# Flow Enhancement Studies for San Francisquito Creek between Bayshore/101 and Middlefield Bridges

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## *Overview*

On November 20, 2009 I sent an email describing a number of steps that may increase the capacity of San Francisquito Creek (SFC) in the reach between Bayshore (Hwy 101) and Middlefield bridge to convey approximately the 100-year flood level (~9,400 cfs). This study was NOT a design study – rather it was a conceptual study to see how the creek capacity could be increased by relatively simple interventions. As part of that analysis, I widened six areas of the channel to be more consistent in size with the surrounding natural creek channel. I also did some runs with lower channel Manning n-values between Bayshore and just above where the University Avenue bridge is located (RS ~134+00). This document provides more details about that work.

The effects of these interventions (selective widening and channel smoothing) on water surface elevations along this reach are shown in Figures 1 (9400 cfs flow) and 2 (8000 cfs flow). These profiles are based on the calibrated Noble Consultants model of existing SFC conditions, developed under the Army Corps of Engineers.

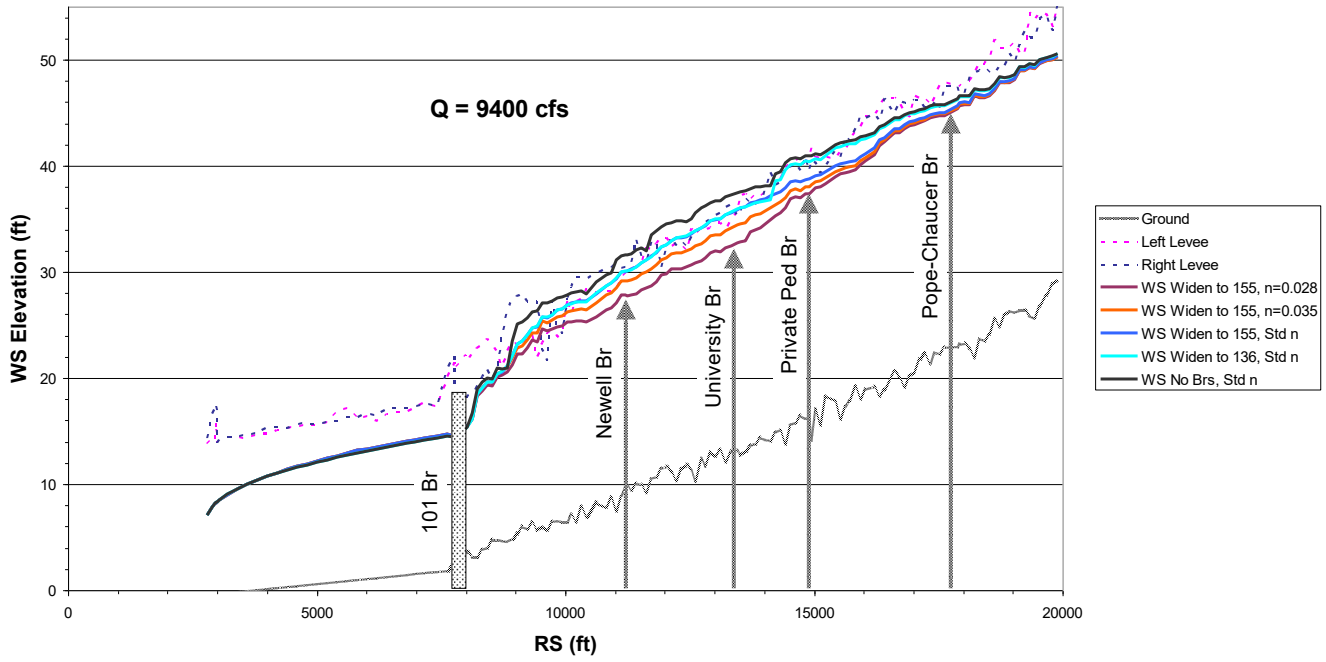



**Figure 1: Effects on WS elevation of selective channel widening and smoothing for a 9400 cfs flow**

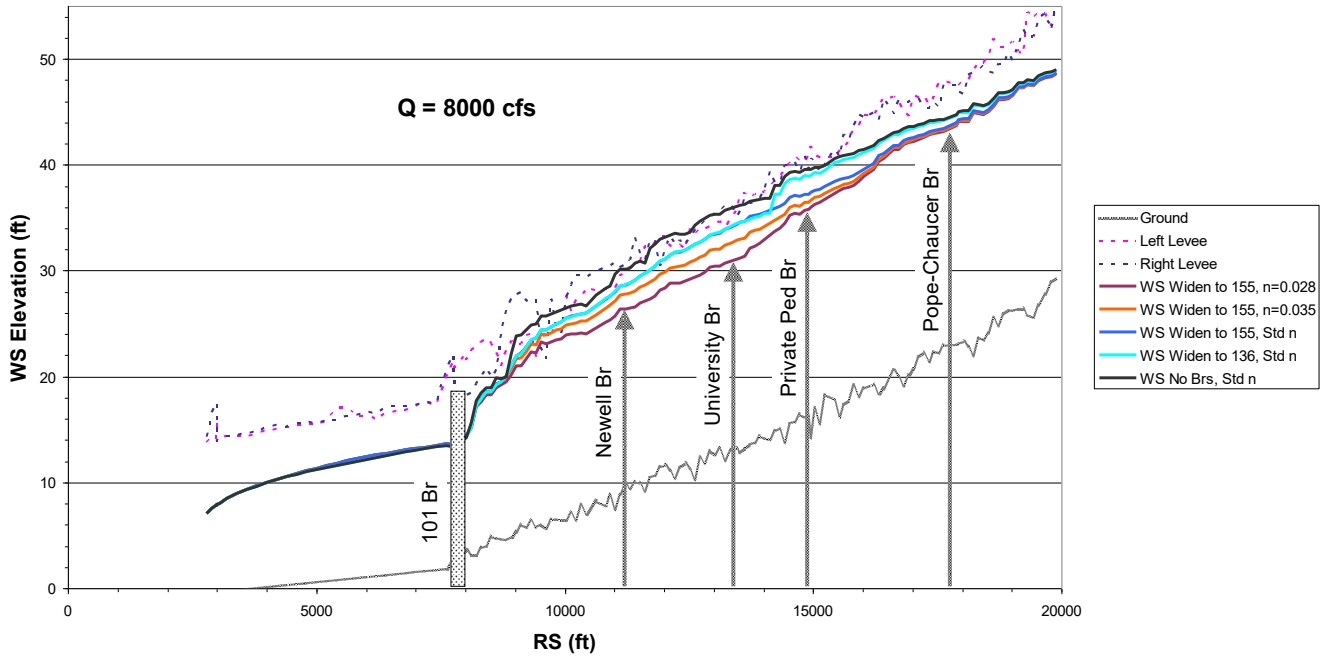



**Figure 2: Effects on WS elevation of selective channel widening and smoothing for a 8000 cfs flow**

Figure 1 shows the HEC-RAS results for a 9400 cfs flow (100-year flow) and Figure 2 shows the corresponding results for an 8000 cfs flow (50-year flow). In addition to the creek bottom, left (Menlo Park) and right (Palo Alto) levee heights, and bridge locations are shown. The profile plots show water surface elevations resulting from five channel configurations as summarized below.

1. **WS No Brs, Std n** – this run uses the calibrated Noble HEC-RAS model, but with the Middlefield, Pope-Chaucer, Private Pedestrian, University, and Newell bridges removed. We know these bridges need to be replaced to provide greater conveyance. They are removed entirely for these analyses in order to study the native channel characteristics of the creek. The Bayshore/101 bridge is widened to simulate adding a fourth barrel. The reach from Bayshore to the bay is widened to match the wider 101 bridge and assumes a new (tidal level) termination at the Faber Tract. Manning n values are as supplied by Noble.
2. **WS Widen to 136, Std n** – this run is similar to 1) above, but with four areas of the channel widened between 101 and University Avenue. The widening is discussed in greater detail below.
3. **WS Widen to 155, Std n** – this run is similar to 2) above, but with two additional areas of the channel widened around the Euclid/Manhattan Street (East Palo Alto) intersections with the creek and upstream between the W. Crescent Drive and Palm Street (Palo Alto) intersections with the creek.
4. **WS Widen to 155, n=0.035** – this run is similar to 3) above, but with the Manning n values in the creek channel reduced from 0.043 (Noble model) to 0.035 between Bayshore and where University Avenue crosses the creek. This corresponds to a treatment (to be determined) that smoothes the channel to facilitate water flow.
