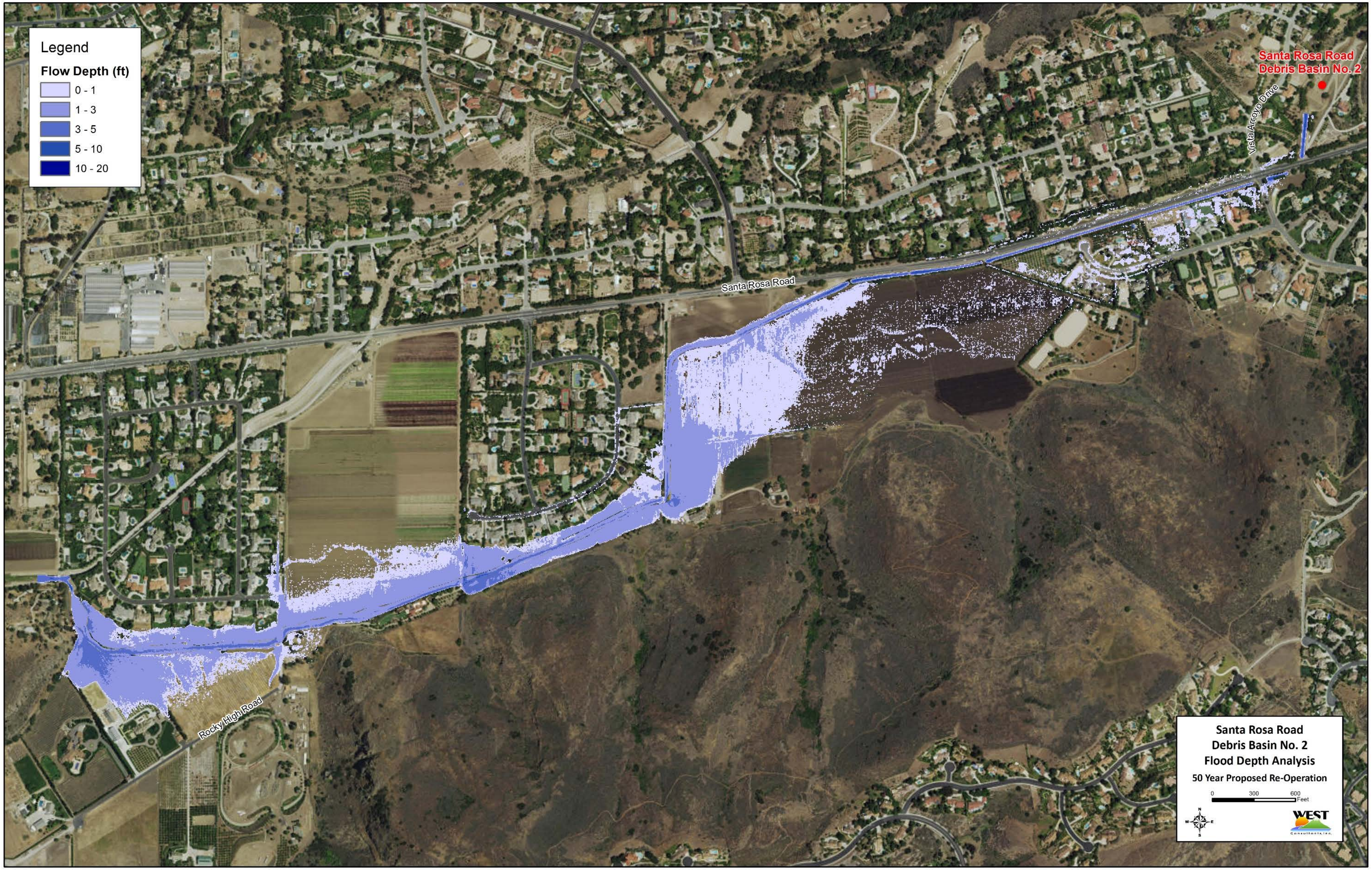


Figure D-10. 50-year Event Inundation Extent, Reoperation.

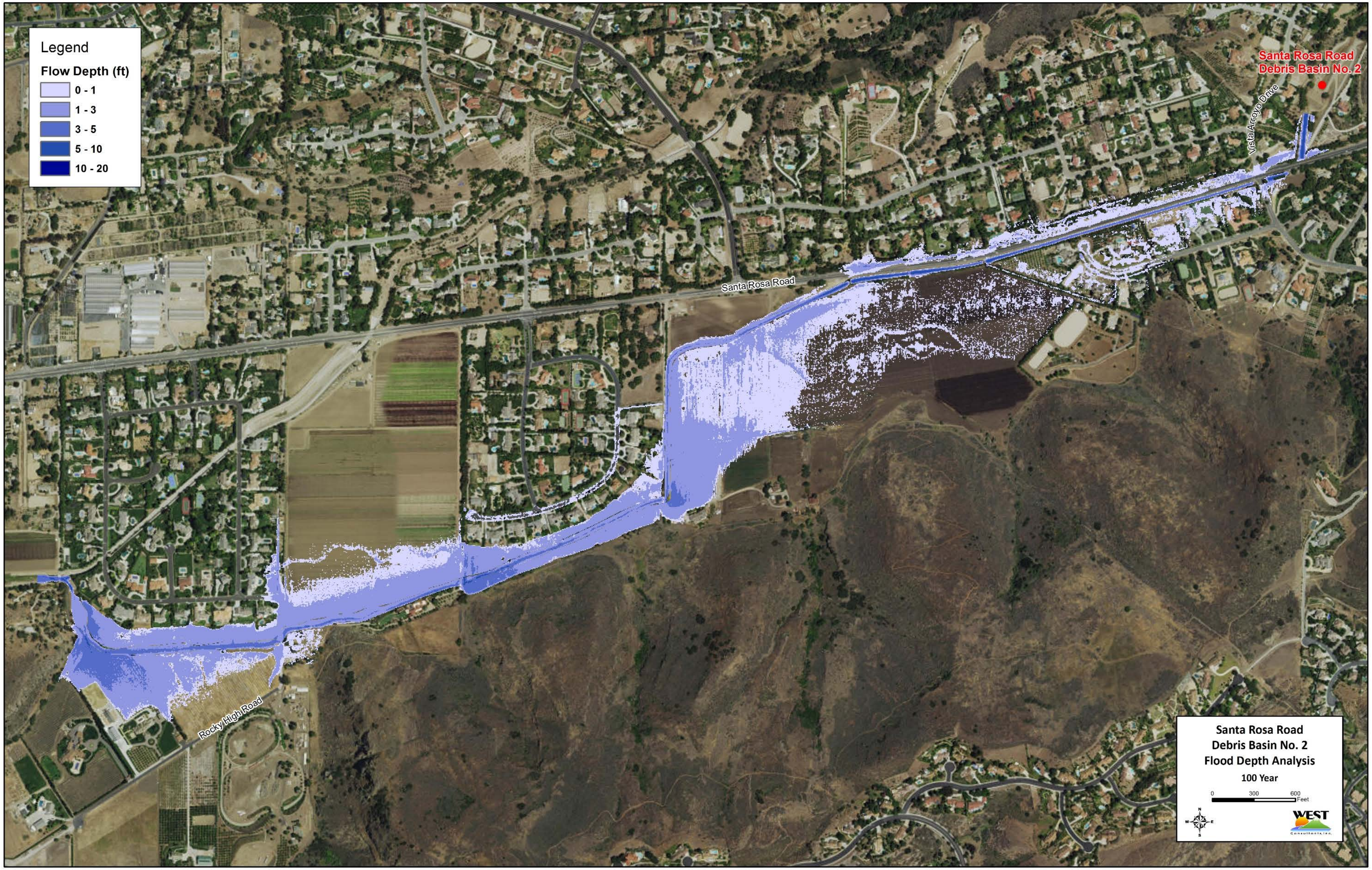


Figure D-11. 100-year Event Inundation Extent.

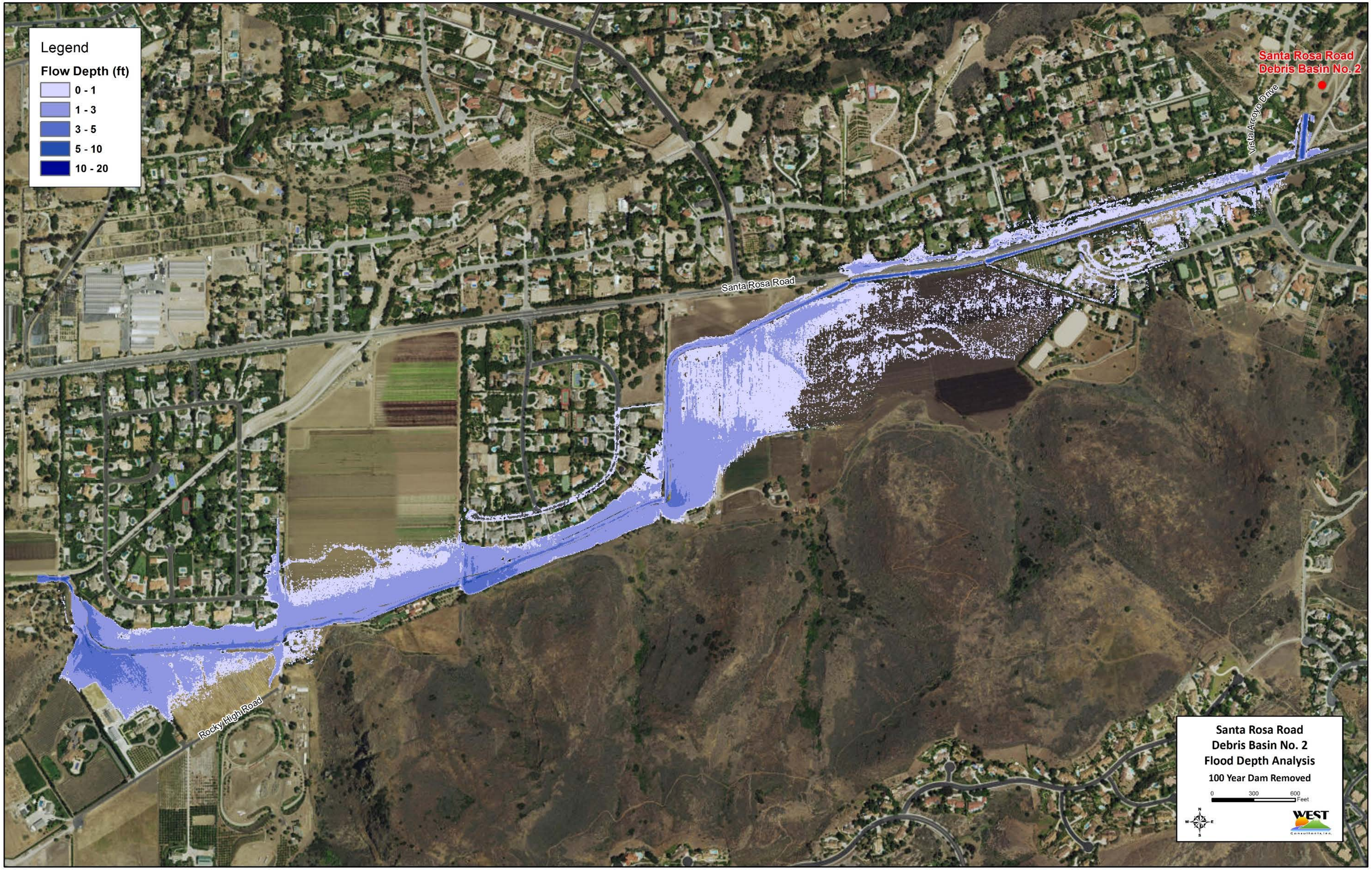


Figure D-12. 100-year Event Inundation Extent, Dam Removed.

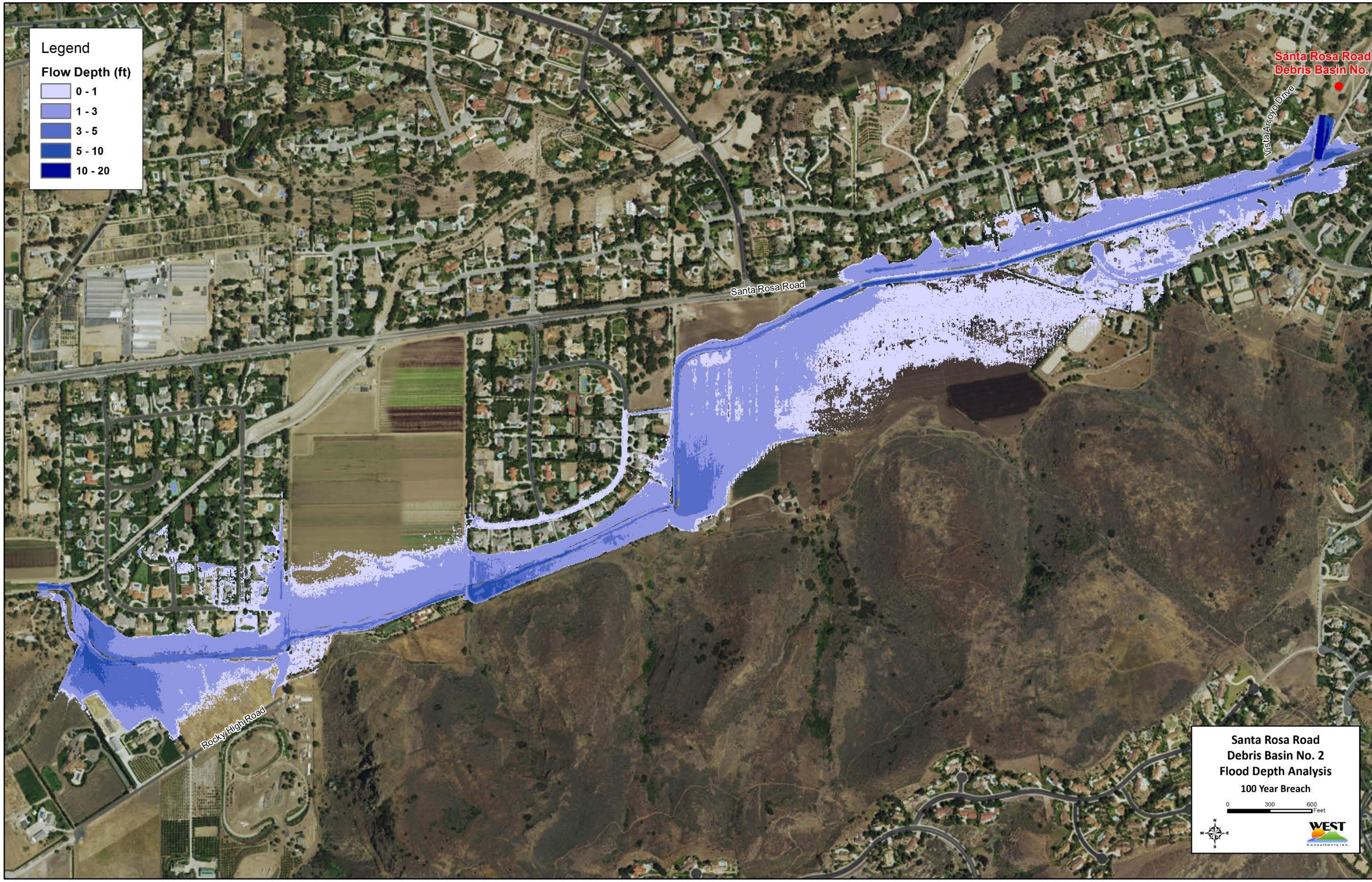


Figure D-13. 100-year Event Inundation Extent, Dam Breach.

