



US Army Corps
of Engineers ®
Los Angeles District

**SECTION 216
REVIEW OF COMPLETED PROJECTS**

**INITIAL APPRAISAL REPORT
SANTA CLARA RIVER LEVEE (SCR-1)
VENTURA COUNTY, CALIFORNIA**

**LOS ANGELES DISTRICT
U.S. ARMY CORPS OF ENGINEERS**

MAY 2014

**SECTION 216
REVIEW OF COMPLETED PROJECTS**

**Initial Appraisal
Santa Clara River 1 Levee System (SCR-1)
Ventura County, California**

1. PURPOSE

The purpose of this Initial Appraisal Report (IAR) is to determine whether there is potential Federal interest to undertake modifications to the existing U.S. Army Corps of Engineers (Corps) project, the Santa Clara River 1 Levee System (SCR-1). The project includes approximately 4.72 miles of levee extending along the southeast bank of the Santa Clara River from Interstate Highway 101 to the community of Saticoy (Figure 1).

This Initial Appraisal will determine whether it is in the Federal interest for the Corps to participate in the resolution of critical rated items found to be unacceptable for this levee system as documented in a Periodic Inspection performed by the Corps in 2010. These critically rated items require improvements to meet changed hydrologic conditions and are not from lack of operations and maintenance activities. This evaluation is consistent with the general Corps' policy that completed projects be observed and monitored to ascertain whether they continue to function in a satisfactory manner as well as whether improved performance could occur that may better serve the public's best interests.

Due to the time and funding limitations under the Section 216 authority, this Initial Appraisal is limited to reviewing existing information. If there is potential Federal interest in modifying this project to correct the unacceptable items so that the project will function in the manner for which it was originally authorized, the next phases (Reconnaissance and Feasibility) would include additional studies requiring data collection and detailed analyses.

2. STUDY AUTHORITY

This Initial Appraisal is authorized by Section 216 of the Flood Control Act of 1970 (Public Law 91-611) as amended, which states:

"The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

The Section 216 process starts with the preparation of an Initial Appraisal. This Initial Appraisal has been completed by Ventura County Watershed Protection District (VCWPD) and has been provided to the Corps for its consideration.