5. **WS Widen to 155, n=0.028** – this run is similar to 4) above, but with the Manning n values in the creek channel reduced to 0.028 between Bayshore and where University Avenue crosses the creek. This corresponds to a more severe treatment (to be determined) to smooth the channel to facilitate water flow.

As can be seen in Figures 1 and 2, the profiles showing the effects of these interventions are qualitatively similar for 8000 and 9400 cfs, the main difference being that the water surface elevations are about ~1.5 feet lower for the 8000 cfs flow. Water level reductions of ~2 feet can be achieved by modest channel widening alone and reductions of 3-5 feet by widening and additional channel smoothing. These would translate directly into reduced requirements for levee heights to contain high-volume flows.

It should also be noted that levee heights in the Noble HEC-RAS model at least between Bayshore and the University bridge are not accurate. Sometimes existing flood walls (left and/or right) are included in channel cross-sections, but often they are not. In general, flood wall heights are uniform in this reach relative to the creek bottom and, when interpreting Figures 1 and 2, the higher levee heights shown should be assumed to apply throughout. This means that for most of the reach shown in the figures, the creek could be contained with the suggested modifications (selective widening and channel smoothing). It is hoped that Noble will update their HEC-RAS model to more consistently include existing levees in the model cross-sections.

In addition to the static plots above, I previously made a number of movies from HEC-RAS runs showing the dynamics of filling the creek with flows from 3500 cfs to 9400 cfs in 100 cfs increments in various configurations:

1. The movie at http://tcracs.org/tcr/sfc/RAS_Existing-Geometry.091119.wmv shows the creek filling with the calibrated Noble model for existing conditions.
2. The movie at http://tcracs.org/tcr/sfc/RAS_Existing-wo-Mfld+PC-Br.091119.wmv shows the creek filling with the Middlefield and Pope-Chaucer bridges removed to eliminate the effects of ponding upstream of the bridges.
3. The movie at http://tcracs.org/tcr/sfc/RAS_No-Br+Widen-Faber-130.091119.wmv shows the creek filling with the remaining bridges removed down to 101 (private pedestrian bridge, University Ave Br, and Newell Rd Br), with the 101 bridge widened to have 4 barrels, with the channel between 101 and the Faber Tract widened and shortened, and with four areas of the channel widened between 101 and University Avenue (~RS 136+00).
4. The movie at http://tcracs.org/tcr/sfc/RAS_No-Br+Widen-Faber-150.091119.wmv shows the creek filling with two additional areas of the channel widened around Euclid/Manhattan Streets (East Palo Alto) and upstream between the W. Crescent Drive and Palm Street (Palo Alto).
5. The movie at http://tcracs.org/tcr/sfc/RAS_No-Br+Widen-Faber-150+Gabion-101-Univ.091119.wmv shows the creek filling with reduced Manning n values in the channel between Bayshore and University Avenue. The n values were lowered from 0.043, as estimated by Noble in their calibration, to 0.028.