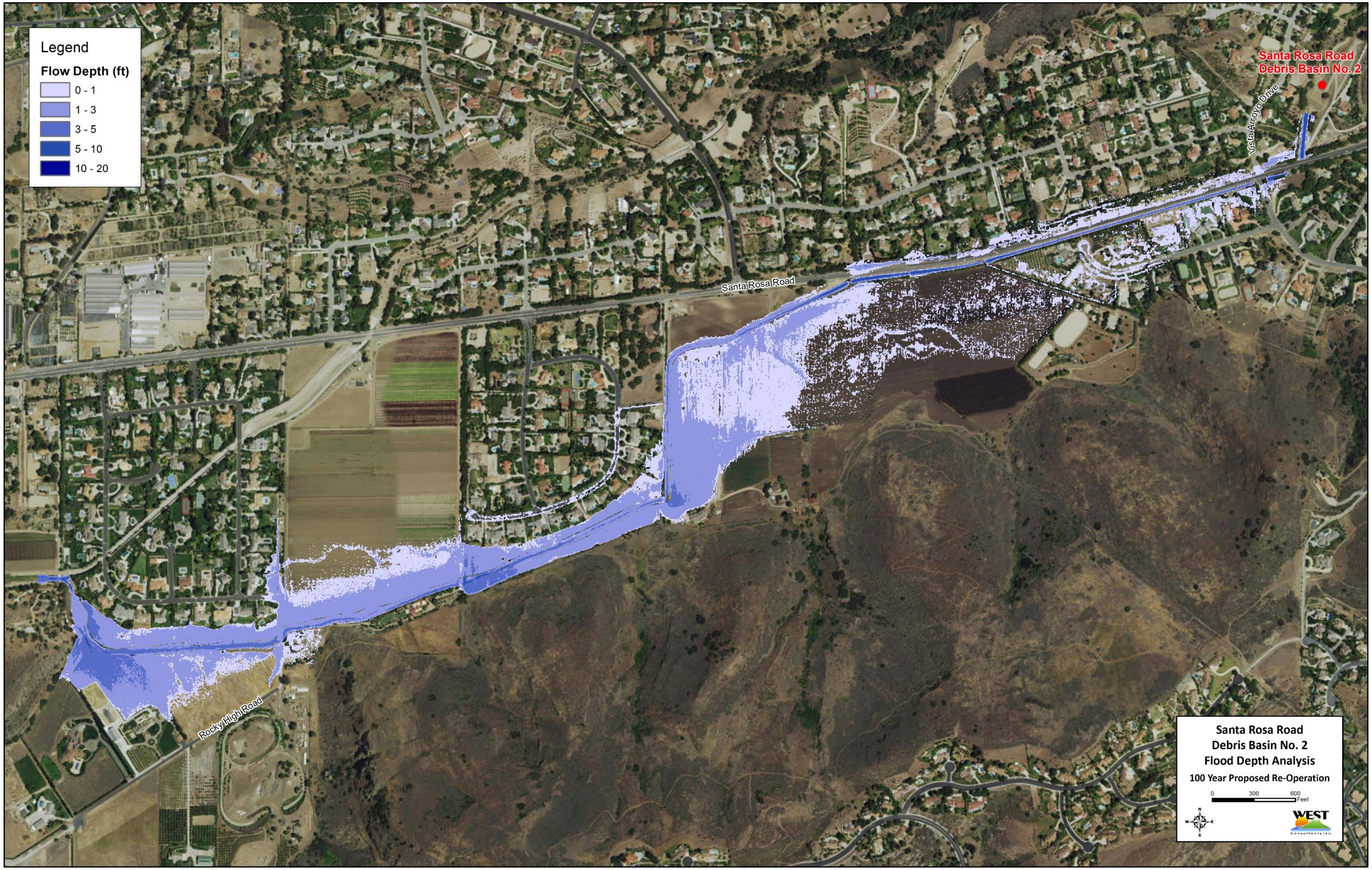


Figure D-14. 100-year Event Inundation Extent, Reoperation.

APPENDIX E

SEDIMENT TRANSPORT ANALYSIS RESULTS

2007 REPORT

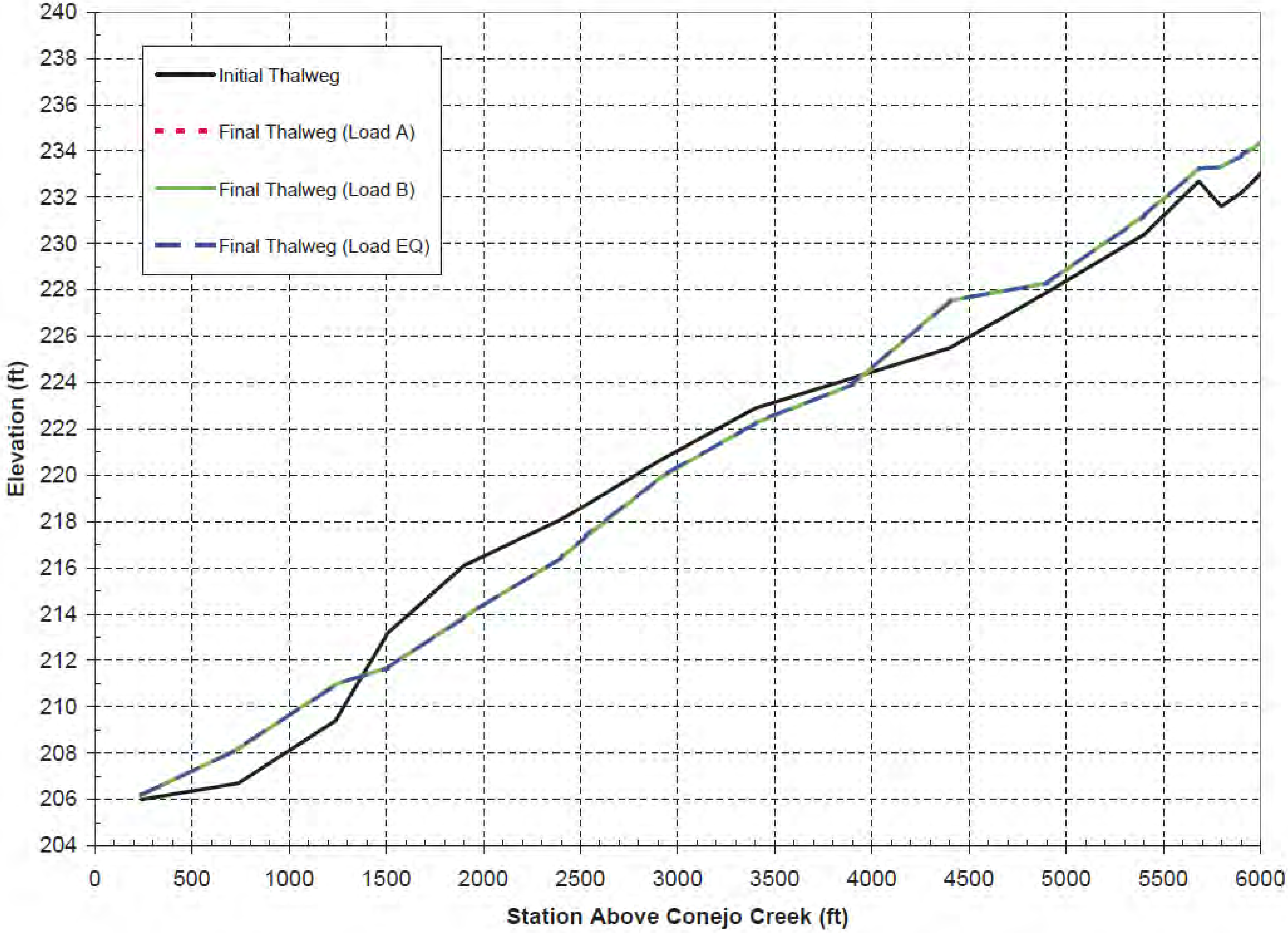


Figure E-1A. Santa Rosa Basin Existing Conditions Invert Profile – Initial and Final Conditions.

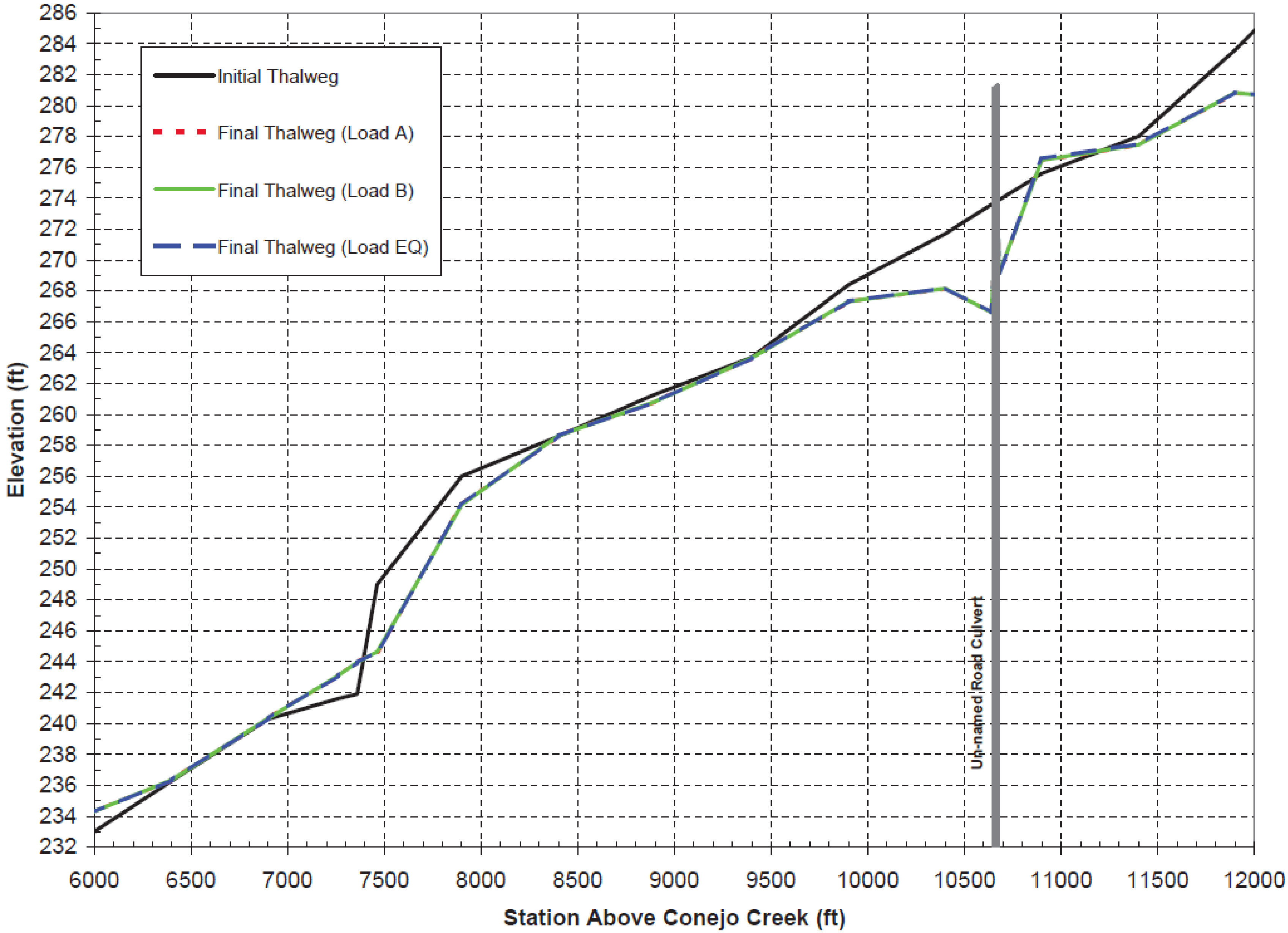


Figure E-1B. Santa Rosa Basin Existing Conditions Invert Profile – Initial and Final Conditions.

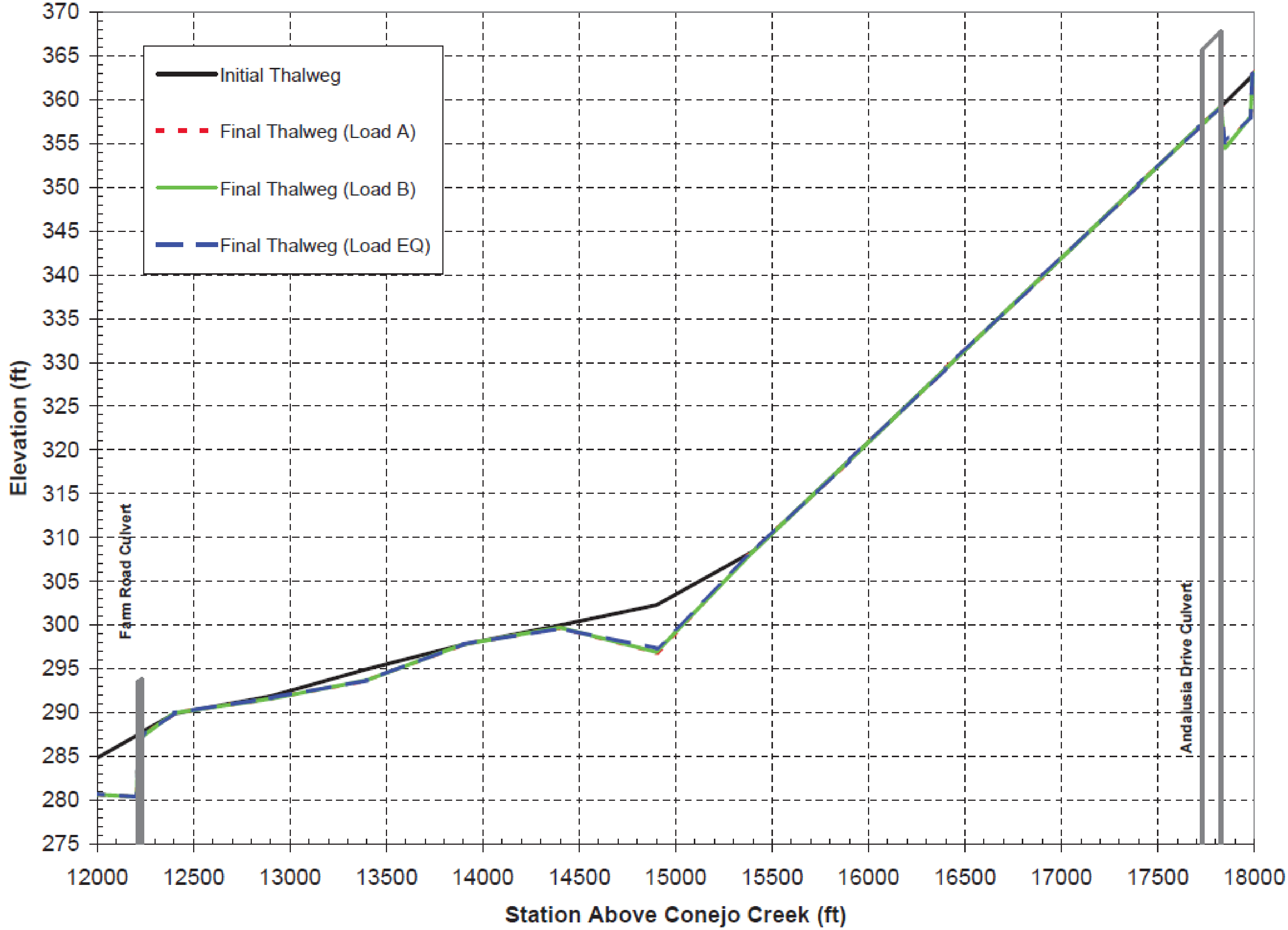


Figure E-1C. Santa Rosa Basin Existing Conditions Invert Profile – Initial and Final Conditions.

