1243 Alpine Road, Suite 108
Walnut Creek, CA 94596
Phone: 925.941.0017
Fax: 925.941.0018
www.wreco.com

Final Memorandum

Date: **April 14, 2014**

To: **Edric Kwan, Public Works Director/Town Engineer - Town of Moraga**

From: **Grant Wilcox/Kazuya Tsurushita/Sonia Leung - WRECO**

Subject: **Laguna Creek Hydraulic Study Project**

Background

The Laguna Creek Hydraulic Study Project (Project) is located in the Hacienda de Las Flores Park in the Town of Moraga (Town), Contra Costa County, California. Laguna Creek, within the Project limits, is contained within an 8-ft diameter, 242-ft long corrugated metal pipe (CMP) culvert. The Pavilion located on the southwest side of the culvert experiences flooding during rain events, and the Town is currently seeking alternatives to relieve impacts created by flows draining in the 8-ft CMP culvert.

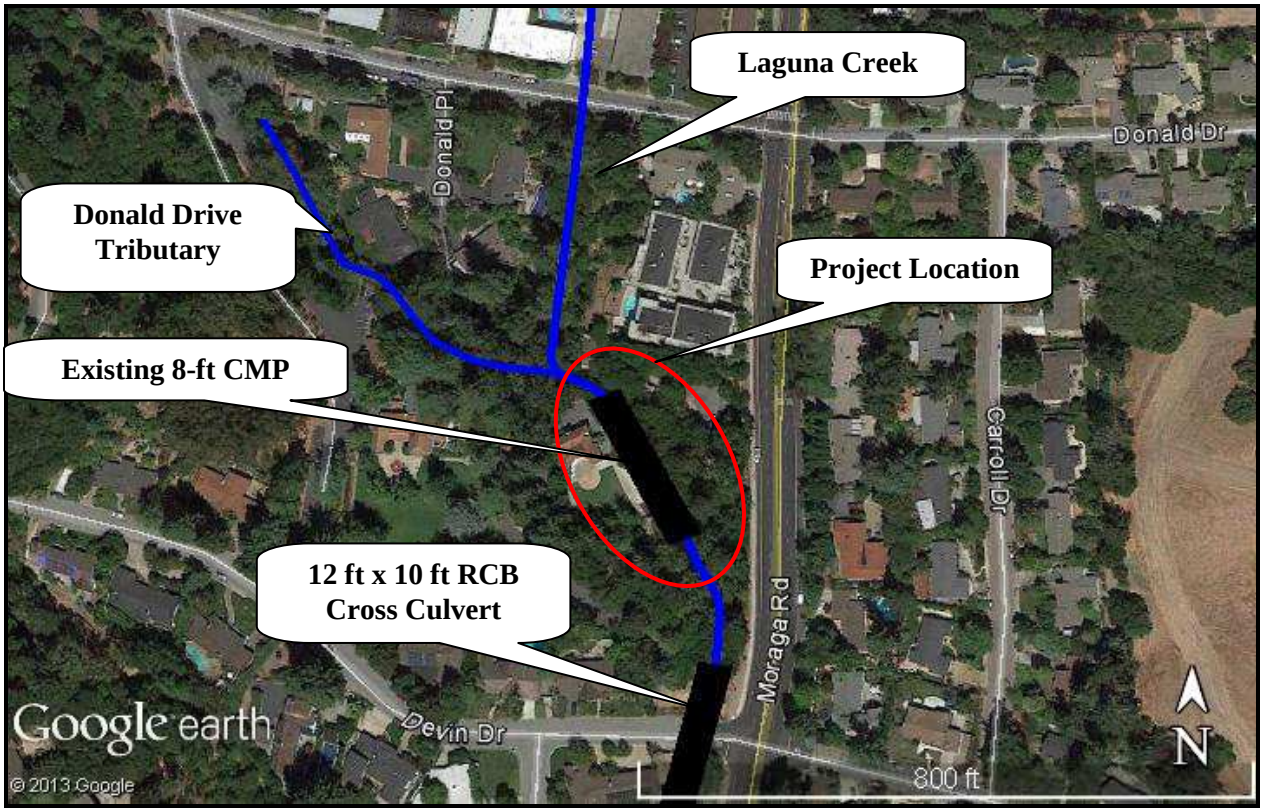

Figure 1. Project Location Map

Source: Google Earth

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1. Purpose of Study

The purpose of this study is to evaluate the feasibility of the various alternatives to lower the water surface elevations (WSEs) of Laguna Creek, raise or protect the Pavilion, and prevent future flooding within the Project limits.

2. Watershed

The Project is located within the San Francisco Bay hydrologic region, sub-area No. 204.20 per the California Department of Transportation (Caltrans) Water Quality Planning Tool. Laguna Creek generally flows in a southeast direction. Approximately 2 mi downstream of the Project site, Laguna Creek joins the Upper San Leandro Reservoir. Based on data from the U.S. Geological Survey (USGS), Laguna Creek drains a watershed area of 1.94 square mi (mi^2) at the Project site. The watershed delineation from the USGS digital elevation model (DEM) is presented in Figure 2. The USGS DEM standard is a geospatial file format for storing a raster-based elevation model.

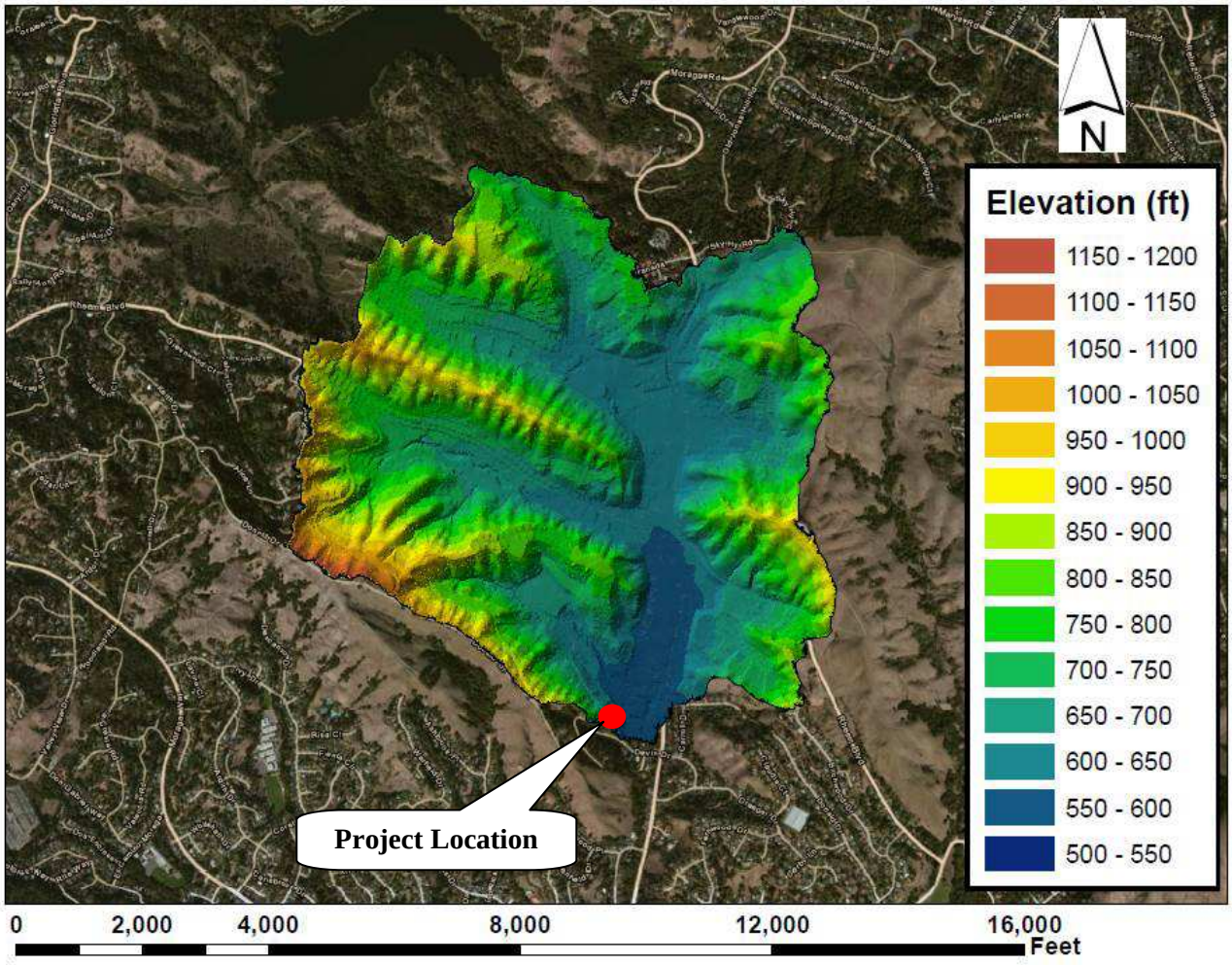

Figure 2. Watershed Draining to the Project

Source: USGS and Google Earth

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3. Description of Stream and Site

About 50 ft upstream of the existing 8-ft diameter CMP culvert, Laguna Creek flows through a sharp 90 degree turn and converges with Donald Drive Tributary; see Photo 1. This sharp turn is caused by the relocation of the channel in the 1930's; Laguna Creek used to run where the Pavilion is now located and the turn angle was more moderate. Immediately upstream of the confluence, the Central Contra Costa Sanitary District (CCCSD) installed a concrete spillway apron to protect an existing 18-in sewer line; see Photo 2. This sewer line is nearly parallel to the existing culvert, and it flows from northwest to southeast. The inlet face of the existing CMP culvert was repaired during the construction project 2013; see Figure 3. About 110 ft downstream from the CMP culvert's inlet face, the top of the CMP is exposed; see Photo 3. These photos were taken on December 19, 2013 during WRECO's site visit.