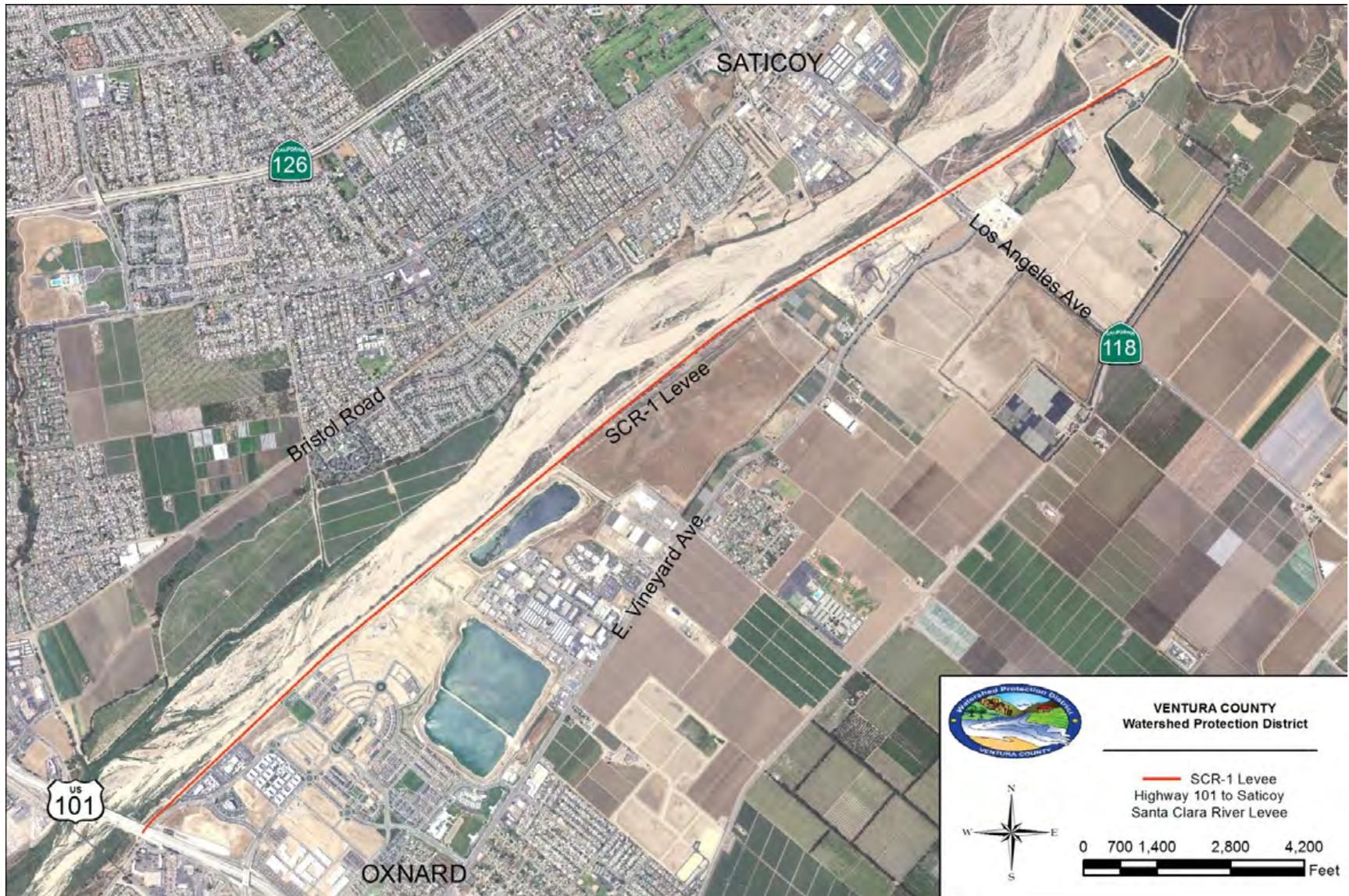


Figure 1: Santa Clara River 1 Levee System (SCR-1) Location Map

3. EXISTING AUTHORIZED PROJECT

- a. Name of Completed Project: Santa Clara River 1 Levee System (SCR-1), Ventura County, California.
- b. Authorized Purpose: Constructed by act of Congress, under Section 203 of the Flood Control Act of 1948 (Public Law 80-858), 88th Congress, 2nd Session, as approved on June 30, 1948. An excerpt of the Act reads as follows:

“Section 203. That the following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and the supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated and subject to the conditions set forth therein:”
- c. Date Constructed: The project was completed in April 1961.
- d. Non-Federal Project Sponsor: Ventura County Watershed Protection District (formerly Ventura County Flood Control District), California.
- e. Project Location and Description: SCR-1 is located in the city of Oxnard and in unincorporated Ventura County, California. The SCR-1 project comprises 4.72 miles of levee extending on the left (southeast) bank of the Santa Clara River. The levee begins upstream at South Mountain and ends at Highway 101. SCR-1 was originally designed in 1958 by the Corps to control the predicted Standard Project Flood peak discharge of 225,000 cubic feet per second (cfs), a peak emanating from a partially regulated 1,600-square-mile Santa Clara River watershed. Typically SPFs developed in the southern California region were between a 200-year and 500-year return period. The height of SCR-1 varies from approximately 4 feet to 13 feet. The compacted fill embankment that forms SCR-1 has a top width of 18 feet, and the levee embankment slopes are 2-horizontal-to-1-vertical (2H:1V) on both the landward and riverward sides. The riverward side of the embankment has a 1.5- to 2-foot-thick layer of rock revetment with concrete grout in the vicinity of highway bridges. The rock revetment extends from the top of the embankment to varying depths above to below the river thalweg. The depth of the rock revetment below the thalweg is defined herein as its toedown.

4. REVIEW OF EXISTING STUDIES

Numerous reports have been prepared for SCR-1 since it was authorized. The following is only a partial list of these reports that provided reference information used in the completion of this Initial Appraisal.

Santa Clara River Levee Design Memorandum No. 2 (General Design Memorandum), U.S. Army Corps of Engineers, Los Angeles District, California. 1958. Original design document for SCR-1. Based on a 50-year economic period, this levee would be six years beyond its original design life.

Santa Clara River 1 Levee System, Highway 101 to Saticoy, Ventura County, California, Periodic Inspection Report No. 1, Submitted: August 2011. Under the Corps' Levee Safety Program, periodic inspections of levee systems are conducted to verify proper operation and maintenance; evaluate operational adequacy and structural ability; identify features to monitor over time; and improve the ability to communicate the overall condition and safety of the levee system. In 2010, the Corps performed a periodic inspection on SCR-1. This report presents the findings of the inspection and the final Corps rating for SCR-1 as "unacceptable."

FEMA PAL Response Report, Ventura County, California, Santa Clara River Levee (SCR-1) Highway 101 to Saticoy, FEMA ID No. 18, November 2009. As part of the nationwide effort to certify all existing flood control levees, the Federal Emergency Management Agency (FEMA) has identified existing levee facilities in Ventura County. FEMA has requested that the VCWPD evaluate SCR-1 and prepare a document for the certification process based on FEMA's regulatory requirements as identified in Title 44 of the Code of Federal Regulations, Section 65.10 (44 CFR 65.10). The current 100-year flood event peak discharge is 226,000 cfs. Based on the review of existing data, field inspections conducted in 2008, and additional engineering analyses, it was determined that SCR-1 does not meet the requirements of 44 CFR 65.10 for freeboard and erosion protection.

5. PROBLEMS AND OPPORTUNITIES

Problems

According to the National Levee Database (NLD) the leveed area is approximately 2.2 square miles (Figure 2). The levee failed in the 1969 floods with a peak discharge of 147,000 cfs, which is approximately a current 40-50 year return event. Exhibit 1 includes the potential failures associated with a critical breach. A breach prior to overtopping would inundate the landside improvements from the downstream end (101 Freeway) to Station 360+00 for a 25-year return event, and up to Station 400+00 for 50-year and 100-year return events. Overtopping of the levee would occur from the downstream end of the levee up to Station 304+00 for a 200-year return event, and up to Station 354+00 for a 500-year return event.