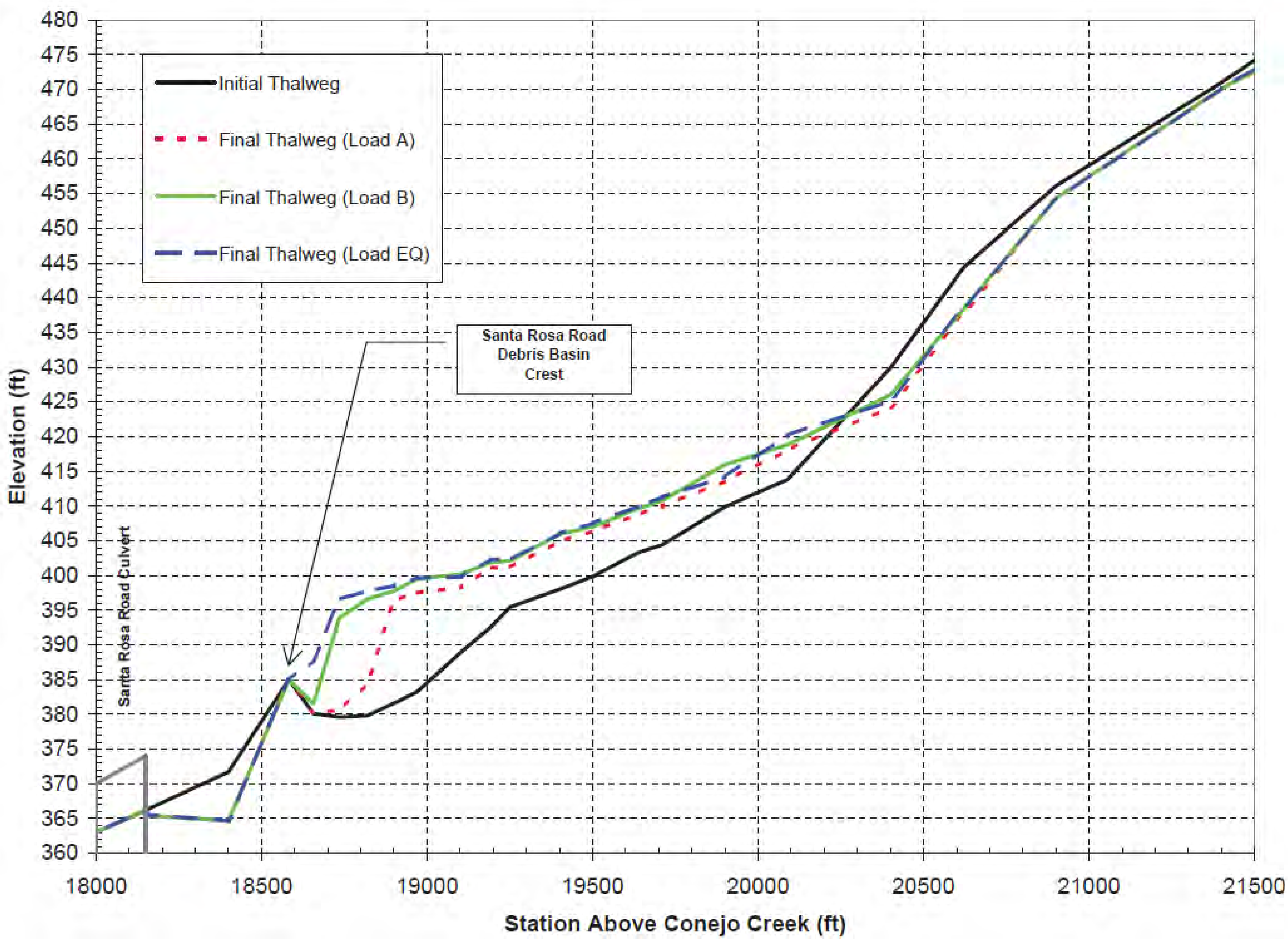


Figure E-1D. Santa Rosa Basin Existing Conditions Invert Profile – Initial and Final Conditions.

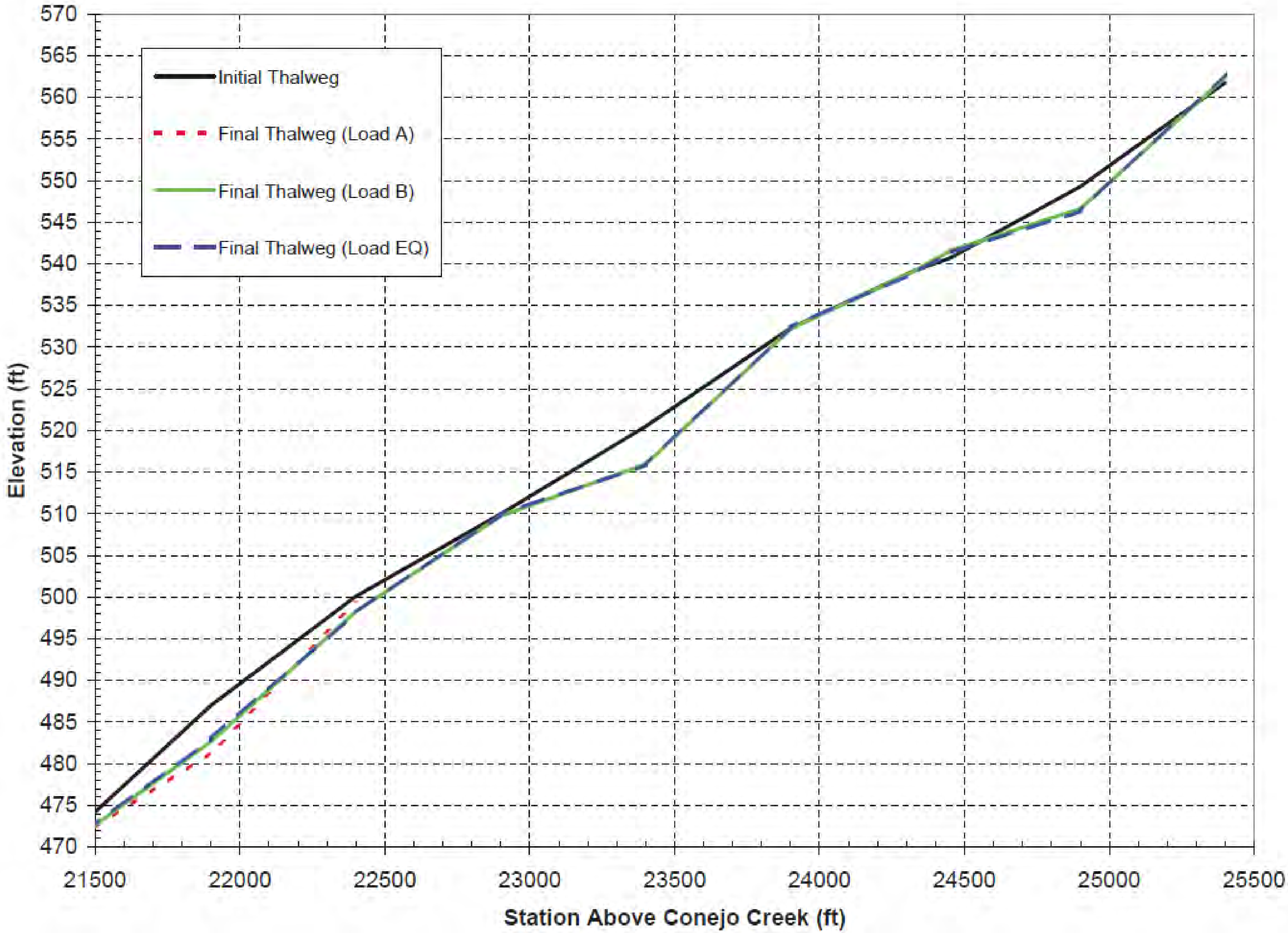


Figure E-1E. Santa Rosa Basin Existing Conditions Invert Profile – Initial and Final Conditions.

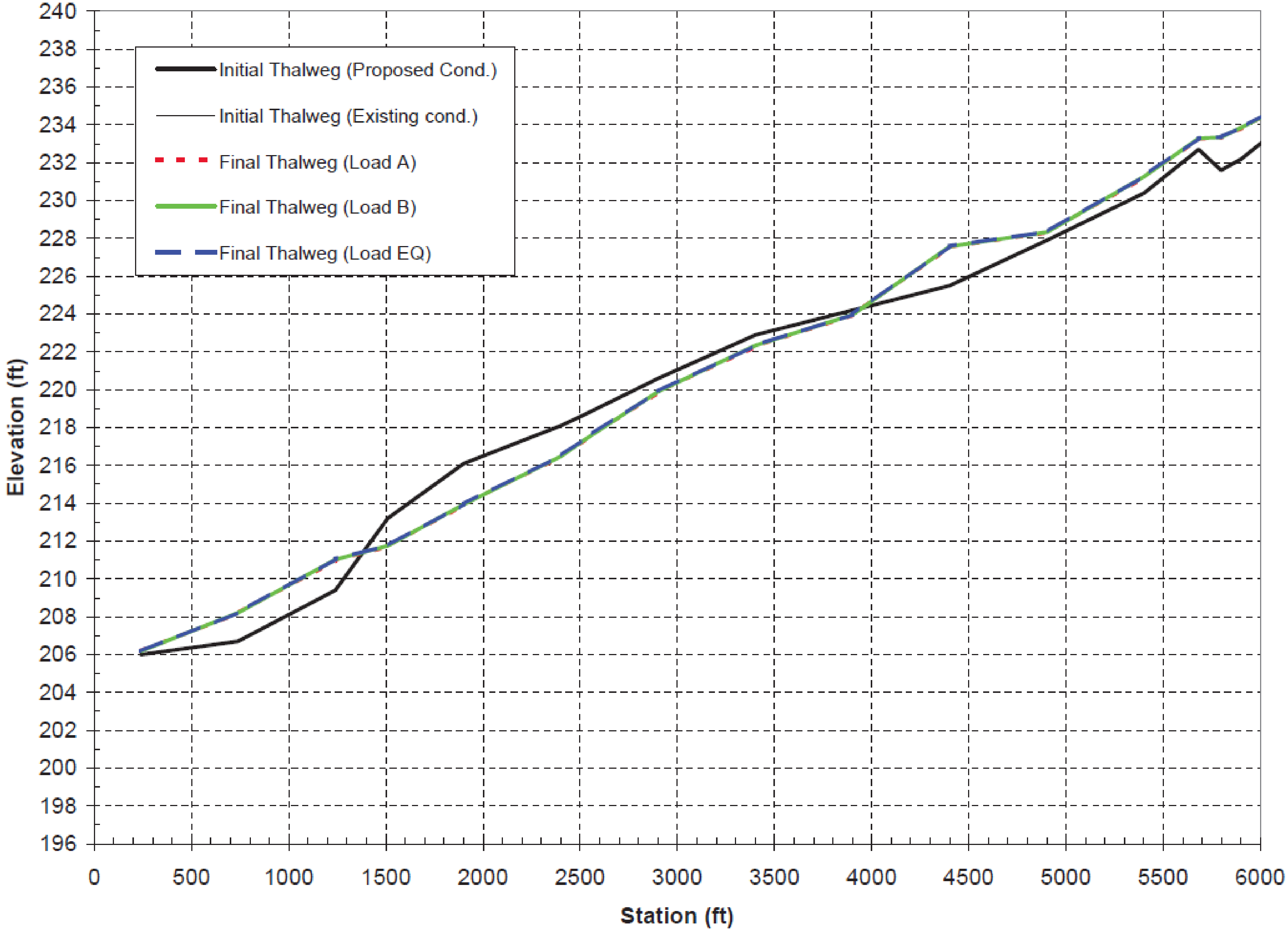


Figure E-2A. Santa Rosa Basin Proposed Conditions (Removal) Invert Profile – Initial and Final Conditions.

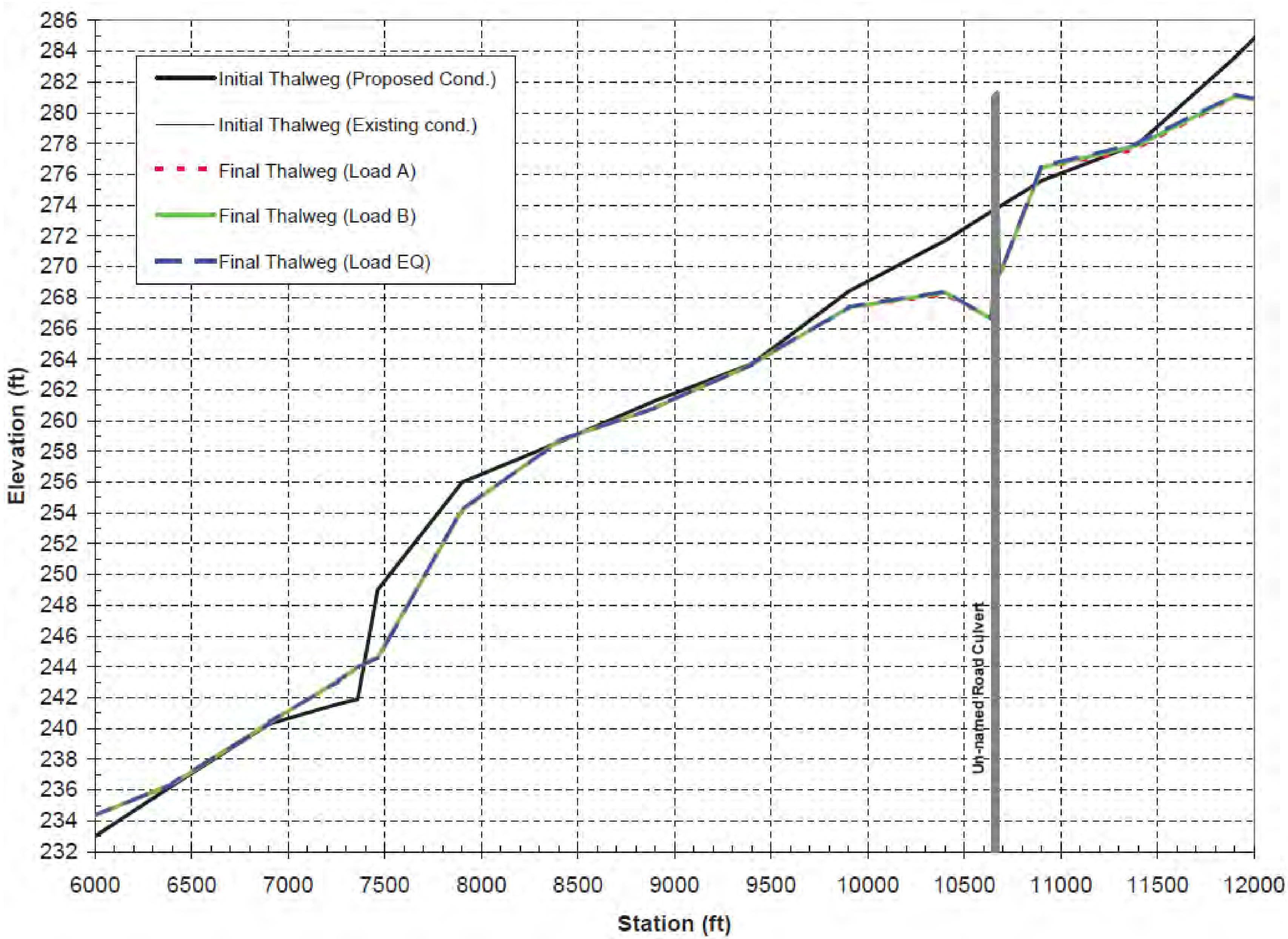


Figure E-2B. Santa Rosa Basin Proposed Conditions (Removal) Invert Profile – Initial and Final Conditions.