Photo 1. Upstream of Existing 8-ft CMP Culvert

Photo 2. Concrete Spillway Apron

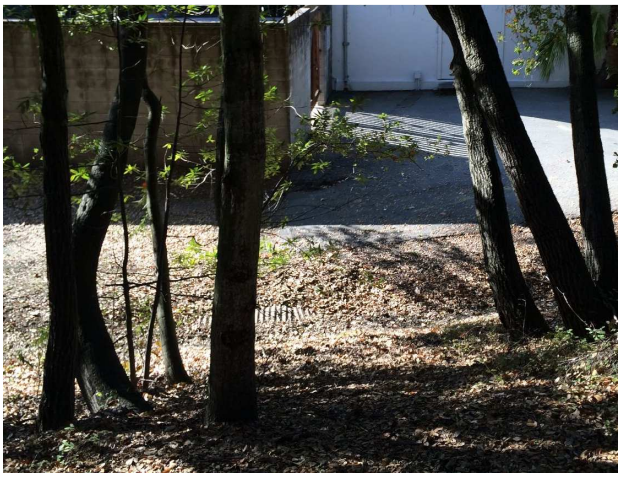

Photo 3. Exposed Existing CMP

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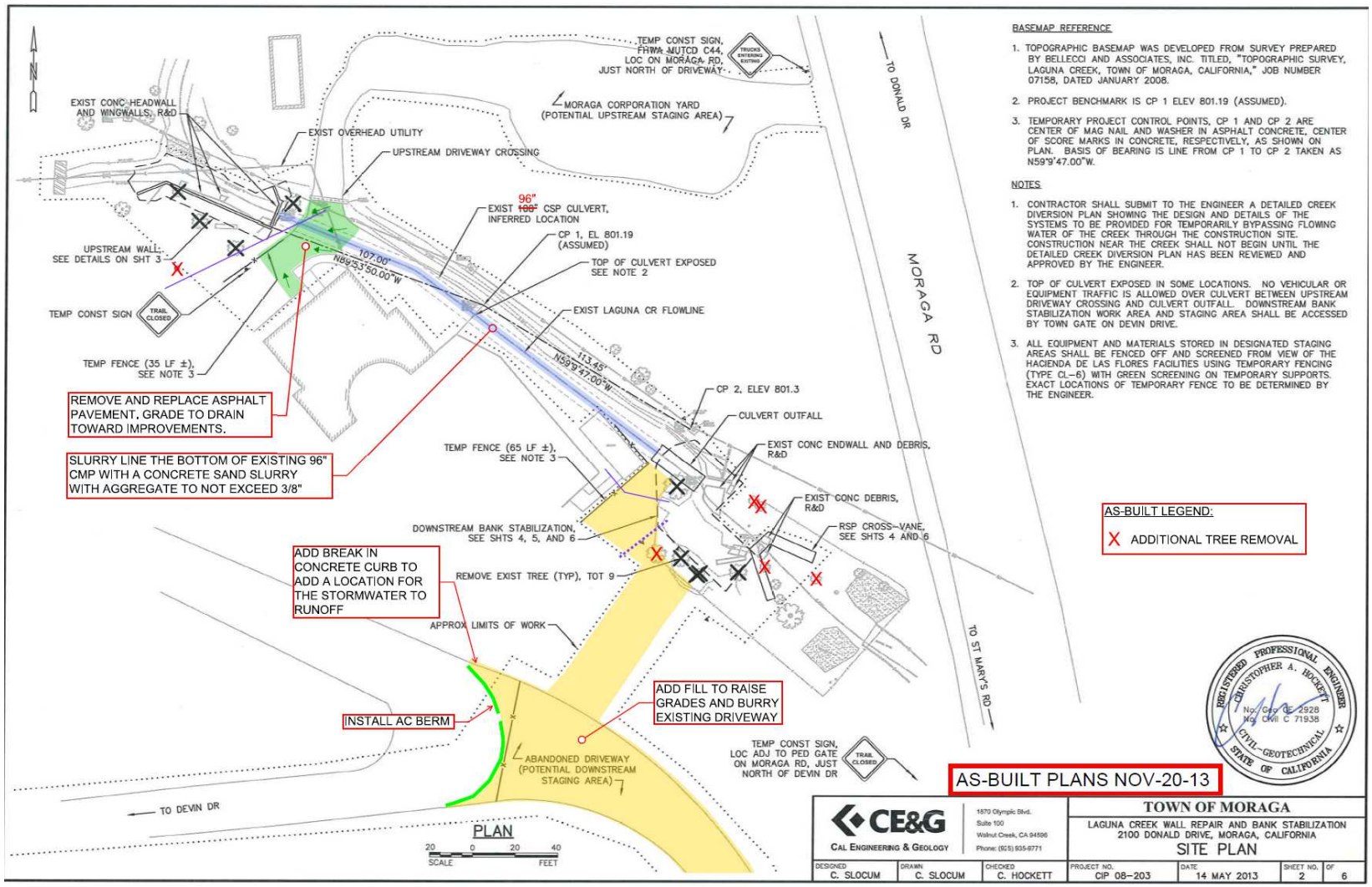

Figure 3. Existing Project Condition

Source: Town of Moraga

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Before the construction project in 2013, the retaining wall on the downstream side of the existing 8-ft CMP culvert fell into the creek after the storm events in 2005. The outfall from the culvert was causing a scouring problem to the downstream and the broken concrete pieces from the failed headwall and wing walls were left in the stream. The construction project in 2013 repaired the scoured channel by providing the 1-ton rock slope protection (RSP) at the outlet face of the 8-ft CMP culvert (see Photo 4) to prevent further erosion caused by the outflows from the existing 8-ft CMP culvert. The RSP was also installed at the damaged channel slope to provide additional channel protection (see Photo 5). The wing walls left in the stream were removed and replaced by the RSP cross vane (see Photo 6).

Photo 4. Downstream Face of the Existing 8-ft CMP Culvert

Photo 5. Laguna Creek Looking Downstream from the Existing 8-ft CMP Culvert

Photo 6. RSP Cross Vane

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4. Hydrology

Design discharges were retrieved from two sources including a study on the Federal Emergency Management Agency's (FEMA) *Flood Insurance Study* (FIS), and calculated flows between Donald Drive and Devin Drive that were provided by the Contra Costa County Flood Control District (CCCFCD).

The published design discharges from the effective FEMA FIS (2009) presents the 50- and 100-year flows for Laguna Creek at Rheem Boulevard and Corliss Drive (see Figure 4). Rheem Boulevard and Corliss Drive are located approximately 0.60 mi upstream and 0.35 mi downstream of the Project site, respectively. The effective FIS states that the flow was estimated based on approximate methods. The peak discharges were estimated to be 450 cfs for the 10-year design storm, 750 cfs for the 50-year design storm and 850 cfs for the 100-year design storm at Rheem Boulevard; and 660 cfs for the 10-year design storm, 1,100 cfs for the 50-year design storm, and 1,300 cfs for the 100-year design storm at Corliss Drive.

In addition to the design discharges from the FEMA FIS, the CCCFCD also provided hydrologic information of Laguna Creek watershed in the Project vicinity. The study included 10-, 50-, and 100-year flows for Laguna Creek between Donald Drive and Devin Drive, which includes the Project location (see Figure 4). The resulting flows were estimated to be 1,110 cfs for the 10-year design storm, 1,560 cfs for the 50-year design storm, and 1,720 cfs for the 100-year design storm.

Figure 4. FEMA FIS Flow Locations

Source: FEMA and Google Earth

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The flows provided by the CCCFCD are more site-specific, and the values were more conservative than the flows estimated using the FEMA FIS. Therefore, WRECO adopted the flows that were based on the CCCFCD flows information for this study. The design discharges from the CCCFCD are summarized in Table 1.

Table 1. Summary of Design Discharges

Flow Condition	Design Discharge (cfs)
10-year Recurrence Interval	1,110
50-year Recurrence Interval	1,560
100-year Recurrence Interval	1,720

Source: Contra Costa County

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5. Proposed Alternatives

There are 10 proposed alternatives, which will be detailed in this section.

Alternative 1 – No Build

For this alternative, there would be no change to the existing 8-ft diameter CMP. Inspection and maintenance on the existing pipe may be required for this alternative.

Alternative 2 – Line Existing Culvert with Smooth Pipe

The inside of the existing culvert would be lined with a smaller smooth pipe in this alternative. This alternative would prevent further structural damage to the existing culvert, but it would not resolve the backwater at the inlet face of the culvert. In 2013, the Town's contractor filled gaps and voids in the bottom of the existing culvert with grout, which were caused by corrosion.

Alternative 3 – Parallel 9-ft Reinforced Concrete Pipe (RCP)

An additional 9-ft diameter RCP would be installed parallel to the existing sewer line on the northeast in this alternative; see Figure 5. A flow diversion structure would be required upstream of the concrete spillway apron to divert some flow into the new pipe. However, the downstream connection from the RCP to Laguna Creek would be a challenge because of the existing sewer pipe that runs parallel to Laguna Creek. The existing culvert would need to be inspected and may require maintenance. See Figure 6 for cross sections for this alternative. The additional 9-ft diameter RCP would prevent overtopping at the upstream face of culvert for 50-year or smaller intensity storm events.

