Saint Mary's Road Double Roundabouts Project
Town of Moraga, Contra Costa County, California

Draft Floodplain Evaluation Report

Prepared for:

Prepared by:

August 2019

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Town of Moraga, Contra Costa County, California

Draft Floodplain Evaluation Report

Submitted to:
Town of Moraga

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

_____
Kazuya Tsurushita, P.E.
Registered Civil Engineer

_____
Date

August 2019

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Executive Summary

The Town of Moraga (Town) is proposing the Saint Mary's Road Double Roundabouts Project (Project). The Project would construct two roundabouts on Saint (St.) Mary's Road at the Rheem Boulevard and Bollinger Canyon Road intersections and create safer pedestrian and bicycle crossings. The Project would be implemented in the Town of Moraga, Contra Costa County, California. The purpose of the Project is to alleviate the current congestion, reduce intersection delays and queues, improve safety, and to better accommodate pedestrian and bicycle traffic.

The proposed improvements include widening St. Mary's Road, Rheem Boulevard, and Bollinger Canyon Road to accommodate two new roundabouts and the approaches to the roundabouts. Efforts to improve traffic operations and safety would require the roadway to be relocated, partially outside the existing right-of-way. The two directions of traffic would be separated by road stripping (and medians approaching the roundabouts). Retaining walls are proposed at the St. Mary's Road/Bolling Canyon Road intersection to avoid impacts to the creek due to steeper surface slopes from the proposed roadway widenings. The Project does not propose to make any modifications to the existing cross culvert that conveys Las Trampas Creek across St. Mary's Road.

The purpose of this study is to examine and analyze the existing Las Trampas Creek base (100-year) floodplain within the Project limits, to document any potential impacts to or encroachments upon the floodplain, and to recommend any avoidance, minimization, or mitigation measures that may be required. The Federal Highway Administration (FHWA) defines impacts to and significant encroachment on a floodplain using the following conditions:

1. Significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route,
2. Significant risk (which may result from changes in land use, fill inside the floodplain, or change in water surface elevation [WSE]), or
3. Significant adverse impact on the natural and beneficial floodplain values.

The guidelines of the implementation of the California Environmental Quality Act (CEQA) describe significant environmental effects to include impacts that can be mitigated but not reduced to a level of insignificance.

The Las Trampas Creek floodplain at the Project crossing on St. Mary's Road and in the vicinity of the Project is a FEMA designated Zone AE area with a regulatory floodway. The flood profile of Las Trampas Creek from FEMA FIS shows 100-year flood would overtop St. Mary's Road crossing. Zone AE floodplains represent areas subject to inundation during the 100-year flood event determined by detailed methods where base flood elevations (BFE) are provided. The remainder of the proposed Project improvements are located within a FEMA unshaded Zone X region, which represent areas of minimal flood hazard defined to be outside of the special flood hazard area (SFHA) and above the 500-year flood level.

FEMA defines floodways as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing

the WSE more than a designated height. Development within the adopted regulatory floodway are prohibited, under federal regulations, unless it has been demonstrated through hydrologic and hydraulic analyses that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the 100-year flood.

FEMA Flood Insurance Study (FIS) for Contra Costa County, California, and Incorporated Areas were reviewed to obtain hydrologic data about the Project area. The 1,500 cubic feet per second (cfs) 100-year peak discharge of Las Trampas Creek at Saint Mary's Road provided in the FIS (volume 1 of 5) was selected as the Project's design flow. The hydraulic analysis was performed using the Unites States Army Corps of Engineers' (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling software (Version 5.0.3). The resulting 100-year WSEs of the existing and proposed conditions are presented in the following table.

100-Year Water Surface Elevations

RS*	Location/Distance from Existing Bridge Centerline	Water Surface Elevations (ft)		
		Existing Condition	Proposed Condition	Change
1196	600 ft Upstream of Existing Culvert / Upstream Limit of Hydraulic Model	552.39	552.41	0.02
1008	410 ft Upstream of Existing Culvert	552.38	552.39	0.01
834	240 ft Upstream of Existing Culvert	552.38	552.40	0.02
675	80 ft Upstream of Existing Culvert	552.38	552.40	0.02
610	Culvert	--	--	--
515	80 ft Downstream of Existing Culvert	522.21	522.21	0.00
5	590 ft Downstream of Existing Culvert / Downstream Limit of Hydraulic Model	514.81	514.81	0.00

*Note: RS = River Station.

As indicated by the hydraulic models, the proposed improvements would not cause any significant changes to the existing condition WSEs. Similar to the FEMA FIS flood profiles, the 100-year flow would overtop the culvert and inundate St. Mary's Road, potentially causing traffic interruptions in the existing and proposed conditions and therefore, there are no risks associated with changes to WSEs. Subsequently, the potential for traffic interruptions would not be changed as a result of the Project.

The proposed Project would not change the overall land use within the Project watershed and would not cause significant impacts due to increased impervious areas. Proposed fill within the floodway due to roadway improvements would be balanced by cut. Fill within the floodway due to the proposed retaining walls would not cause any impacts to the floodplain as indicated by the hydraulic model results. Therefore, the overall Project's possible adverse effects to the base floodplain would be insignificant, and additional avoidance, minimization, and/or mitigation measures were not considered.

Per the Project's Biological Resources Study (BRS), there are potential impacts to jurisdictional Other Waters of the U.S., Alameda whipsnake, California red-legged frog habitat, and nesting

San Francisco dusky foot woodrats. The Project's impacts to the above listed natural and beneficial floodplain values are currently being assessed and will be completed upon the completion of the pertinent aspect of the Project design. Avoidance, minimization, and/or mitigation measures to restore the natural and beneficial floodplain values identified within the Project's biological study area (BSA) will be included during the Project's design phase, if needed.

Acronyms

ADT	average daily traffic
BFE	Base Flood Elevation
BIR	Bridge Inspection Report
BRS	Biological Resources Study
BSA	biological study area
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIP	Capital Improvement Program
DWR	Department of Water Resources
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
ft	foot / feet
HEC-RAS	Hydrologic Engineering Center's River Analysis System
inches	in.
LOS	level of service
NFIP	National Flood Insurance Program
NAVD 88	North American Vertical Datum of 1988
NFHL	National Flood Hazard Layer
Project	Saint Mary's Road Double Roundabouts Project
PS&E	Plans, Specifications, and Estimates
RS	river station
SFHA	special flood hazard area
SSSC	side-street stop-controlled
St.	Saint
sq. mi.	square mile(s)
USGS	United States Geological Survey
USACE	Unites States Army Corps of Engineers

TECHNICAL INFORMATION FOR LOCATION HYDRAULIC STUDY

Dist. 4 Co. Contra Costa County Rte. Saint Mary's Road P.M.
Federal-Aid Project Number: N/A Project ID: N/A
Bridge No. N/A

Floodplain Description:
The Las Trampas Creek floodplain at the project crossing on Saint Mary's Road and in the vicinity of the project is a FEMA designated Zone AE area with a regulatory floodway. Zone AE floodplains represent areas subject to inundation during the 1%-annual chance (or the 100-year) flood event determined by detailed methods where base flood elevations (BFE) are provided. The remainder of the proposed Project improvements are located within a FEMA unshaded Zone X region, which represent areas of minimal flood hazard defined to be outside of the special flood hazard area (SFHA) and above the 500-year flood level. Per FEMA FIS, the existing roadway is overtopped at the culvert crossing at Saint Mary's Road.

1. Description of Proposal *(include any physical barriers i.e. concrete barriers, sound walls, etc. and design elements to minimize floodplain impacts)*
The Project would widen St. Mary's Road, Rheem Boulevard, and Bollinger Canyon Road to accommodate two new roundabouts and the approaches to the roundabouts. Efforts to improve traffic operations and safety would require the roadway to be relocated, partially outside the existing right-of-way.

2. ADT: Current N/A Projected N/A

3. Hydraulic Data:

Base Flood Q100= 1,500 CFS
WSE100= 553.3 ft (Existing, overtopping) and 553.3 ft (Proposed, overtopping)

The flood of record, if greater than Q100:
Q= N/A CFS WSE= N/A
Overtopping flood Q= 1,190 CFS WSE= 551.7 ft

Are NFIP maps and studies available? NO ____ YES X

4. Is the highway location alternative within a regulatory floodway?
NO ____ YES X

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain.

Potential Q100 backwater damages:

A.	Residences?	NO X	YES ____
B.	Other Bldgs?	NO X	YES ____
C.	Crops?	NO X	YES ____
D.	Natural and beneficial Floodplain values?	NO ____	YES X

"Natural and beneficial flood-plain values" shall include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

TECHNICAL INFORMATION FOR LOCATION HYDRAULIC STUDY cont.

Dist. 4 Co. Contra Costa County Rte. Saint Mary's Road P.M. _____
Federal-Aid Project Number: N/A Project ID: N/A
Bridge No. N/A

6. Type of Traffic:

A. Emergency supply or evacuation route?	NO _____	YES X
B. Emergency vehicle access?	NO _____	YES X
C. Practicable detour available?	NO X	YES _____
D. School bus or mail route?	NO _____	YES X

7. Estimated duration of traffic interruption for 100-year event hours: N/A

8. Estimated value of Q100 flood damages (if any) – moderate risk level.

A.	Roadway	$ N/A
B.	Property	$ N/A
	Total	$ N/A

9. Assessment of Level of Risk

Low	X
Moderate	
High	

For High Risk projects, during design phase, additional Design Study Risk Analysis may be necessary to determine design alternative.

PREPARED BY:

Signature:
I certify that I have conducted a Location Hydraulic Study consistent with 23 CFR 650 and that the information summarized in items numbers 3, 4, 5, 7, and 9 of this form is accurate.

_____ *Date* _____
District Hydraulic Engineer *(capital and 'on' system projects)*

_____ *Date* _____
Local Agency/Consulting Hydraulic Engineer *(local assistance projects)*

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible Floodplain development? NO X YES _____

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

I certify that item numbers 1, 2, 6 and 8 of this Location Hydraulic Study Form are accurate and will ensure that Final PS&E reflects the information and recommendations of said report:

TECHNICAL INFORMATION FOR LOCATION HYDRAULIC STUDY cont.

Dist. 4 Co. Contra Costa County Rte. Saint Mary's Road P.M. _____
Federal-Aid Project Number: N/A Project ID: N/A
Bridge No. N/A

_____ *Date* _____
District Project Engineer *(capital and 'on' system projects)*

_____ *Date* _____
Local Agency Project Engineer (*local assistance projects)*

CONCURRED BY:
I have reviewed the quality and adequacy of the floodplain submittal consistent with the attached checklist, and concur that the submittal is adequate to meet the mandates of 23 CFR 650.

_____ *Date* _____
District Project Manager *(capital and 'on' system projects)*

_____ *Date* _____
Local Agency Project Manager *(Local Assistance projects)*

_____ *Date* _____
District Local Assistance Engineer *(or District Hydraulic Branch for very complex projects or when required expertise is unavailable. Note: District Hydraulic Branch review of local assistance projects shall be based on reasonableness and concurrence with the information provided).*

I concur that the natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.

_____ *Date* _____
District Senior Environmental Planner *(or Designee)*

Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.

