



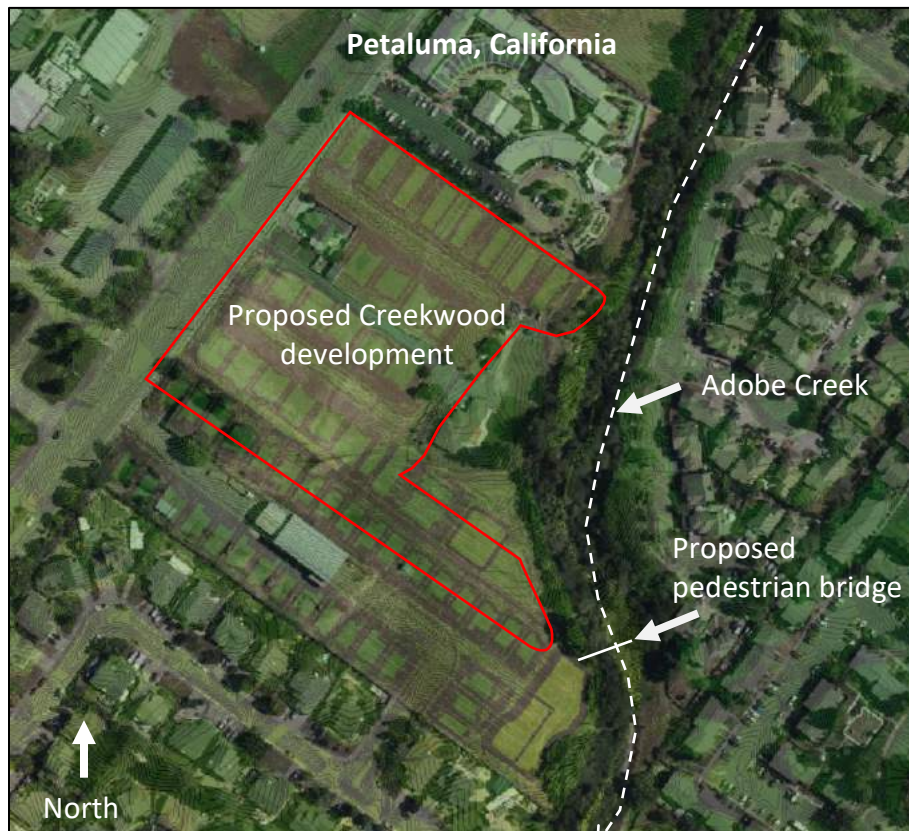
**MEMORANDUM**

Project: Creekwood Adobe Creek HEC-RAS 2D  
Subject: Results Summary  
Date: March 4, 2022  
To: Doyle Heaton, DRG Builders  
From: David S. Smith, P.E., WEST Consultants, Inc.



*David S. Smith*

This memo summarizes the analysis completed by WEST Consultants, Inc. (WEST) for Falcon Point Associates, LLC c/o DRG Builders to evaluate whether the proposed Creekwood development and pedestrian bridge in the City of Petaluma, CA (City) will cause an increase in the 100-year water surface elevation at nearby properties. Two pedestrian bridge lengths were considered in this analysis—90 feet and 120 feet. The location of the proposed development and pedestrian bridge is illustrated in Figure 1.



*Figure 1. Location of proposed Creekwood development and pedestrian bridge.*

The HEC-RAS model previously developed to evaluate the proposed Casa Grande development was also used to evaluate the impact of the adjacent proposed Creekwood development (see Model Development section below). Inflows to the RAS 2D model were based on the xpstorm model that was used for the 2012 FEMA remapping. The reach studied extends from the headwaters of Adobe Creek as modeled in the City’s xpstorm model to the confluence with the Petaluma River.

**Model Development**

WEST used HEC-RAS version 6.0 for this analysis. Inflow hydrographs for the 100-year event were input in HEC-RAS 2D at the same locations as in the xpstorm model. Terrain data for the existing condition 2D model is the same terrain used for the FEMA mapping and xpstorm model, which is a combination of ground and photogrammetric survey collected prior to 2006. The Casa Grande development terrain provided by Steven J. Lafranchi & Associates, Inc. (SJLA) on February 7, 2022 was included as existing conditions. The Casa Grande development grading included in the model prevents flow from reaching Del Oro Circle.

The Creekwood development and pedestrian bridge terrain provided by SJLA were incorporated into the existing condition topography to develop the proposed condition topography. WEST evaluated three proposed condition scenarios for the pedestrian bridge. Scenario 0 consists of a 90-foot single span bridge with a preliminary orientation and abutment design from SJLA, dated November 11, 2021 (Figure 2). This initial simulation was used to evaluate hydraulic characteristics at the bridge after which bridge layout changes were implemented. Results from Scenario 0 are not presented in this memo or included as Exhibits. Scenarios 1 and 2 represent the adjusted orientation of the single span pedestrian bridge as provided by SJLA on February 7, 2022 for 90- and 120-foot lengths, respectively (see Figures 3 and 4)