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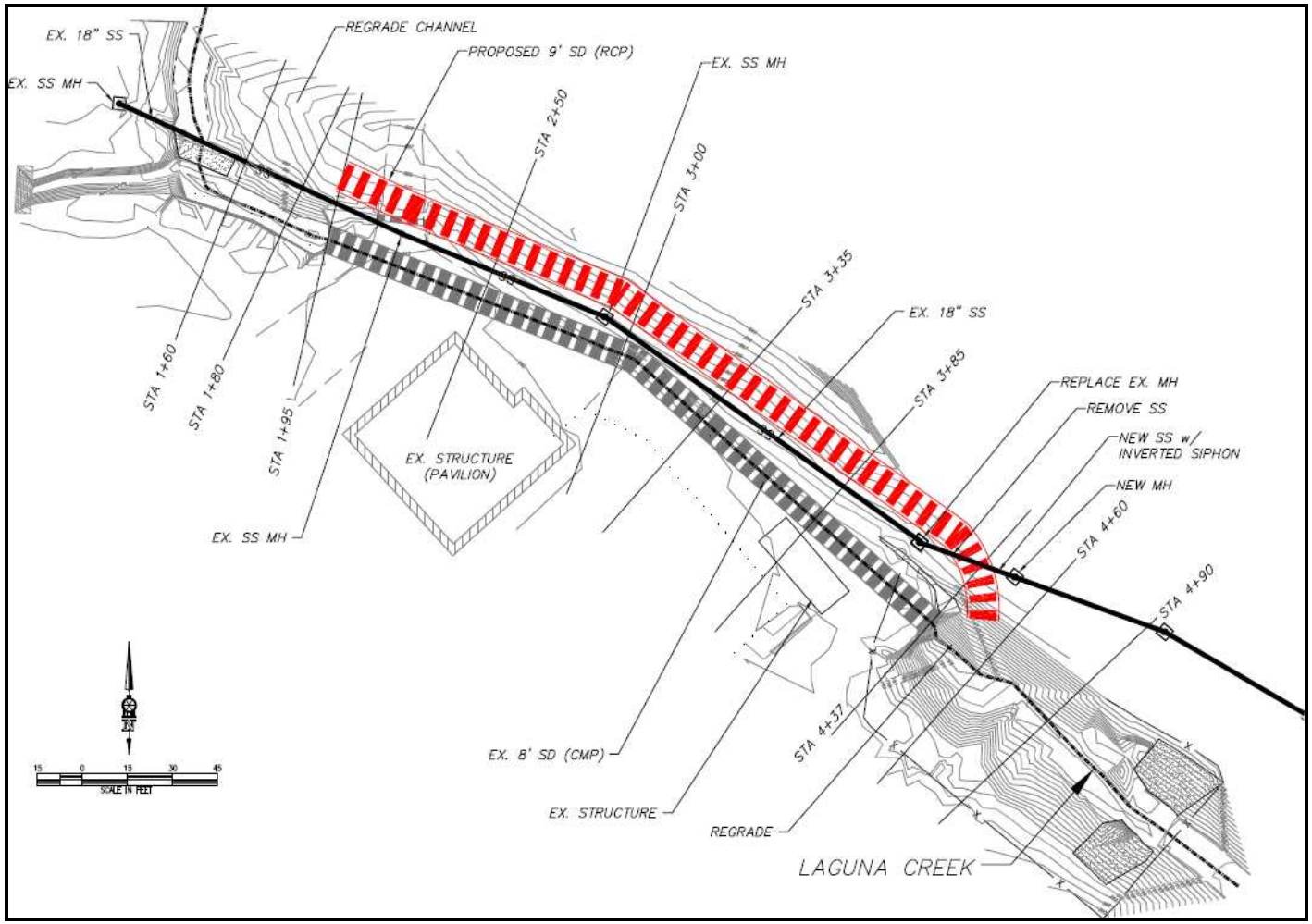

Figure 5. Plan for Alternative 3 – Parallel 9-ft RCP

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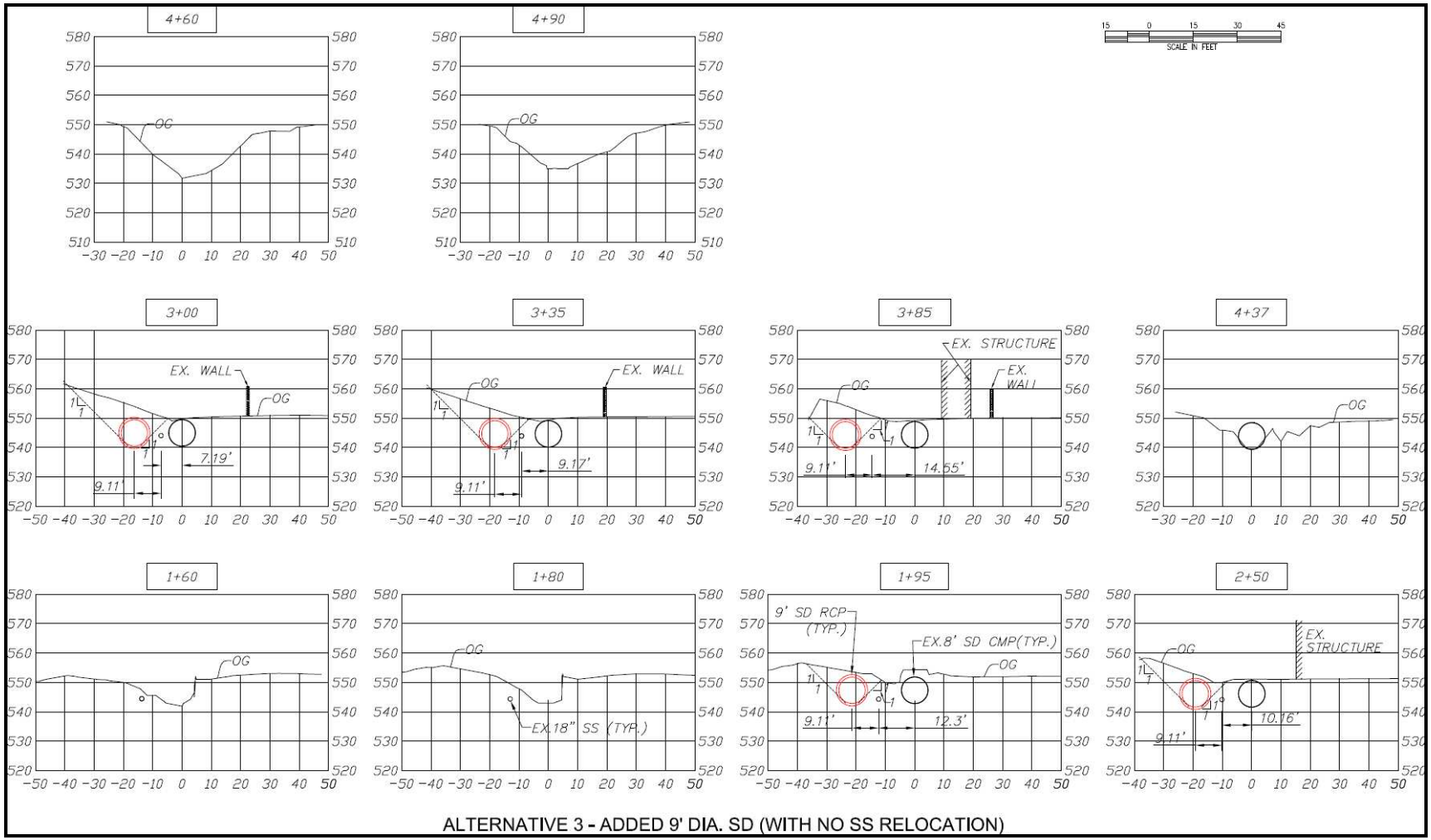

Figure 6. Cross Sections for Alternative 3 – Parallel 9-ft RCP

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Alternative 4 – Parallel 9-ft RCP and Sewer Line Relocation

An additional 9-ft diameter RCP would be installed parallel to the existing culvert on the northeast. The existing sewer line would be relocated to the northeast of the new culvert; see Figure 7. Excavation would be required to widen the channel to fit the additional culvert, and new headwalls would need to be installed. Also, additional easement, permit, and fees by the Town of Moraga and the Central Contra Costa Sanitary District (CCCSD) would be required for the sewer line relocation. The existing culvert would need to be inspected and may require maintenance. See Figure 8 for cross sections for this alternative. The additional 9-ft diameter RCP would prevent overtopping at the upstream face of culvert for 50-year or smaller intensity storm events.

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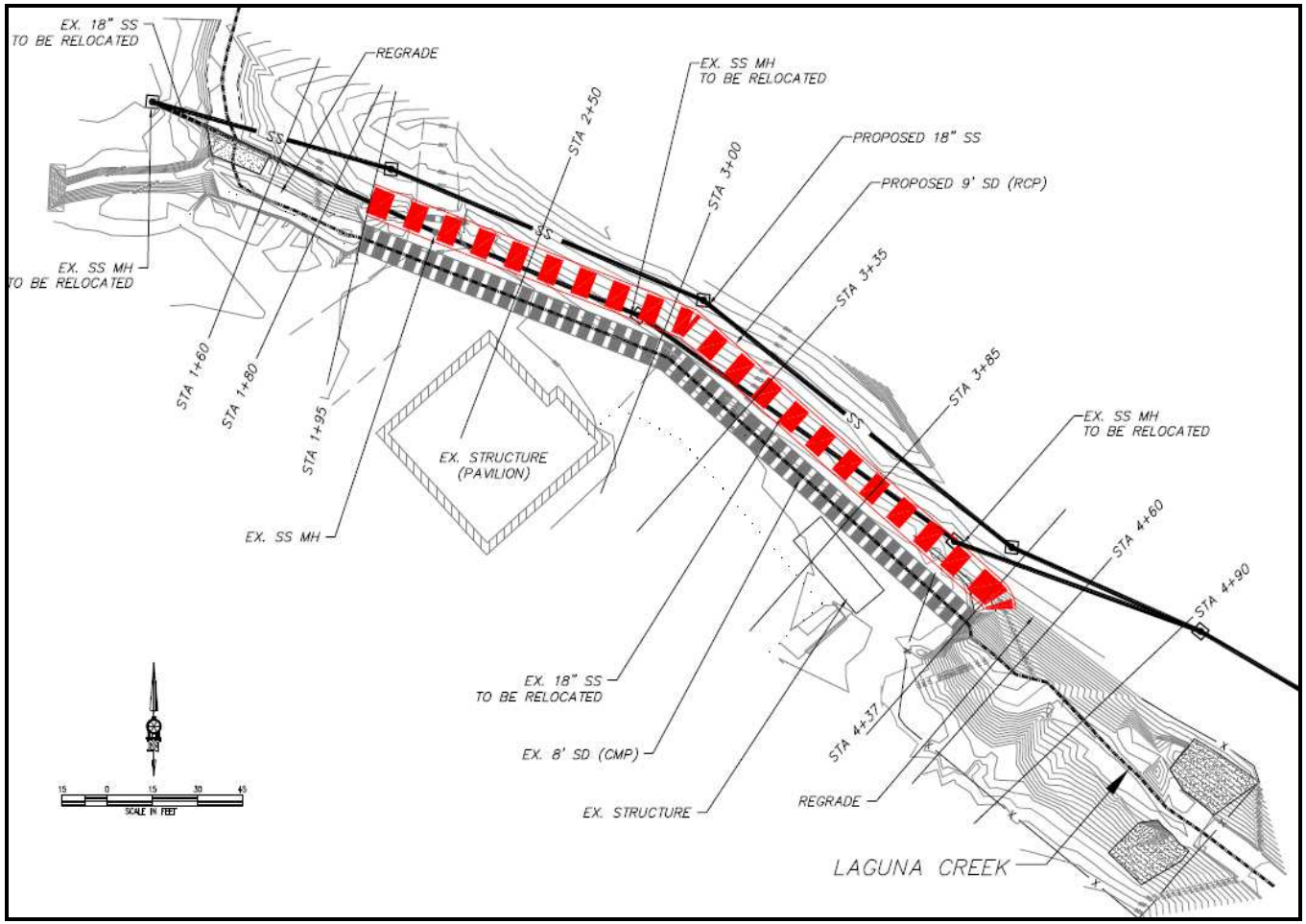