## *Selective Channel Widening Studies*

In the remaining sections of this note, we describe the channel areas which were widened in the course of these experiments. There are six areas of widening located as shown in Table 1 and Figure 3 below.

| # | Location | Description |
|---|---|---|
| 1 | ~RS 87+00 – 89+00 | Just US of the Bayshore Apartments |
| 2 | ~RS 104+00 – 109+00 | DS of Newell Br between Philips Rd and Jefferson Dr |
| 3 | ~RS 113+00 – 118+00 | US of Newell Br and DS of Cooley Ave |
| 4 | ~RS 122+00 – 126+00 | US of Cooley Ave and DS of Southwood Ave |
| 5 | ~RS 140+00 – 143+00 | US of University Br between Manhattan St & Euclid St |
| 6 | ~RS 151+00 – 155+00 | US of W Crescent Dr to just below Palm St |

**Table 1: Locations of SFC channel areas widened between Hwy 101 and Pope-Chaucer bridge DS = Downstream, US = Upstream**

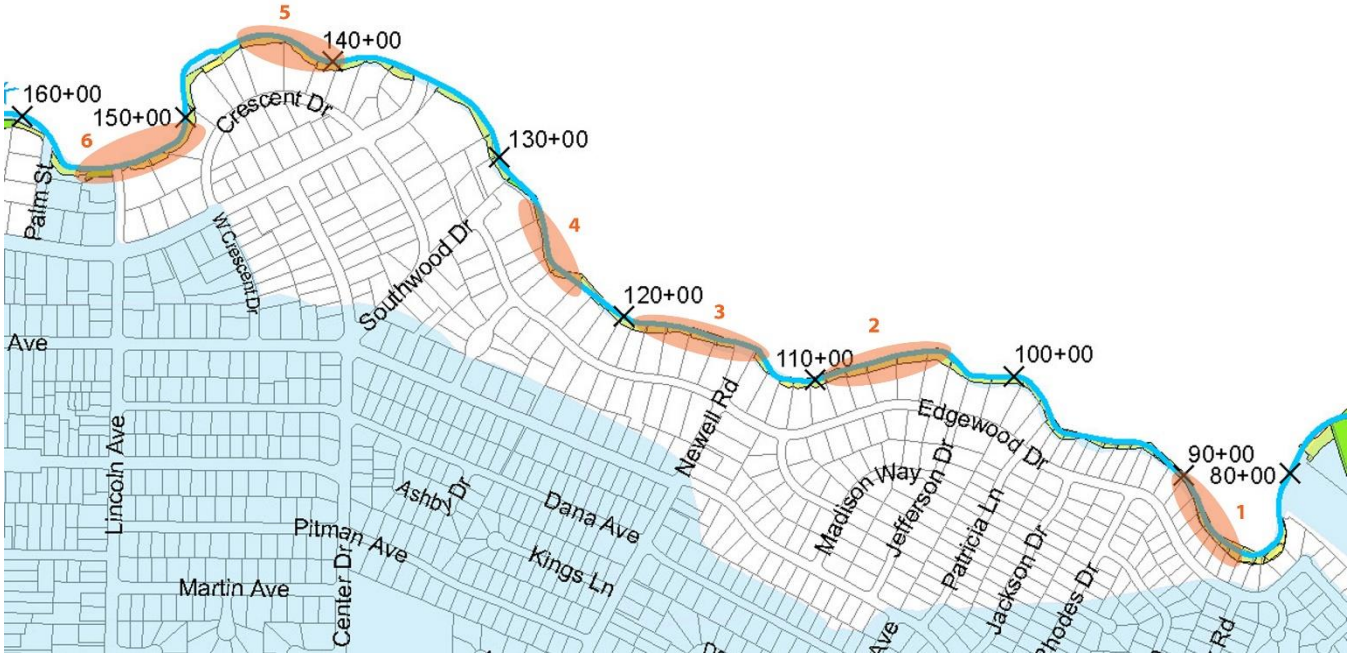
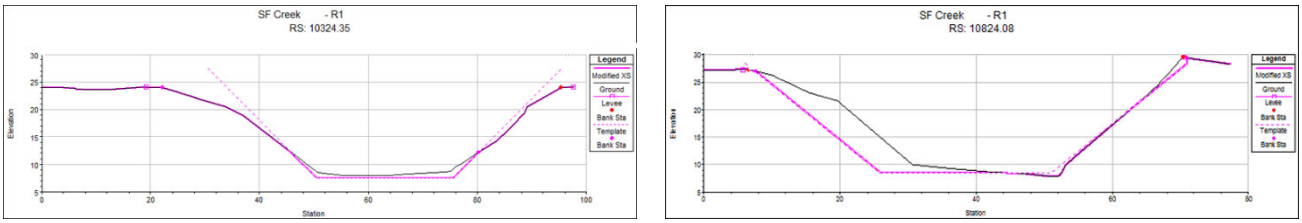



**Figure 3: Santa Clara Valley Water District map of the Palo Alto side of SFC with the six areas of channel widening noted with orange ovals**

Each of these areas (noted with the numeric label 1-6 shown in Figure 3) is discussed below. The descriptions are based on data from the San Francisquito Creek Bank Stabilization and Revegetation (SFCBS&R) study done in 1999, including systematic photographs of the creek channel taken every 200 feet in upstream and downstream directions, and bank topography maps. It should be noted that these data are ten years old by now, but they are likely representative of current creek conditions and at least indicate which areas represent natural creek environments and which man-made structures. We also include examples of HEC-RAS channel cross-sections from the recent Noble Consultants model which indicate the degree of widening involved.

In general terms, the channel widening sought only to remove natural and man-made constrictions in localized parts of the channel so that the channel cross-section would be more uniform and consistent with the “natural” or prevailing channel cross-section. The channel-widening template used was a trapezoid with a 25 ft bottom, a 20 ft depth, and side slope of 45 deg. Examples are shown in Figure 4 where the existing channel cross-section is in black the template modifications are in pink. Figure 4a shows a prevailing channel cross-section requiring no widening (at RS 103+24) and Figure 4b shows a channel cross-section (at RS 108+24) that was widened about 25%.




(a) RS 103+24 – natural channel (b) RS 108+24 – widened channel

**Figure 4: Examples of channel shape in (a) a naturally open area and (b) in a close-by area that was widened to match the template**

## Area 1) ~RS 87+00 to 89+00– Just upstream of the Bayshore Apartments

Area 1, as situated in Figure 3, is detailed in the oval outline in the segment of SFCBS&R Map 01 shown in Figure 5.