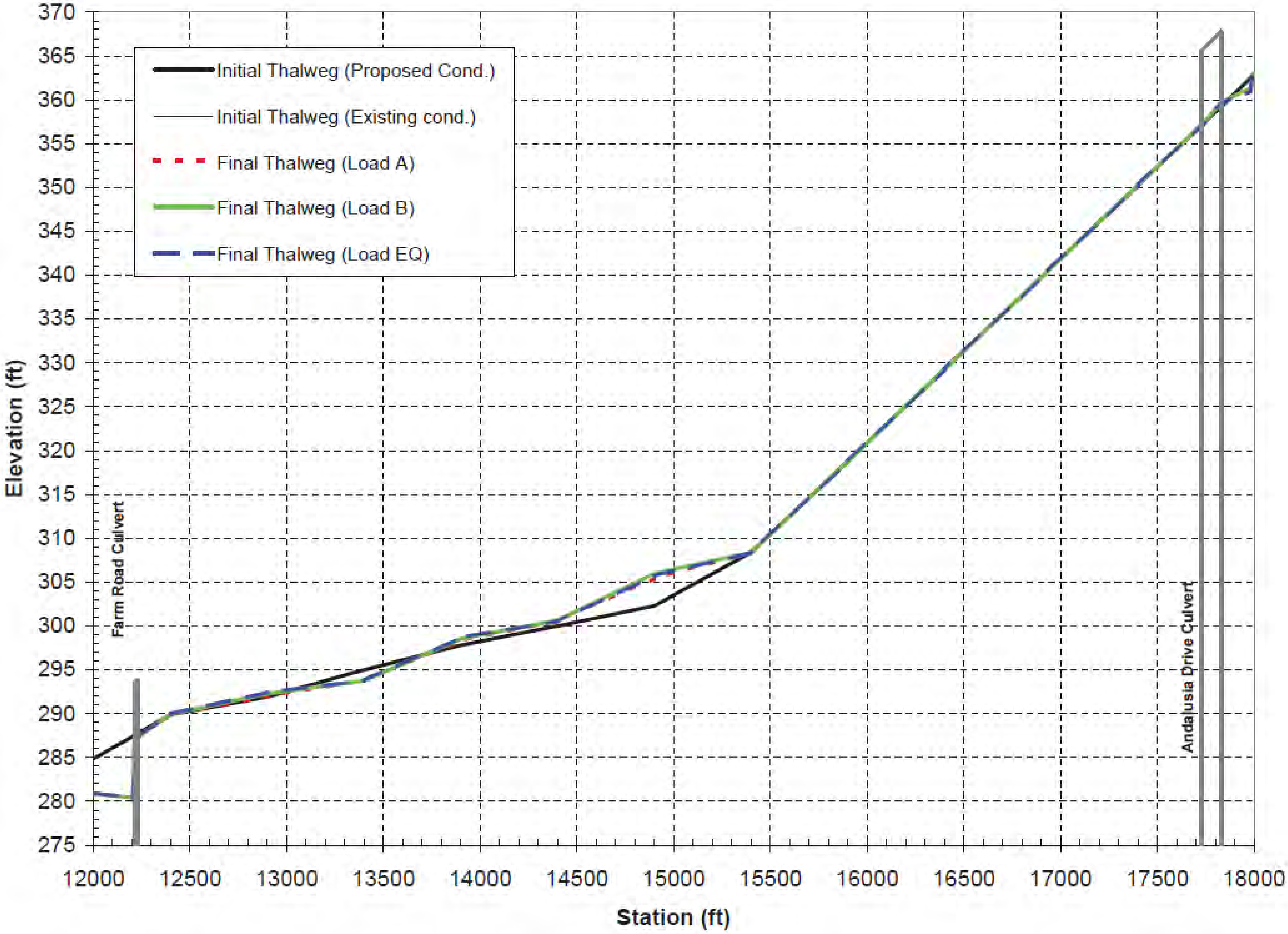


Figure E-2C. Santa Rosa Basin Proposed Conditions (Removal) Invert Profile – Initial and Final Conditions.

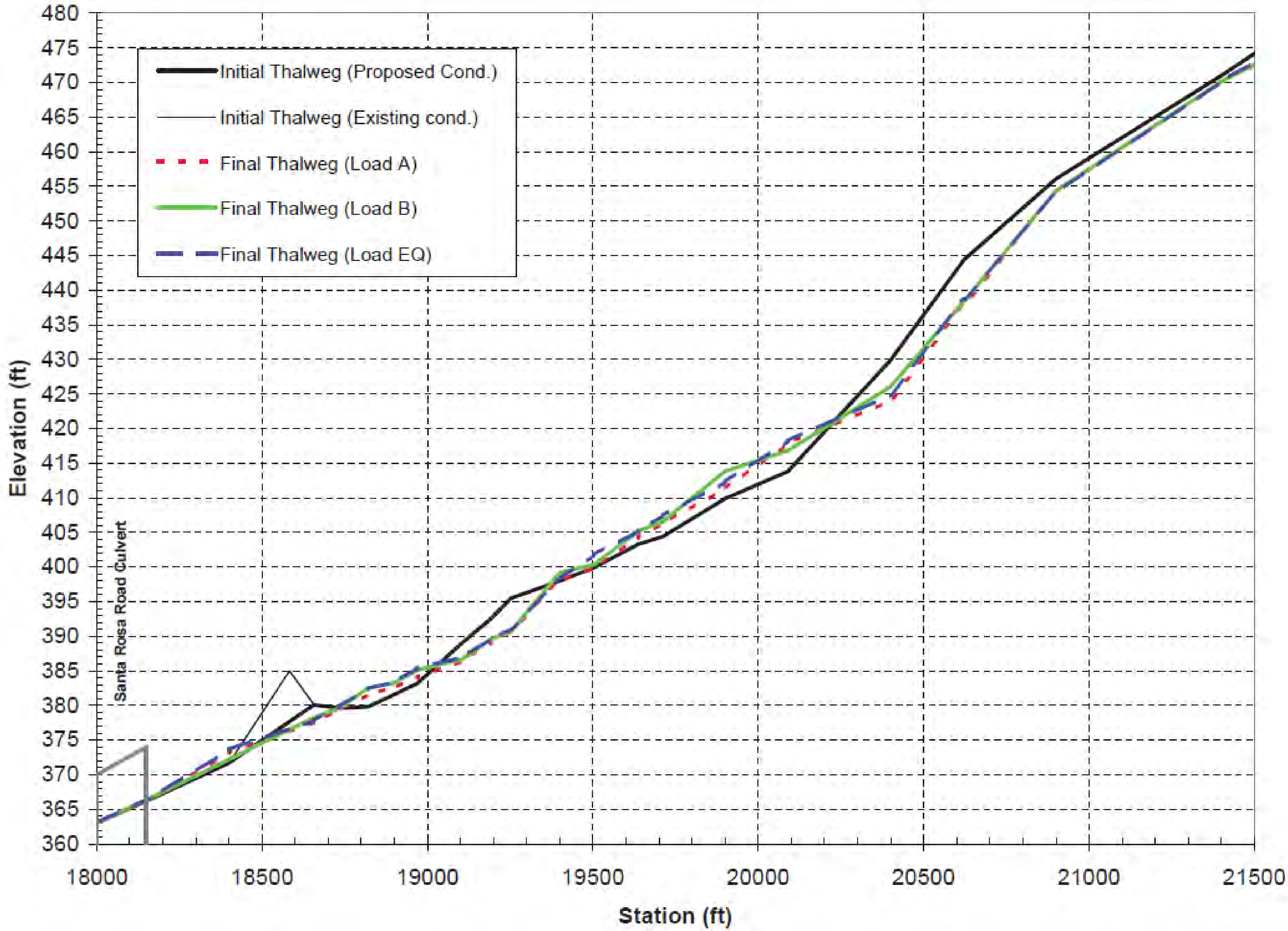


Figure E-2D. Santa Rosa Basin Proposed Conditions (Removal) Invert Profile – Initial and Final Conditions.

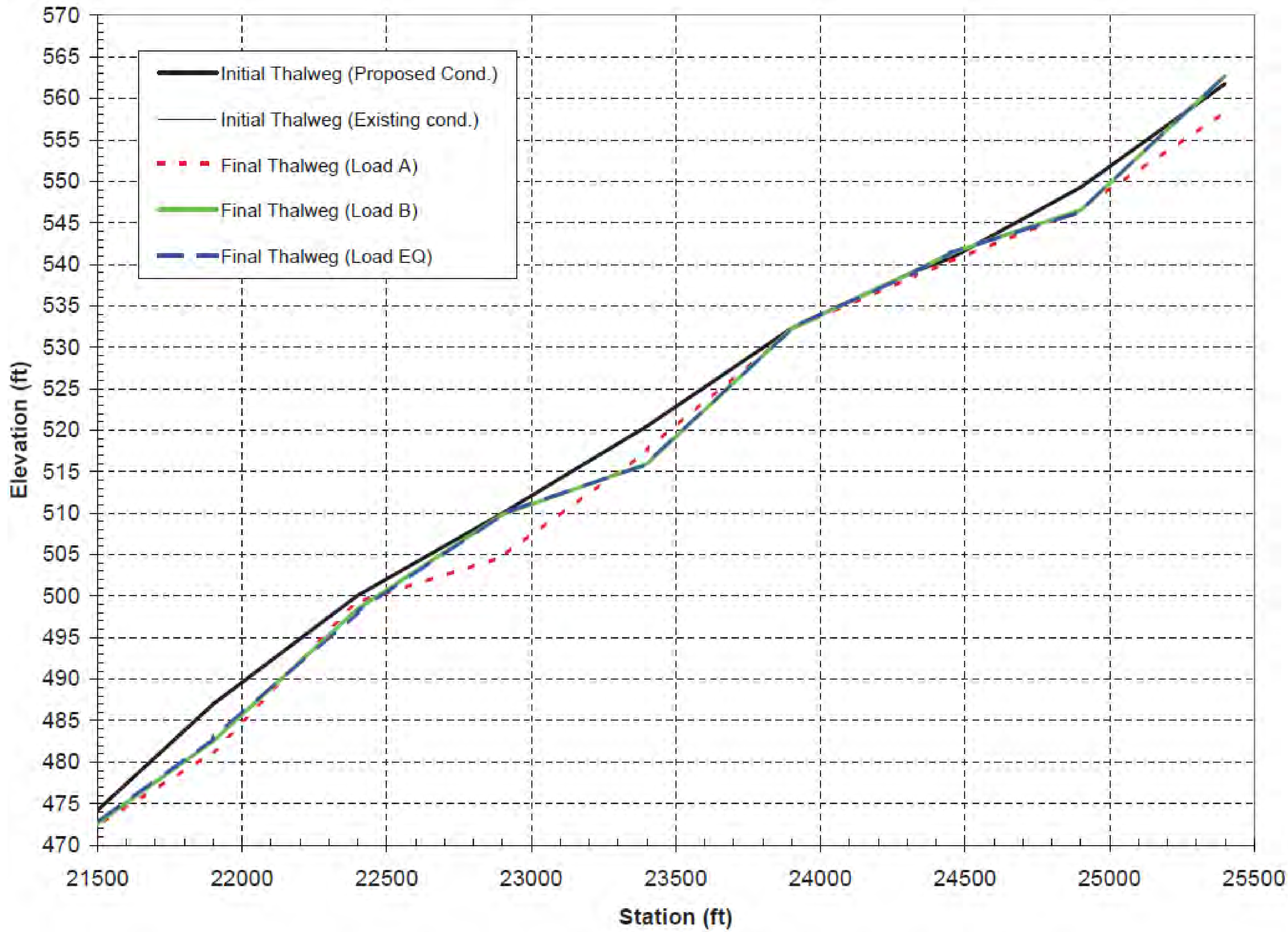


Figure E-2F. Santa Rosa Basin Proposed Conditions (Removal) Invert Profile – Initial and Final Conditions.