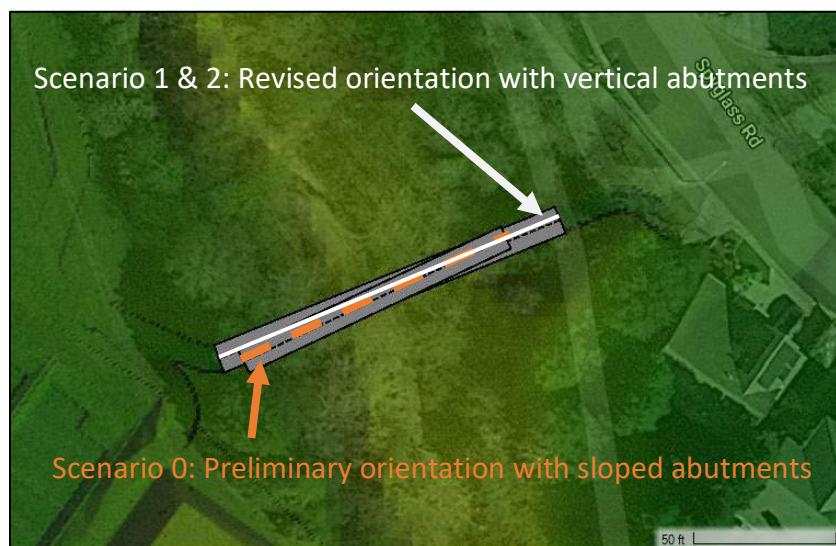


Figure 2. Preliminary orientation versus revised orientation of pedestrian bridge

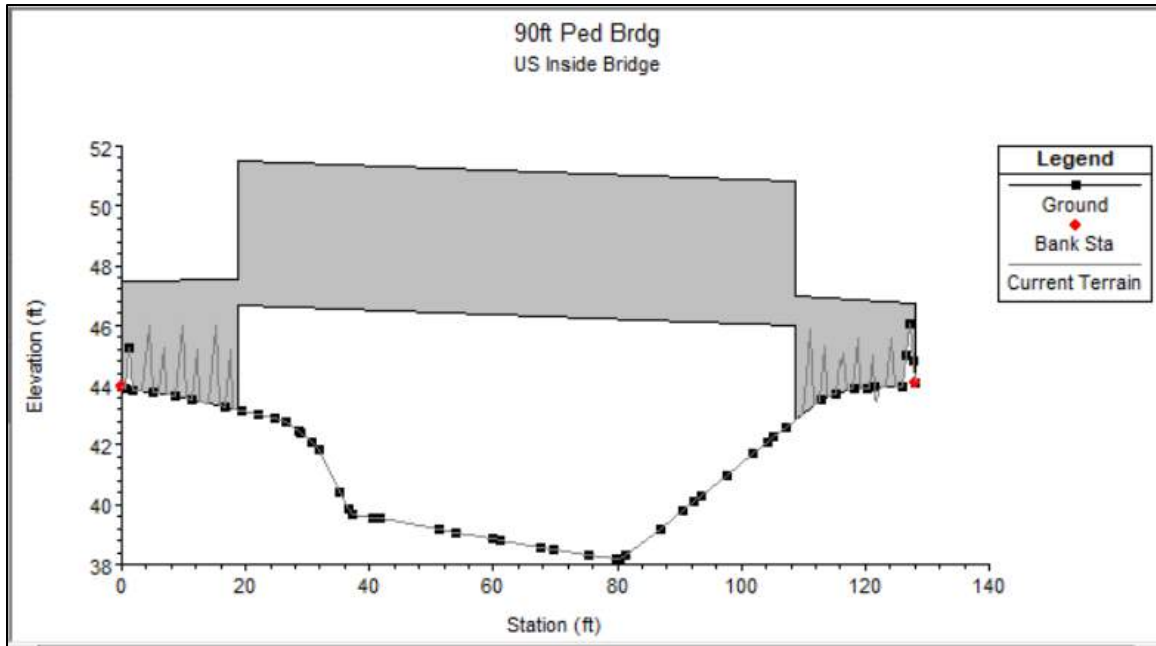


Figure 3. 90-foot pedestrian bridge (Scenario 1).

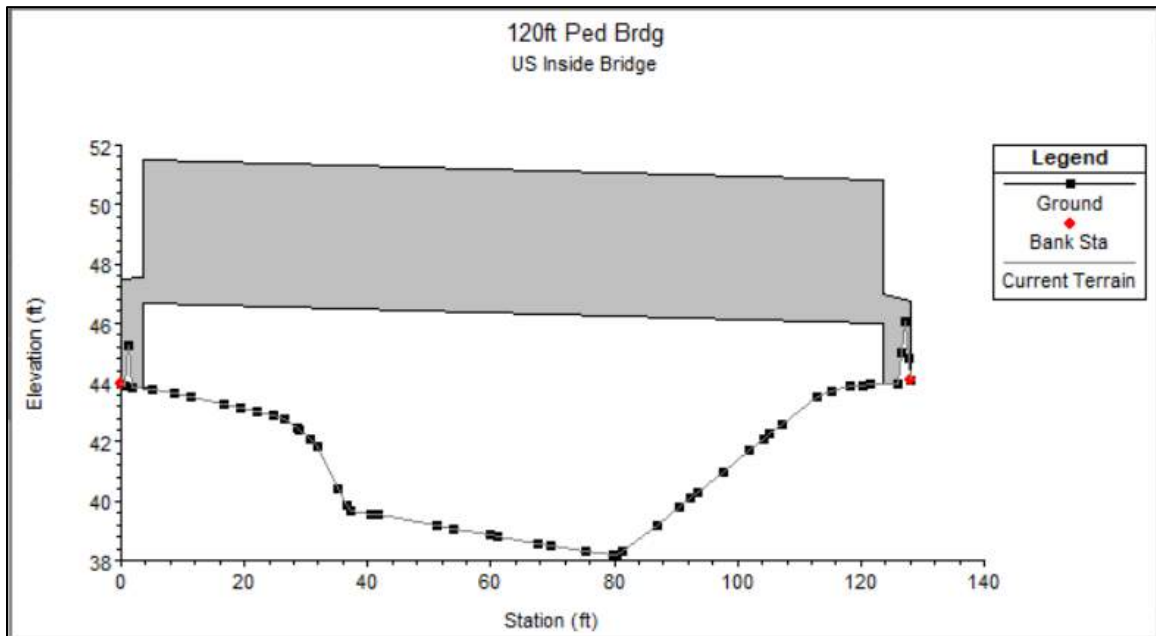


Figure 4. 120-foot pedestrian bridge (Scenario 2).