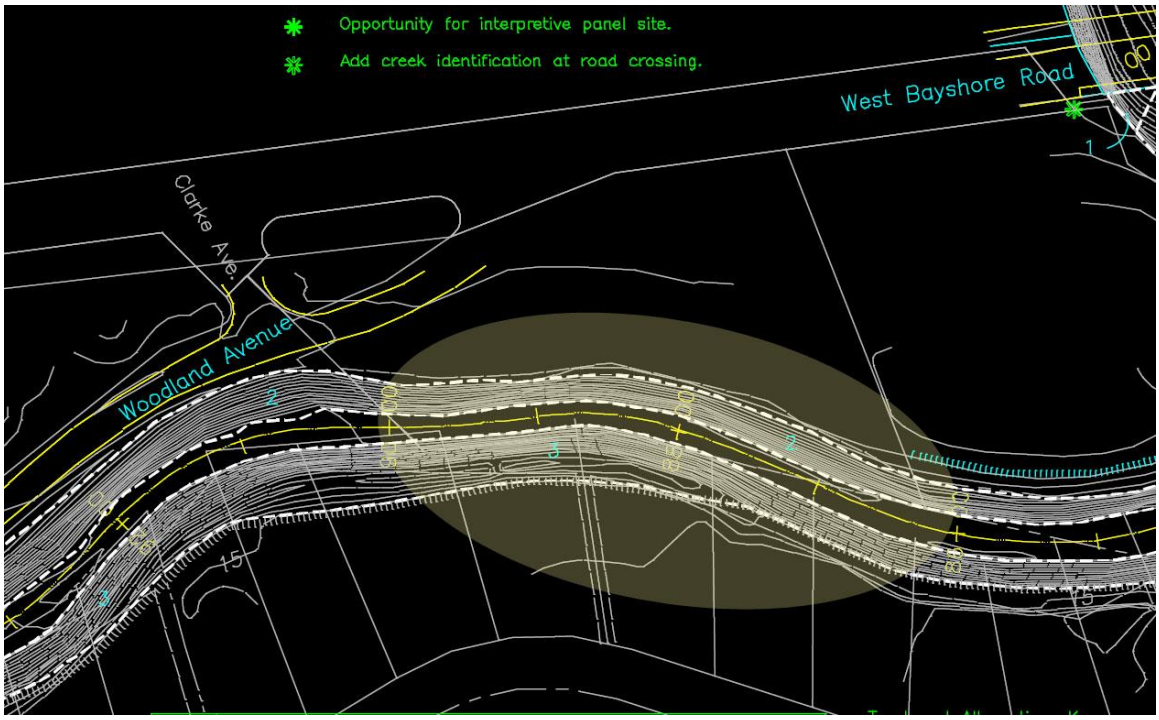



**Figure 5: Excerpt from SFCBS&R Map 01 for ~RS 87+00 to 89+00**

Photographs of this creek section are shown in Figure 6.

| Looking Upstream | Looking Downstream |
|---|---|
|   |   |
|   |   |

**Figure 6: Upstream and Downstream SFCBS&R photographs of ~RS 87+00 to 89+00**

An example of the widening done in this reach is shown in Figure 7.

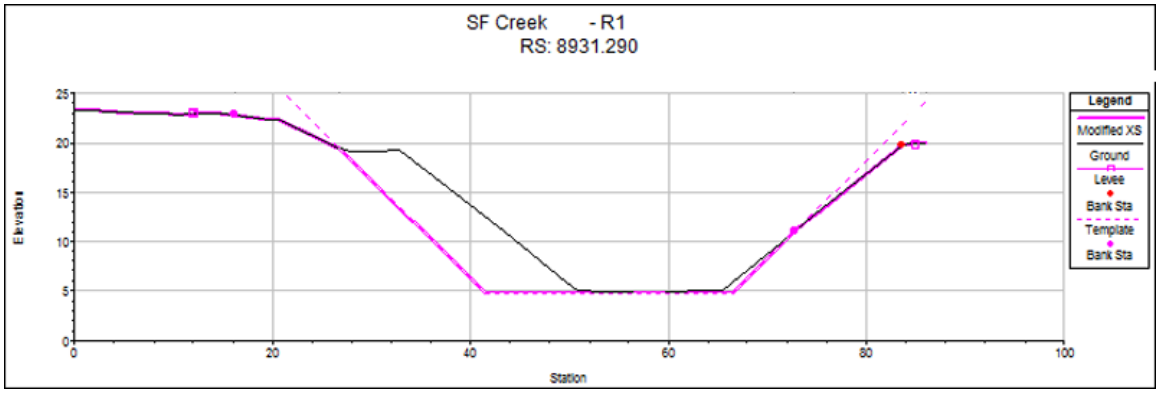



**Figure 7: Channel cross-section with widening at RS 89+31**

## Area 2) ~RS 104+00 to 109+00 – Downstream of Newell bridge between Philips Rd and Jefferson Dr

Area 2, as situated in Figure 3, is detailed in the oval outline in the segment of SFCBS&R Map 02 shown in Figure 8.