Failure of the levee would result in countless millions of dollars of urban infrastructure and commercial/residential property losses, not to mention the potential for significant loss of life—particularly if a portion of the levee were to collapse suddenly during the night. Based on the information presented on Exhibit 1 the following economic information was generated and is listed in the NLD:

- a) Daytime population at risk is 7,025 and nighttime is 7,364,
- b) It is estimated that as many as 1,410 structures would be inundated by levee failure with property damages of nearly \$291,000,000,
- c) Critical infrastructure in the area includes 2 chemical industries, 2 correctional facilities, 1 fire station, 4 oil/gas pipelines, 1 school and 13 oil wells.

The most recent periodic inspection conducted by the Corps in 2010 rated SCR-1 as “unacceptable.” In the report (2011), the primary factors driving the unacceptable rating were broken down into critical and non-critical items. The critical items affect the entire 4.72-mile length of the levee system, whereas the non-critical items occur at intermittent locations along the levee. The critical items seriously impair the functioning of the levee system, whereas the non-critical items are serious, but they should not prevent the levee system from performing as intended during the next significant runoff event.

Since the 2010 inspection, VCWPD has made progress toward correcting identified non-critical items. Corrective actions included removal of unwanted vegetation; repair of access ramps and embankment erosions; removal of miscellaneous unauthorized/unpermitted encroachments; removal of sediment or obstructions to interior drainage facilities; repair of grate inlets; and evaluation of the need for flap gates on two side drains.



Figure 2: SCR-1 Leveed Area

However, correction of other critical items would be more complex and will involve interagency collaboration as well as environmental studies and approvals prior to their implementation. As identified in the Corps’ periodic inspection report identified in Section 4, the most significant issues that must be addressed for SCR-1 to be eligible for rehabilitation assistance from the Federal government (PL84-99) are related to inadequate scour and erosion protection along the entire length of the levee system as follows.

Inadequate Toedown. The revetment toedown along SCR-1 varies from 5 to 10 feet below the river thalweg between Highway 101 and a distance approximately 8,500 linear feet upstream, beyond which the depth of toedown changes significantly, from approximately 5 feet below the streambed to approximately 10 feet above the thalweg. Further upstream, at Highway 118, the toedown depth changes to approximately 5 feet above the thalweg. Beyond Highway 118, the toedown depth changes from approximately 5 feet above the thalweg to approximately 18 feet above the thalweg at the upstream end of the levee (Figures 3A thru 3D).

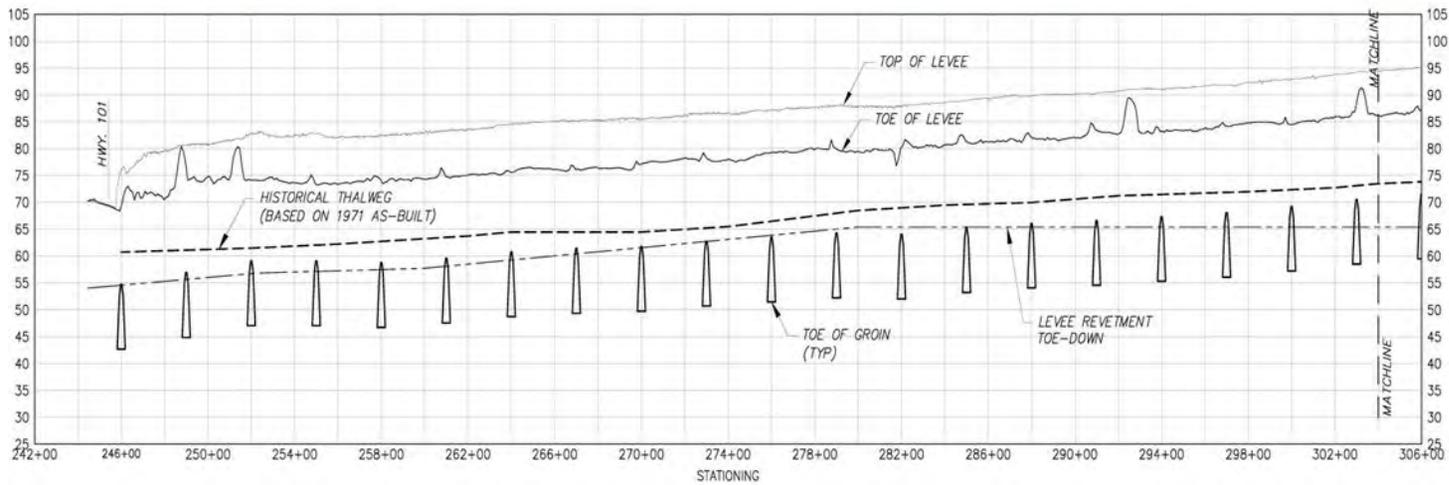
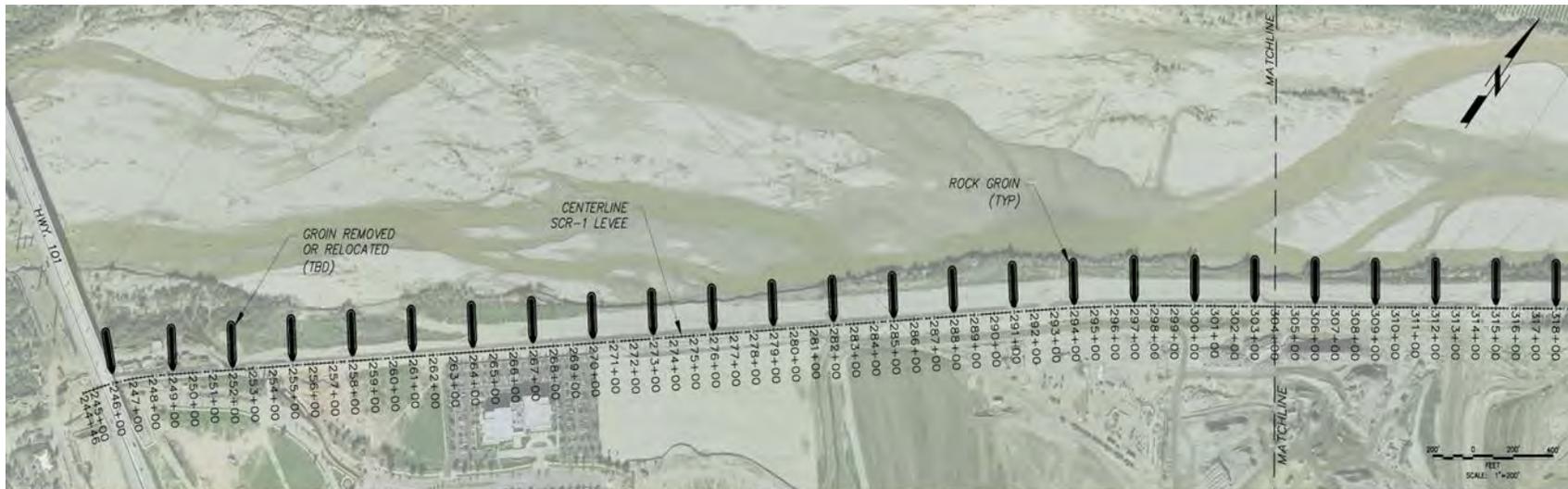