Culvert sizes and slopes for road crossings along Adobe Creek were based on the xpstorm data; however, the culvert invert elevations specified in the xpstorm model were lower than the terrain invert elevations at the culverts. Modeling in this manner is not possible in HEC-RAS 2D so the invert elevations of the culverts in HEC-RAS were raised to the terrain elevation. This assumption will artificially increase the capacity of the culvert if there is sediment deposition partially blocking the culvert, but it agrees with the xpstorm model

results. Hydraulic structures at Ely Blvd, Satori Drive, Lakeville Highway, and South McDowell Blvd were modeled using rating curves derived from the xpstorm model.

The default grid size used for the HEC-RAS 2D evaluation was 20 feet. HEC-RAS 2D breaklines were added along the channel banks and finer grid cells of approximately 10 feet were defined for the main channel. A time step of 1 second was used to satisfy Courant criteria based on an average channel velocity of about 10 feet per second. The Manning's  $n$  values from the FEMA model were used in this study. The Manning's  $n$  values range from 0.028 to 0.07 in the channel (primarily 0.035 to 0.04), and 0.035 to 0.1 in the overbanks. The existing and proposed conditions Manning's  $n$  values within the Casa Grande and Creekwood development sites are 0.05 and 0.2, respectively.

### **Model Runs and Model Names**

The HEC-RAS project file name for this evaluation is *Creekwood-AdobeCreek.prj*. The following model runs were conducted (model plan names are provided in parenthesis):

1. Existing\_with\_Casa 2-7-22 (*AdobeCreek.p15*).
2. Proposed Creekwood 90ft alt 2-7-22 (*AdobeCreek.p13*)
3. Proposed Creekwood 120ft alt 2-7-22 (*AdobeCreek.p14*)

### **Results**

A floodplain exhibit is provided for each model run. An exhibit for each scenario showing the added areas inundated due to the proposed development and pedestrian bridge are included. The FEMA floodplain boundary polygon is also included in the background for reference:

- Exhibit 1 – Existing conditions
- Exhibit 2 – Proposed conditions: Creekwood development and 90-foot span pedestrian bridge (Scenario 1)
- Exhibit 3 – Proposed conditions: Creekwood development and 120-foot span pedestrian bridge (Scenario 2)
- Exhibit 4 – Floodplain area added due to proposed development (Scenario 1)
- Exhibit 5 – Floodplain area added due to proposed development (Scenario 2)
- Exhibit 6 – Floodplain area added due to proposed development (Scenario 1) zoomed near the vicinity of the bridge
- Exhibit 7 – Floodplain area added due to proposed development (Scenario 2) zoomed near the vicinity of the bridge

Depth results less than 0.1 feet are not shown as the implied accuracy would not be reasonable.

**Discussion**

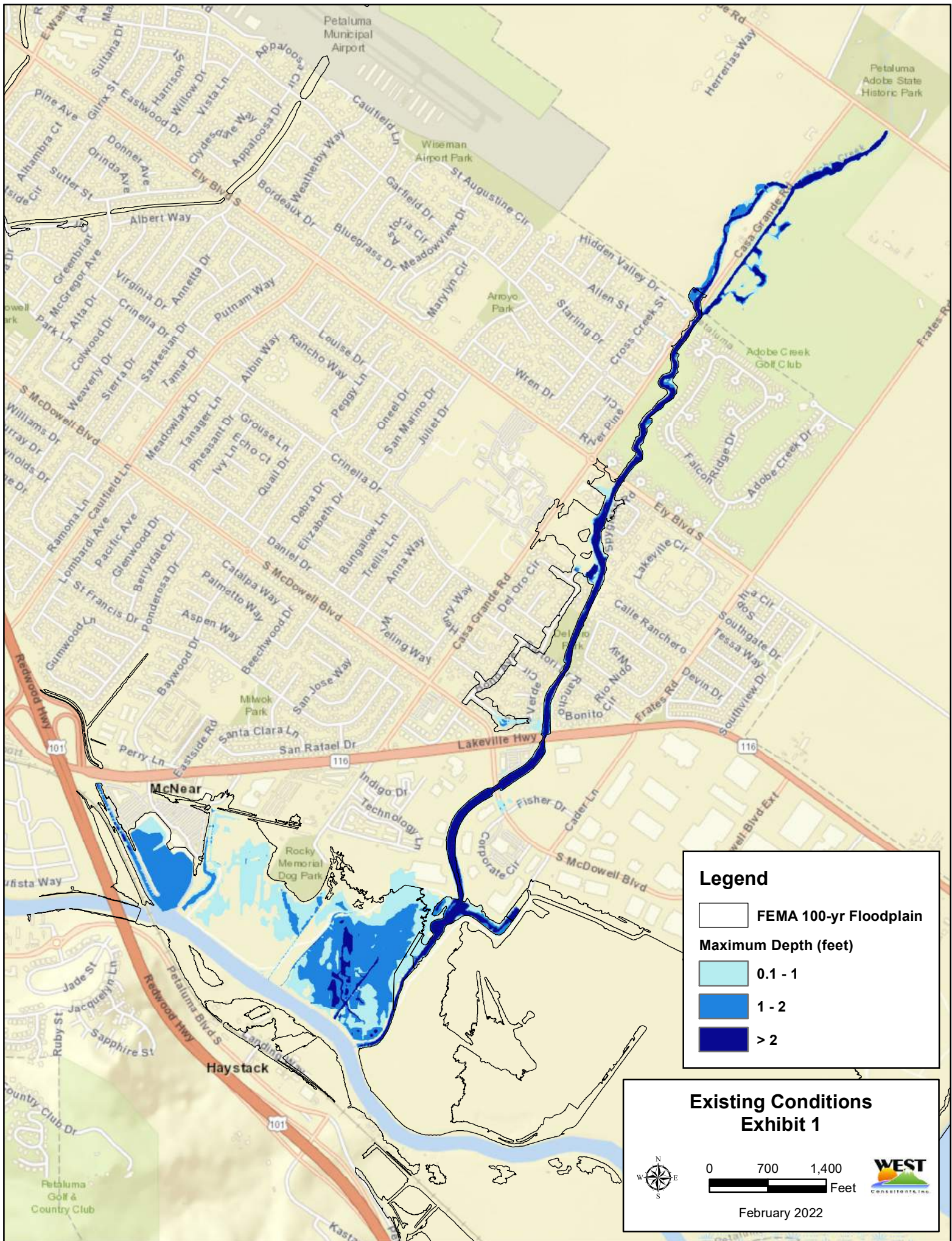
The proposed development and bridge scenarios were evaluated in HEC-RAS 2D and compared to existing condition model results. The results show that there is an increase in water surface elevation (WSE) in the Adobe Creek channel upstream of the proposed pedestrian bridge. For the 90-foot bridge (Scenario 1), the maximum increase in WSE is approximately 0.06 feet just upstream of the bridge. For the 120-foot bridge (Scenario 2), the maximum increase in WSE is approximately 0.04 feet just upstream of the bridge.