Figure 7. Plan for Alternative 4 – Parallel 9-ft RCP and Sewer Line Relocation

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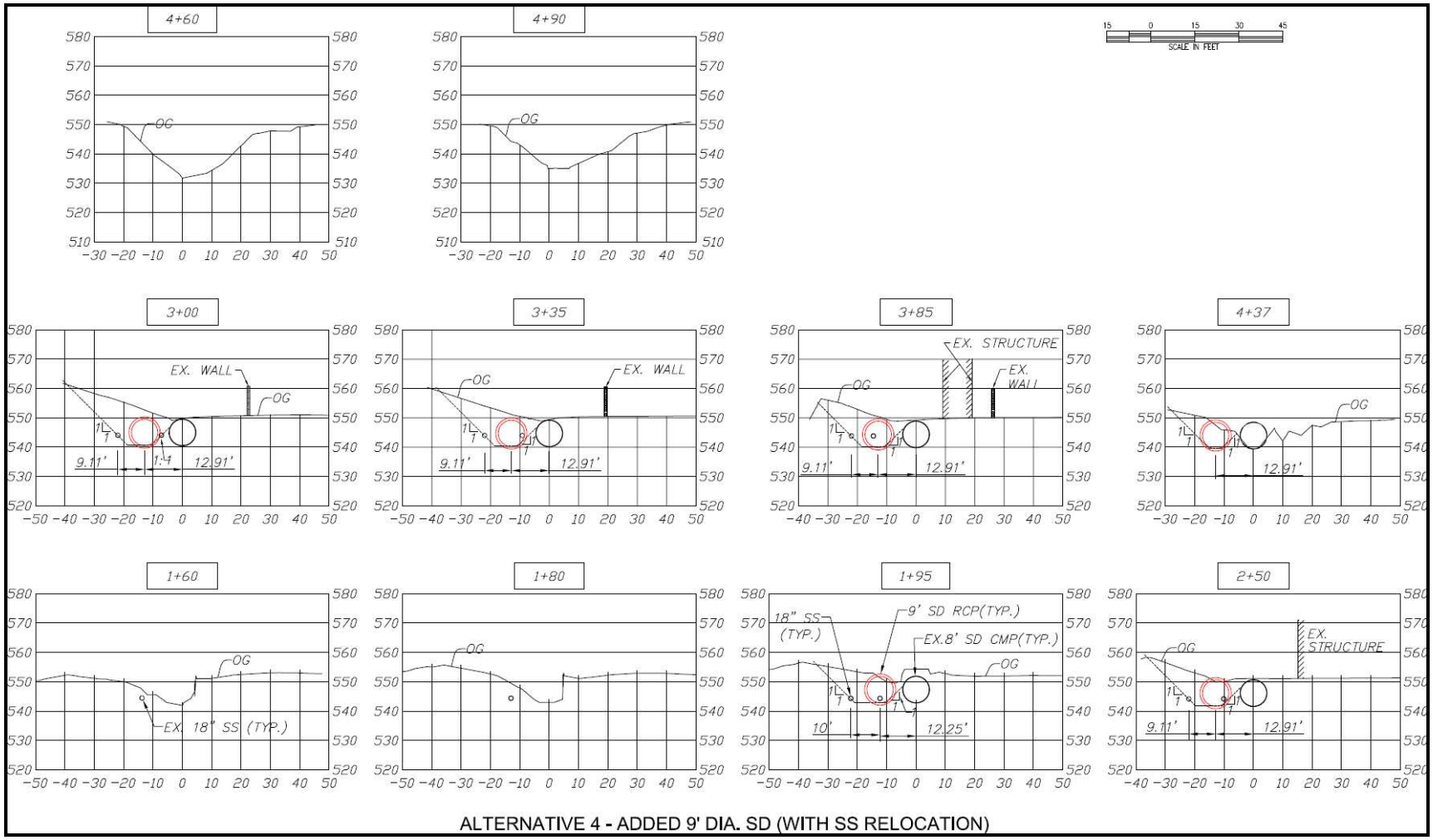

Figure 8. Cross Sections for Alternative 4 – Parallel 9-ft RCP and Sewer Line Relocation

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Alternative 5 – Replace Existing Culvert with 14-ft by 12-ft Reinforced Concrete Box Culvert

In this alternative, the existing 8-ft diameter CMP would be replaced by a 14-ft by 12-ft reinforced concrete box (RCB) culvert. In general, the new culvert would have the same alignment with the existing 8-ft culvert; see Figure 9. Because the proposed box culvert is wider than the existing 8-ft diameter CMP, the existing storage shed southwest of the CMP would need to shift southwest to fulfill the horizontal clearance requirement of the Town. See Figure 10 for cross sections for this alternative.

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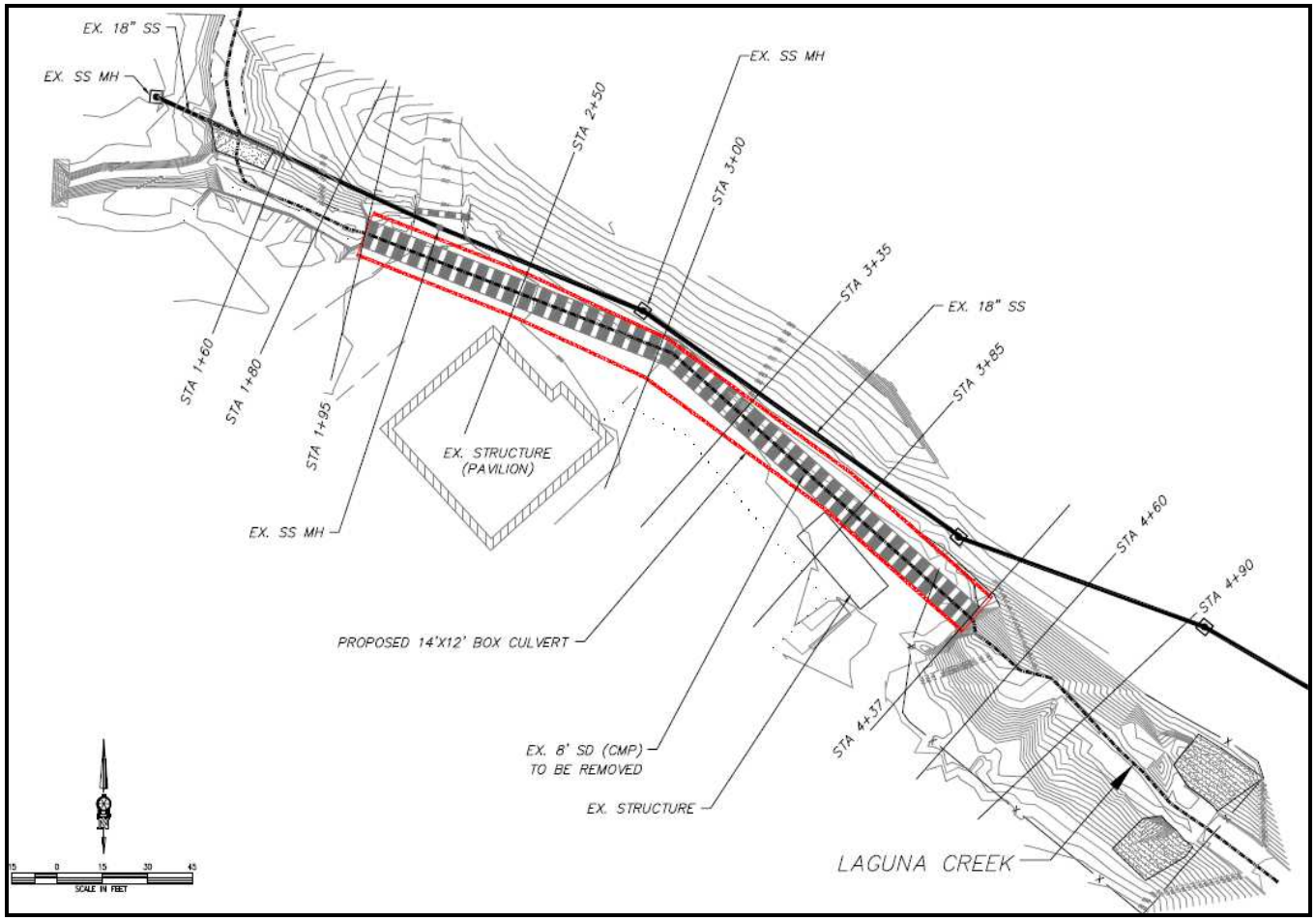

Figure 9. Plan for Alternative 5 – Replace Existing Culvert with 14-ft by 12-ft RCB Culvert