Figure 3A: Plan and Profile along the Santa Clara River Levee 1 System

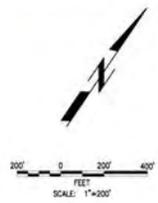
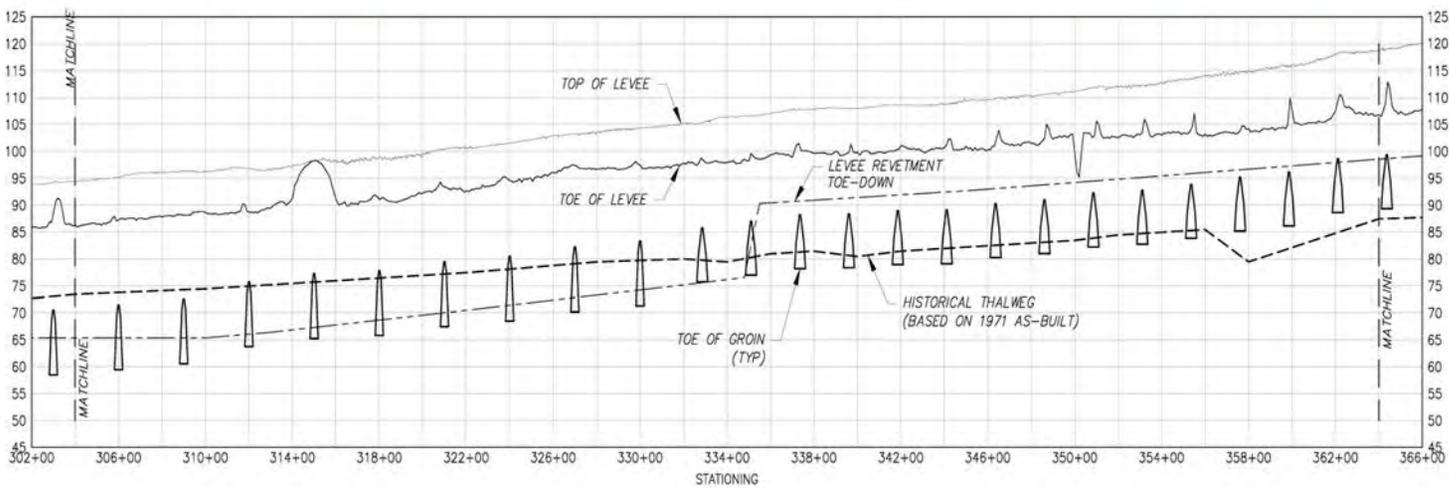