APPENDIX F

HEC-HMS OUTPUT HYDROGRAPHS /

HEC-RAS INPUT HYDROGRAPHS

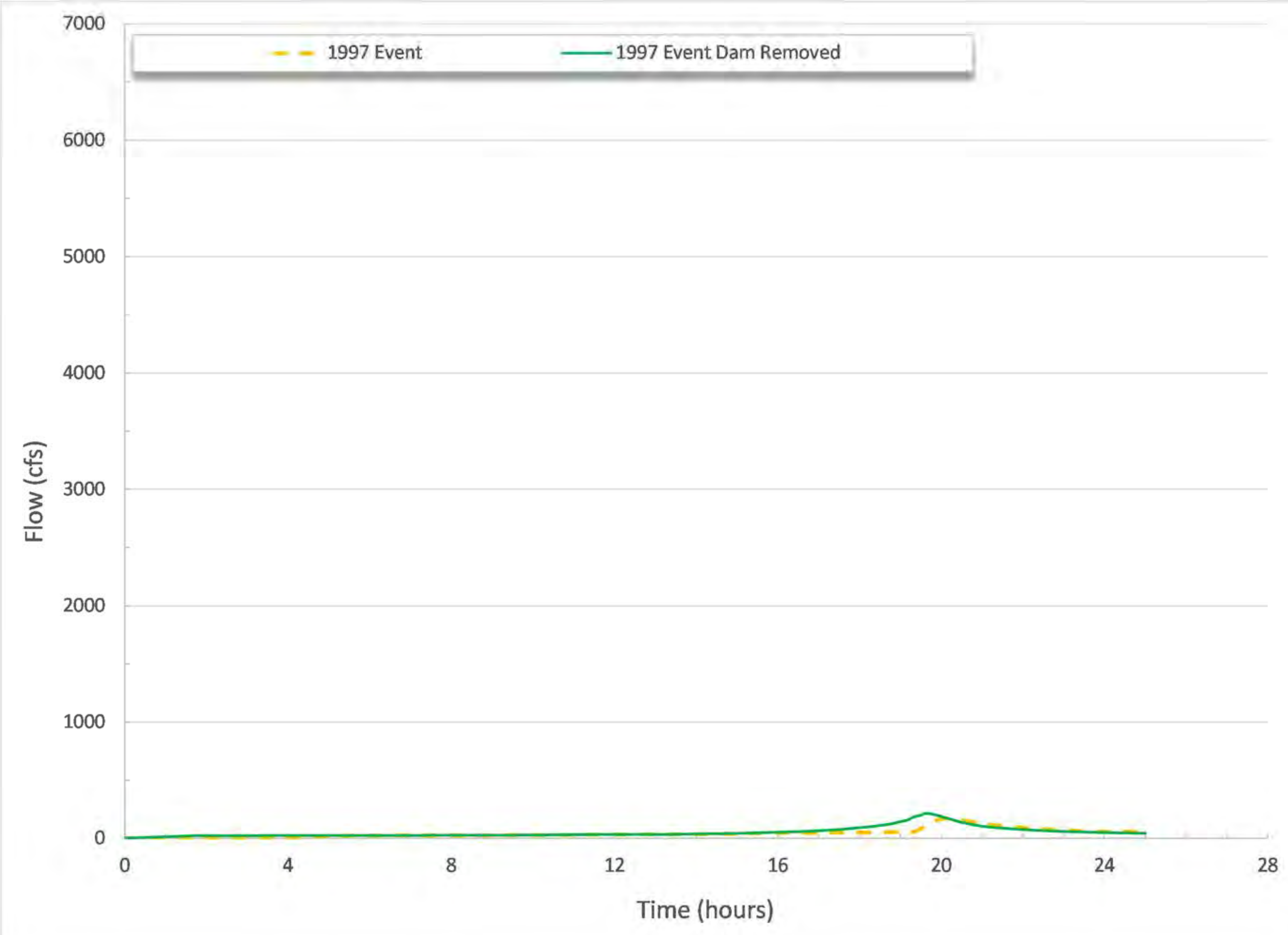


Figure F-1. 1997 Event HEC-HMS Output Hydrographs

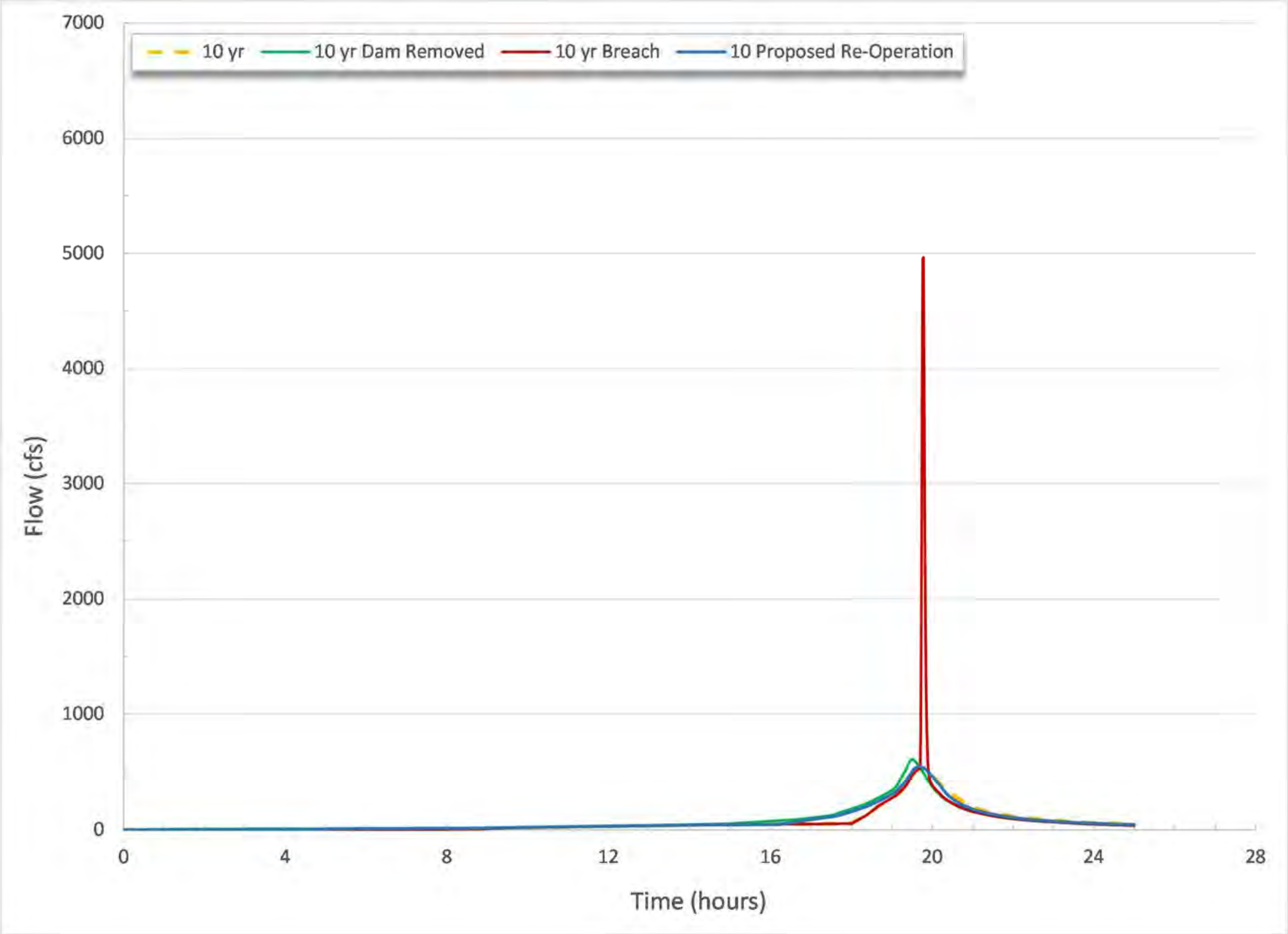


Figure F-2. 10 Year HEC-HMS Output Hydrograph.

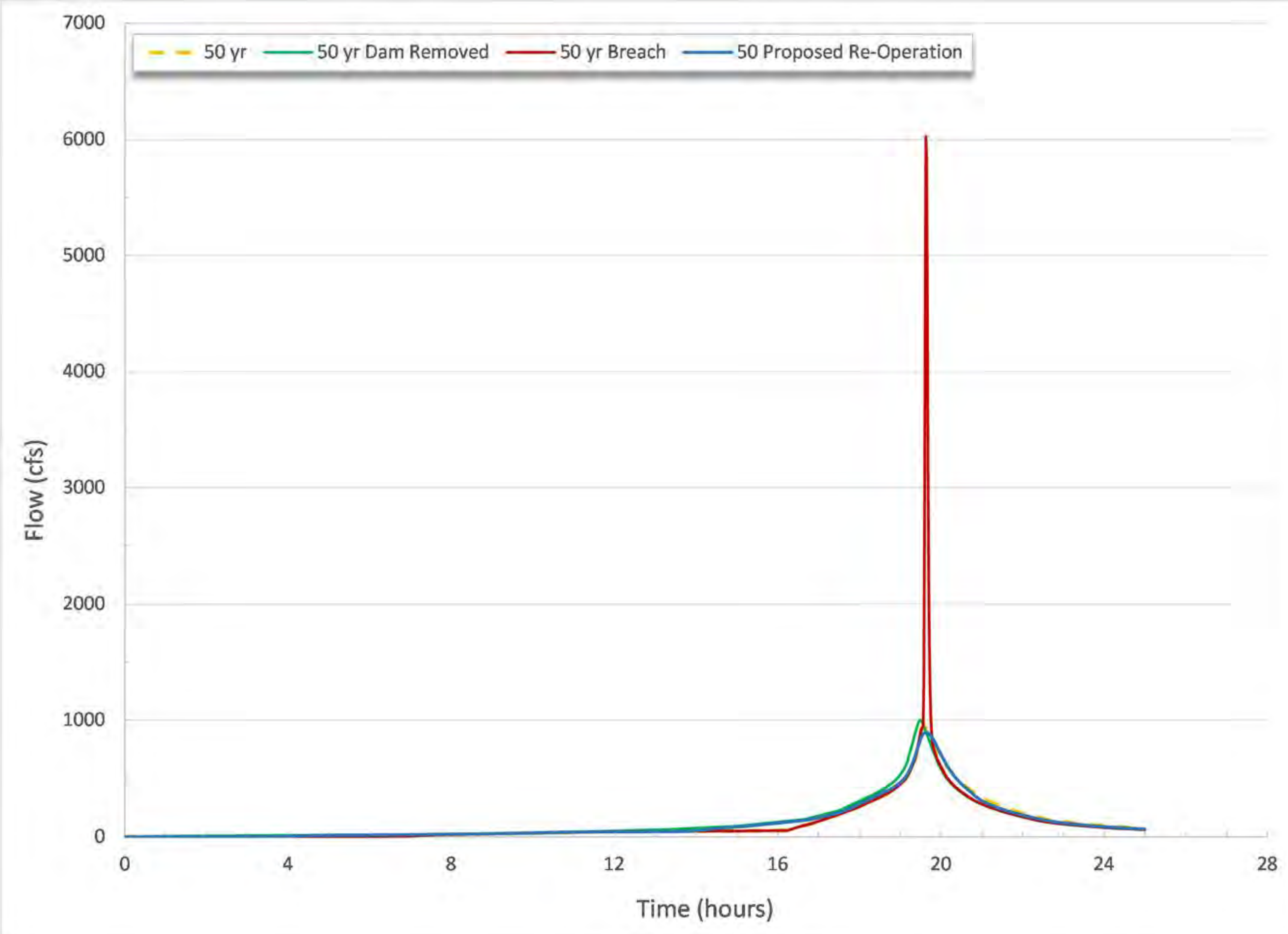


Figure F-3. 50 Year HEC-HMS Output Hydrograph.

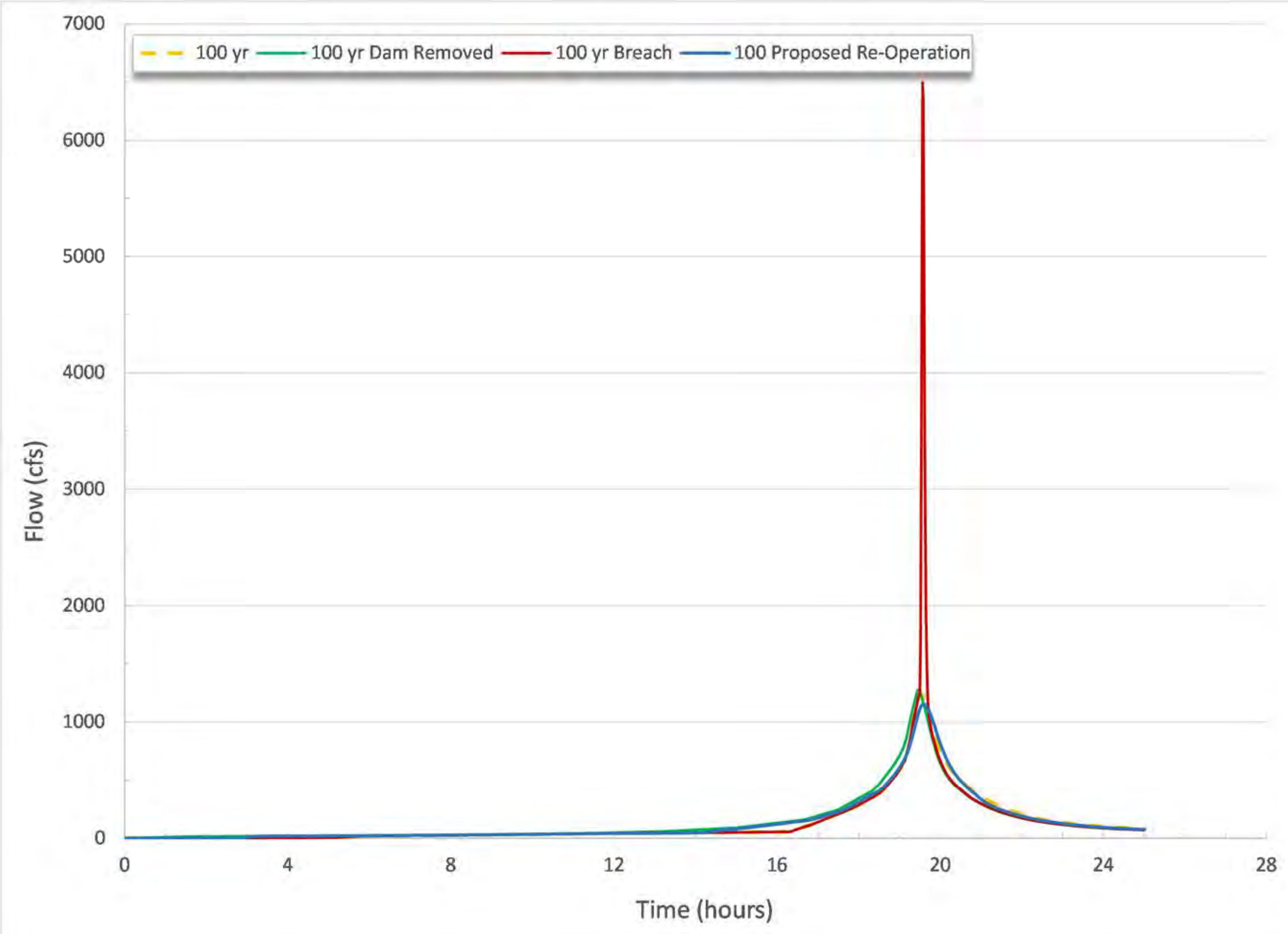
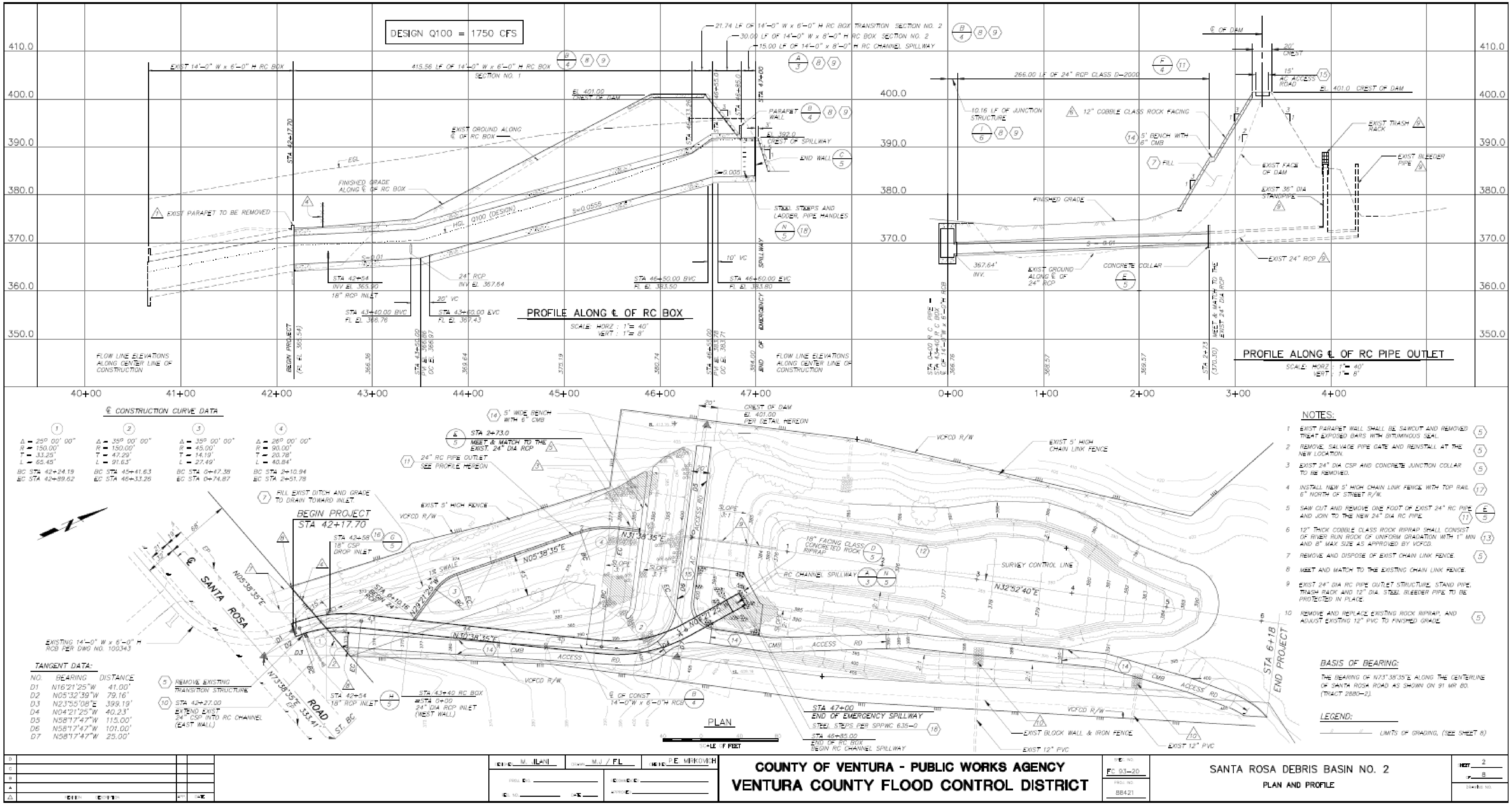