FLOODPLAIN EVALUATION REPORT SUMMARY

Dist. 4 Co. Contra Costa County Rte. Saint Mary's Road K.P. _____
Federal-Aid Project Number *(Local Assistance)* N/A Project No.: N/A
Bridge No. N/A

Limits: The Project would widen St. Mary's Road, Rheem Boulevard, and Bollinger Canyon Road to accommodate two new roundabouts and the approaches to the roundabouts. Efforts to improve traffic operations and safety would require the roadway to be relocated, partially outside the existing right-of-way.

Floodplain Description: The Las Trampas Creek floodplain at the Project crossing on St. Mary's Road and in the vicinity of the project is a FEMA designated Zone AE area with a regulatory floodway. Zone AE floodplains represent areas subject to inundation during the 1%-annual chance (or the 100-year) flood event determined by detailed methods where base flood elevations (BFE) are provided. The remainder of the proposed Project improvements are located within a FEMA unshaded Zone X region, which represent areas of minimal flood hazard defined to be outside of the special flood hazard area (SFHA) and above the 500-year flood level.

		No	Yes
1.	Is the proposed action a longitudinal encroachment of the base floodplain?	✓	
2.	Are the risks associated with the implementation of the proposed action significant?	✓	
3.	Will the proposed action support probable incompatible floodplain development?	✓	
4.	Are there any significant impacts on natural and beneficial floodplain values?	✓	
5.	Routine construction procedures are required to minimize impacts on the floodplain. Are there any special mitigation measures necessary to minimize impacts or restore and preserve natural and beneficial floodplain values? If yes, explain.	✓	
6.	Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR, Section 650.105(q).	✓	
7.	Are Location Hydraulic Studies that document the above answers on file? If not explain.		✓

PREPARED BY:

_____ *Date* _____
District Project Engineer *(capital and 'on' system projects)*

_____ *Date* _____
Local Agency/Consulting Hydraulic Engineer *(local assistance projects)*

FLOODPLAIN EVALUATION REPORT SUMMARY cont.

Dist. 4 Co. Contra Costa County Rte. Saint Mary's Road K.P.
Federal-Aid Project Number *(Local Assistance)* N/A Project No.: N/A
Bridge No. N/A

CONCURRED BY:

_____ *Date* _____
District Project Manager *(capital and 'on' system projects)*

_____ *Date* _____
District Local Assistance Engineer *(Local Assistance projects)*

I concur that impacts to natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.

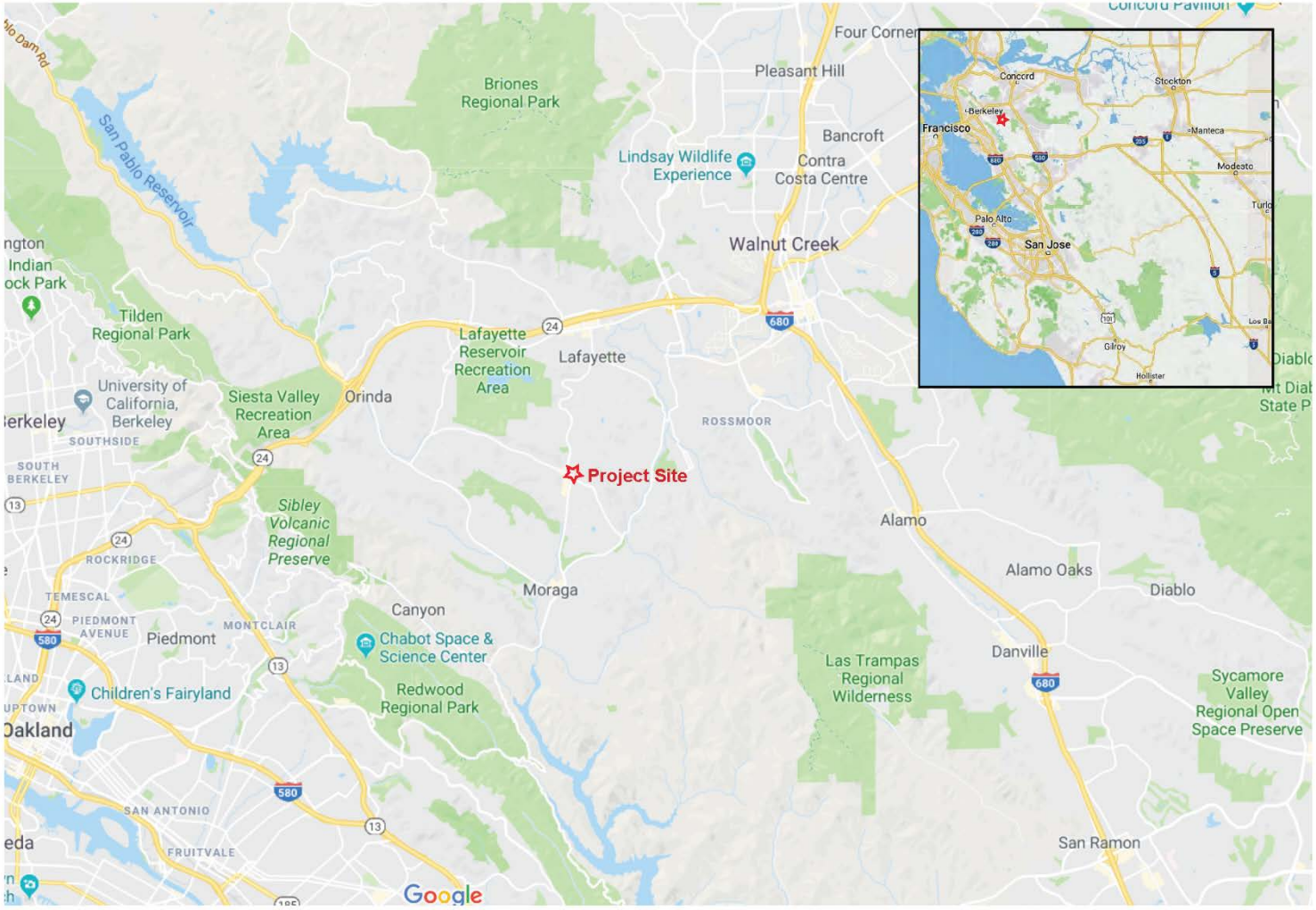
_____ *Date* _____
District Senior Environmental Planner *(or Designee)*

Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.

1 GENERAL DESCRIPTION

The Town of Moraga (Town) proposes to provide improvements to a single-lane roundabout corridor at the intersections of St. Mary's Road/Rheem Boulevard and St. Mary's Road/Bollinger Canyon Road. The St. Mary's Double Roundabouts Project (Project) would improve traffic operations and pedestrian and bicycle access and safety. The Project would construct two roundabouts on St. Mary's Road at the Rheem Boulevard and Bollinger Canyon Road intersections and create safer pedestrian and bicycle crossings. The Project would be implemented in the Town of Moraga, Contra Costa County, California. Figure 1, *Regional Location Map*, and Figure 2, *Vicinity Map*, shows the Project vicinity and location, respectively. The Town is the lead agency under CEQA.

The Project is included in the Town of Moraga Capital Improvement Program (CIP). The design concept and scope of the Project is consistent with the Project description in the CIP and is intended to meet the traffic needs in the area based on local land use plans. The Project would improve traffic operations, and pedestrian and bicycle access and safety. The Project is partially funded through Measure J 2013 Strategic Plan: Major Streets category.



Source: Google Maps, 2019

Figure 1: Regional Location Map
St Mary's Double Roundabouts Project

Not to scale

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Figure 1. Project Location

Source: ESRI World Imagery, 2019.

Figure 1: Vicinity Map
St Mary's Double Roundabouts Project

Figure 2. Project Vicinity

1.1 Project Purpose

The purpose of the Project is to provide congestion relief at the St. Mary's Road and Rheem Boulevard intersection and improve stopping sight distance and visibility at the Rheem Boulevard and Bollinger Canyon Road intersections. The Project is proposed to alleviate the current congestion, reduce intersection delays and queues, improve safety and to better accommodate pedestrian and bicycle traffic.

1.2 Project Need

The proposed Project is needed because the roadway presently experiences inadequate intersection level of service (LOS) under cumulative build-out conditions with traffic queue lengths exceeding existing intersection geometry. Improvements at this intersection are also needed to accommodate projected growth of the St. Mary's College campus, and to address safety issues at the intersection. Additionally, the roadway geometry and topography at these closely spaced intersections has insufficient stopping sight distance with visibility issues approaching the Rheem Boulevard and Bollinger Canyon Road intersections, which in turn, result in high accident rates and decreased safety.

Traffic collision data from 2010 through 2015 for the Rheem Boulevard and Bollinger Canyon Road intersections were provided by the Town of Moraga Police Department. Eight traffic related incidents were reported involving minor injuries and property damage. A majority of reported accidents occurred at the St. Mary's/Rheem stop controlled intersection with rear end and side impact collisions between motor vehicles due to limited visibility and sight distance. Two collisions involving bicyclists were also reported, one resulting in an injury. There was also a report of an overturned truck on the curve in between the intersections in 2012.

In December 2008, Fehr & Peers prepared a report titled St. Mary's Road Improvement Evaluation at Rheem Boulevard and Bollinger Canyon Road, which evaluated the physical and operation characteristics of the St. Mary's intersections at Rheem Boulevard and Bollinger Canyon Road to recommend near-term and long-term improvements. In May 2015, Omni-means prepared the St. Mary's Road Roundabout Feasibility Study, which analyzes the design features and safety assessment of a proposed single-lane roundabout corridor at the intersections of St. Mary's Road/Rheem Boulevard and St. Mary's Road/Bollinger Canyon Road in the Town of Moraga.

The heavy congestion along this roadway can be attributed to several regional destinations having access from St. Mary's Road, including the St. Mary's College campus, the shopping center on Moraga Way, and existing residential development.

In addition to vehicle traffic, the Project site contains pedestrian and bicycle traffic. The Lafayette/Moraga Regional Trail runs parallel to St. Mary's Road and crosses the intersection of St. Mary's Road/Rheem Boulevard via an at-grade crosswalk. The crossing is marked with white striping and does not have any lighting or sign features. Currently, there are gaps in the pedestrian network, with limited sidewalks along most of the Project corridor. This results in unsafe pedestrian movements through the Project site.

1.3 Existing Facilities

1.3.1 Roadway Facilities

St. Mary's Road is a two-lane roadway that intersects with Bollinger Canyon Road just to the east of the Las Trampas Creek crossing. Bollinger Canyon Road is aligned fairly parallel to the Las Trampas creek channel upstream of St. Mary's Road. Rheem Boulevard intersects with St. Mary's Road approximately 500 ft south of the St. Mary's Road/Bollinger Canyon Road intersection. Rheem Boulevard lies on the downstream side of the Project crossing and diverges away from the creek channel further away from the Project crossing.

1.3.2 Bicycle and Pedestrian Facilities

The Lafayette/Moraga Regional Trail runs parallel and west of St. Mary's Road, crossing Rheem Boulevard via a cross walk in front of the side-street stop-controlled (SSSC) intersection.