Figure 3B: Plan and Profile along the Santa Clara River Levee 1 System

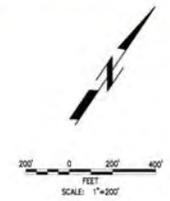
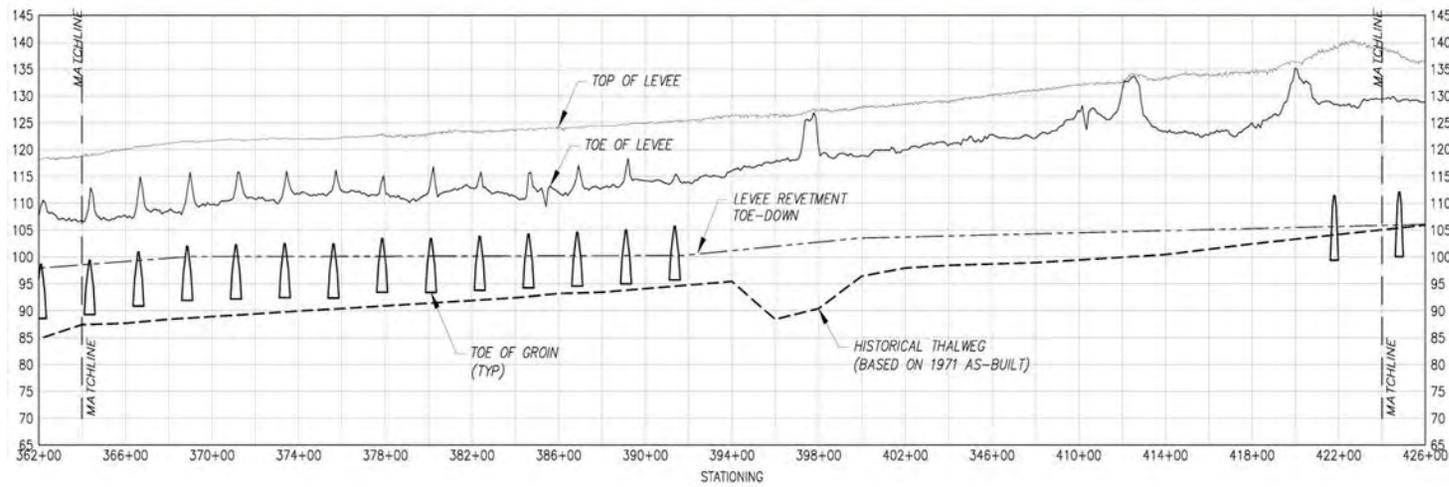


Figure 3C: Plan and Profile along the Santa Clara River 1 Levee System

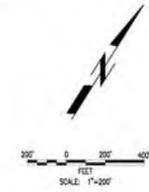
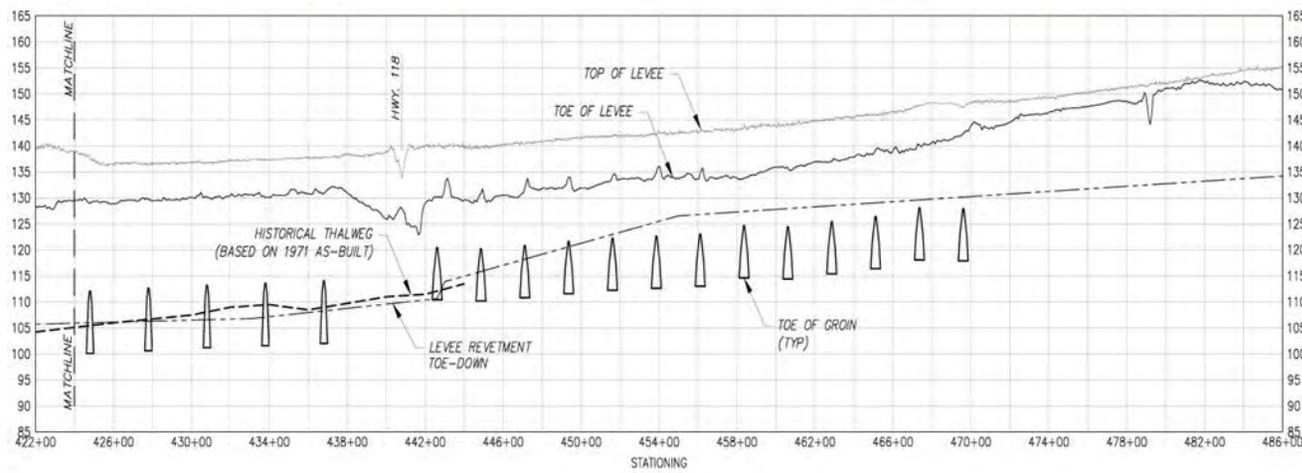


Figure 3D: Plan and Profile along the Santa Clara River Levee System

The reason for the varying depths of rock revetment along SCR-1 is documented in a 1958 Corps General Design Memorandum (GDM) that describes the differences between the project document plan and the recommended plan. The GDM indicates that, at the time of design, a board of consultants was convened to provide project design recommendations for the configuration of the rock revetment. According to the GDM, the board of consultants recommended, *“that (a) instead of a levee with a deep toe-down (the toe-down would extend 12 feet below the streambed), where a 200-foot berm of undisturbed granular streambed material exists between the levee and the main-stream channel, the depth of the toe-down be extended only 5 feet below the top elevation of this undisturbed material or (b) in the absence of this undisturbed material and at locations subject to direct attack by streamflow, groins extending 150 feet into the stream and spaced 225 feet – with slight deflection in the downstream direction – be built.”*

Based on current hydrological data, the *PAL Response Report* concludes that the levee is inadequate from Station 360+00 to Station 421+00 because the depth of the levee revetment toedown and the volume of the stone toe, along with shallow burial depth of the groins, is insufficient to prevent the erosion of the levee in the event that the current channel thalweg migrates toward the levee.