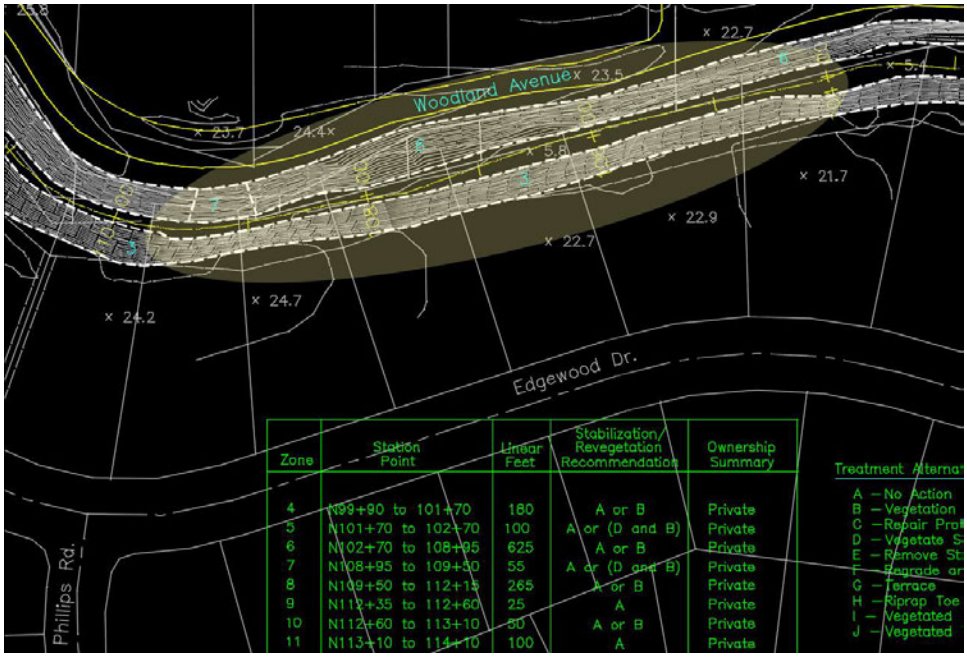



**Figure 8: Excerpt from SFCBS&R Map 02 for ~RS 104+00 to 109+00**

Photographs of this creek section are shown in Figure 9.

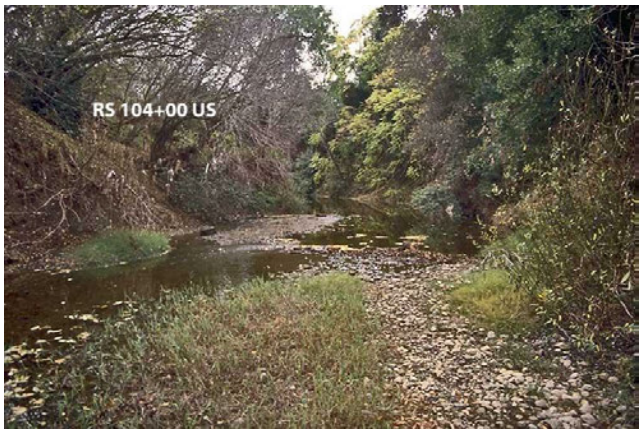
| Looking Upstream | Looking Downstream |
|---|---|
|  |  |


**Figure 9: US and DS SFCBS&R photographs of ~RS 104+00 to 109+00**

An example of the widening done in this reach is shown in Figure 10.

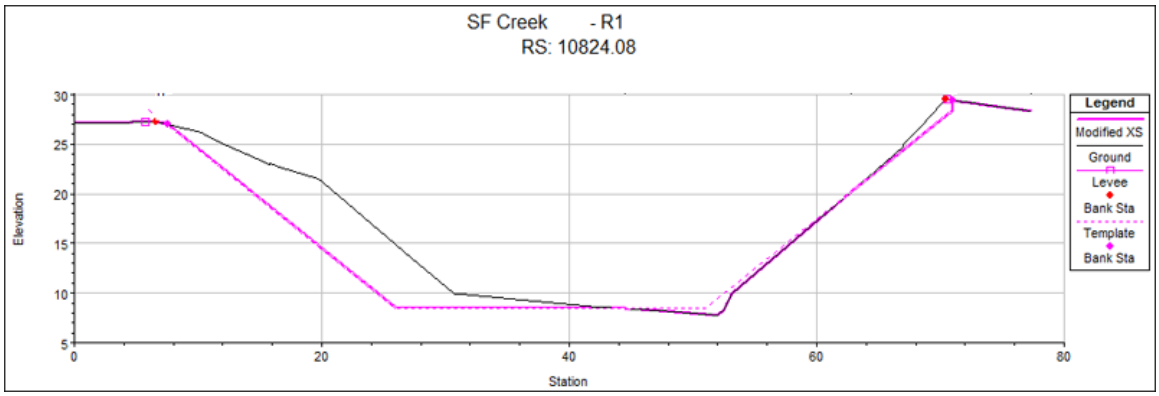



**Figure 10: Channel cross-section with widening at RS 108+24**

## 3) ~RS 113+00 to 118+00 – Upstream of Newell bridge and downstream of Cooley Ave

Area 3, as situated in Figure 3, is detailed in the oval outline in the segment of SFCBS&R Map 03 shown in Figure 11.

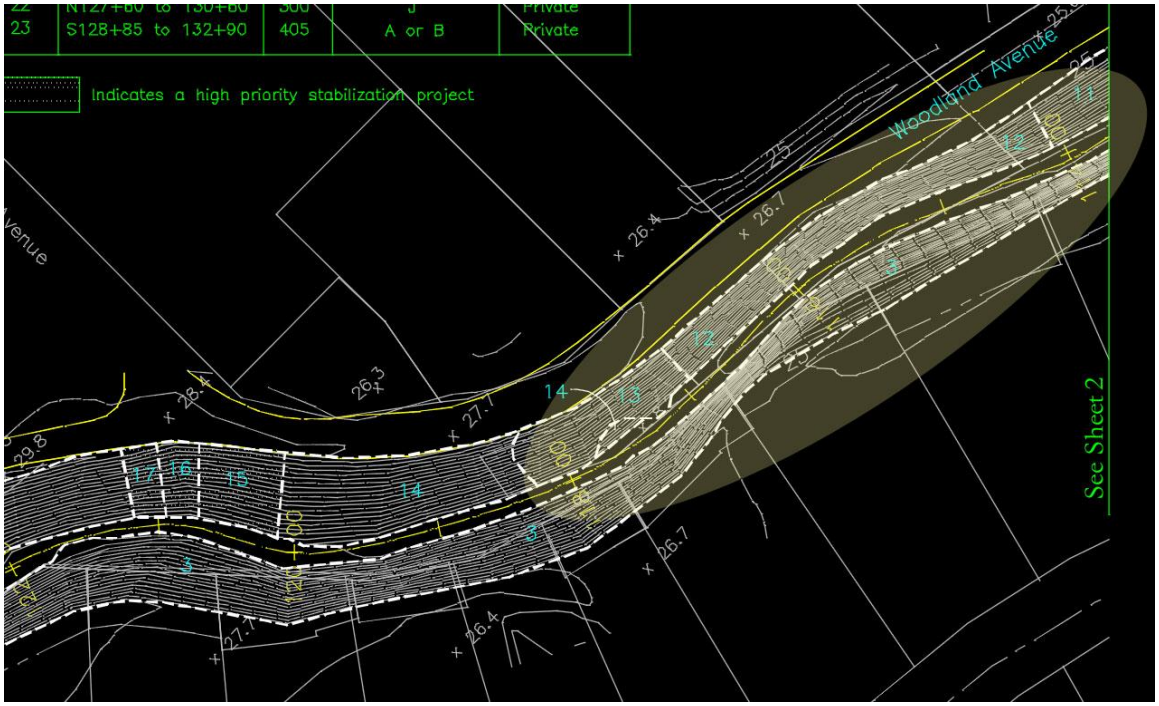



**Figure 11: Excerpt from SFCBS&R Map 03 for ~RS 113+00 to 118+00**

Photographs of this creek section are shown in Figure 12.