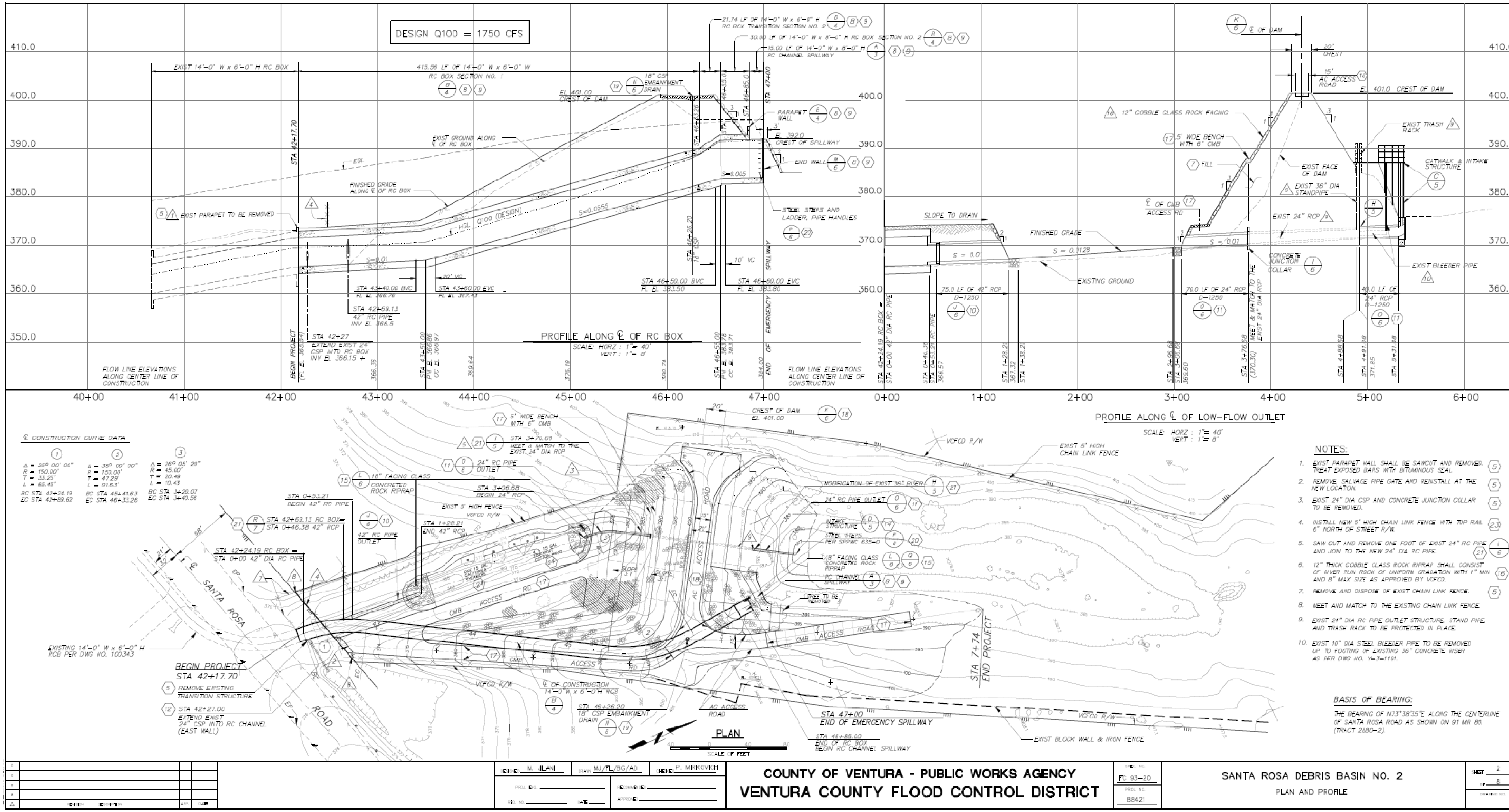
Figure F-4. 100 Year HEC-HMS Output Hydrograph.

APPENDIX G

SANTA ROSA ROAD DEBRIS BASIN NO. 2

VCWPD 1993 DESIGN DRAWINGS


DESIGN Q100 = 1750 CFS
PROFILE ALONG ℄ OF RC BOX
PROFILE ALONG ℄ OF RC PIPE OUTLET
PLAN
COUNTY OF VENTURA - PUBLIC WORKS AGENCY
VENTURA COUNTY FLOOD CONTROL DISTRICT
SANTA ROSA DEBRIS BASIN NO. 2
PLAN AND PROFILE


DESIGN Q100 = 1750 CFS
PROFILE ALONG ℄ OF RC BOX
SCALE: HORZ : 1"= 40'
VERT : 1"= 8'
PROFILE ALONG ℄ OF LOW-FLOW OUTLET
PLAN
BEGIN PROJECT
STA 42+17.70
STA 7+74
END PROJECT
SANTA ROSA ROAD
NOTES:
1. EXIST PARAPET WALL SHALL BE SAWCUT AND REMOVED. TREAT EXPOSED BARS WITH BITUMINOUS SEAL.
2. REMOVE, SALVAGE PIPE GATE AND REINSTALL AT THE NEW LOCATION.
3. EXIST 24" DIA CSP AND CONCRETE JUNCTION COLLAR TO BE REMOVED.
4. INSTALL NEW 5' HIGH CHAIN LINK FENCE WITH TOP RAIL 6" NORTH OF STREET R/W.
5. SAW CUT AND REMOVE ONE FOOT OF EXIST 24" RC PIPE AND JOIN TO THE NEW 24" DIA RC PIPE.
6. 12" THICK COBBLE CLASS ROCK RIPRAP SHALL CONSIST OF RIVER RUN ROCK OF UNIFORM GRADATION WITH 1" MIN AND 8" MAX SIZE AS APPROVED BY VCFCD.
7. REMOVE AND DISPOSE OF EXIST CHAIN LINK FENCE.
8. MEET AND MATCH TO THE EXISTING CHAIN LINK FENCE.
9. EXIST 24" DIA RC PIPE OUTLET STRUCTURE, STAND PIPE, AND TRASH RACK TO BE PROTECTED IN PLACE.
10. EXIST 10" DIA STEEL BLEEDER PIPE TO BE REMOVED UP TO FOOTING OF EXISTING 36" CONCRETE RISER AS PER DWG NO. Y-3-1191.
BASIS OF BEARING:
THE BEARING OF N73°38'35"E ALONG THE CENTERLINE OF SANTA ROSA ROAD AS SHOWN ON 91 MR 80. (TRACT 2880-2).
COUNTY OF VENTURA - PUBLIC WORKS AGENCY
VENTURA COUNTY FLOOD CONTROL DISTRICT
SANTA ROSA DEBRIS BASIN NO. 2
PLAN AND PROFILE

APPENDIX H

HEC-RAS File List

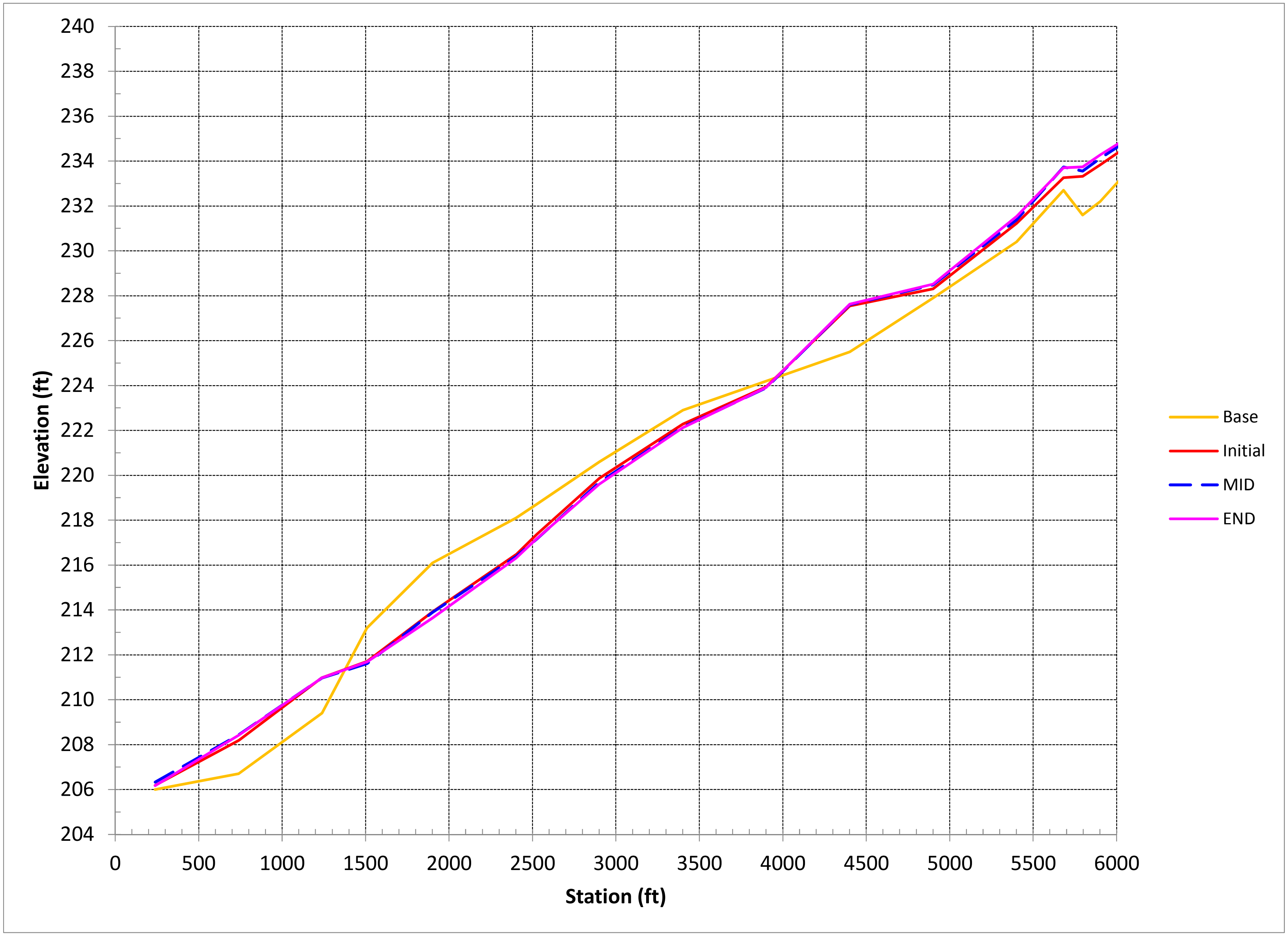
HEC-RAS Project Name: Existing 2D Model

Plan Name	Plan Filename Extension	Geometry Filename	Geometry Filename Extension	Unsteady Flow Filename	Unsteady Flow Filename Extension
10yr	.p01	1D Channel 2D Overbanks	.g01	10yr	.u01
10yr Breach	.p02	1D Channel 2D Overbanks_1 lid	.g04	10yr Breach	.u02
50 yr	.p03	1D Channel 2D Overbanks	.g01	50yr	.u03
50yr Breach	.p04	1D Channel 2D Overbanks_1 lid	.g04	50yr Breach	.u04
100yr Breach	.p05	1D Channel 2D Overbanks_1 lid	.g04	100yr Breach	.u06
100yr	.p06	1D Channel 2D Overbanks	.g01	100yr	.u05
1997 Event	.p07	1D Channel 2D Overbanks	.g01	1997 Event	.u07
10yr with Dam Removed	.p09	1D Channel 2D Overbanks	.g01	10yr with Dam Removed	.u09
50yr with Dam Removed	.p10	1D Channel 2D Overbanks	.g01	50yr with Dam Removed	.u10
100yr with Dam Removed	.p11	1D Channel 2D Overbanks	.g01	100yr with Dam Removed	.u11
1997 Event with Dam Removed	.p12	1D Channel 2D Overbanks	.g01	1997 Event with Dam Removed	.u12
100yr Proposed ReOp	.p13	1D Channel 2D Overbanks	.g01	100yr Proposed ReOp	.u13
50yr Proposed ReOp	.p16	1D Channel 2D Overbanks	.g01	50yr Proposed ReOp	.u15
10yr Proposed ReOp	.p17	1D Channel 2D Overbanks	.g01	10yr Proposed ReOp	.u16
100yr Breach_1 sec	.p18	1D Channel 2D Overbanks	.g01	100yr Breach	.u06

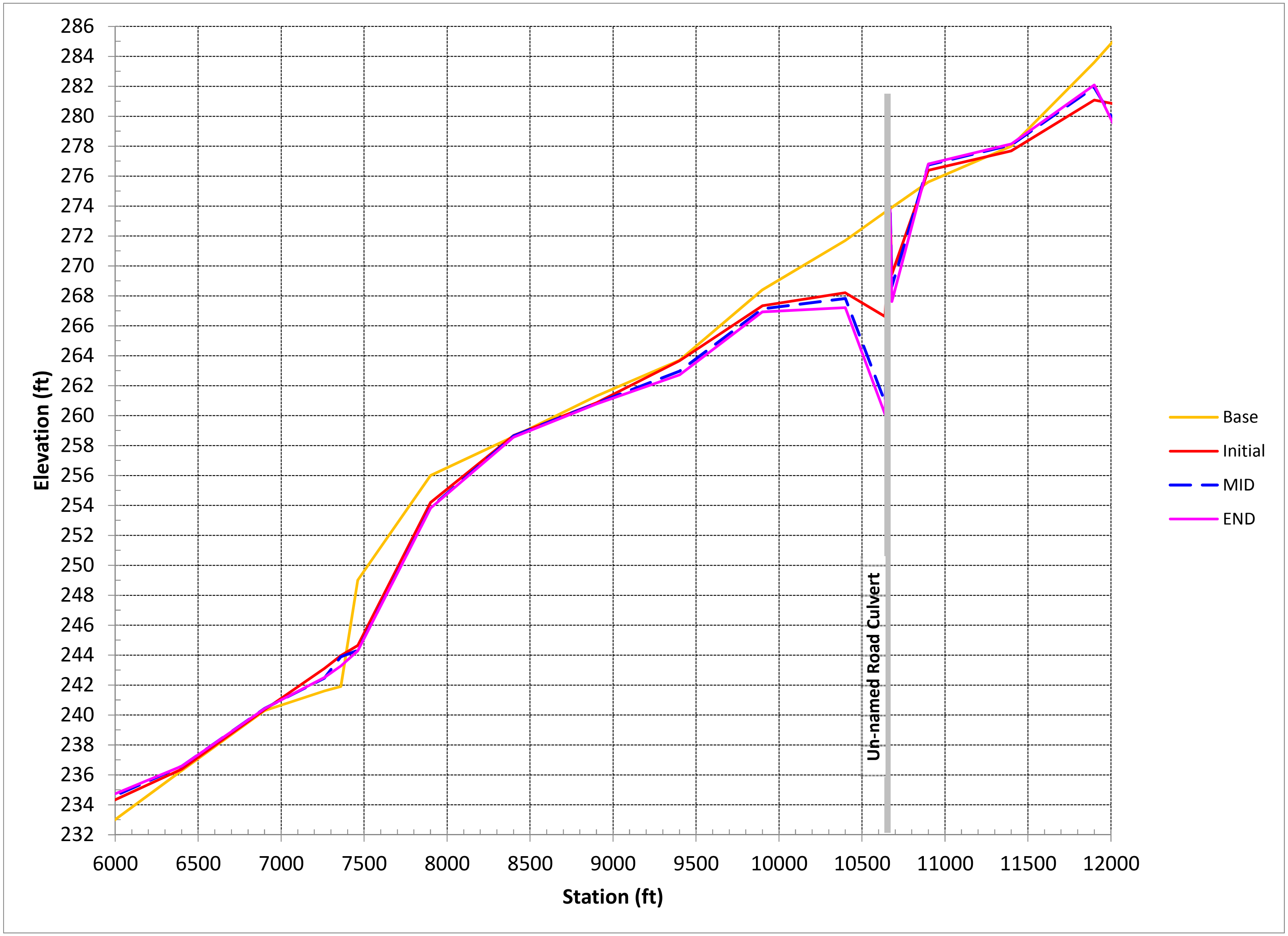
*The “100yr Breach_1 sec” plan is identical to the “100yr Breach” plan except a 1 second time step was used during the model run instead of a 5 second time step to evaluate the effect on results. The difference was deemed inconsequential.