Between the north Creekwood development boundary and the pedestrian bridge, the maximum increase in WSE ranges from 0.01 to 0.06 feet for the 90-foot bridge (Scenario 1) and 0.01 to 0.04 feet for the 120-foot bridge (Scenario 2). Given that these ranges of results are less than 0.1 feet (below which the implied accuracy of the model may not be reasonable) the results of the two bridge scenarios are essentially identical. Therefore, from these hydraulic modeling results, increasing the size of the proposed pedestrian bridge from 90-feet to 120-feet does not provide a discernable hydraulic benefit.

# **Exhibit 1**

## **Existing Conditions**



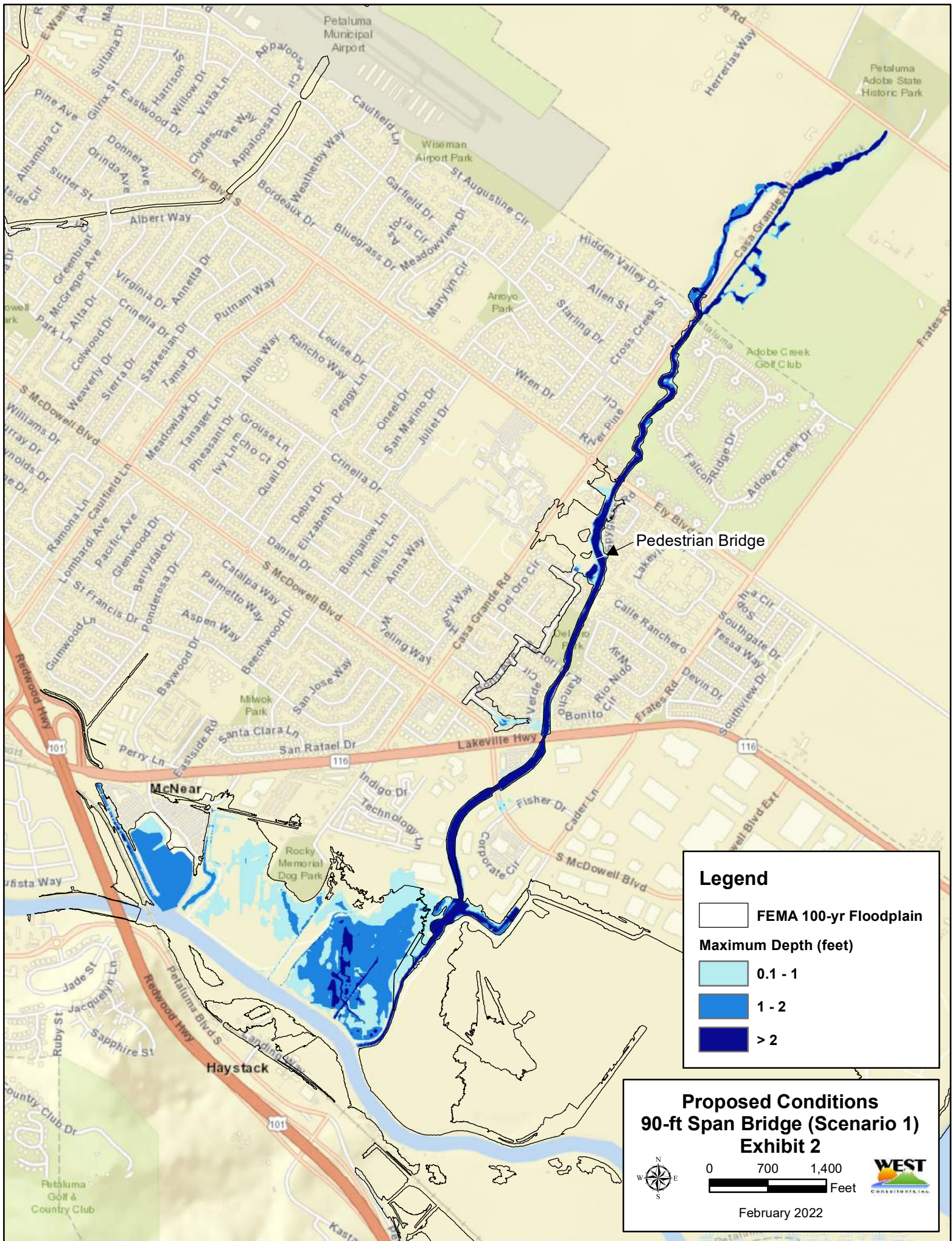