Inadequate Rock Size and Quality. The rock originally used as erosion protection of the levee slopes has weathered and degraded. The effects of weathering have broken the rock into smaller fragments. Due to the degradation of the original rock, it is no longer suitable for its design purpose.

Inadequate Rock Groins. The project as completed in 1961 included 40 rock groins. After extensive damage occurred along SCR-1 during floods in January and February 1969, the Corps repaired seven of the original 40 rock groins located between Station 330+00 and Station 344+50, as shown in Figure 4; restored 2,100 linear feet of levee embankment and provided deeper rock revetment between Station 311+00 and Station 332+00; and added 35 new rock groins between Station 246+00 and Station 330+00 and between Station 421+80 and Station 436+80. These repairs and enhancements were completed in 1971. There are currently 75 rock groins in place along the SCR-1 project reach, extending from Station 246+00 to Station 470+00.

After the 1983 floods, with a peak discharge of 100,000 cfs, which is approximately a current 10-20 year return event, five groins (which included one of the original 1961 rock groins and four 1971 groins) sustained damage to the ends, ranging from 40 to 100 feet from the groin tips. The damage was likely due to the low-flow channel encroaching and washing out the top portion of the groin tips. The repairs included removal of approximately 2 feet of existing rock and placement of 2-ton stone riprap back to the original design dimensions, followed by backfilling with uncompacted fill by VCWPD.