| Looking Upstream | Looking Downstream |
| --- | --- |
|   |   |
|   |   |
|   |   |


**Figure 12: US and DS SFCBS&R photographs of ~RS 113+00 to 118+00**

An example of the widening done in this reach is shown in Figure 13.

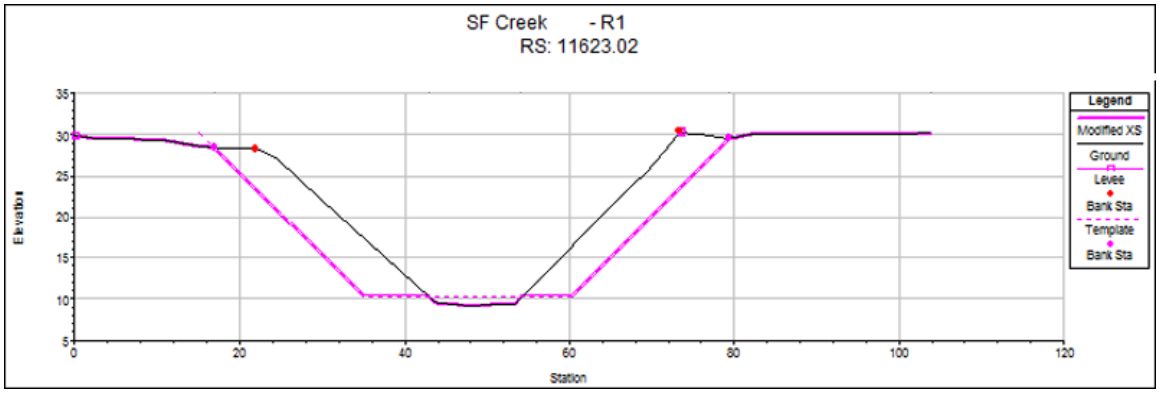



**Figure 13: Channel cross-section with widening at RS 116+23**

## Area 4) ~RS 122+00 to 126+00 – Upstream of Cooley Ave and downstream of Southwood Ave

Area 4, as situated in Figure 3, is detailed in the oval outline in the segment of SFCBS&R Map 03 shown in Figure 14.

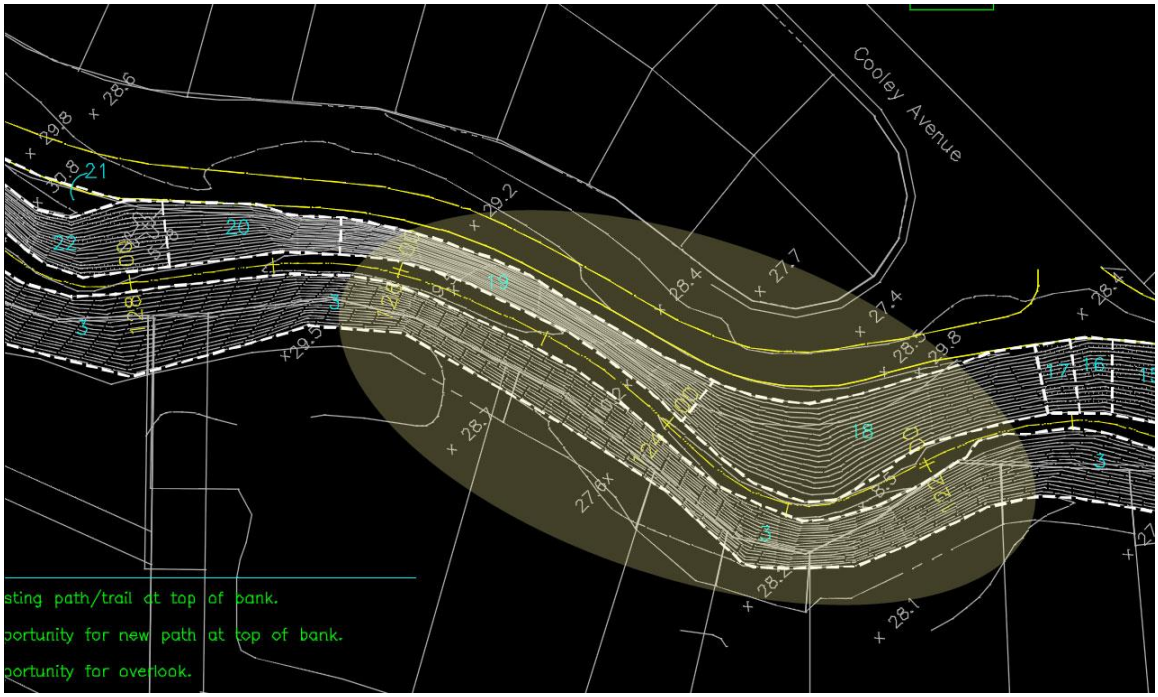



**Figure 14: Excerpt from SFCBS&R Map 03 for ~RS 122+00 to 126+00**

Photographs of this creek section are shown in Figure 15.