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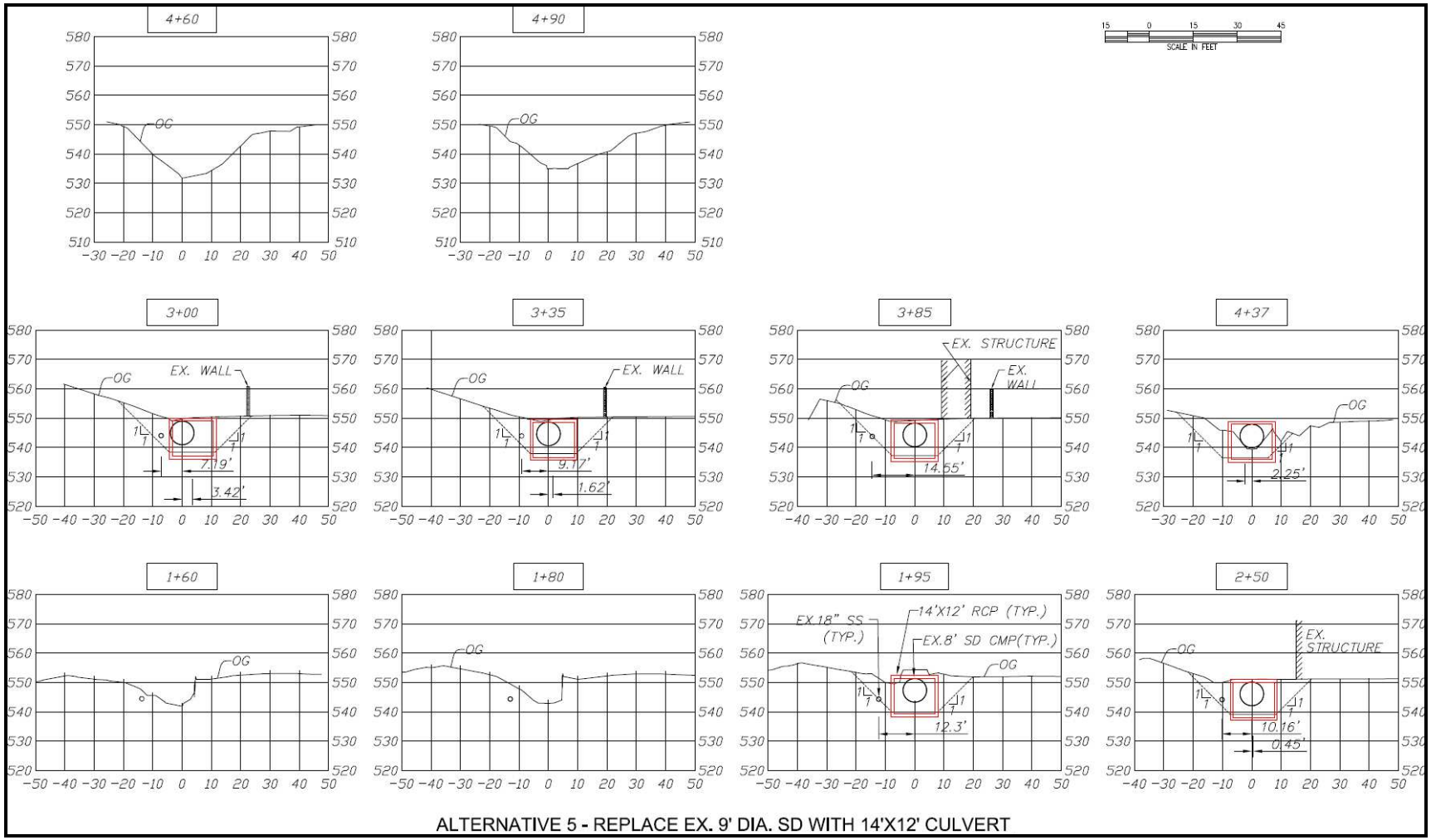

Figure 10. Cross Sections for Alternative 5 – Replace Existing Culvert with 14-ft by 12-ft Box Culvert

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Alternative 6 – Detention Basin Upstream

In this alternative, a detention basin would be constructed upstream of the Project limits. WRECO estimated that a storage volume of approximately 60 acre-ft would be needed for the proposed detention basin to prevent overtopping at the upstream face of the existing 8-ft CMP culvert during 100-year, 12-hour storm event. See Figure 11 for the three potential locations. Location 1 is a multi-use field at the Campolindo High School. Location 2 is playfield at the Donald Rheem Elementary School. Location 3 is parking lot at the Rheem Valley Shopping Center. The areas potentially usable for on-surface or underground detention basin for each location is summarized in Table 2

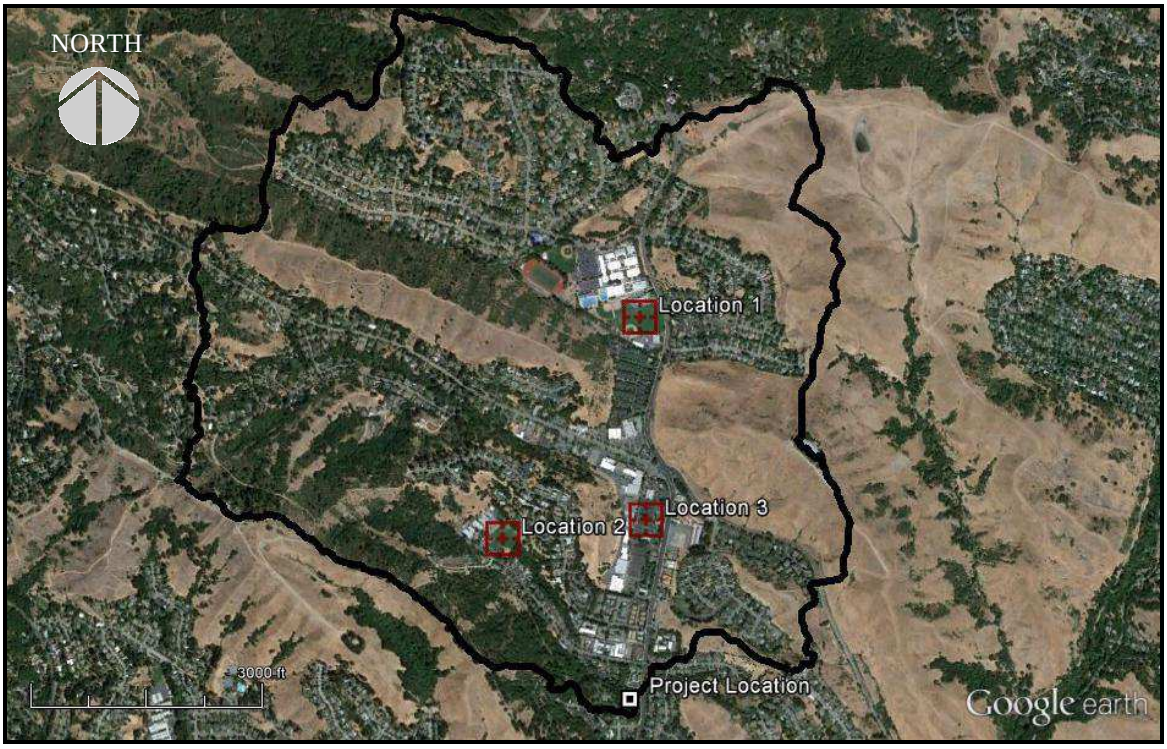

Figure 11. Potential Locations of Detention Basin for Alternative 6

Source: USGS and Google Earth

Table 2. Areas Potentially Usable for Detention Basin

Location	Area (ac)
Campolindo High School	7
Donal Rheem Elementary School	4
Rheem Valley Shopping Center	17

This alternative will require large area to provide storage volume of approximately 60 acre-ft. It will also require coordination with the property owners and stakeholders (Acalanes Union High School District, Moraga School District, Rheem Valley Shopping Center, Parent and Teacher Association, etc.).

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Alternative 7 – Raise Pavilion Above 100-year WSE

The Pavilion is located on the southwest side of the 8-ft CMP culvert, approximately 30 ft southeast from the upstream headwall. Records show that the building experiences flooding during rain events, so WRECO considered raising the finish floor elevation of the building. According to the Federal Emergency Management Agency's (FEMA's) *Homeowner's Guide to Retrofitting*, elevating the house is one of the most common retrofitting methods to protect the home from flooding.

The foundation of the Pavilion should be raised approximately 4 ft above the existing ground level to raise the floor level above the 100-year flood elevation. The elevation techniques would be selected based on the construction type and existing structure condition of the Pavilion (see Figure 12 for sample technique). Stairs and/or ramps should be installed to provide access to enter the raised Pavilion. Raising the courtyard to match the raise of the Pavilion structure requires significant fill volume inside the floodplain and also increases the cost and construction time period. This option was not evaluated further in this study.