1.3.3 Las Trampas Creek Cross Culvert

The existing Las Trampas Creek cross culvert below St. Mary's Road is a single 6 ft x 8 ft (span x height) reinforced concrete box culvert with a length of approximately 119 ft. The culvert has concrete aprons at the inlet and outlet that extend approximately 14 ft from the headwalls. Photo 1 shows the upstream culvert headwall and apron of the cross culvert.

Photo 1. Existing Las Trampas Creek Cross Culvert (Upstream Face)

1.4 Build Alternative (Proposed Project)

The proposed Project would accommodate anticipated multimodal transportation increases by improving capacity for all travel modes, provide designated facilities separated from the vehicular traffic for pedestrians and bicycles, improve intersection capacity, and reduce overall delays and improve safety.

1.4.1 Roadway Facilities

The Project would widen St. Mary's Road, Rheem Boulevard, and Bollinger Canyon Road to accommodate two new roundabouts and the approaches to the roundabouts. The existing two-lane roadways would remain as two-lane roadways. The roundabout geometry will be designed in a way to decrease approaching speeds at these intersections and improve visibility, subsequently improving traffic operations and safety. These improvements would require the roadway to be relocated, partially outside the existing right-of-way.

As shown in Figures 3a, 3b, and 3c, *Proposed Roadway Design*, the vehicle travel lanes would be 12 feet (ft) wide. The proposed roundabouts would have single-lane entries on all intersection approaches and the central islands would be circular in shape with a symmetric diameter. The St. Mary's Road/Rheem Boulevard roundabout would be approximately 120 ft in diameter, with landscaping in the center. The St. Mary's Road/Bollinger Canyon roundabout would be a mini roundabout, approximately 80 ft in diameter. The two directions of traffic would be separated by road stripping (and medians approaching the roundabouts). The existing roadway would be excavated from between 4 to 16 inches (in.) where pavement would be replaced. The new relocated segments of roadway would require excavation of depths up to 2 ft. The two directions of traffic would be separated by road striping and medians approaching the roundabouts. The medians would be excavated to a maximum depth of 6 ft, measured from existing roadway surface, to provide room for import soil and roadway signs.

To accommodate the roadway widening, existing slopes would need to be excavated and laid back. This may result in a vertical difference between the existing slope surface and the new slope surface. Retaining walls would be needed at the St. Mary's Road Bollinger Canyon Road intersection to avoid impacts to the creek. Retaining walls would range in height up to a maximum of 8 ft. Retaining walls would require excavation up to 10 ft from existing surface.

Native material from the Project site would be used to construct the proposed roadway embankment. Up to 480 cubic yards of native materials would need to be imported to the site during construction.

As shown in Figures 4a and 4b, *Proposed Roundabout Sections*, the existing intersections of St. Mary's Road / Rheem Boulevard and St. Mary's Road / Bollinger Canyon Road would be converted to roundabouts. The existing SSSC intersections of St. Mary's Road / Rheem Boulevard and St. Mary's Road / Bollinger Canyon Road would be converted to 'yield' approaches. New yield sign pole foundations may be necessary at both intersections, requiring excavation of up to 6 ft deep.

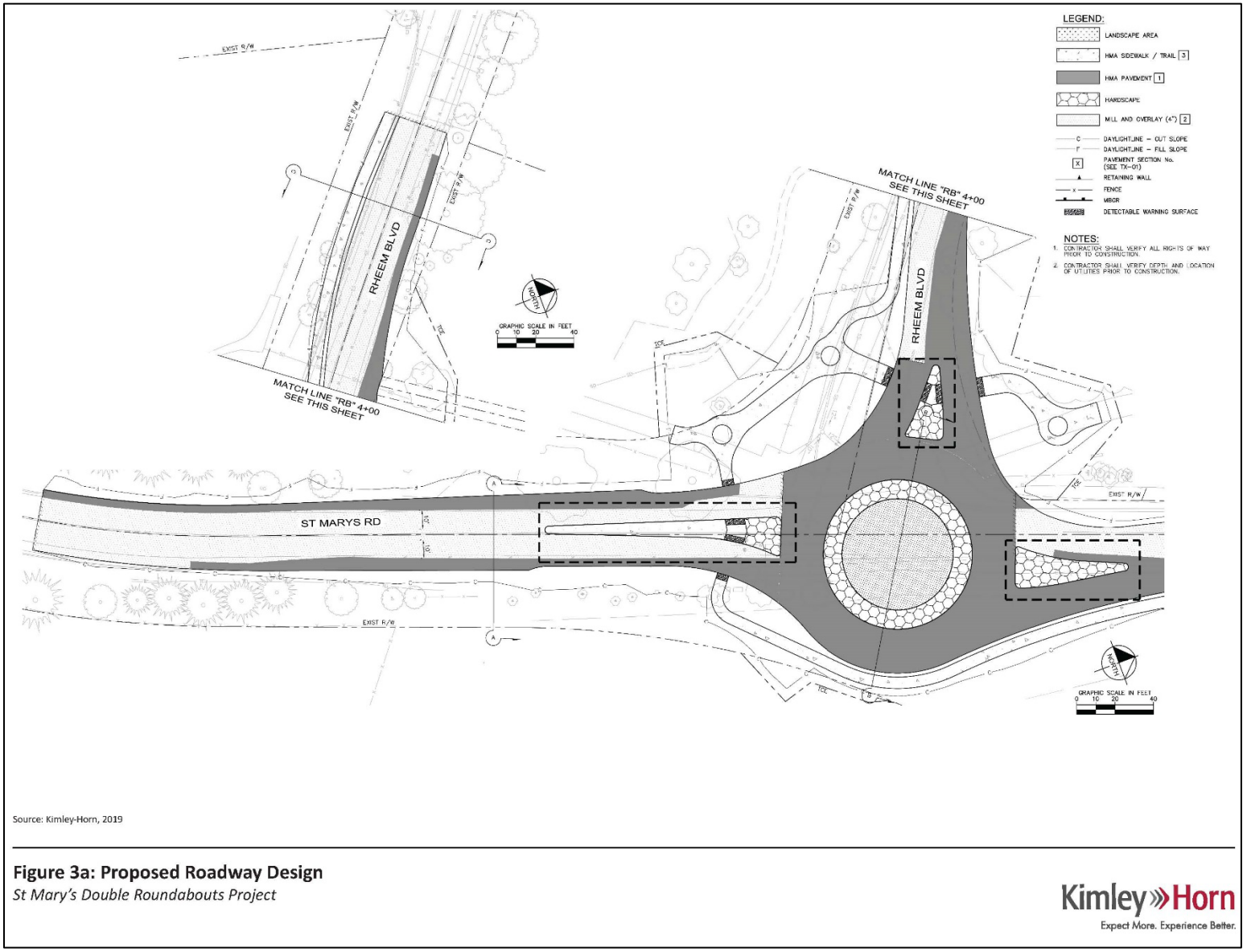
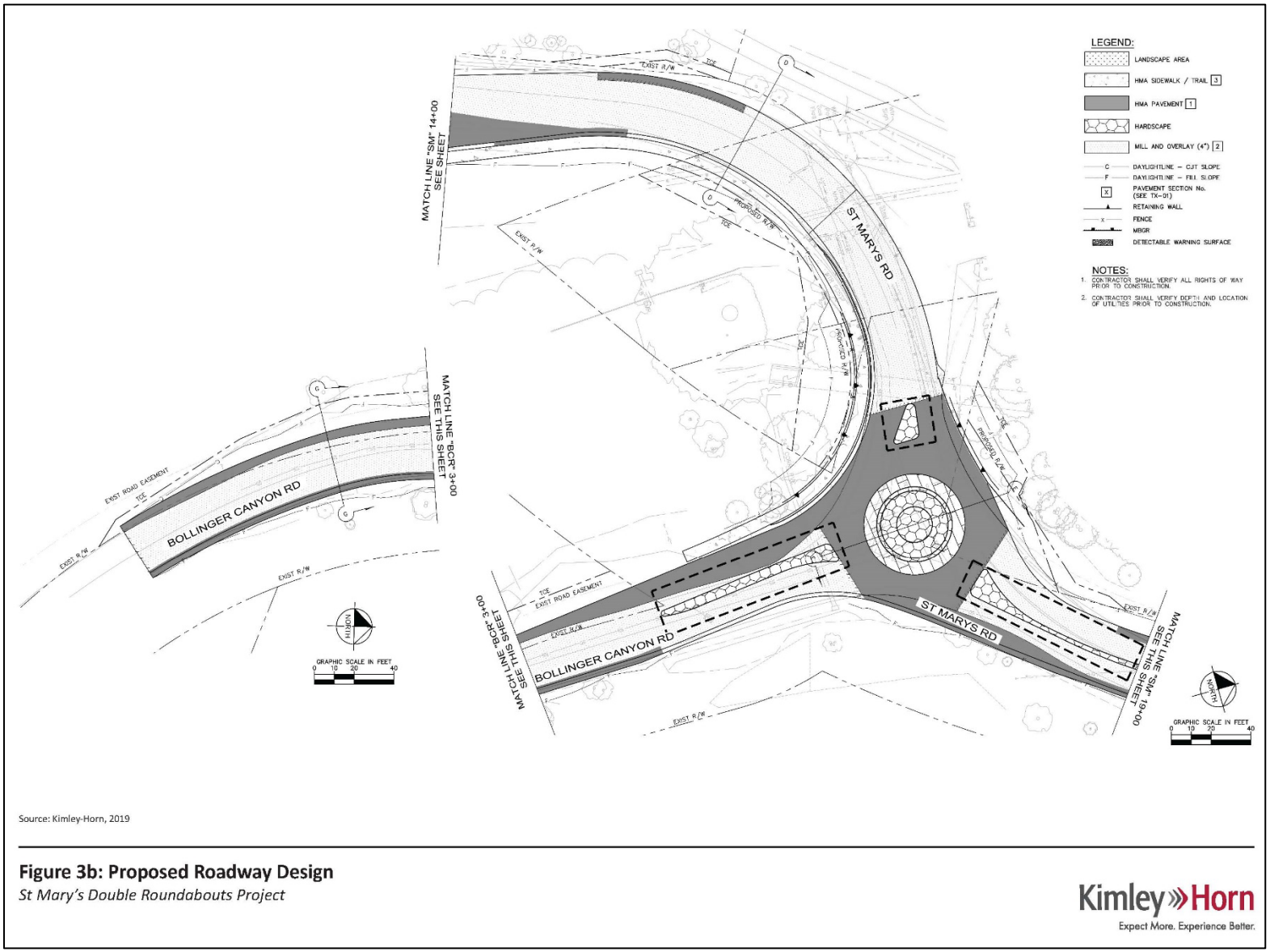


Figure 3a. Proposed Roadway Design



Source: Kimley-Horn, 2019

Figure 3b: Proposed Roadway Design
St Mary's Double Roundabouts Project

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Figure 3b. Proposed Roadway Design