APPENDIX I

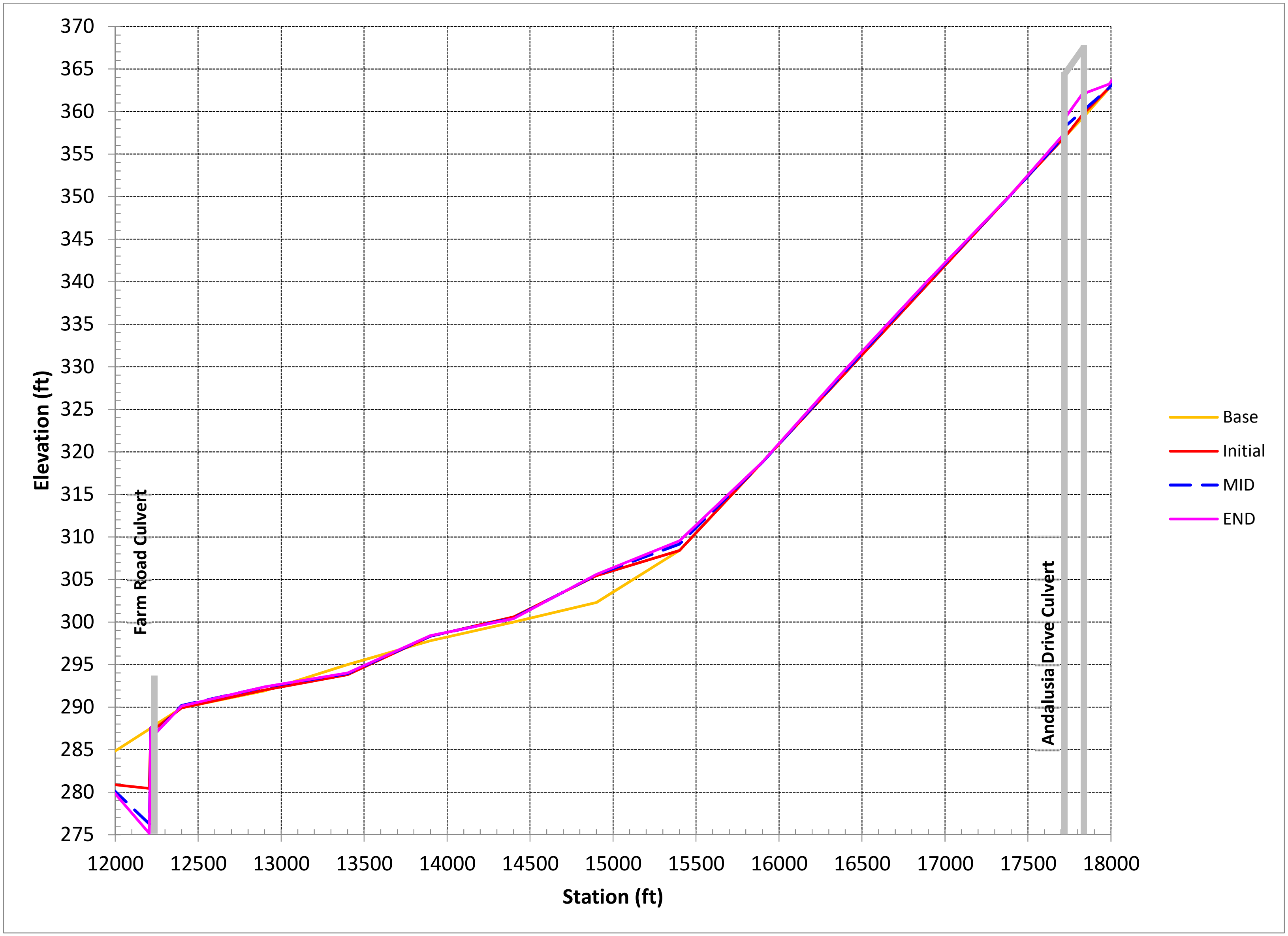
100-YEAR EVENT SEDIMENT TRANSPORT ANALYSIS RESULTS



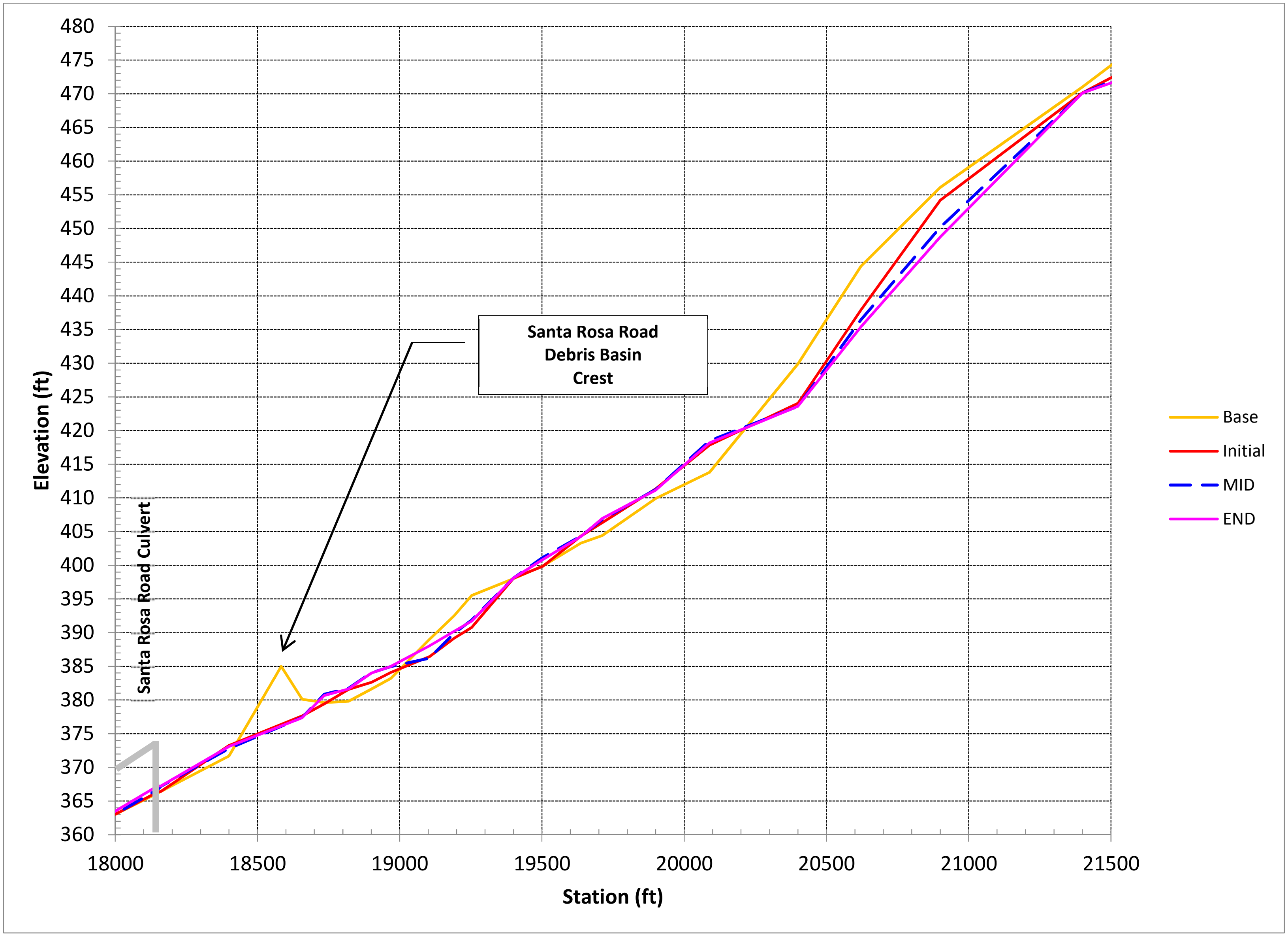
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for “Load A” – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



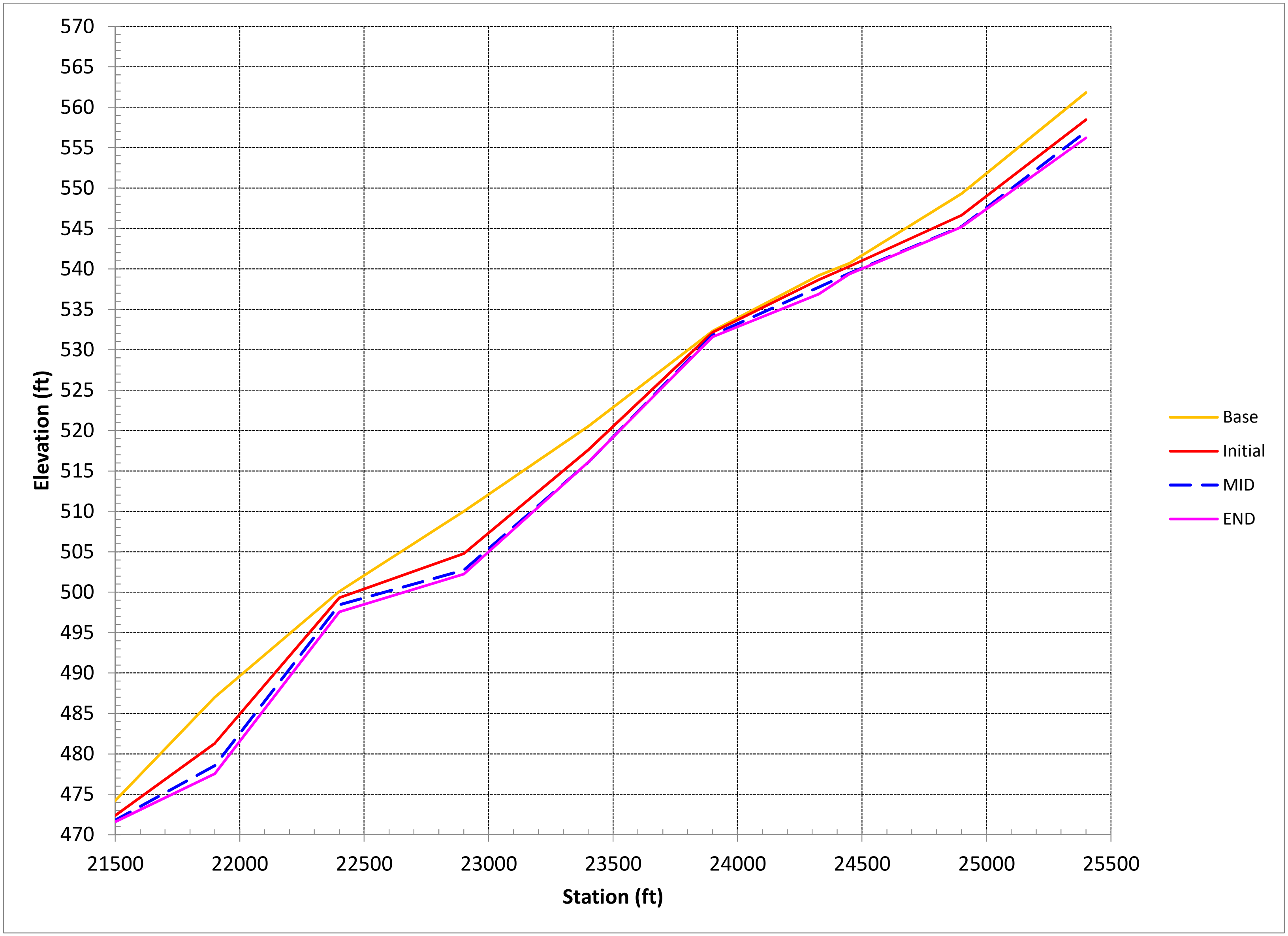
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for “Load A” – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



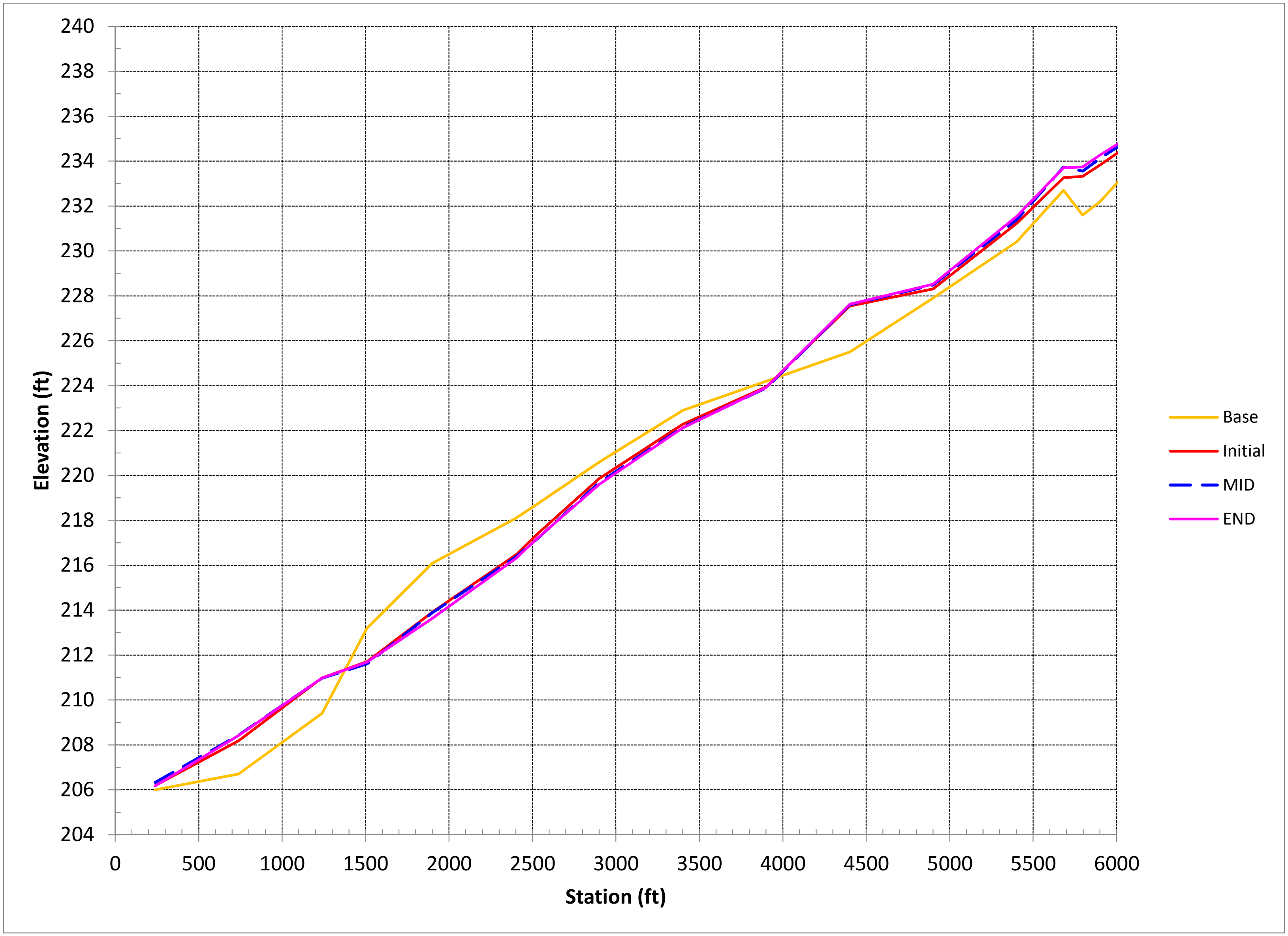
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for "Load A" – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