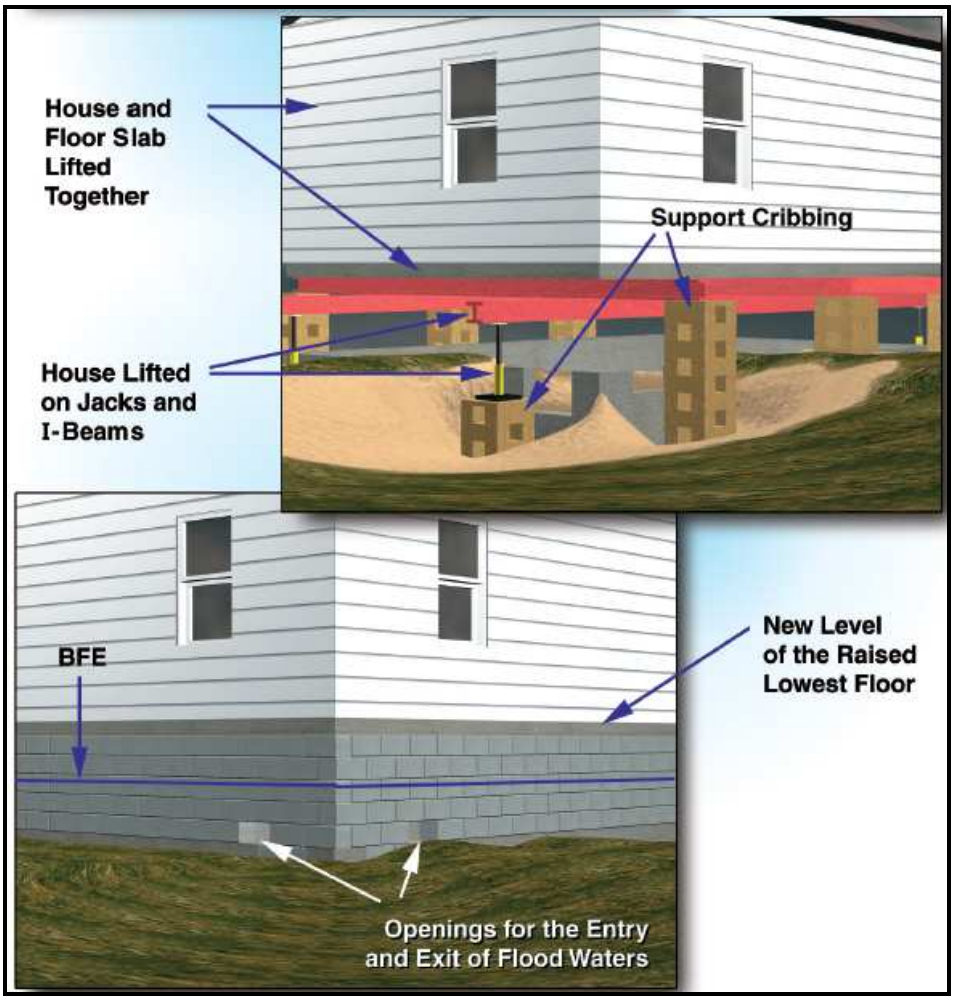

Figure 12. Sample Technique to Raise the Building above Base Flood Elevation

Source: FEMA

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In 2001, the City of Roseville completed a home elevation program that elevated 27 homes and two home buy-outs inside the FEMA 100-year floodplain with the cost of approximately $1 million. This effort resulted in 22 flood-prone homes with raised floor levels higher than the floodplain level (see Photo 7 and Photo 8).

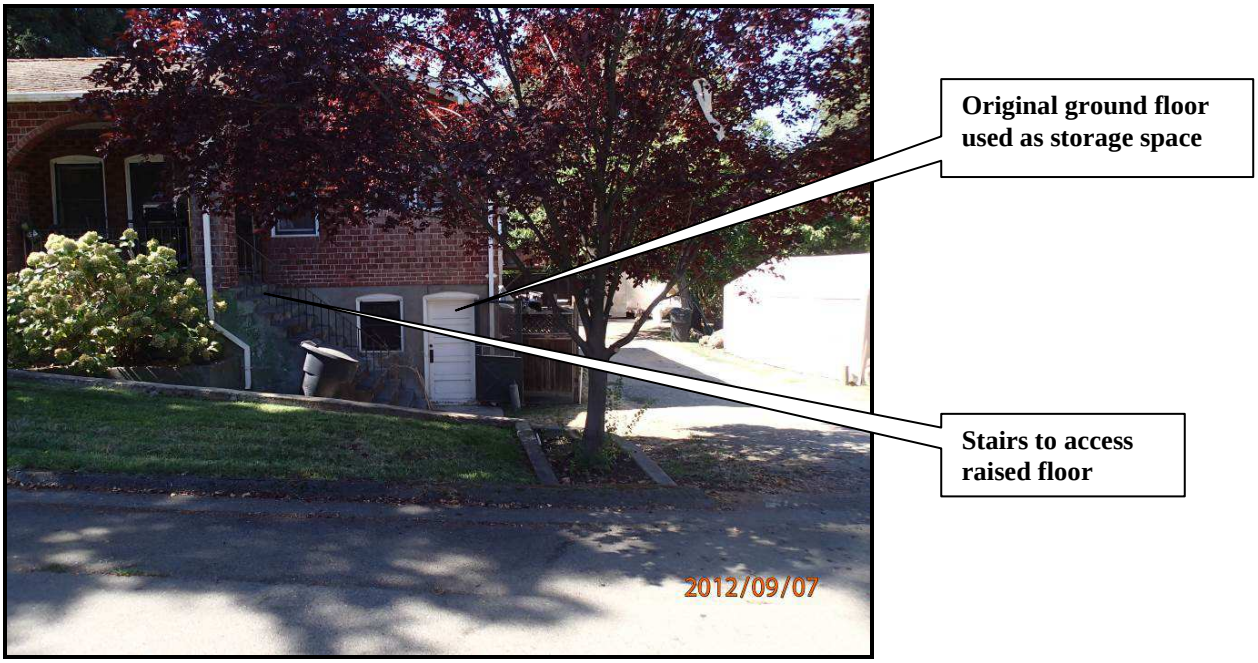

Photo 7. Elevated Home in the City of Roseville, Example 1

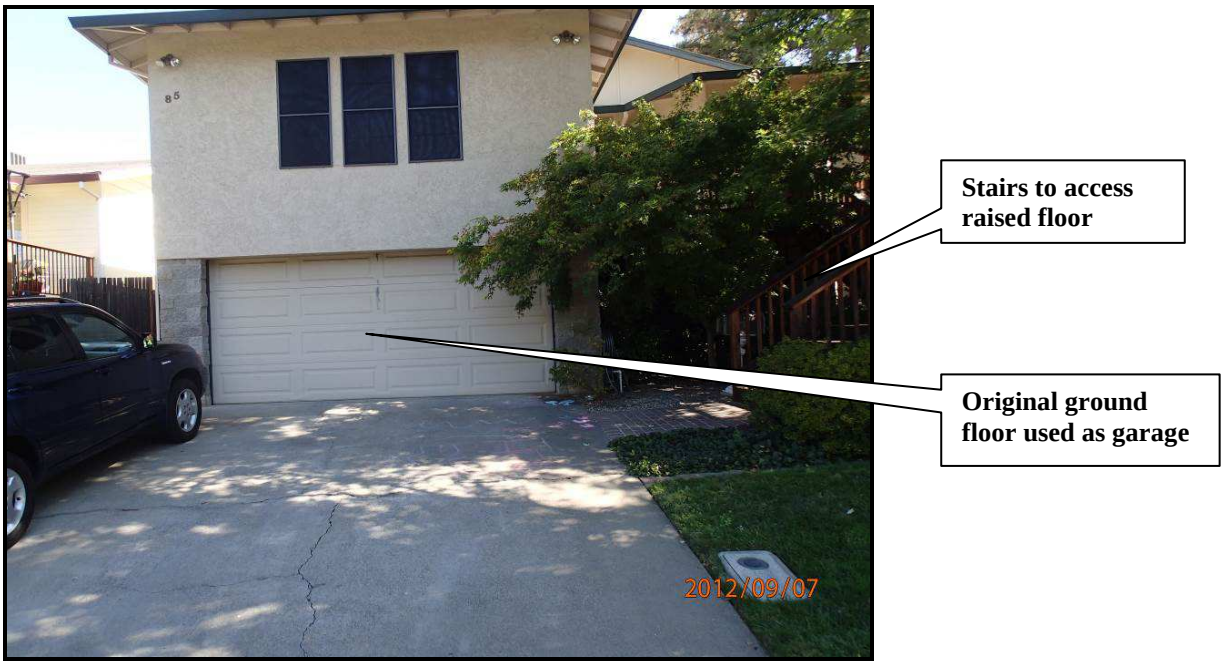

Photo 8. Elevated Home in the City of Roseville, Example 2

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Alternative 8 – Relocate Pavilion outside of the 100-year Floodplain

Unlike the other buildings in Hacienda de Las Flores, the Pavilion structure and surrounding grounds are only a few feet above Laguna Creek. WRECO considered moving the Pavilion building to higher grounds that would not receive flood flows from Laguna Creek and also be outside of the FEMA designated floodplain. The relocation process involves lifting a building off its foundation, placing it on a heavy-duty trailer, hauling it to a new site, and lowering onto the new foundation. This alternative would provide protection from flooding and alleviate concern of future floods. However, the large trees and steeply sloped ground make this method impractical for consideration.

When considering Alternatives 7 and 8, it should be noted that a couple of local historic buildings were raised and moved. A Victorian style home build in 1877 was moved from Lora Nita farm to current location at the Forest Home Parks Historic in San Ramon in the late 1990s. The Masonic Temple in the City of Concord built in 1927 at 1765 Galindo Street was relocated across the street to 1928 Clayton Road, Concord on May 25, 2013. Both of these buildings were raised and moved without damage. See below for the pictures taken when moving the Masonic Temple.

Photo 9. Inserting I-Beam below Masonic Temple

Photo 10. Hydraulic Jack used to Lift the Masonic Temple

Photo 11. Winch Cable used to pull the Temple

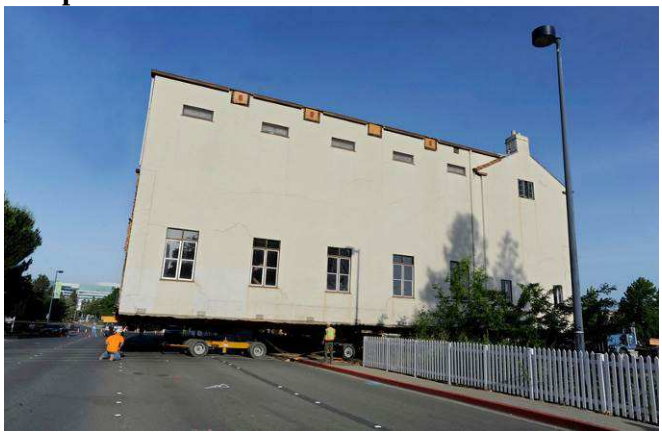

Photo 12. Temple Crossing the Street

Source: Mercurynews.com

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Photo 13. Underbelly of Temple When Moving

Photo 14. Masonic Temple at 1928 Clayton Road
Source: Mercurynews.com

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Alternative 9 – Construct Flood Wall Around Pavilion

A flood wall constructed around the northwest and northeast sides of the Pavilion is another option to be considered to protect the building from flooding (see Figure 13). Concrete, masonry, or a combination of both is typically used as a material to build a flood wall.