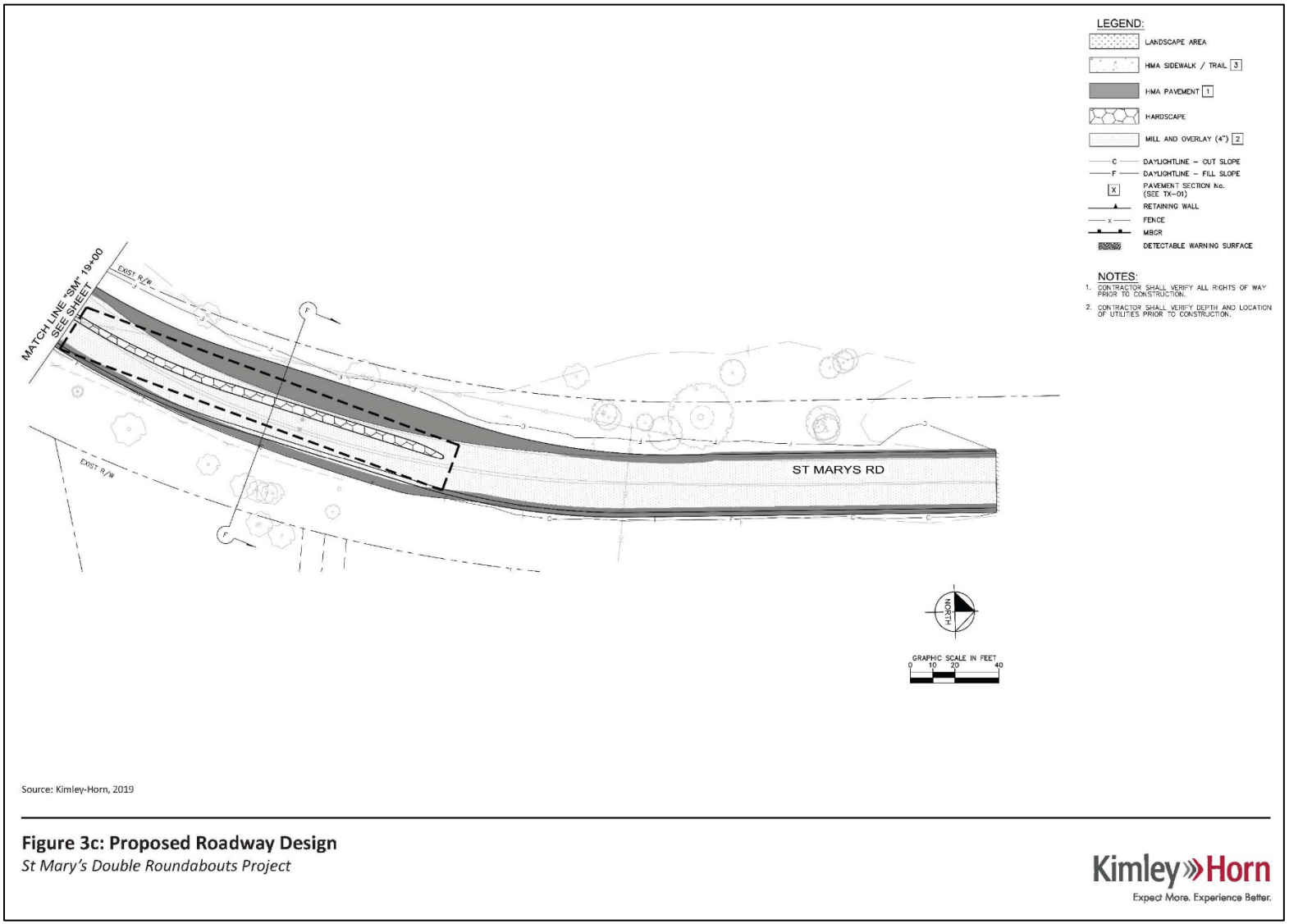


Figure 3c. Proposed Roadway Design

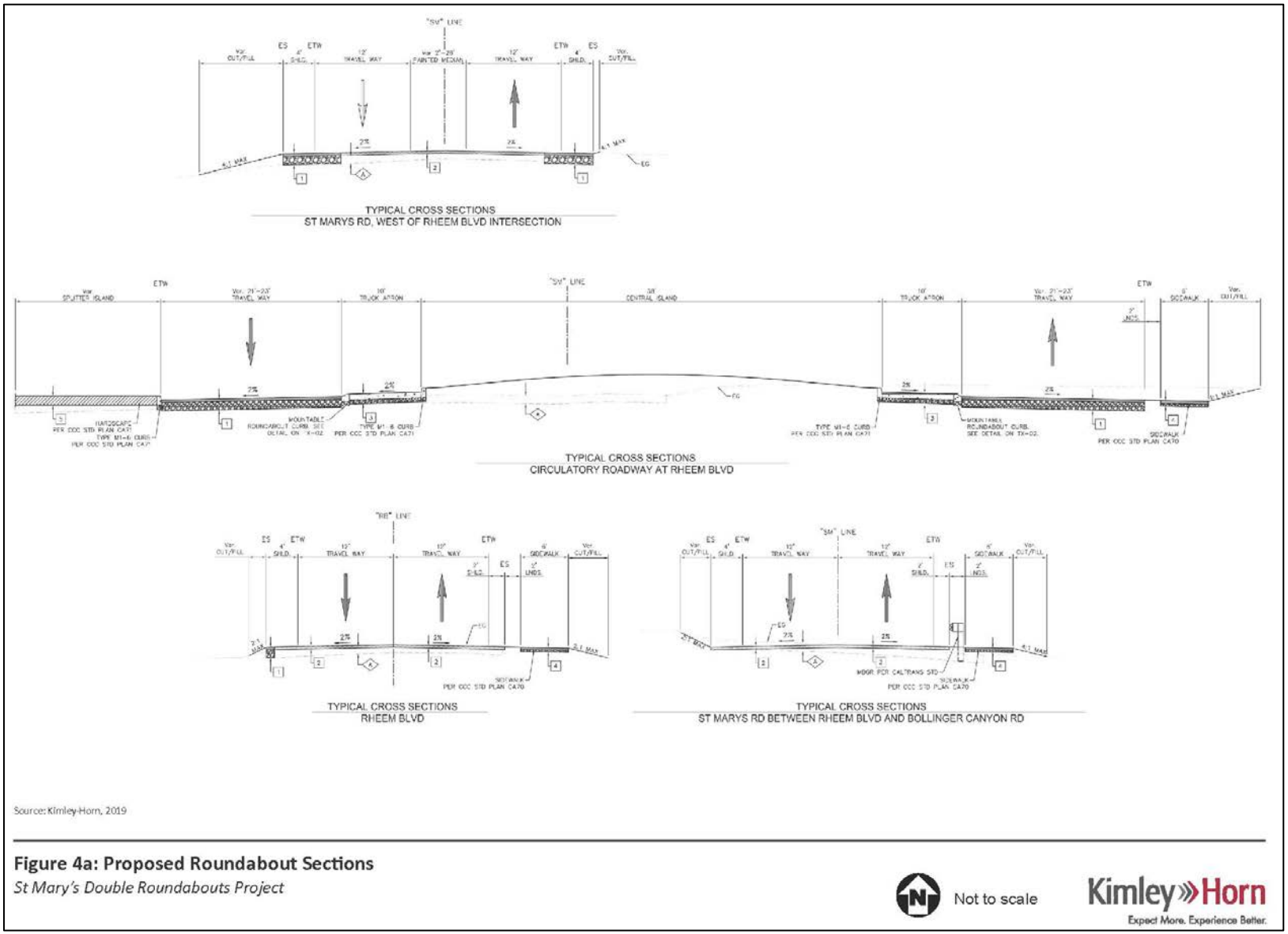


Figure 4a. Proposed Roundabout Sections

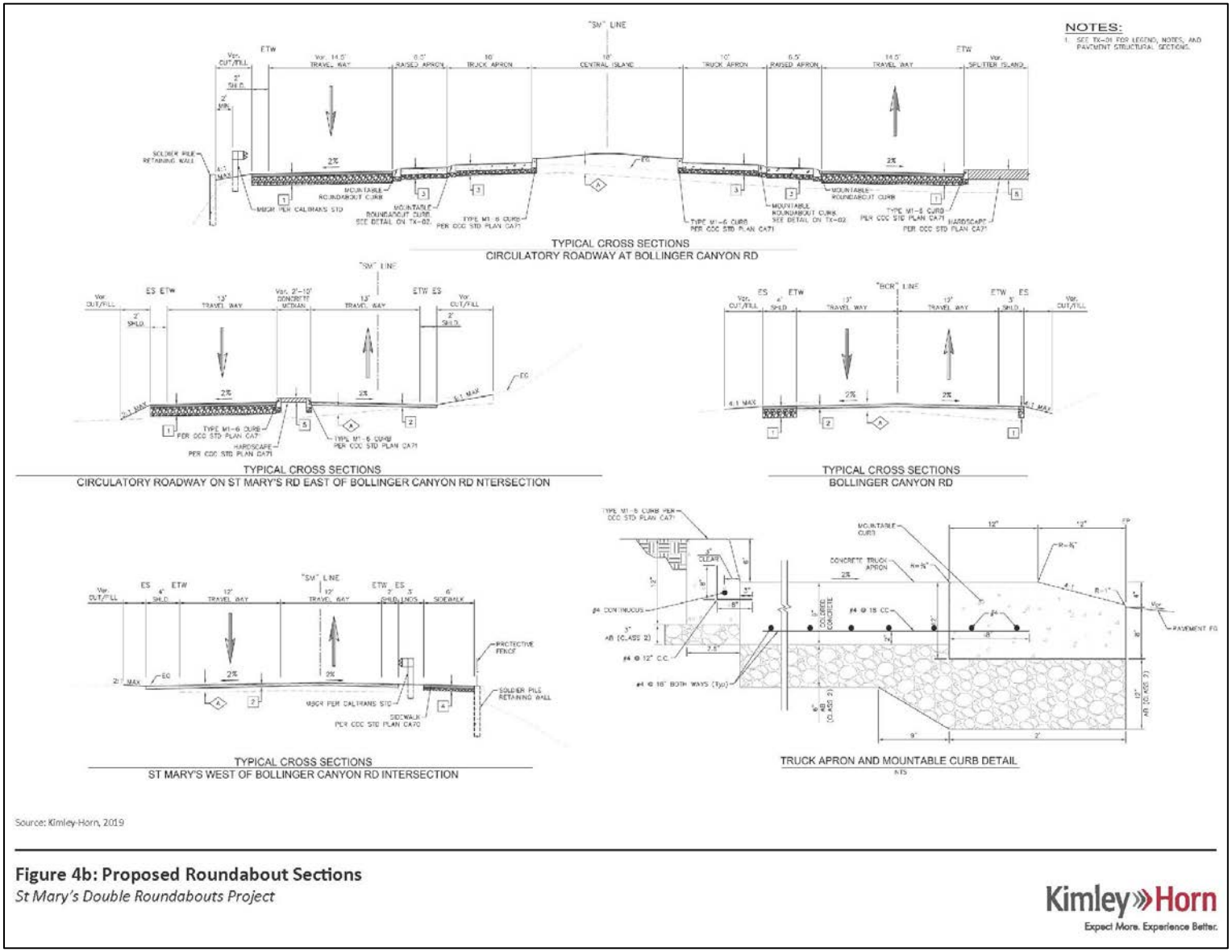


Figure 4b. Proposed Roundabout Sections

1.4.2 Bicycle and Pedestrian Facilities

The Lafayette/Moraga Regional Trail runs parallel and west of St. Mary's Road, crossing Rheem Boulevard via a crosswalk in front of the SSSC intersection. A new trail crossing at Rheem Boulevard would realign the trail crossing to be located approximately 40 ft west of the existing trail crossing. The new crossing would connect to the existing trail. The new trail crossing would allow for safe pedestrian and bicycle crossings west of the proposed roundabout by improving visibility and with decreased approaching vehicular speeds.