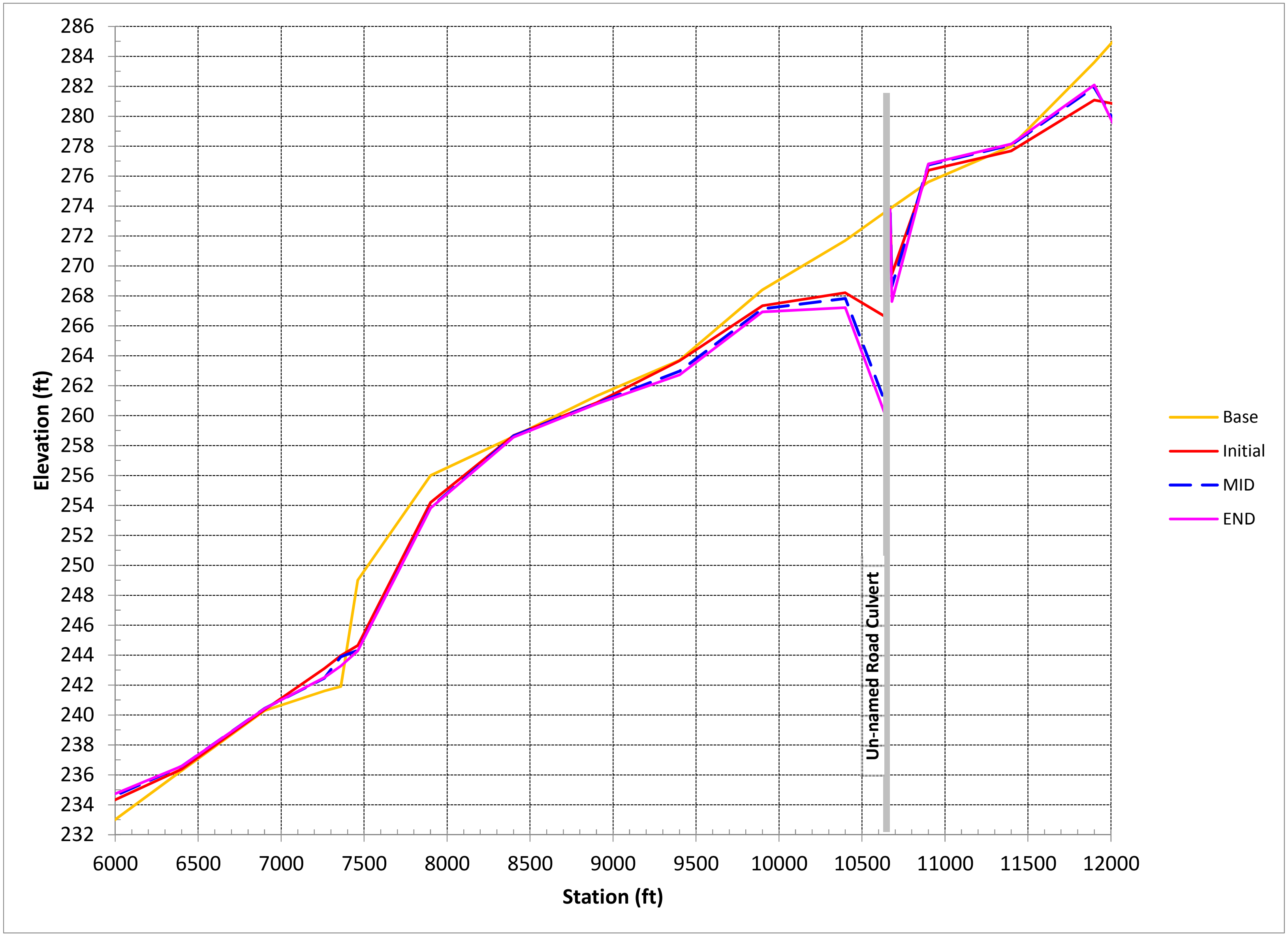
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for "Load A" – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



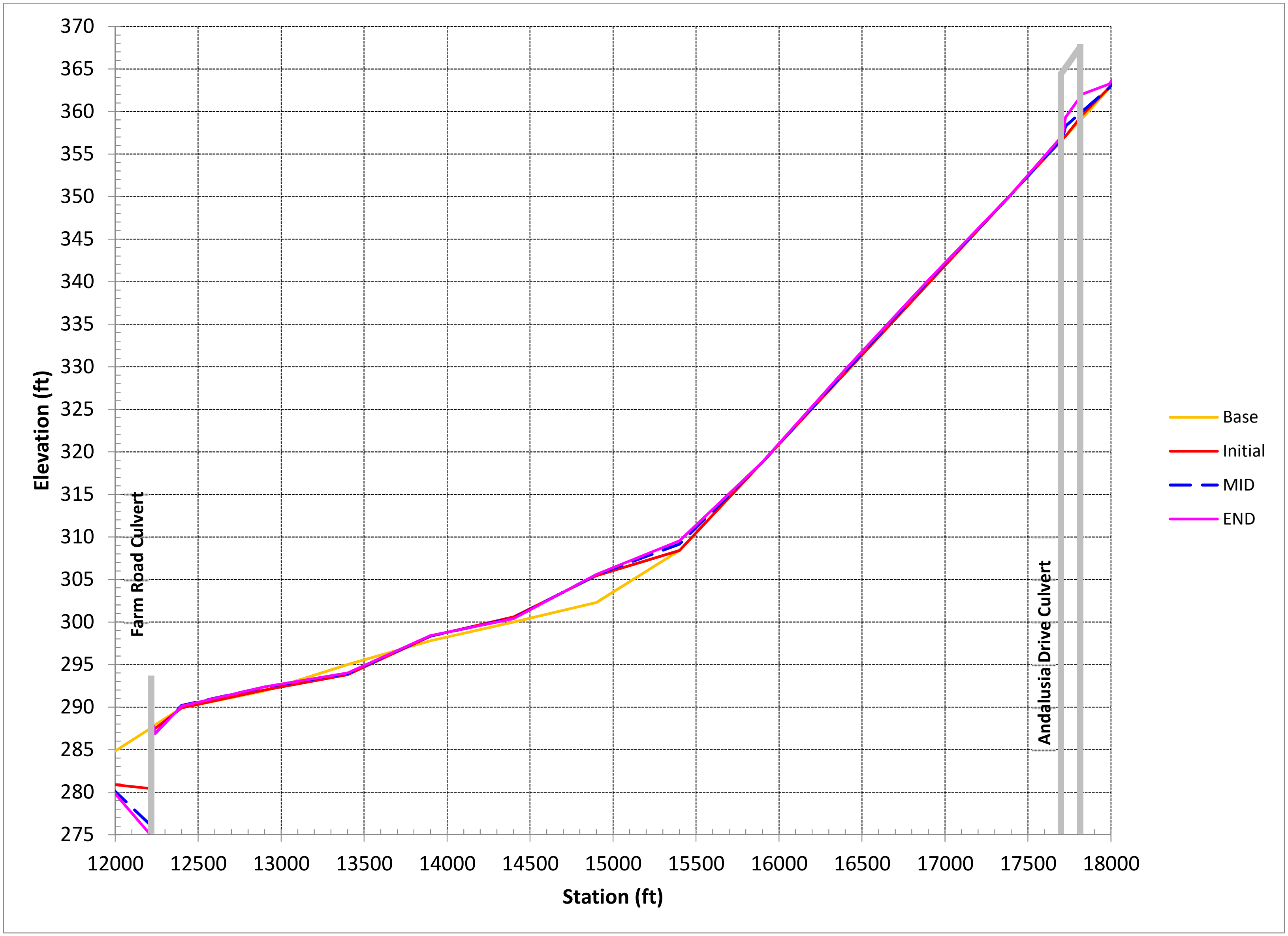
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for “Load A” – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



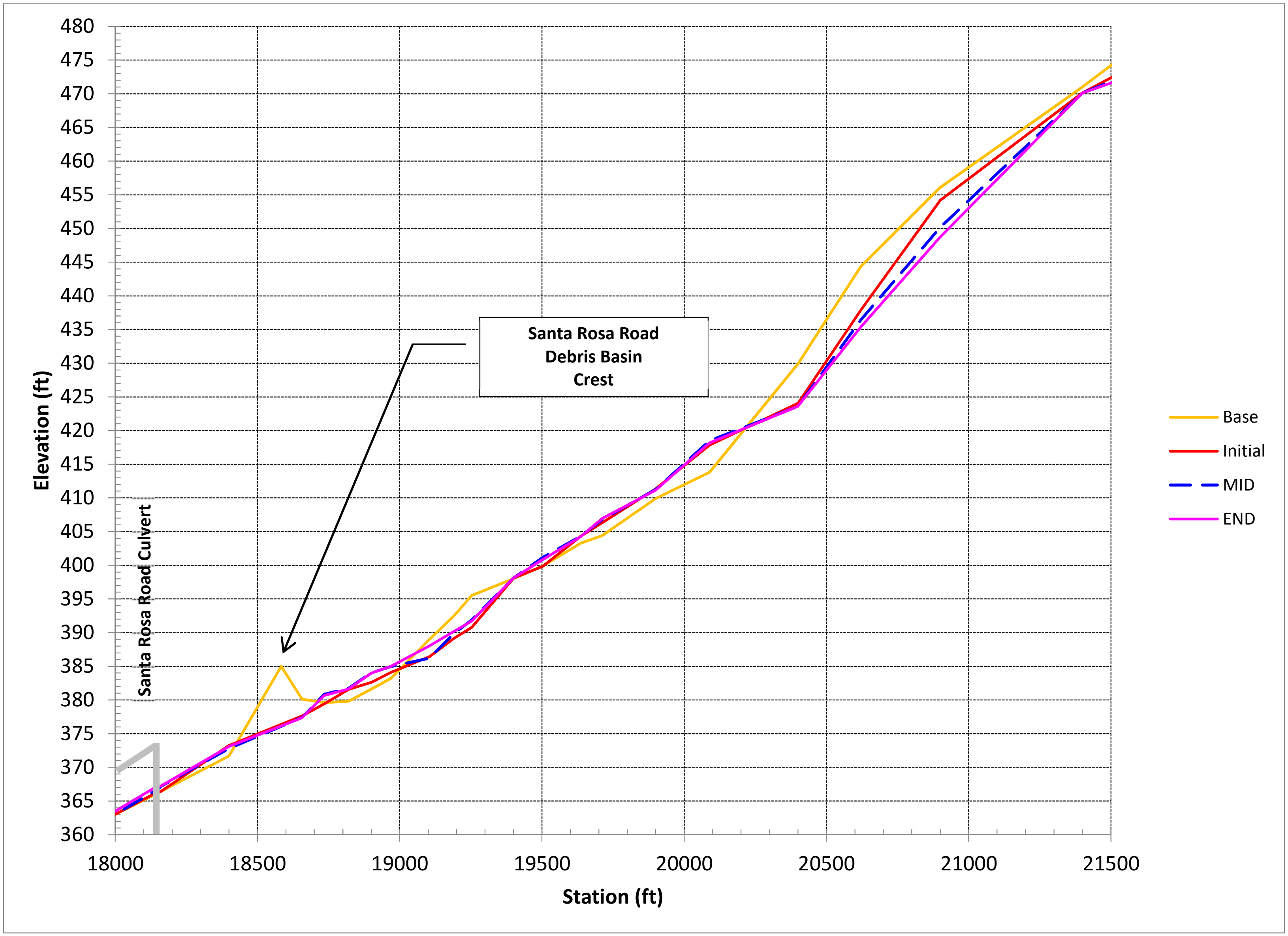
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for "Load B" – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



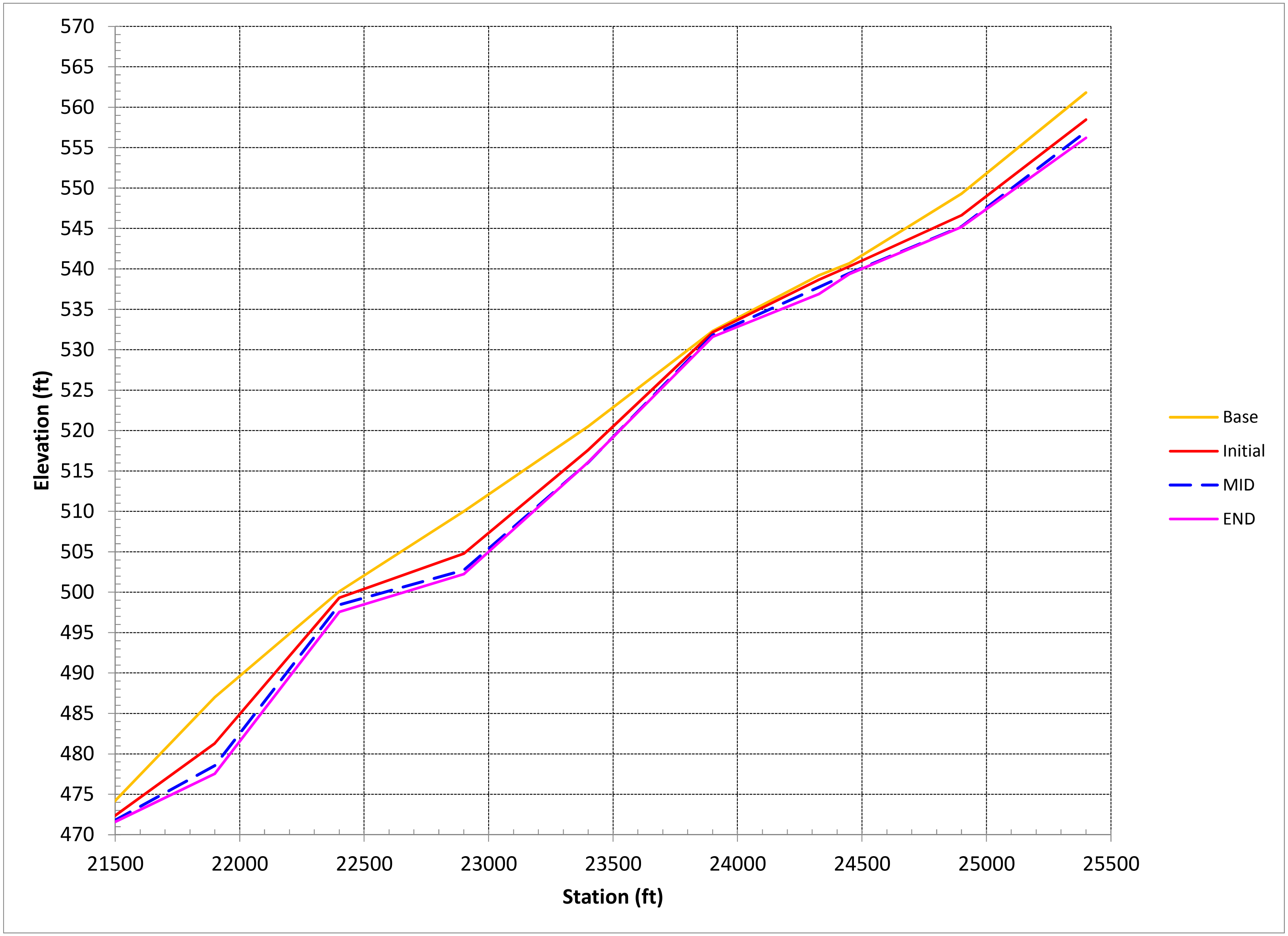
Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for “Load B” – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for “Load B” – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for "Load B" – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.



Santa Rosa Basin Proposed Conditions (Removal) Invert Profile for “Load B” – Base (before long-term simulation), Initial (after long-term simulation), Mid (peak of 100-year event), and Final Conditions.