See Figure 13 for the conceptual plan for constructing the flood wall to protect the Pavilion. The proposed flood wall should be at least at an elevation of 556 ft when referencing North American Vertical Datum of 1988 (NAVD88) as vertical datum to provide 1 ft of freeboard above the 100-year WSE. The elevation of floodwall will be approximately 5 to 6 ft when measured from the existing pavement elevation around the pavilion. Photos on the following page show the floodwall and floodwall gate at the Roseville Veterans Memorials Hall in the City of Roseville, CA to protect the historic building from the flooding of Dry Creek.

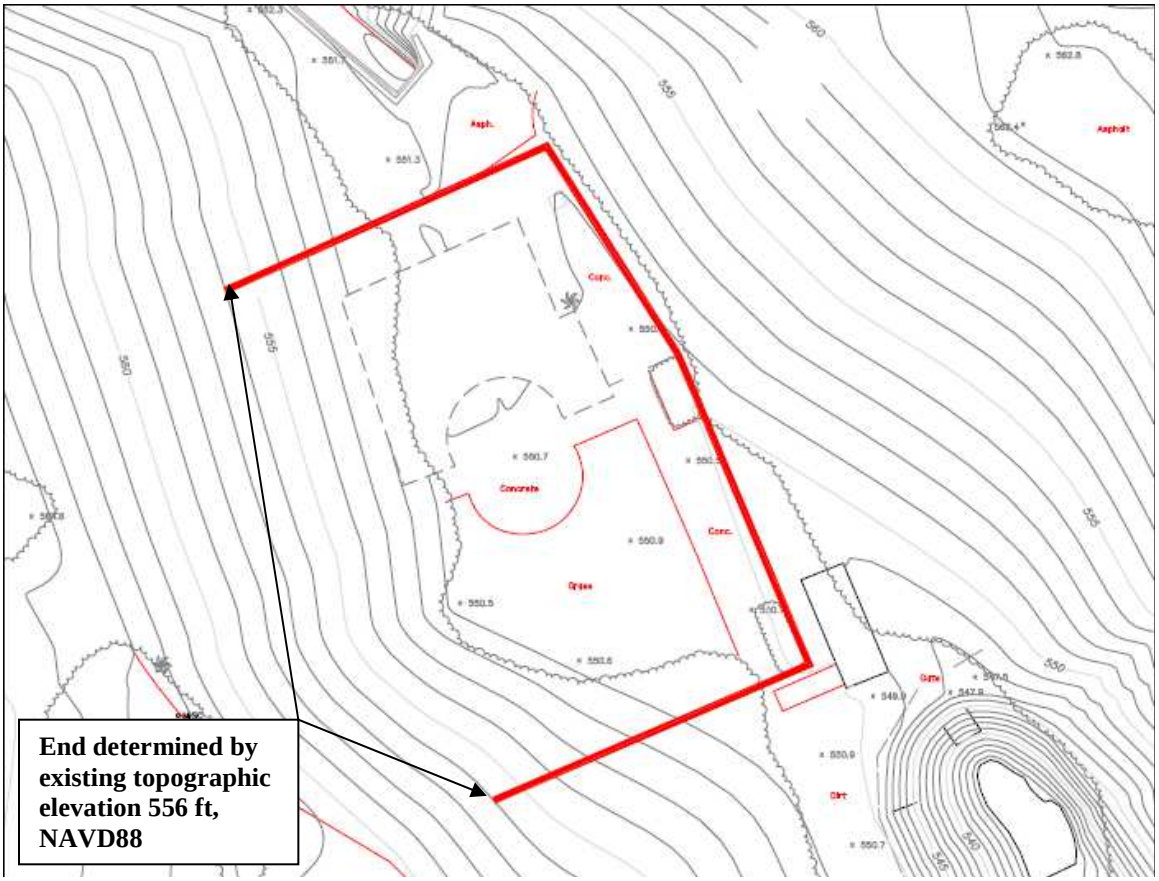

Figure 13. Conceptual Plan of Flood Wall

* Floodwall must extend up to the conform point (556 ft NAVD88 based on local survey provided by Bellecci and Associates, Inc and BKF Engineers).

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Photo 15. Floodwall at the Roseville Veterans Memorial Hall

Photo 16. Floodwall Gate at the Roseville Veterans Memorial Hall

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Alternative 10 – Restore Natural Channel

Another alternative at the Project location would be the complete removal of the existing 8' CMP culvert and restoration of the natural stream channel. "Daylighting" describes projects that deliberately expose some or all of the flow of previously covered streams. It re-establishes a waterway in its old channel where feasible, or in a new channel threaded between the structures now present in the vicinity of the stream site.

This alternative would remove the existing 8-ft CMP culvert and the restored channel would be designed to provide sufficient capacity to convey the 100-year flow. This method would prevent flooding at the Pavilion by removing the inlet face of the culvert that is currently acting as a choke point. In addition, there are other benefits to daylighting:

- Amenity for the Public and an educational opportunity
- Replacing deteriorating culverts with an open drainage system that can be easily monitored and repaired.
- The cost is less, or only marginally more, than replacing the existing culvert with a proposed culvert that has the capacity to convey the 100-year flow.
- Recreate aquatic habitat and improving fish passage.
- Would create red-legged frog habitat (larger agencies such as California Department of Transportation are always looking for off-site mitigation).
- May be able to qualify as a mitigation site or for grant funding

The San Francisco Bay Area features the highest concentration of daylighting activity in the United States. See the following pages for the pre-and post-project photos for Strawberry Creek daylighting (Photo 17 and Photo 18) and Codornices Creek daylighting in Berkeley (Photo 19).

This alternative would still require a short culvert or bridge to provide access to the upper parking area. The culvert could be an arched culvert with natural bottom, which would provide unimpeded passage of fishes, macroinvertebrates, and sediments (see Photo 20 and Photo 21).

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Photo 17. (Left) Strawberry Creek Prior to Daylighting
Photo 18. (Right) Daylighted Section of Strawberry Creek

Source: Rocky Mountain Institute and Ecocity Builders

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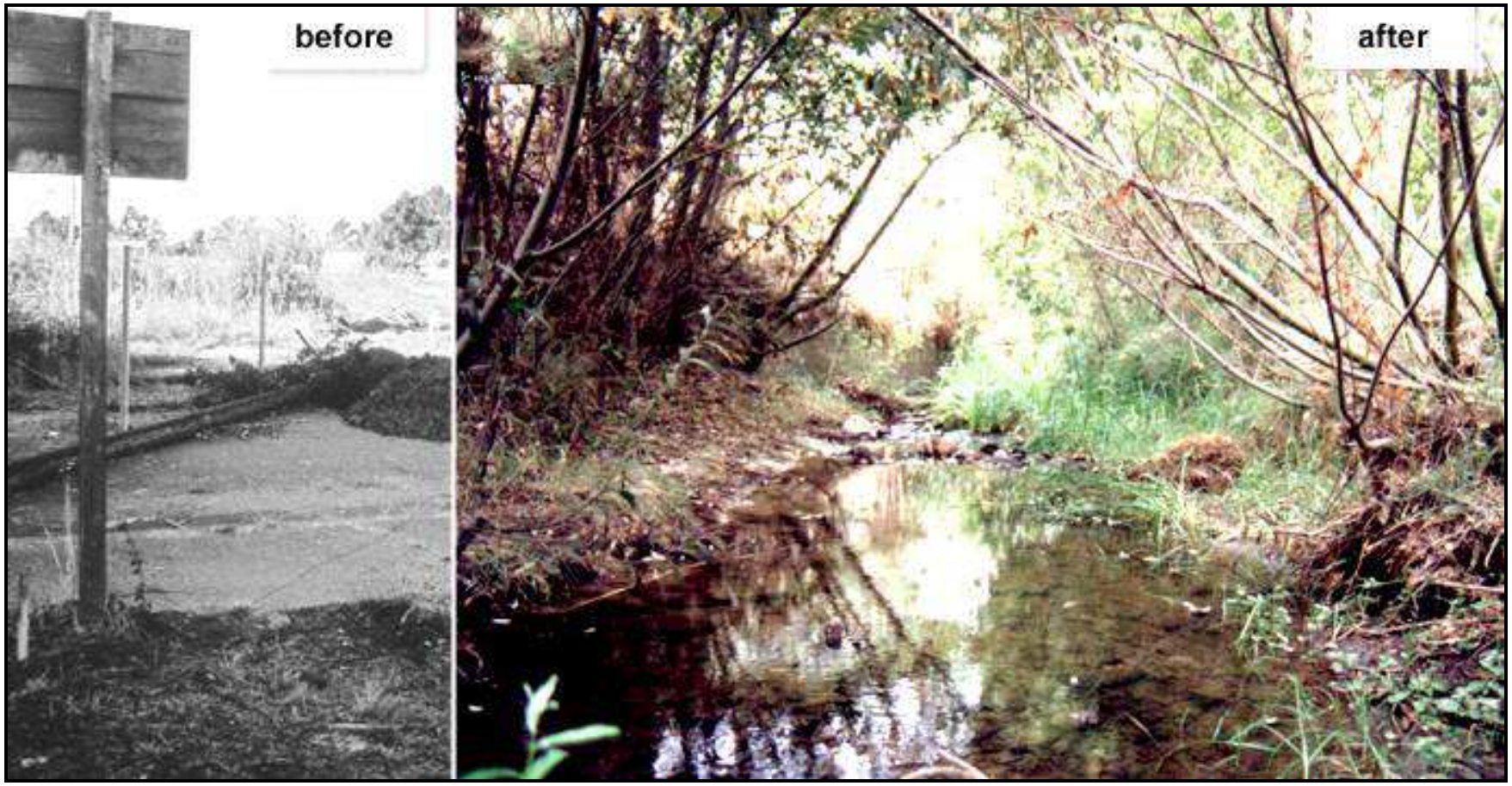

Photo 19. Codornices Creek, Before and After Daylighting

Source: Ecocity Builders

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Photo 20. (Left) Sickle Creek Precast Concrete Arch with Wingwalls
Photo 21. (Right) West Weaver Creek Bottomless Arch Culvert

Source: United States Forest Service

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6. Hydraulics

The hydraulics at Laguna Creek in the study area under the existing and proposed conditions were evaluated using the USACE's Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 4.1.0, hydraulic modeling software.