Map showing existing conditions for flooding in Petaluma, California. The map displays the FEMA 100-year floodplain (white outline) and the maximum depth of flooding (feet) in various areas. The map includes street names, parks, and landmarks such as the Petaluma Municipal Airport, Wiseman Airport Park, Arroyo Park, Adobe Creek Golf Club, and Petaluma Adobe State Historic Park. The map is dated February 2022 and is provided by WEST CONSULTING.

## **Exhibit 2**

### **Proposed Conditions – 90-ft Bridge**





**Legend**

- FEMA 100-yr Floodplain

**Maximum Depth (feet)**

- 0.1 - 1
- 1 - 2
- > 2

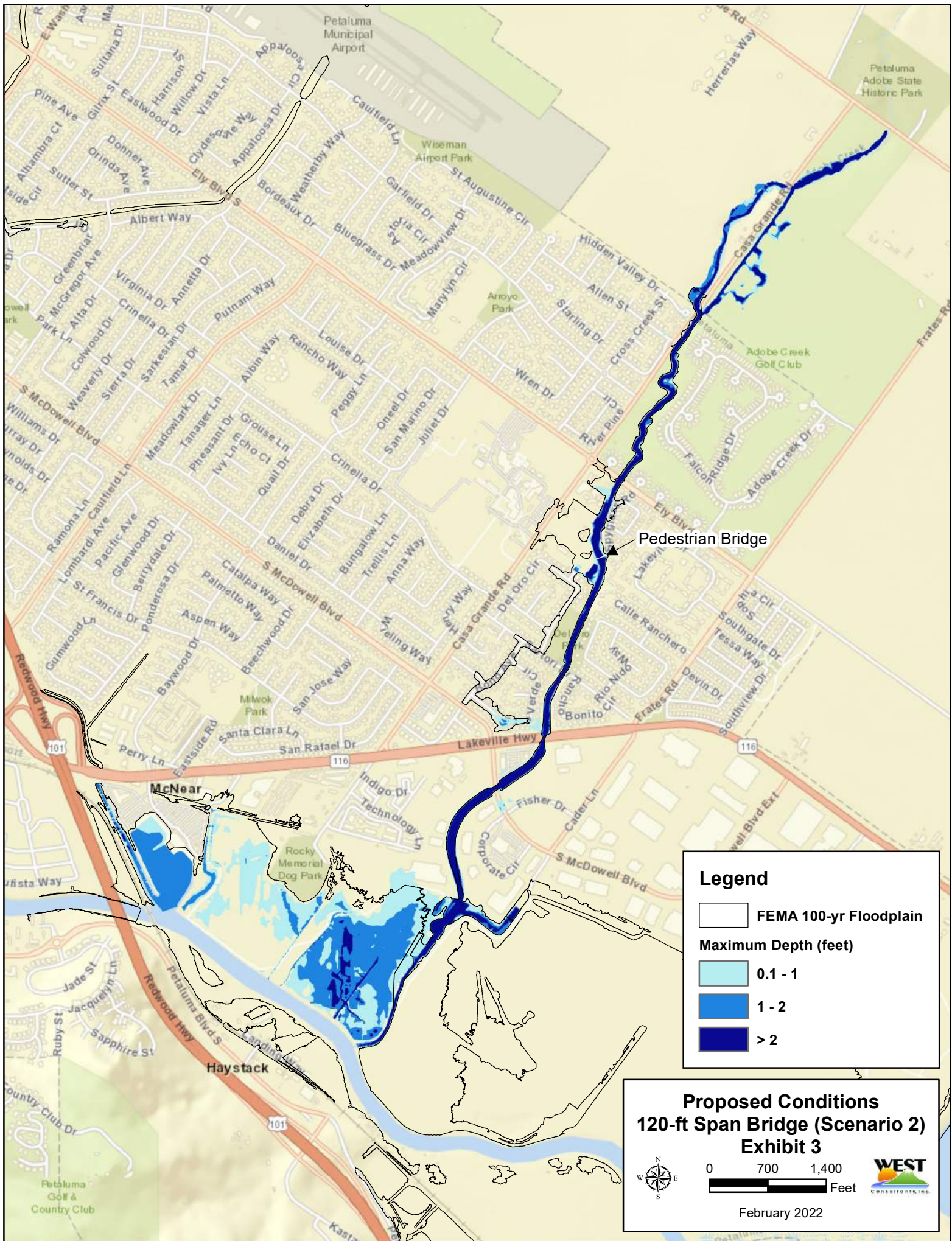
**Proposed Conditions  
90-ft Span Bridge (Scenario 1)  
Exhibit 2**