The roundabouts accommodate bicyclists by allowing users to choose their path of travel. Cyclists who have experience and confidence riding on the roadway can travel through the facility as a vehicle by merging with other vehicular traffic and occupying the lane within the roundabout itself. Other cyclists that may not feel comfortable riding within the travel lane can access the shared-use pathway with bike ramps and travel through the roundabout and cross as a pedestrian.

A new sidewalk is proposed along the east side of St. Mary's Road, starting near the Bollinger Canyon Road intersection and connecting to the regional trail on the south side of the proposed roundabout at the Rheem Boulevard intersection. The new sidewalk installation would allow for safe pedestrian crossings for the users on Bollinger Canyon Road.

1.4.2.1 Utilities

There are existing street lights within the Project area along the St. Mary's Road, which would be relocated. A new streetlight would be constructed outside of the proposed roadway pavement area. These would require excavation up to 6 ft in depth.

Existing telephone and electrical poles and boxes are located along St. Mary's Road. These telephone and electrical poles and boxes would be relocated outside the proposed roadway. These would require excavation up to 6 ft in depth.

Several sanitary sewer manholes exist along St. Mary's Road and one, located at the St. Mary's Road/Bollinger Canyon Road intersection, would require relocation. The new sanitary sewer manhole will require excavation with maximum depths of 10 ft.

There are existing water lines within the proposed Project limits. It is intended the water valves be adjusted to the proposed grade. An existing culvert crosses Rheem Boulevard, just north of the St. Mary's Road/Rheem Boulevard intersection. The Project would realign a portion of the culvert, requiring excavation up to 2 ft in depth.

1.4.2.2 Construction Activities

Construction of the proposed Project is anticipated to take 12 months. St. Mary's Road would remain open during construction; however, there may be temporary lane closures on St. Mary's Road, Rheem Boulevard, and Bollinger Canyon Road during non-commute times, and there may be one-way traffic control at night during stage construction switchovers. Access to adjacent and adjoining properties would be maintained during the duration of construction activities. Bus

access would also be maintained. Construction methods would include excavator trenching, pipe, valve and fitting installation, backfill and compaction of native fill.

Construction limits are the limits of the proposed Project. A staging area would be located on the east side of St. Mary's Road, between Rheem Boulevard and Bollinger Canyon Road intersections.

1.5 Regulatory Setting

1.5.1 Executive Order 11988 (Floodplain Management, 1977)

Executive Order 11988 (Floodplain Management) directs all federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Requirements for compliance are outlined in Title 23, Code of Federal Regulations, Part 650, Subpart A (23 CFR 650A) titled "Location and Hydraulic Design of Encroachment on Floodplains" (2015).

If the preferred alternative involves significant encroachment onto the floodplain, the final environmental document (final Environmental Impact Statement or finding of no significant impact) must include:

- The reasons why the proposed action must be located in the floodplain,
- The alternatives considered and why they were not practicable, and
- A statement indicating whether the action conforms to applicable state or local floodplain protection standards.

1.5.2 California's National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) is the nationwide administrator of the National Flood Insurance Program (NFIP), which is a program that was established by the National Flood Insurance Act of 1968 to protect lives and property, and to reduce the financial burden of providing disaster assistance. Under the NFIP, FEMA has the lead responsibility for flood hazard assessment and mitigation, and it offers federally backed flood insurance to homeowners, renters, and business owners in communities that choose to participate in the program. FEMA has adopted the 100-year floodplain as the base flood standard for the NFIP. FEMA is also concerned with construction that would be within a 500-year floodplain for proposed projects that are considered "critical actions," which are defined as any activities where even a slight chance of flooding is too great. FEMA issues the Flood Insurance Rate Maps (FIRM) for communities that participate in the NFIP. These FIRMs present delineations of flood hazard zones.

In California, nearly all of the state's flood-prone communities participate in the NFIP, which is locally administered by the California Department of Water Resources' (DWR) Division of Flood Management. Under California's NFIP, communities have a mutual agreement with the state and federal government to regulate floodplain development according to certain criteria and standards, which is further detailed in the NFIP.

1.5.3 Contra Costa County Floodplain Data

As part of the NFIP, typically, each county (or community) has a Flood Insurance Study (FIS) that is used to locally develop FIRMs and Base Flood Elevations (BFE). The effective FIS for Contra Costa County, California, and Incorporated Areas (06013CV001C-5C) last revised on March 21, 2017, the county-wide National Flood Hazard Layer (NFHL) last revised on February 07, 2019, and FIRMs 06013C0426F and 06013C0428F last revised on June 16, 2009 were reviewed to obtain floodplain information of the Project area.

1.6 Design Standards

1.6.1 FEMA Standards

FEMA standards are employed for design, construction, and regulation to reduce flood loss and to protect resources. Two types of standards are often employed: design criteria and performance standards.

A performance standard dictates that a goal is to be achieved, leaving it to the individual application as to how to achieve the goal (e.g., providing protection to the regulatory flood, keeping post-development stormwater runoff the same as pre-development, or maintaining the present quantity and quality of water in a wetland).

The 1%-annual chance flood and floodplain have been adopted as a common design and regulatory standard in the United States. The NFIP adopted it in the early 1970s, and it was adopted as a standard for use by all federal agencies with the issuance of Executive Order 11988. State or local agencies are free to impose a more stringent standard within their jurisdiction.

A design criterion or specified standard dictates that a provision, practice, requirement, or limit be met (e.g., using the 1% flood and establishing floodway boundaries so as not to cause more than a 1-ft increase in flood stages).

The floodway is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood. Floodwaters generally are deepest and swiftest in the floodway, and anything in this area is in the greatest danger during a flood. According to Section 60.3(d)(3) of Title 44, *Code of Federal Regulations* (Federal Register, 2018), a community shall "prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge."

1.7 Traffic

St. Mary's Road is an emergency evacuation route and accessed by emergency vehicles. It is also a mail access route. The Project's Draft Traffic Letter (KHA, 2019), provides peak AM and PM hourly traffic near the St. Mary's Road/Bollinger Canyon Road intersection and the St. Mary's Road/Rheem Boulevard intersection per travel lane. The peak traffic values are provided for the

existing condition and the proposed condition projected to 2040 including the full-buildout of the Project (see Table 1 for the range of AM and PM peak traffic volumes per travel lane).

Table 1. Average Peak Traffic

Location	Existing Condition		Proposed Condition (Year 2040)	
	AM Peak Range	PM Peak Range	AM Peak Range	PM Peak Range
St. Mary's Road/Bolliner Canyon Road	5 - 414	10 - 487	16 - 500	32 - 582
St. Mary's Road/Rheem Boulevard	32 - 341	55 - 424	37 - 429	62 - 540

Source: KHA, 2019

Local roads connecting to St. Mary's Road could be used as detour routes in the event of potential traffic interruptions that might occur as a result of flooding. However, these routes would be relatively long and therefore, are not considered to be practicable detours.

1.8 Vertical Datum

The Project references a local datum used to capture the topographic survey of the Project area.

2 AFFECTED ENVIRONMENT

2.1 Geographic Location

The Project site is located in a lightly-dense residential area, near St. Mary's College at 37.847342° North, -122.1089321° West.

2.2 Watershed Description

Las Trampas Creek originates from the hills located between the Town of Moraga and the unincorporated community of Alamo, and flows in a northwesterly direction towards the Project site. Per the FEMA FIS, Las Trampas Creek drains a watershed of 3.2 square miles (sq. mi.) at the St. Mary's Road. Lake La Salle Dam (see Photo 2) is located approximately 600 ft upstream of the crossing.

Photo 2. Lake La Salle Dam

Source: KHA, 2017

Downstream of the Project crossing, Las Trampas Creek meanders through the City of Lafayette and joins with San Ramon Creek approximately 0.5 mile downstream of its Intestate-680 crossing, forming Walnut Creek. Las Trampas Creek receives flow from multiple of its tributaries as it flows towards San Ramon Creek. The confluence with Grizzly Creek is located approximately 1.7 miles downstream of the Project crossing. Other tributaries of Las Trampas Creek downstream of the Project location include Tice Creek, Rueze Creek, and Lafayette Creek.

2.3 Channel Description

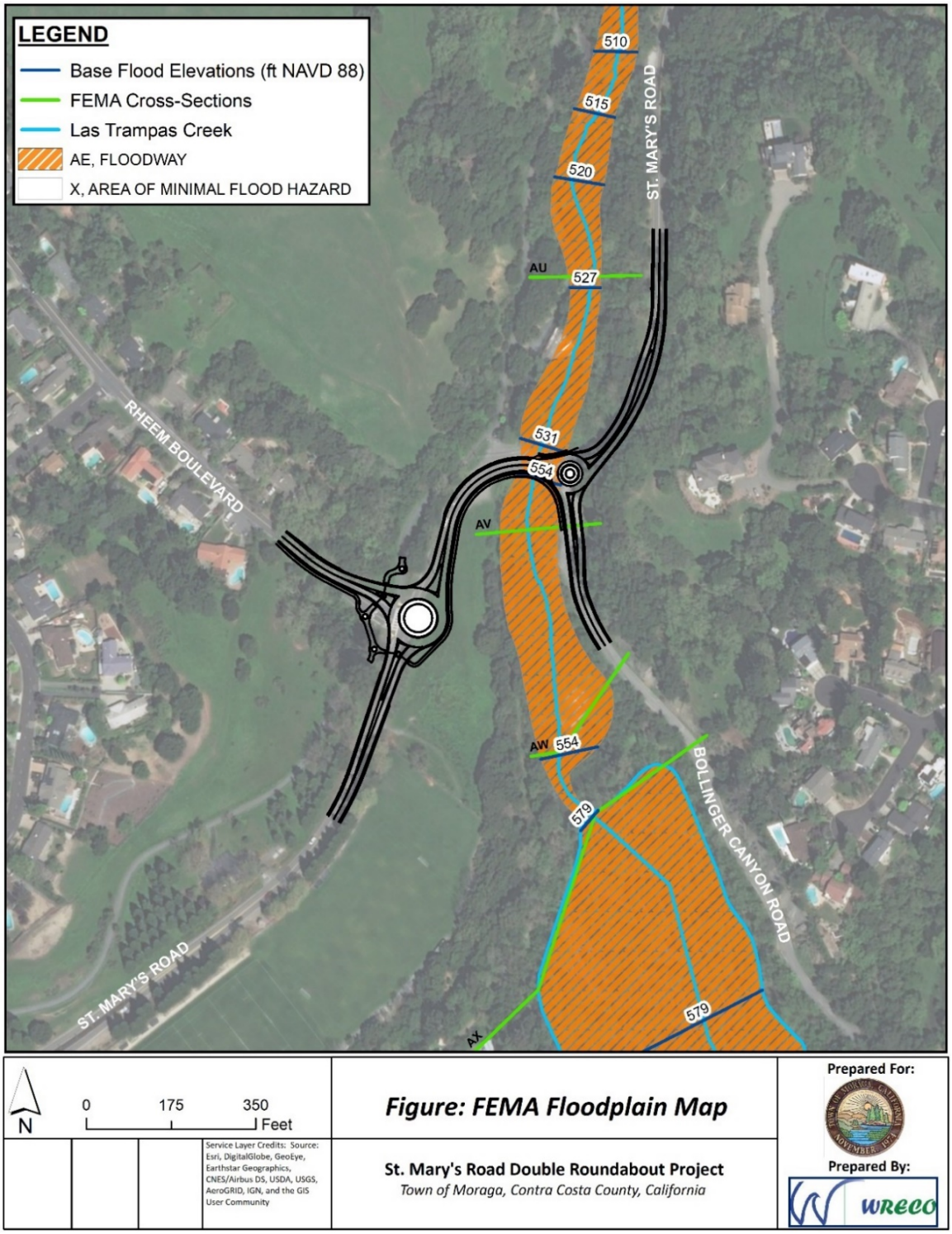
Based on aerial imagery, site photos, and field observations, the channel consists of cobbles with medium to dense brush-covered banks and floodplain in the vicinity of the Project (see Photo 3).