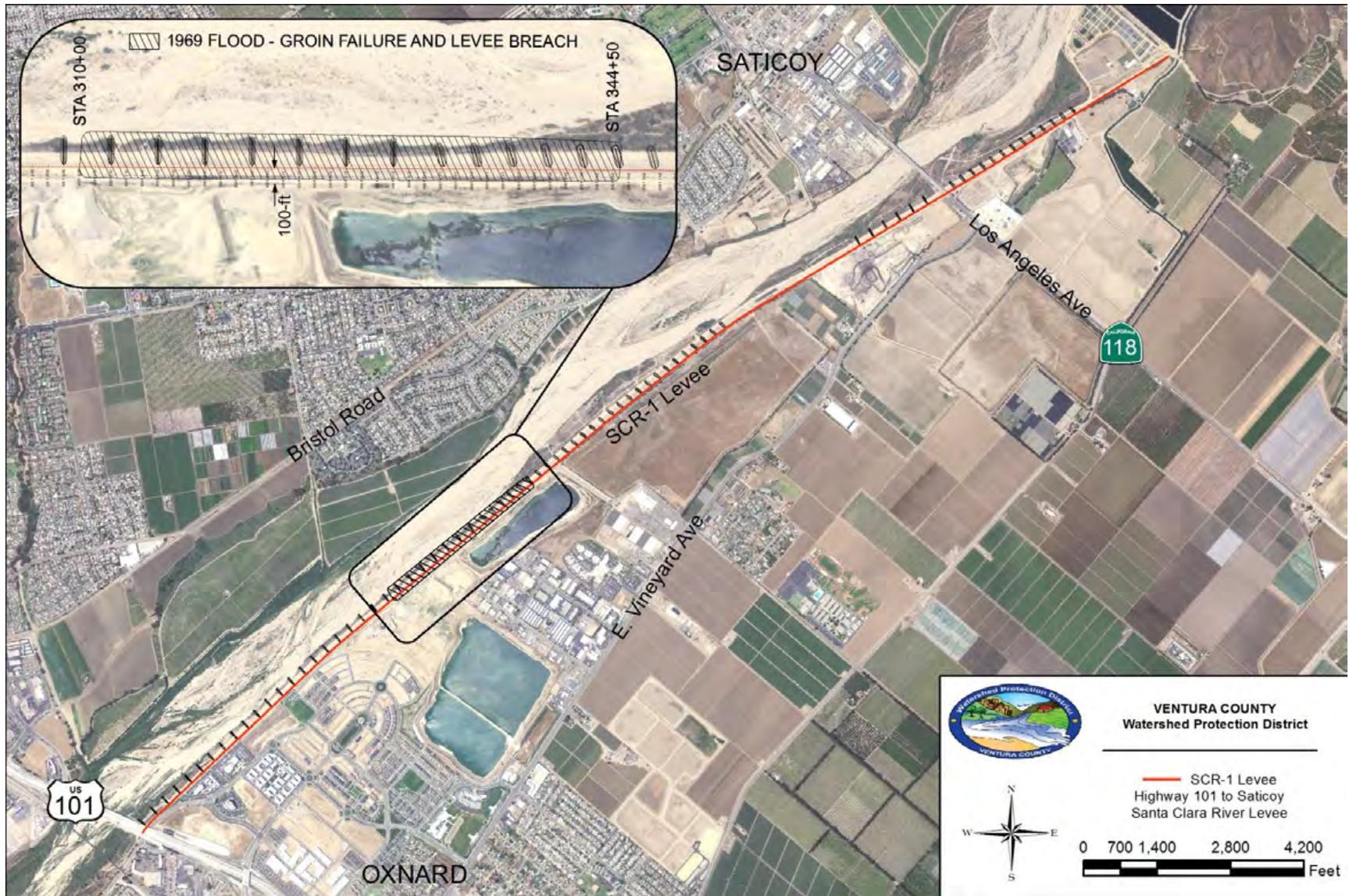


Figure 4: 1969 Flood Damage along SCR-1

The rock groins were placed along SCR-1 to prevent the river from migrating against the levee side slopes. Because of the rock groin placement, it was considered unnecessary to design the levee toedown to protect against impingement of the river thalweg on the levee toe. However, per the *PAL Response Report* the rock groins themselves are inadequate to prevent the migration of the channel for the following reasons:

- The rock groins are undersized and cannot withstand the hydraulic forces of the design flood event. A comparison of the current design criteria computed groin rock size and the as-built groin rock size indicates that the as-built groin rock does not meet the current design criteria to withstand the predicted hydraulic forces during the design flood event.

The average channel hydraulic parameters (flow velocity of 12.88 fps and depth of 11.33 ft) of the design flood event require a D_{50} in the range of 270 to 400 lbs for the current design criteria. The as-built rock size of the groins was calculated to have a D_{50} of 30 to 200 lbs.

- The rock groins, for much of their length, are not buried deep enough to prevent their failure from undermining if lateral migration and scour occur.

Since the rock groins are insufficient to prevent lateral migration of the river thalweg against the levee side slope, in order for the levee to remain stable, it must resist the hydraulic forces and the attendant scour that would occur with the thalweg located against the toe of the levee. However, per the *PAL Response Report* the current levee protection is inadequate to resist the resulting forces and scour for several reasons as stated below:

- During the design flood, the estimated potential total scour depth of 15 feet below the existing river thalweg would undercut the entire rock-revetment toedown along the levee.
- The additional volume of material that was placed as the weighted stone toe is insufficient to launch and protect the levee toedown against the currently calculated scour depth.
- Based on data from test pits, the rock revetment on the levee side slope is inadequate, particularly in terms of its size at some locations and the quality of its gradation at others.

Opportunities

Based on the problems discussed above the following opportunities have been identified:

- Reduce the risks of property damages or loss of life for more than 7,000 residents in the leveed area.
- Reduce the risk of flood inundation damages to properties within the leveed area.
- Protect critical infrastructure within the leveed area including chemical industries, correctional facilities, fire station, oil/gas pipelines, school, and oil wells.
- Improve the current levee system to protect from channel migration.

6. ELIGIBILITY FOR MODIFICATIONS TO COMPLETED PROJECTS

Engineering Regulation 1165-2-119, Section 7.a lists five questions to determine eligibility for modifications to completed projects. The answers to those questions as they pertain to this project are discussed below.

1. The work to correct the critical items is required to make this project function as initially intended by the designer, which is to say that it needs to be able to pass the design flow without failure.
2. The work to correct the critical items is not required because of changed physical conditions, but rather the hydrologic conditions have changed.
3. The work to correct the critical items is generally limited to the existing project features and would be consistent with the scope and function of the authorized project.
4. The work to correct the critical items is justified by safety and economic considerations as the NLD lists computed consequences due to levee failure; a) loss of life at 5 persons, b) property damages of \$291 million.
5. The work to correct the critical items is not required because of inadequate operations and maintenance activities.