February 2022

# **Exhibit 3**

## **Proposed Conditions – 120-ft Bridge**





**Legend**

- FEMA 100-yr Floodplain

**Maximum Depth (feet)**

- 0.1 - 1
- 1 - 2
- > 2

**Proposed Conditions  
120-ft Span Bridge (Scenario 2)  
Exhibit 3**

0      700      1,400

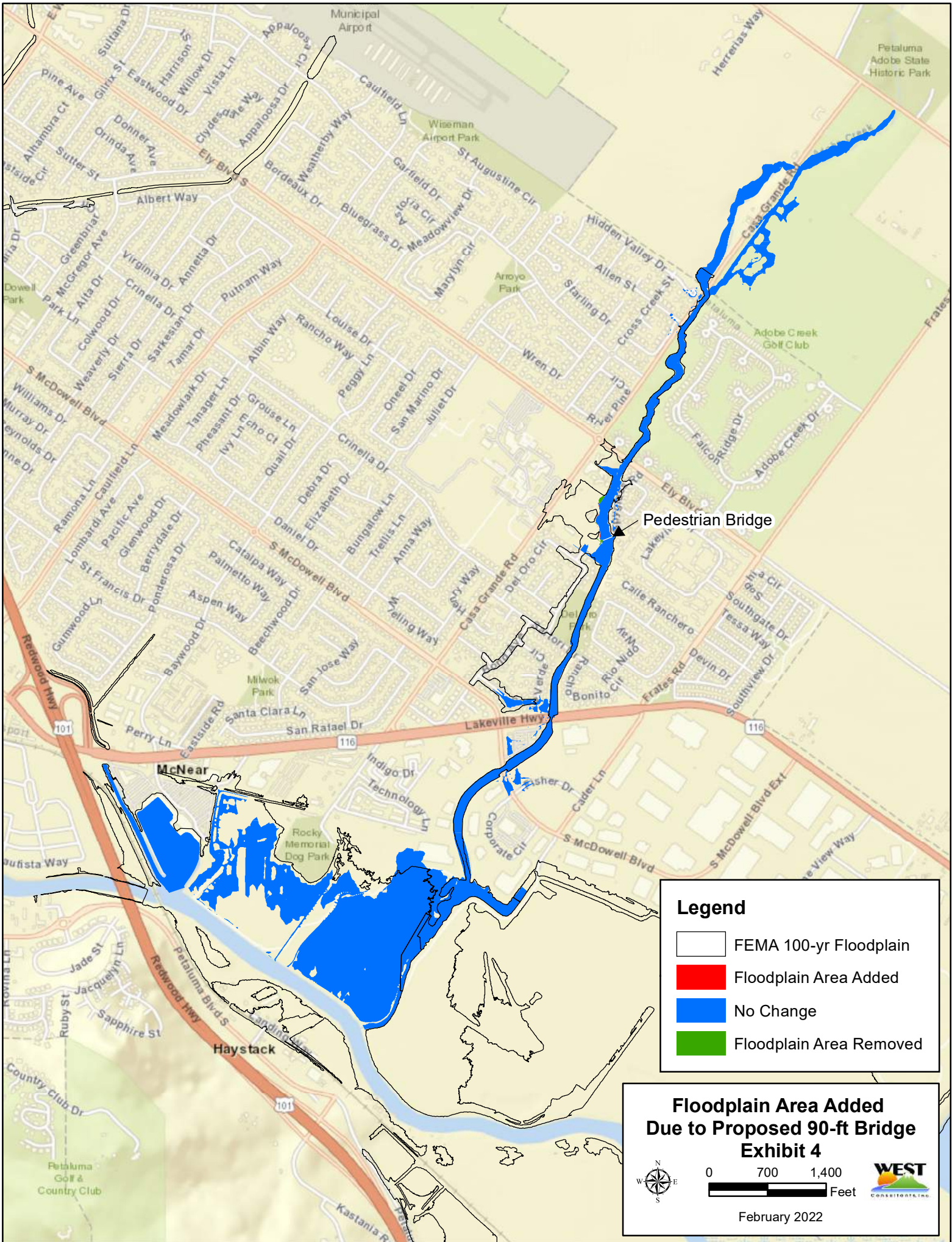
Feet

February 2022

# **Exhibit 4**

## **Floodplain Difference – 90-ft Bridge**





Pedestrian Bridge

McNear

Haystack