The model geometry was developed using topographic survey provided by Bellecci & Associates, Inc. and surface data downstream of the CMP culvert provided by Cal Engineering & Geology. A total of 19 cross sections were used in the hydraulic model for each alternative. The hydraulic model extends approximately 89 ft upstream of the inlet face and 105 ft downstream of the outlet face of the existing CMP culvert. The downstream limit of the hydraulic model is also the upstream face of the existing 12 ft x 10 ft RCB cross culvert below Devin Drive. The cross section naming convention is by river stations (RS), starting with 0 at the most downstream cross section.

The normal depth condition was used as the upstream control, and the hydraulic grade line elevation at the inlet face of the existing 12 ft x 10 ft RCB cross culvert was set as the downstream control in the HEC-RAS model.

7. Water Surface Elevations

The WSEs in Laguna Creek were estimated for Alternatives 1, 2, 3, 4, 5, and 10. For Alternatives 3 and 4, differences in the design of the headwall were assumed to have an insignificant impact to the hydraulic analysis. Therefore, Alternatives 3 and 4 were evaluated using the same hydraulic model.

For Alternative 6, a hydrologic analysis was not performed to evaluate the performance of the proposed basins. Therefore, 50- and 100-year flows of Laguna Creek at the Project location were not estimated to perform the hydraulic analysis.

Alternatives 7 through 9 did not modify the existing 8-ft CMP culvert. The hydraulic conditions upstream of the CMP culvert inlet face and downstream of the CMP culvert outlet face were assumed to remain the same as in the existing condition.

The 50- and 100-year WSEs of Laguna Creek at the Project location are summarized in Table 3 and Table 4, respectively.

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Walnut Creek, CA 94596
Phone: 925.941.0017
Fax: 925.941.0018
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Table 3. 50-year Water Surface Elevations

Location	Water Surface Elevation				
	Alternative 1 No Build (ft, NAVD88)	Alternative 2 Smooth Lining (ft, NAVD88)	Alternative 3/4 Parallel 9-ft RCP (ft, NAVD88)	Alternative 5 14x12 ft RCB (ft, NAVD88)	Alternative 10 Daylighting (ft, NAVD88)
50 ft Upstream of Existing CMP Culvert	557.2	557.2	555.2	553.4	554.2
At Upstream Face of CMP Culvert	557.1	557.1	554.8	551.2	550.6
At Downstream Face of CMP Culvert	548.3	548.3	548.3	548.3	548.5
Downstream Limit of Hydraulic Model (100 ft Downstream of the CMP Culvert Downstream Face)	548.2	548.2	548.2	548.2	548.2

Table 4. 100-year Water Surface Elevations

Location	Water Surface Elevation				
	Alternative 1 No Build (ft, NAVD88)	Alternative 2 Smooth Lining (ft, NAVD88)	Alternative 3/4 Parallel 9-ft RCP (ft, NAVD88)	Alternative 5 14x12 ft RCB (ft, NAVD88)	Alternative 10 Daylighting (ft, NAVD88)
50 ft Upstream of Existing CMP Culvert	557.5	557.5	556.1	553.9	554.8
At Upstream Face of CMP Culvert	557.5	557.4	555.7	552.0	551.1
At Downstream Face of CMP Culvert	550.1	550.1	550.1	550.1	550.2
Downstream Limit of Hydraulic Model (100 ft Downstream of the CMP Culvert Downstream Face)	550.0	550.0	550.0	550.0	550.0

Notes:
The elevation of the culvert wingwall is approximately 555 ft. The pavement elevation around the pavilion is approximately 551 ft.

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8. Preliminary Cost Estimate

Alternative 1 is the no build alternative; there would be no cost for that. Annual maintenance costs were not considered because all alternatives would require maintenance. Alternatives 3 (parallel 9-ft RCP culvert), 6 (upstream detention basin), and 8 (relocate pavilion) are not feasible for this Project because of the existing sewer line location, limited space for a new detention basin, and moving the Pavilion outside of the existing 100-year floodplain would be problematic. Alternative 2 (Smooth lining of the existing pipe) would also offer no benefit for the Project location. Therefore, costs for these alternatives were not estimated in this memorandum.

The unit cost of construction items are based on the information available from the California Department of Transportation's *Contract Cost Data* and FEMA *Homeowner's Guide to Retrofitting*. Based on limited data and preliminary alternatives design, the costs for Alternatives 4, 5, 7, 9, and 10 are summarized in Table 5.

9. Potential Extra Cost Required with Sanitary Sewer Line Relocation

Alternatives 4 (parallel 9-ft RCP culvert with sewer relocation) and 10 (daylighting) would involve an existing sewer line relocation and granting an additional easement. This will require coordination between the Town of Moraga and CCCSD. The process time for granting an additional easement may take up to 6 months, and sewer line relocation may take up to an additional 6 months.

10. Recommendation and Decision

The flow capacity of the culvert for Alternatives 1, 2, 3, and 4 would not be able to convey the peak 100-year flow of Laguna Creek at the Project location. These design alternatives would not be able to prevent potential flooding at the Pavilion during the 100-year storm event. Alternatives 7, 8, and 9 would provide protection to the Pavilion during the 100-year storm event, but they would not resolve the existing flooding issues at the Project location. Alternative 6 would reduce the peak 100-year flow at the Project location, but this alternative may not be feasible because of the required storage (160 ac-ft) volume to reduce the peak 100-year flow and unavailable basin sites within the watershed.

Alternatives 5 (14 ft x 12 ft RCB culvert) and 10 would improve the channel capacity to convey the 100-year flow and would provide flood protection to the Pavilion during the 100-year storm event. Alternative 10, daylighting, would require less construction cost than Alternative 5, installation of 14 ft x 12 ft RCB culvert (see Table 5). In addition, daylighting would be eligible for the mitigation credit for channel restoration and would have more potential funding sources than Alternative 5.

Based on this study, the most feasible proposed alternative for the Project is Alternative 10, daylighting the creek and restoring a natural channel.

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Table 5. Estimated Construction Costs for Alternatives 4, 5, 7, 9, and 10

Item Description	Unit Price	Unit Measure	Alternative 4 9-ft RCP Culvert		Alternative 5 14 ft x 12 ft RCB Culvert		Alternative 7 Raise Pavilion		Alternative 9 Flood Wall		Alternative 10 Daylighting (Recommended)	
			Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price
Funding Source	-	-	FEMA Flood Mitigation Assistance		FEMA Flood Mitigation Assistance		FEMA Flood Mitigation Assistance		FEMA Flood Mitigation Assistance		FEMA Flood Mitigation Assistance Local Agencies	
Design and Town Approval	-	-	6 month		6 month		6 month		6 month		6 month	
Environmental Permits	-	-	9 month		9 month		9 month		9 month		9 month	
Duration of Work	-	-	2 month (±2 weeks)*		2 month (±2 weeks)*		1 month (±1 week)**		1 month (±1 week)**		2 month (±2 weeks)*	
Remove Culvert	$40	LF	0	$ -	242	$ 9,680	0	$ -	0	$ -	242	$ 9,680
Smooth Line Existing Culvert	$1,000	LF	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
9-ft RCP Culvert	$1,200	LF	242	$ 290,400	242	$ 290,400	0	$ -	0	$ -	0	$ -
18-in. Sanitary Sewer	$250	LF	435	$ 108,750	0	$ -	0	$ -	0	$ -	435	$ 108,750
14 ft x 12 ft Box Culvert	$5,100	LF	0	$ -	242	$ 1,234,200	0	$ -	0	$ -	0	$ -
Pipe Culvert Headwall	$9,500	EA	2	$ 19,000	0	$ -	0	$ -	0	$ -	0	$ -
Box Culvert Headwall	$2,200	EA	0	$ -	2	$ 4,400	0	$ -	0	$ -	0	$ -
Raise Building Foundation	$125	SF	0	$ -	0	$ -	3000	$ 375,000	0	$ -	0	$ -
Building Relocation	$120	SF	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -
Floodwall	$800	LF	0	$ -	0	$ -	0	$ -	400	$ 320,000	0	$ -
Interior Drainage System	$7,200	EA	0	$ -	0	$ -	0	$ -	1	$ 7,200	0	$ -
Channel Excavation	$25	CY	0	$ -	0	$ -	0	$ -	0	$ -	8500	$ 212,500
Rock Slope Protection (1/2 Ton)	$200	CY	0	$ -	0	$ -	0	$ -	0	$ -	630	$ 126,000
Rock Slope Protection (Backing No.1)	$150	CY	0	$ -	0	$ -	0	$ -	0	$ -	280	$ 42,000
Transplant Tree	$1,000	EA	50	$ 50,000	50	$ 50,000	0	$ -	0	$ -	80	$ 80,000
New Culvert/Bridge	-	LS	0	$ -	0	$ -	0	$ -	0	$ -	1	$ 75,000
Construction Management	-	LS	1	$ 40,000	1	$ 40,000	1	$ 20,000	1	$ 20,000	1	$ 40,000
Subtotal (rounded up to nearest $1,000)				$ 509,000		$ 1,629,000		$ 395,000		$ 348,000		$ 694,000
Project Administration (5%)				$ 26,000		$ 82,000		$ 20,000		$ 18,000		$ 35,000
Contingency (30%)				$ 152,700		$ 488,700		$ 118,500		$ 104,400		$ 208,200
Design Cost (10%)				$ 50,900		$ 162,900		$ 39,500		$ 34,800		$ 69,400
Total				**$ 738,600**		**$ 2,362,600**		**$ 573,000**		**$ 505,200**		**$ 1,006,600**

Notes:
*Construction activity can only be performed from April 15 to October 15
**Construction can be performed any time of the year, preferably from April 15 to October 15

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