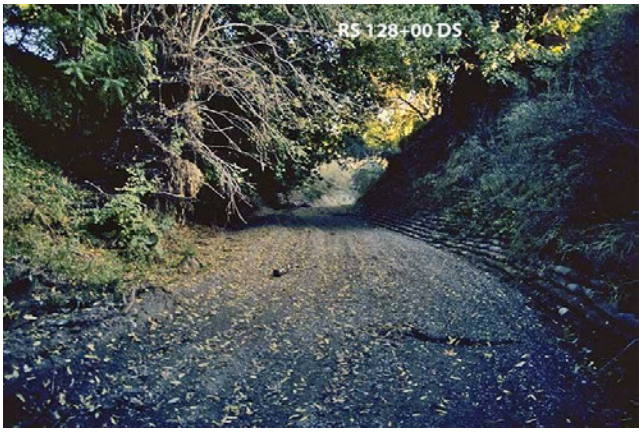
| Looking Upstream | Looking Downstream |
|---|---|
|  |  |


**Figure 15: US and DS SFCBS&R photographs of ~RS 122+00 to 126+00**

An example of the widening done in this reach is shown in Figure 16.

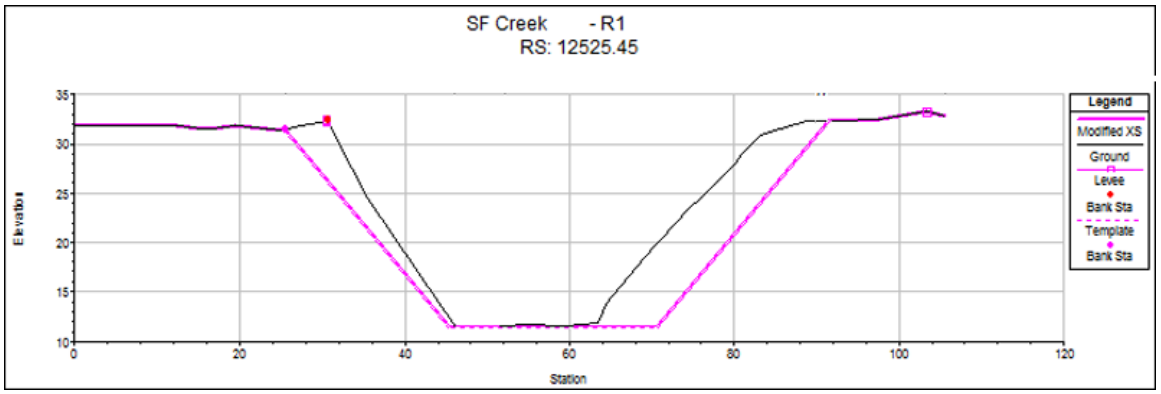



**Figure 16: Channel cross-section with widening at RS 125+25**

## Area 5) ~RS 140+00 to 143+00 – Upstream of University bridge between Manhattan and Euclid St

Area 5, as situated in Figure 3, is detailed in the oval outline in the segment of SFCBS&R Map 04 shown in Figure 17.

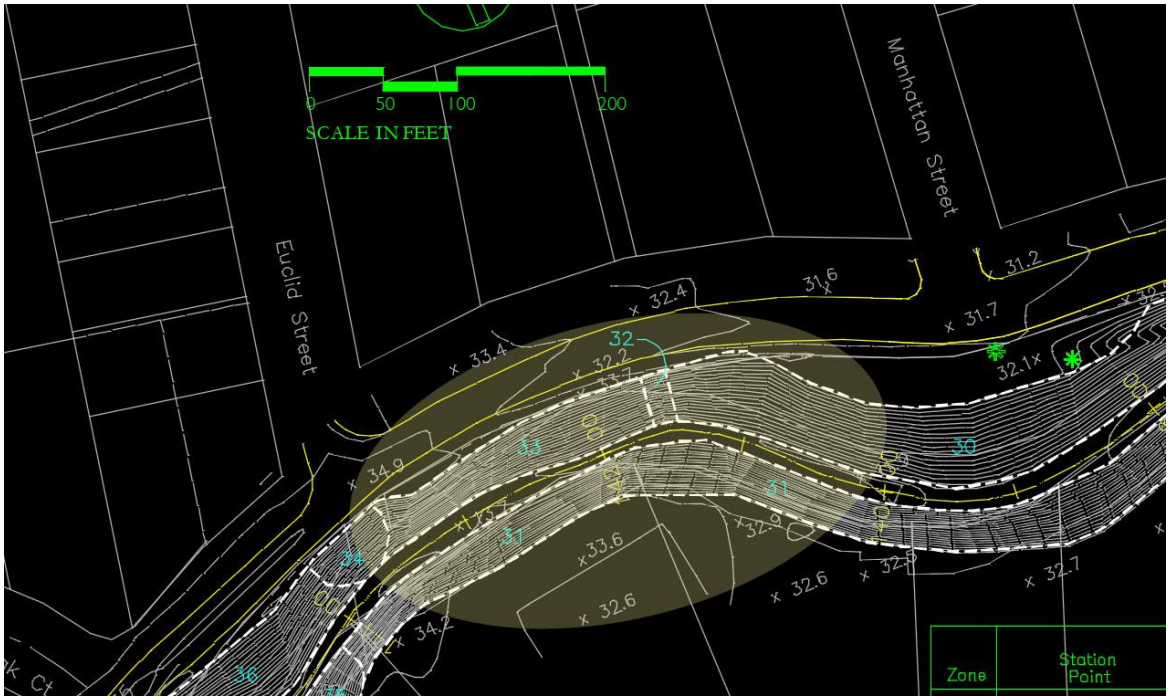



**Figure 17: Excerpt from SFCBS&R Map 04 for ~RS 140+00 to 143+00 (corrected 6/15/2023)**

Photographs of this creek section are shown in Figure 18.

| Looking Upstream | Looking Downstream |
|---|---|
|   |   |


**Figure 18: US and DS SFCBS&R photographs of ~ RS 140+00 to 143+00**

An example of the widening done in this reach is shown in Figure 19.