Municipal Airport

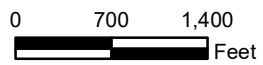
Wiseman Airport Park

Petaluma Adobe State Historic Park

Adobe Creek Golf Club

Rocky Memorial Dog Park

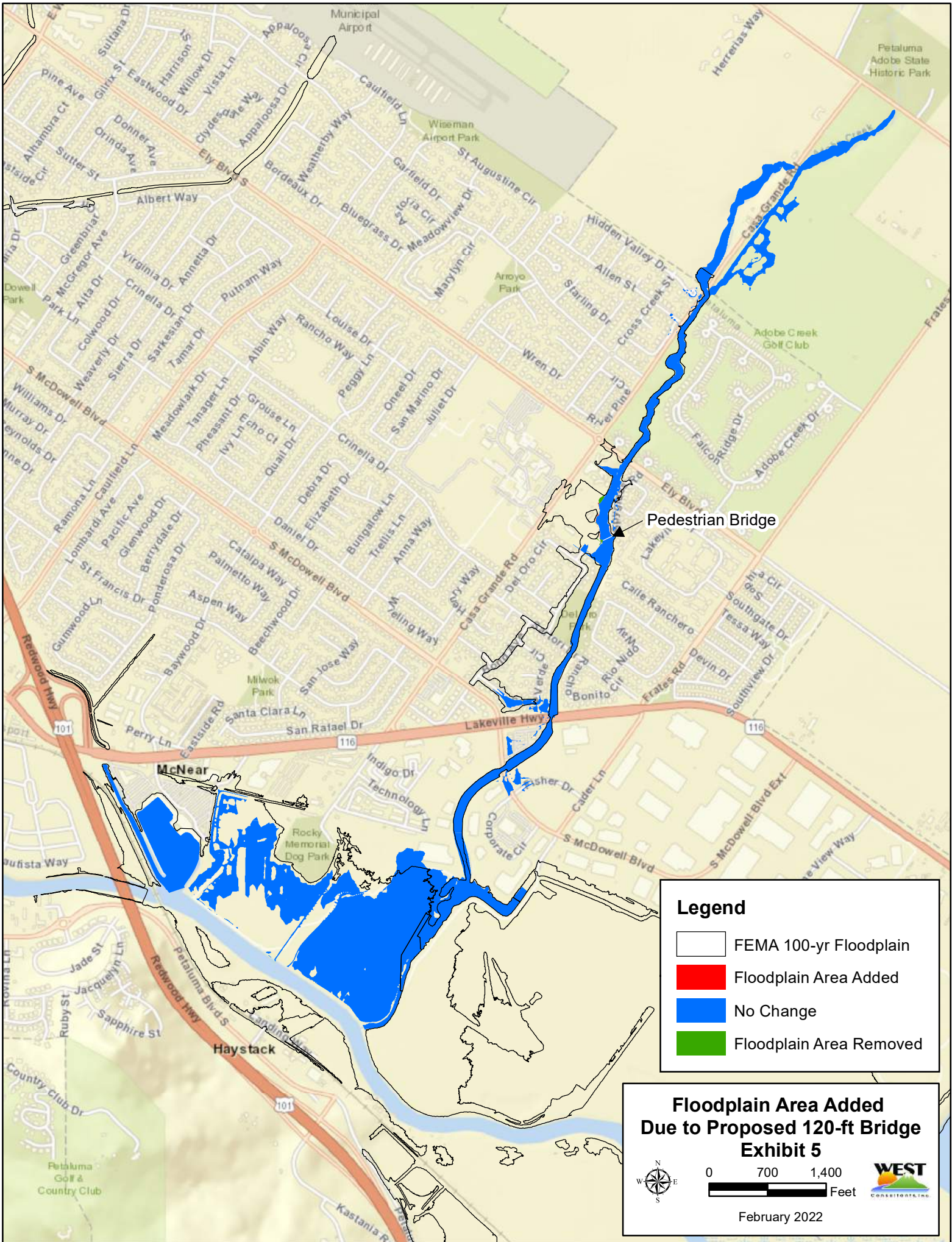
Petaluma Golf & Country Club



# **Exhibit 5**

## **Floodplain Difference 120-ft Bridge**





Pedestrian Bridge

**Legend**

- FEMA 100-yr Floodplain
- Floodplain Area Added
- No Change
- Floodplain Area Removed