Photo 3. Las Trampas Creek Channel (Looking Upstream from Project Location)

2.4 FEMA Floodplains

The Project is located within FEMA FIRM 06013C0426F and 06013C0428F (provided in Appendix A). The Las Trampas Creek floodplain in the vicinity of the Project is a FEMA designated Zone AE area with a regulatory floodway (see Figure 5). Zone AE floodplains represent areas subject to inundation during the 1%-annual chance (or the 100-year) flood event and determined by detailed methods where BFEs are provided. The remainder of the Project area, where improvements are proposed (see Section 1.4 for the details of the proposed improvements) are located within a FEMA designated unshaded Zone X region. Unshaded Zone X represent areas of minimal flood hazard, which are defined as areas outside of the special flood hazard area (SFHA) and above the 500-year flood level.

Per the FIRMs and the County's NFHL, the Las Trampas Creek Project crossing/culvert is located between FEMA cross-sections "AU" and "AV," where the BFEs are 526.9 ft North American Vertical Datum of 1988 (NAVD 88) and 554.0 ft NAVD 88, respectively. The maps also indicate that the BFEs are 554 ft NAVD 88 just upstream and 531 ft NAVD 88 immediately downstream of the Project crossing. The FEMA water surface profile for Las Trampas Creek in the vicinity of the Project crossing is provided in Appendix B. The FEMA water surface profile shows that the elevation of St. Mary's Road ranges approximately from 523 to 552 ft NAVD 88 and the location of the Lake La Salle Dam Spillway upstream of the Project, which corresponds to the narrowing of the floodplain/floodway just upstream of cross section "AW" in Figure 5.



Note: Unshaded Zone X area is transparent.

Figure 5. FEMA FIRM at Project Location

Source: ESRI and FEMA

3 HYDROLOGY AND HYDRAULICS

3.1 Hydrologic Assessment

Two methods were used to determine design discharges of Las Trampas Creek draining to the Project location:

1) Design discharges from FEMA, and
2) USGS flood-frequency equations

3.1.1 FEMA Design Discharges

FEMA FIS for Contra Costa County, California, and Incorporated Areas (06013CV001C effective since March 21, 2017) includes 100-year discharge values of Las Trampas Creek at various locations along the creek. Table 2 provides the discharges provided at locations closest to the Project site. Additionally, the analysis FEMA performed using the Hydrologic Engineering Center – 2 (HEC-2) modeling software in support of the information published in the effective FIS were obtained and used to verify the flows used in the vicinity of the Project.

Table 2. FEMA Flows

Location	Drainage Area (sq. mi.)	100-Year Peak Discharge (cfs)
At St. Mary's Road	3.2	1,500
Upstream of Grizzly Confluence	5.3	2,400

Source: FEMA, 2017

As discussed in Section 2.2, the Grizzly Creek confluence is located approximately 1.7 miles downstream of the Project crossing.

3.1.2 USGS Regional Flood-Frequency Equations

The USGS flood-frequency equations method was used as a basis of comparison for the FEMA flows. USGS flood-frequency equations were developed based on analysis of data from gaging stations. USGS has divided California into six hydrologic regions; the Project site is within the Region 1, North Coast. This method follows the equations that are also outlined in Caltrans' *Highway Design Manual* (HDM) Section 819.2C (2018).

On July 18, 2012, the USGS issued *Methods for Determining Magnitude and Frequency of Floods in California, Based on Data through Water Year 2006* (Gotvald et al. 2012), which contains updated flood-frequency equations and revised the boundaries of the six unique regions within California. These equations are based on annual peak-flow data through water year 2006 for 771 streamflow-gaging stations in California having 10 or more years of data. The updated equations were used in support of the Project's hydrologic analysis.

The flood-frequency equation for the 100-year storm is as follows:

$$Q_{100} = 48.5(DRNAREA)^{0.866}(PRECIP)^{0.556}$$

Where:

Q_n = peak discharge for a storm event with a return period of n years, cubic feet per second (cfs)
DRNAREA = drainage area, sq. mi.
PRECIP = mean annual precipitation, in.
ELEV = mean basin elevation, ft

The drainage area, precipitation, and mean basin elevation parameters used in the flood-frequency equation were obtained from USGS StreamStats, and are summarized in Table 3. The parameters are within the ranges of the basin characteristics of the sites that were used to develop the equations for the North Coast Region (i.e., drainage areas ranging from 0.04 to 3,200 sq. mi and mean annual precipitation ranging from 20 to 125). The 100-year discharge calculated using this method is 880 cfs.

Table 3. USGS Flood-Frequency Flows

DRNAREA (sq. mi.)	3.4
PRECIP (in.)	27.3
ELEV (ft)	1,037
Q_{100} (cfs)	880

3.1.3 Selected Design Discharges

The flood-frequency equations are generally used to estimate stream flow for ungagged sites that are not affected by substantial urban development and that are natural (unregulated) streams. Additionally, the flood-frequency equations were developed for the North Coast region using data from sites with a wide range of basin characteristics (see Section 3.1.2). Therefore, the 100-year FEMA peak discharge of 1,500 cfs at Saint Mary's Road and 2,400 cfs "Upstream of Grizzly Confluence" were adopted as the Project's design flows and applied at the corresponding flow change locations in the hydraulic models.

3.2 Hydraulic Assessment

The hydraulic analysis includes an assessment of the hydraulic characteristics of the existing condition and the changes to the existing hydraulic characteristics based on the proposed Project improvements. The following sub-sections discuss the development of the hydraulic models and summarizes the results. The water surface profile plots, hydraulic summary tables, and channel cross sections are included in Appendix C for the existing condition, and Appendix D for the proposed condition.

3.2.1 Design Tools

A steady-state hydraulic model was developed using the Unites States Army Corps of Engineers' (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling software (Version 5.0.3).

3.2.2 Cross Section Data

The channel geometry for the hydraulic model was developed using topographic survey data provided by KHA (March 18, 2019). The cross sections extend approximately 600 ft upstream and 600 ft downstream of the St. Mary's Road measured along Las Trampas Creek (see Figure 6). The naming convention for the cross sections is by river station (RS) with the cross section number increasing in RS (measured in feet) going upstream. The cross sections reference the local datum of the survey data.

3.2.3 Modeled Hydraulic Structures

The geometry of the cross culvert that conveys Las Trampas Creek across St. Mary's Road is based on the information provided in the Project survey data. As discussed in Section 1.3.3, the culvert is a single 6 ft x 8 ft (span x height) box culvert with a length of approximately 119 ft.

3.2.4 Base Hydraulic Model

Due to the limitations of the modeling software, the roadway embankments and any modifications proposed due to the Project, including the retaining walls, could only be modeled as part of the roadway with a single-linear slope applied to the embankments. Therefore, the roadway embankments were modeled to be linearly sloped down to the top of the culvert headwalls on both the upstream and downstream faces.

3.2.5 Model Boundary Condition

A normal depth boundary condition of 0.017 ft/ft was used condition in the Project's hydraulic models.

3.2.6 Manning's Roughness Coefficients

Manning's roughness coefficients were used in the hydraulic model to estimate energy losses in the flow due to friction. Manning's n values were selected to best describe the channel characteristics of the creek based on aerial imagery and site observations (see Section 2.3). The Manning's roughness coefficients (n) for the main flow channel was set to 0.035 for straight, full channels with stones and weeds, and 0.100 for medium to dense brush overbank areas per the HEC-RAS *Hydraulic Reference Manual* (USACE, 2016b).

3.2.7 Expansion and Contraction Coefficients

Expansion and contraction coefficients were used in the hydraulic model to estimate hydraulic losses at transitions between cross sections. The expansion and contraction coefficients used in the channel were 0.3 and 0.1, respectively. These values represent a channel with gradual transitions between cross sections.

Figure 6. Cross Sections Locations

Source: ESRI

3.2.8 Water Surface Elevations

The WSEs for Las Trampas Creek in the vicinity of the Project were estimated for the existing and proposed conditions using the hydraulic models developed in HEC-RAS. See Table 4 for the comparison of the WSEs between the existing and proposed conditions within the limits of the analysis. The cross sections at the upstream face of the culvert, in the direction of flow (looking downstream) are provided in Figure 7 for the existing condition, and Figure 8 for the proposed

condition. The water surface profile showing the 100-year flow for the existing and proposed conditions is provided in Figure 9.

Table 4. Las Trampas Creek 100-Year Water Surface Elevations

RS	Location/Distance from Existing Bridge Centerline	Water Surface Elevations (ft)		
		Existing Condition	Proposed Condition	Change
1196	600 ft Upstream of Existing Culvert / Upstream Limit of Hydraulic Model	552.39	552.41	0.02
1008	410 ft Upstream of Existing Culvert	552.38	552.39	0.01
834	240 ft Upstream of Existing Culvert	552.38	552.40	0.02
675	80 ft Upstream of Existing Culvert	552.38	552.40	0.02
610	Culvert	--	--	--
515	80 ft Downstream of Existing Culvert	522.21	522.21	0.00
5	590 ft Downstream of Existing Culvert / Downstream Limit of Hydraulic Model	514.81	514.81	0.00

The results of the hydraulic models indicate that the changes in the 100-WSEs due to the Project are less than 0.1 ft, and therefore, are considered to be negligible.