7. PRELIMINARY ALTERNATIVES

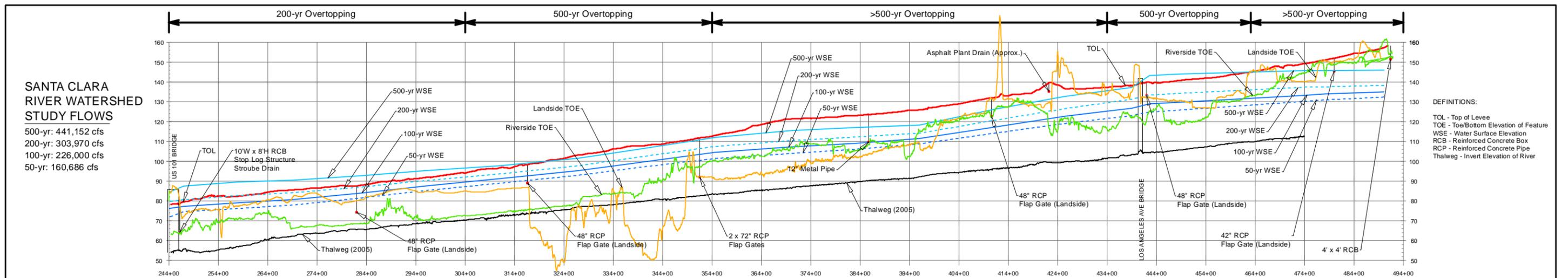
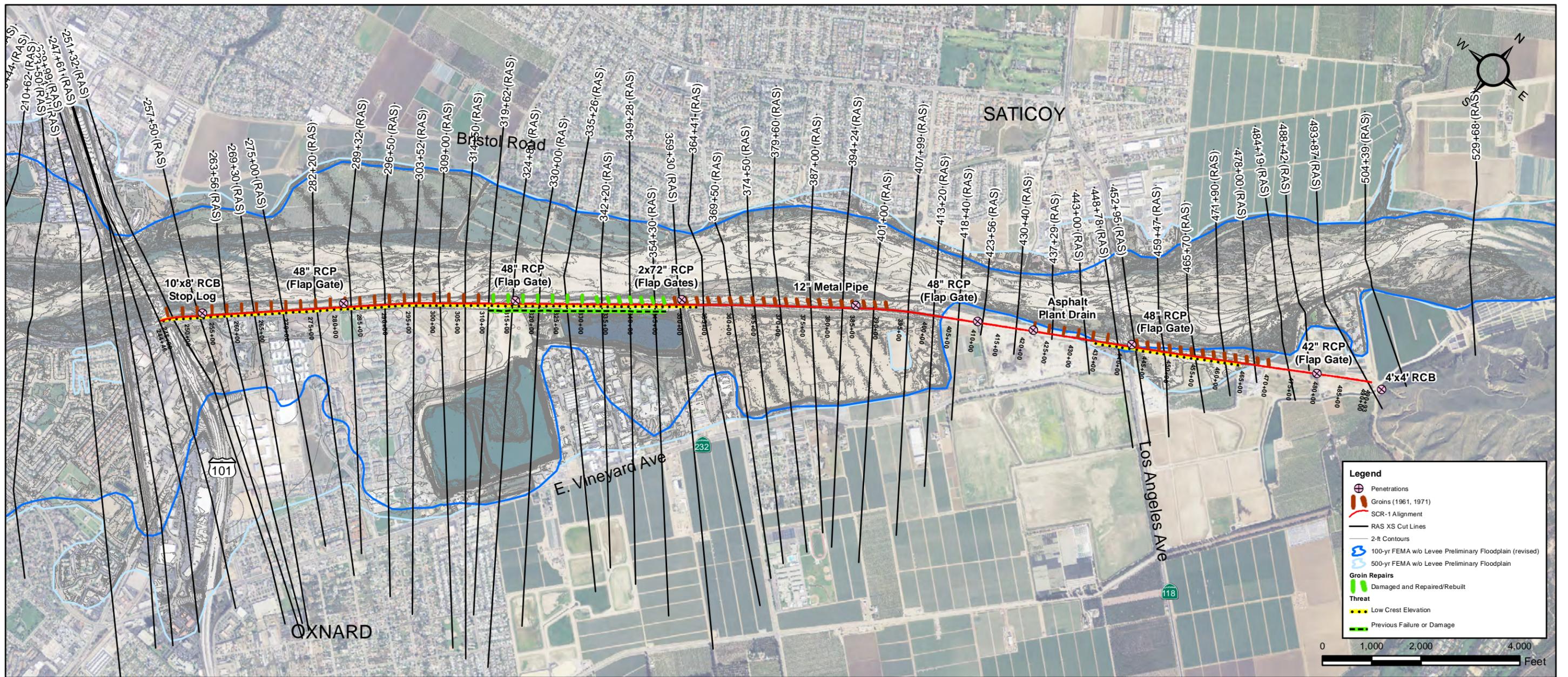
The following preliminary alternatives are initially recommended for subsequent development. Due to the limited nature of this Initial Appraisal and the use of only existing information, these alternatives have not been developed in detail but are presented for consideration in further establishing the Federal interest.

- Deeper, more robust and durable rock revetment (remove/replace or overlay),
- Deeper more robust rock groins,
- Steel sheet piling,
- Soil cement,
- Combination of these measures,

In conjunction with any of the above improvement alternatives; segment the lower reach, which is still a levee condition, from the upper reach, which is incised.

8. RECOMMENDATION

On the basis of changed hydrological conditions, the potential for increasing public safety and the continued provision of flood risk management benefits, there is sufficient Federal interest in investigating the feasibility of modifying the SCR-1 system by preparing a Reconnaissance Phase report. If a more detailed determination is made that there is continued Federal interest, a cost-shared Feasibility Phase report should be initiated to analyze alternatives for addressing the identified problems by means of modifications to the project.



SYMBOL	REVISION DESCRIPTION	DATE	APPROVAL

SANTA CLARA RIVER WATERSHED STUDY FLOWS
 500-yr: 441,152 cfs
 200-yr: 303,970 cfs
 100-yr: 226,000 cfs
 50-yr: 160,686 cfs

CHECKED BY:
 FILE NAME:
 FILE NO:

Tetra Tech
 17885 Von Karman Avenue, Suite 500
 Irvine, CA 92614
 Tel. (949) 809-5000 Fax. (949) 809-5003

VENTURA COUNTY WATERSHED PROTECTION DISTRICT
 VENTURA COUNTY, CALIFORNIA

SUBMITTED BY:

INTERIM RISK REDUCTION MEASURES PLAN MAPPING FOR SANTA CLARA RIVER LEVEE (SCR-1)
Exhibit 1 - HEC-RAS Model, Floodplain Boundary, and Potential Failure Features

1 of 1