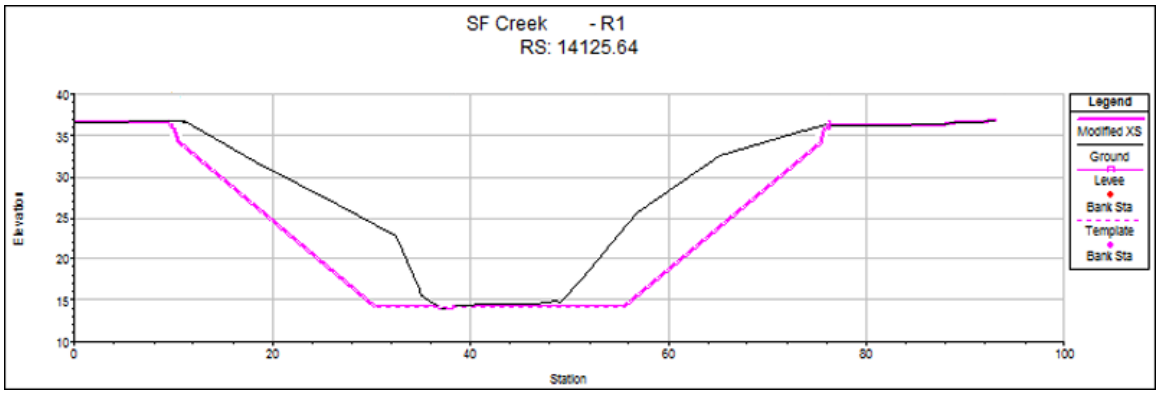



**Figure 19: Channel cross-section with widening at RS 141+25**

## Area 6) ~RS 151+00 to 155+00 – Upstream of W Crescent Dr to just below Palm St

Area 5, as situated in Figure 3, is detailed in the oval outline in the segment of SFCBS&R Map 05 shown in Figure 20.

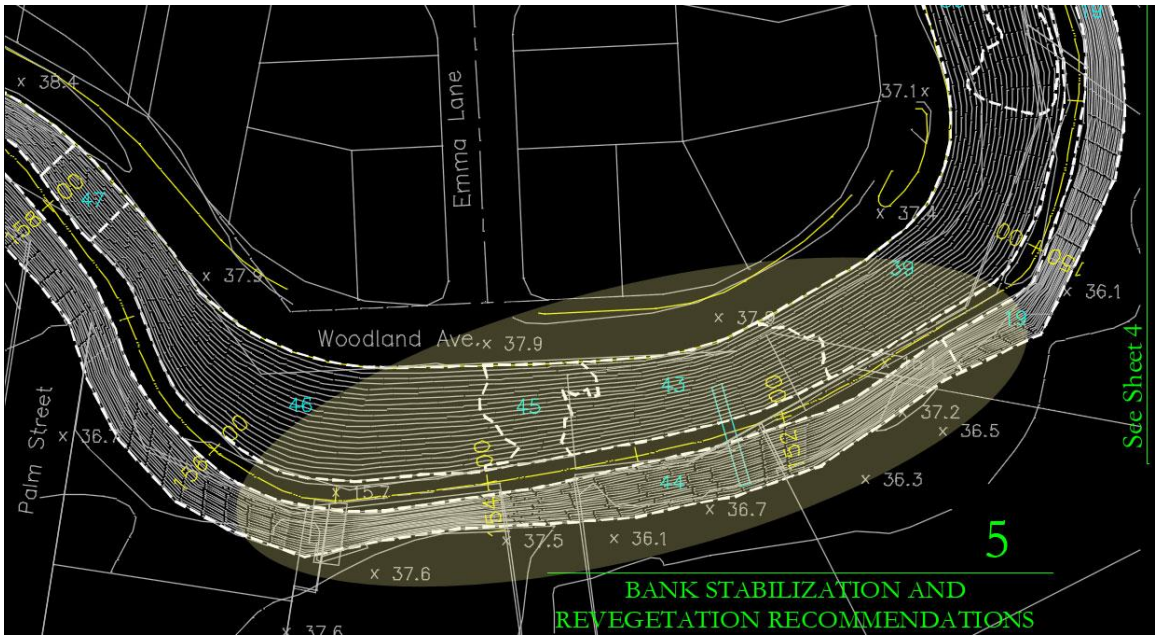



**Figure 20: Excerpt from SFCBS&R Map 05 for ~RS 151+00 to 155+00**

Photographs of this creek section are shown in Figure 21.

| Looking Upstream | Looking Downstream |
|---|---|
|  |  |


**Figure 21: US and DS SFCBS&R photographs of ~ RS 151+00 to 155+00**

An example of the widening done in this reach is shown in Figure 22.

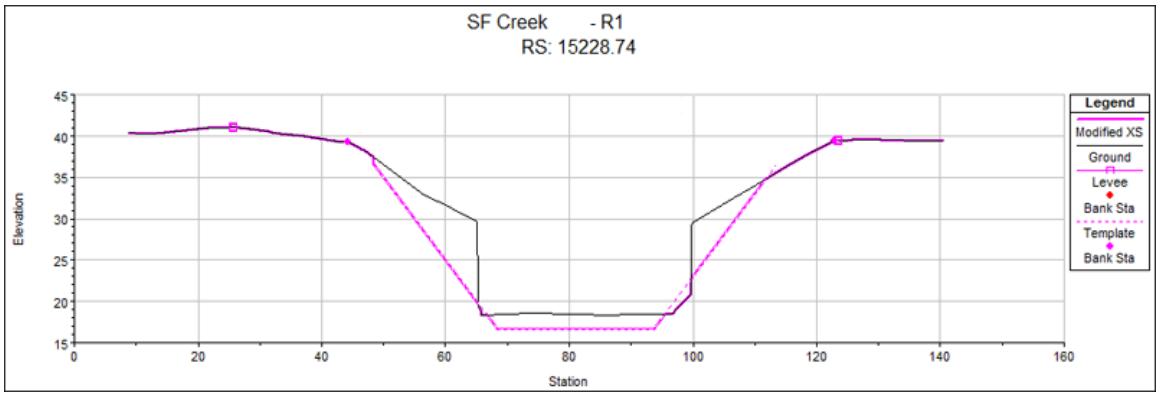



**Figure 22: Channel cross-section with widening at RS 152+28**