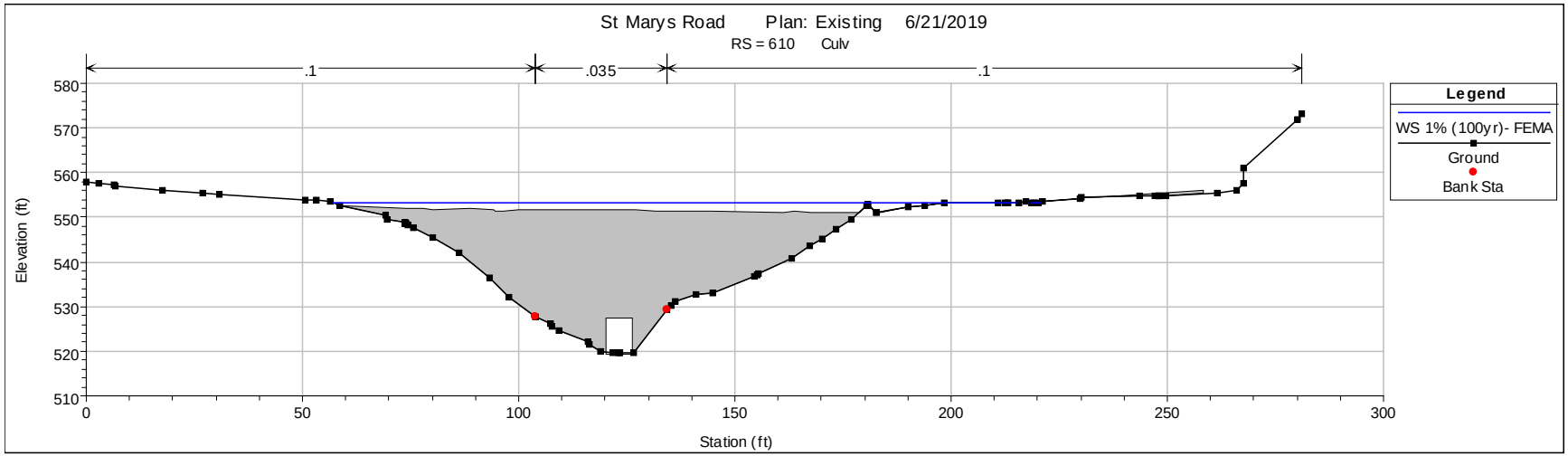


Figure 7. Upstream Face of the Cross Culvert under Existing Condition, Looking Downstream

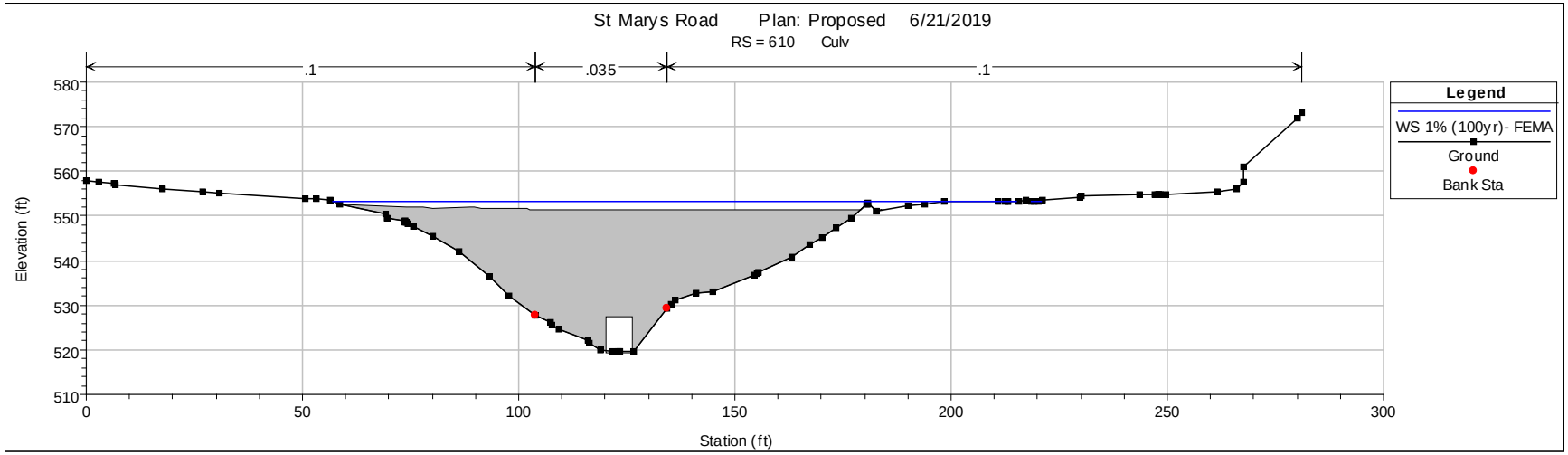


Figure 8. Upstream Face of the Cross Culvert under Proposed Condition, Looking Downstream

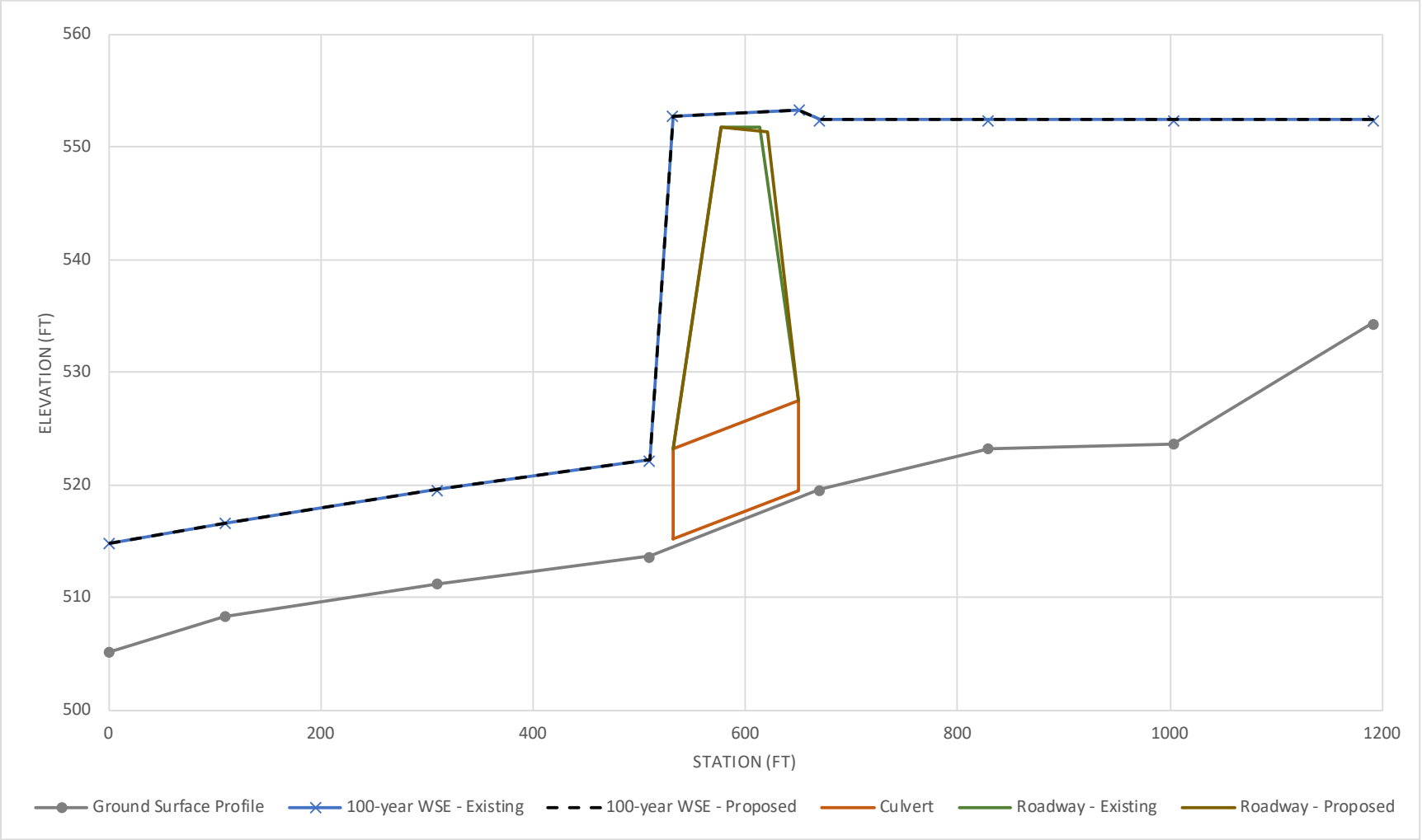


Figure 9. 100-year Flood Profile, Existing and Proposed Conditions

4 PROJECT EVALUATION

Executive Order 11988 requires federal agencies to avoid to the maximum extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. This section analyzes the impacts associated with this Project.

4.1 Risk Associated with the Proposed Action

As defined by the FHWA, risk shall mean the consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the bridge and roadway.

The potential risk associated with the implementation of the proposed action includes but is not limited to: 1) change in land use, 2) change in impervious surface area, 3) fill inside the floodplain, or 4) change in the 100-year water surface elevations within the floodplain. The measures to minimize the potential floodplain or floodway impacts associated with the action are summarized in Section 5.

4.1.1 Change in Land Use

The Project proposes to widen St. Mary's Road, Rheem Boulevard, and Bollinger Canyon Road to accommodate two new roundabouts. The approaches to the roundabouts would be widened and additional improvements that would improve traffic operations and safety would be made (see Section 1.4 for further details on the proposed improvements). These proposed changes would not cause changes to the current land use of the Project area and therefore, there are no risks associated with changes in land use resulting from the Project.

4.1.2 Change in Impervious Surface Area

The net new impervious area (added impervious area minus removed impervious area) proposed by the Project is 0.42 acres. Compared to the overall Project watershed size of 3.2 sq. mi., this entails a net new impervious of 0.02% of the existing impervious area. Therefore, the change in impervious surface area resulting from the proposed Project is considered to be negligible and therefore, there are no associated risks.

4.1.3 Fill Inside the Floodplain

The Project proposes to construct retaining walls at the St. Mary's Road/Bollinger Canyon Road intersection to avoid impacts to the creek due to steeper surface slopes that may result from the proposed roadway widening. Based on the Project's proposed typical roadway cross sections and retaining wall profiles provided by KHA (2019), there is placement of fill proposed to elevate St. Mary's Road within the limits of the floodplain (or floodway) near the creek crossing. The proposed retaining walls would also be placed within the floodplain limits at the downstream and upstream side of the creek crossing.

However, the proposed placement of fill on St. Mary's Road near the creek crossing would be balanced by proposed cut within the floodplain limits and therefore, does not pose any risks associated with fill inside the base floodplain due to the widening of this Project segment.

Although there would be fill within the floodplain from the proposed retaining walls, the results of the proposed condition hydraulic analysis indicate there would be no impact on the BFEs (further details on the WSE results from the hydraulic analysis are provided in Section 3.2.8 and Section 4.1.4) and therefore, there are no risks associated with the placement of fill in the floodplain due to the proposed retaining walls.

4.1.4 Change in the 100-Year Water Surface Elevation

There changes in the BFEs in the proposed condition as compared to the existing condition (see Table 4) within the studied reach of Las Trampas Creek are negligible and therefore, there are no risks associated with the proposed action due to changes in the 100-year WSEs.