**Floodplain Area Added  
Due to Proposed 120-ft Bridge  
Exhibit 5**



0 700 1,400 Feet

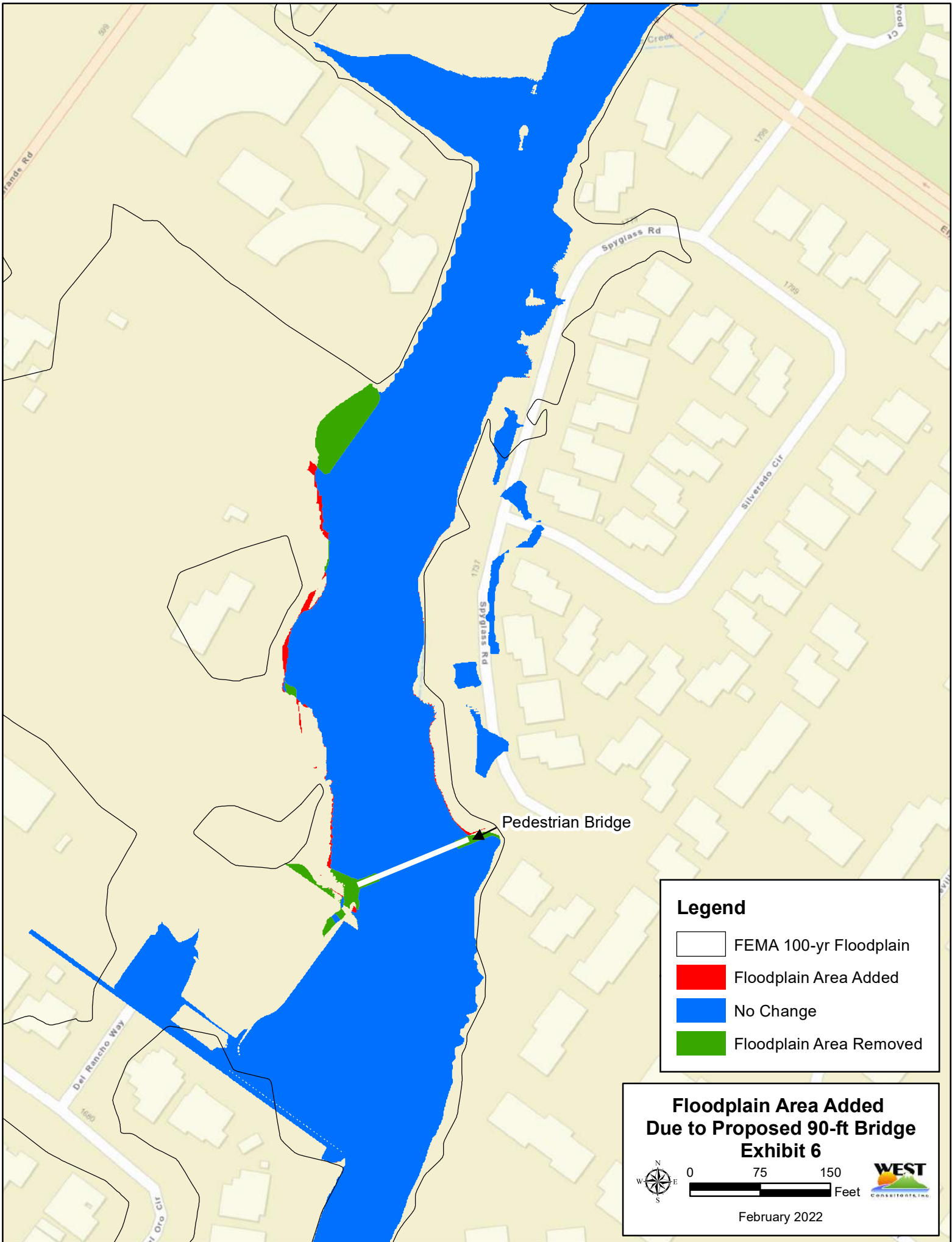


February 2022





## **Exhibit 6**

**Floodplain Difference – 90-ft Bridge (Zoomed)**





**Legend**

-  FEMA 100-yr Floodplain
-  Floodplain Area Added
-  No Change
-  Floodplain Area Removed

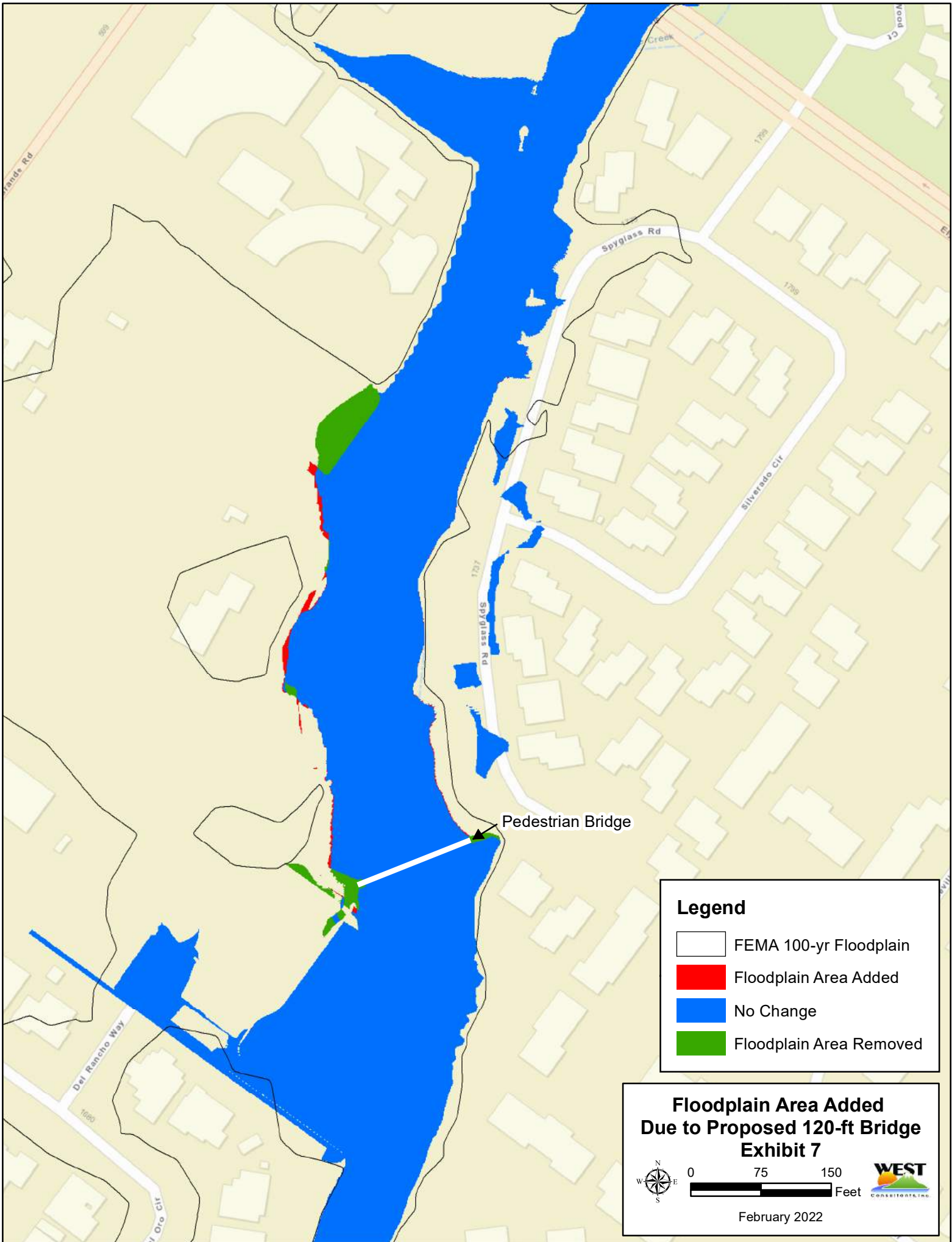
**Floodplain Area Added  
Due to Proposed 90-ft Bridge  
Exhibit 6**



February 2022

## **Exhibit 7**

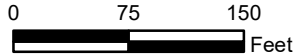
**Floodplain Difference – 120-ft Bridge (Zoomed)**



**Legend**

- FEMA 100-yr Floodplain
- Floodplain Area Added
- No Change
- Floodplain Area Removed

**Floodplain Area Added  
Due to Proposed 120-ft Bridge  
Exhibit 7**



February 2022