4.2 Summary of Potential Encroachments

The Federal Highway Administration (FHWA) defines a significant encroachment as a highway encroachment, and any direct support of likely base floodplain development, that would involve one or more of the following construction or flood-related impacts: 1) significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route, 2) a significant risk, or 3) a significant adverse impact on the natural and beneficial floodplain values (FHWA 1994). The following sections discuss the potential impacts to the floodplain that may result from the proposed action. The risk associated with implementation of the action is discussed in Section 4.1.

4.2.1 Potential Traffic Interruptions for the Base Flood

As shown in the 100-year water surface profile (see Figure 9 for the water surface profile from the hydraulic analysis and Appendix B for the FEMA water surface profile), the cross culvert would not be able to convey the 100-year flow under the existing conditions. As a result, the flow would overtop the culvert and inundate St. Mary's Road. This could potentially cause traffic interruptions in the event of the base flood.

Because the Project would not cause any changes to the WSEs within the modeled reach of Las Trampas Creek, the potential for traffic interruptions in the event of the base flood would occur in the proposed condition to the same extent as in the case of the existing condition and therefore, the Project would not cause any (or additional) encroachment due to traffic interruptions.

Because local roads connecting to St. Mary's Road would be relatively long, practicable detours would not be available in the event of the 100-year flow for both existing and proposed conditions.

4.2.2 Potential Impacts on Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include, but are not limited to: fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge (FHWA, 1979).

Per the Project's Biological Resources Study (BRS) (WRECO, 2019), natural and beneficial floodplain values associated with the base floodplain at the Project site, including three features that qualify as potentially jurisdictional Other Waters of the US, were identified within the biological study area (BSA). These include Las Trampas Creek, an unnamed tributary that flows from the hills to the east, and another unnamed tributary that flows from the hills to the south. Additionally, suitable habitat was identified in the BSA for nesting birds, roosting bats, Alameda whipsnake, western pond turtle, California red-legged frog, and foothill yellow-legged frog. In addition, San Francisco dusky-footed woodrats nests were observed in the BSA. No special-status plant species were identified during botanical surveys.

The Project's impacts to the above listed natural and beneficial floodplain values are currently being assessed and will be completed upon the completion of the pertinent aspect of the Project design. However, they are anticipated to include potential impacts to the creek banks where fill will be placed as well as temporary impacts from construction of the Project and impacts to Alameda whipsnake, California red-legged frog habitat, and nesting San Francisco dusky foot woodrats. The Project is not anticipated to cause impacts to foothill yellow-legged frog or the western pond turtle. Measures to avoid, minimize, and/or mitigate the potential impacts of the Project will be implemented to the maximum extent possible.

Potential short-term adverse effects to the natural and beneficial floodplain values during the construction of the Project include: 1) loss of vegetation during construction activity; and 2) temporary disturbance of wildlife and aquatic habitat. Construction should be planned to avoid adverse effects to the natural and beneficial floodplain areas to the maximum extent practicable. Measures to restore and preserve the natural and beneficial floodplain values are discussed in Section 5.2.

4.2.3 Support of Probable Incompatible Floodplain Development

As defined by the FHWA, the support of incompatible base floodplain development will encourage, allow, serve, or otherwise facilitate incompatible base floodplain development, such as commercial development or urban growth.

The Project would not trigger incompatible floodplain development. The Project would generally maintain local and regional access, and would not create new access routes to developed or undeveloped lands.

4.2.4 Longitudinal Encroachments

As defined by the FHWA, a longitudinal encroachment is an action within the limits of the base floodplain that is longitudinal to the normal direction of the floodplain.
A longitudinal encroachment is "[a]n encroachment that is parallel to the direction of flow. Example: A highway that runs along the edge of a river is usually considered a longitudinal encroachment." The requirement for consideration of avoidance alternatives must be included in a Location Hydraulic Study by including an evaluation and a discussion of the practicability of alternatives to any significant encroachment or any support of incompatible floodplain development.

Bollinger Canyon Road on the upstream side of the Project crossing and St. Mary's Road downstream of the Project crossing run fairly parallel to Las Trampas Creek (see Figure 5). However, longitudinal encroachments are not anticipated as a result of the proposed Project improvements due to the following reasons:

i) The proposed improvements on Bollinger Canyon Road include cut (lowering of the roadway) adjacent to the creek and therefore, would not encroach upon the floodplain.

ii) Downstream of the Project crossing, the water surface profile drops significantly. The water surface profile elevation ranges from 523.5 ft just downstream of St. Mary's Road to 523.0 ft at the downstream limit of the hydraulic study. The proposed improvements on the adjacent roadway (St. Mary's Road) in this reach of the creek would be much higher than the floodplain. The St. Mary's Road existing roadway elevations range from 552.9 ft just downstream of St. Mary's Road to 565.5 ft at the downstream limit of the hydraulic study measured along the centerline of the roadway. The Project proposes to place fill beginning at the eastern end of the proposed concrete median to the western limits of the widening. Therefore, the proposed roadway elevations would be higher than the existing roadway elevations, and in turn, the floodplain and would not encroach upon the floodplain.

5 AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

5.1 Minimize Floodplain Impacts

The proposed Project would not change the overall land use within the Project watershed and will not cause impacts due to increased impervious areas. There would be no changes to the existing 100-year WSEs resulting from the proposed improvements as demonstrated by the hydraulic model results. Therefore, the overall Project's possible adverse effects to the base floodplain are anticipated to be insignificant, and measures to avoid, minimization, and/or mitigate impacts to the floodplain were not considered.

5.2 Restore and Preserve Natural and Beneficial Floodplain Values

Temporary environmental impacts resulting from the Project's construction activities can be minimized with standard measures such as revegetation, best management practices, and other activities that meet the requirements that are part of the Project permit conditions. Required regulatory permits and approvals are expected to include a 1602 Lake and Streambed Alteration Agreement with the California Department of Fish and Wildlife, and 401 Water Quality Certification with the Regional Water Quality Control Board.

The spread of invasive and noxious plants and their seeds to and from the Project site would be avoided by implementing all the necessary steps. Other avoidance, minimization, and/or mitigation measures for the anticipated potential impacts of the Project (see Section 4.2.2) are currently being assessed and will be included upon the completion of the pertinent aspect of the Project design. Mitigation will be required by the biological resources agencies; the type and quantity of mitigation will be negotiated during the resource agency permitting phase of the Project.

5.3 Alternatives to Significant Encroachments

There are no significant encroachments at the Project location due to the proposed roadway alignments and therefore, alternatives to significant encroachments were not analyzed.

5.4 Alternatives to Longitudinal Encroachments

The proposed Project would not encroach upon the base floodplain longitudinally and therefore, alternatives to longitudinal encroachments were not considered.

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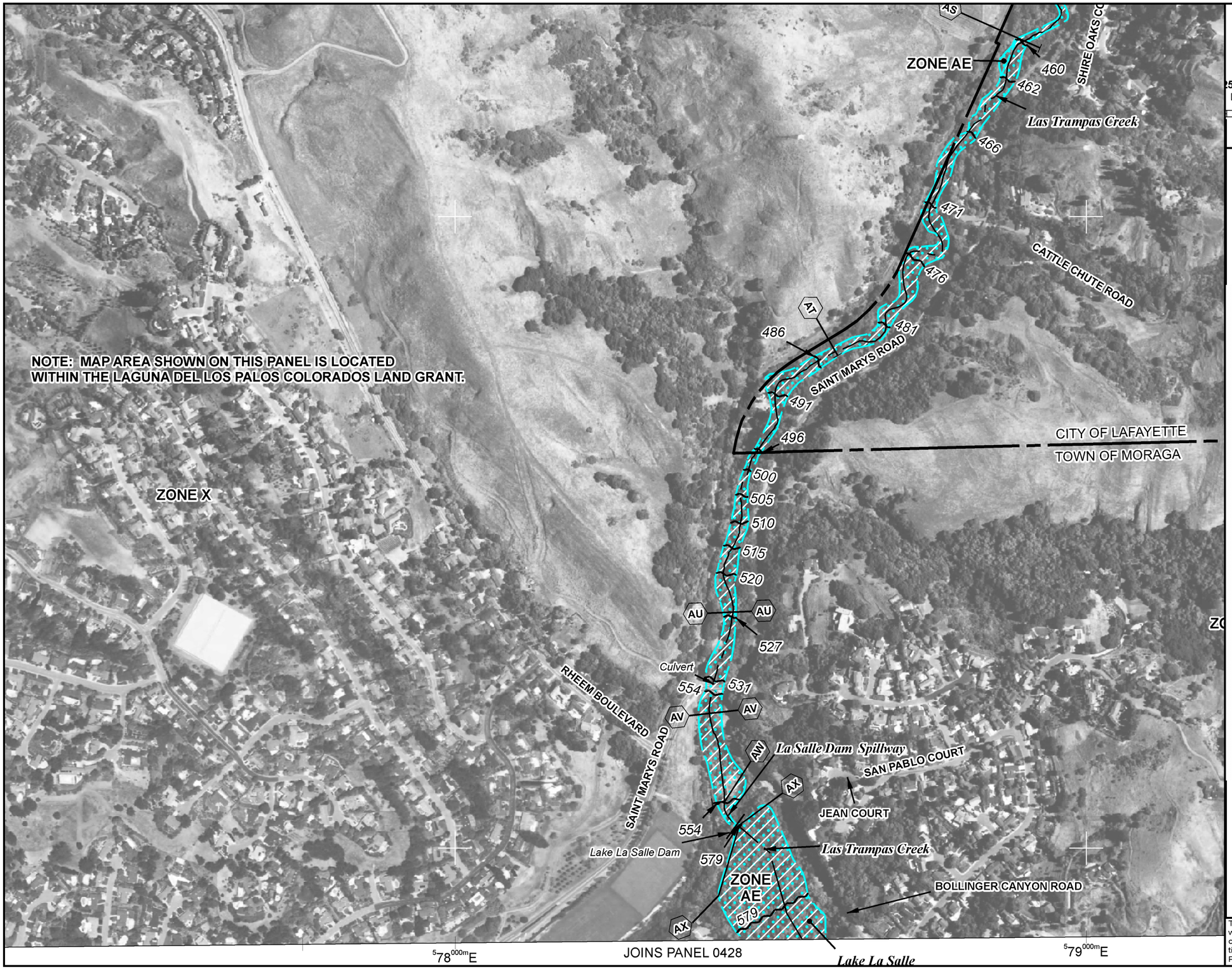
WRECO. (2019). St. Mary's Road Roundabouts Project: Biological Resource Study.

Appendix A Federal Emergency Management Agency Flood Insurance Rate Maps



MAP SCALE 1" = 500'

250 0 500 1000

FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0426F

FIRM

FLOOD INSURANCE RATE MAP

CONTRA COSTA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 426 OF 602
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LAFAYETTE, CITY OF	065037	0426	F
MORAGA, TOWN OF	060637	0426	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06013C0426F

EFFECTIVE DATE
JUNE 16, 2009

Federal Emergency Management Agency

MAP SCALE 1" = 500'

250 0 500 1000

FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0428F

FIRM

FLOOD INSURANCE RATE MAP

CONTRA COSTA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 428 OF 602

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CONTRA COSTA COUNTY	060025	0428	F
MORAGA, TOWN OF	060637	0428	F

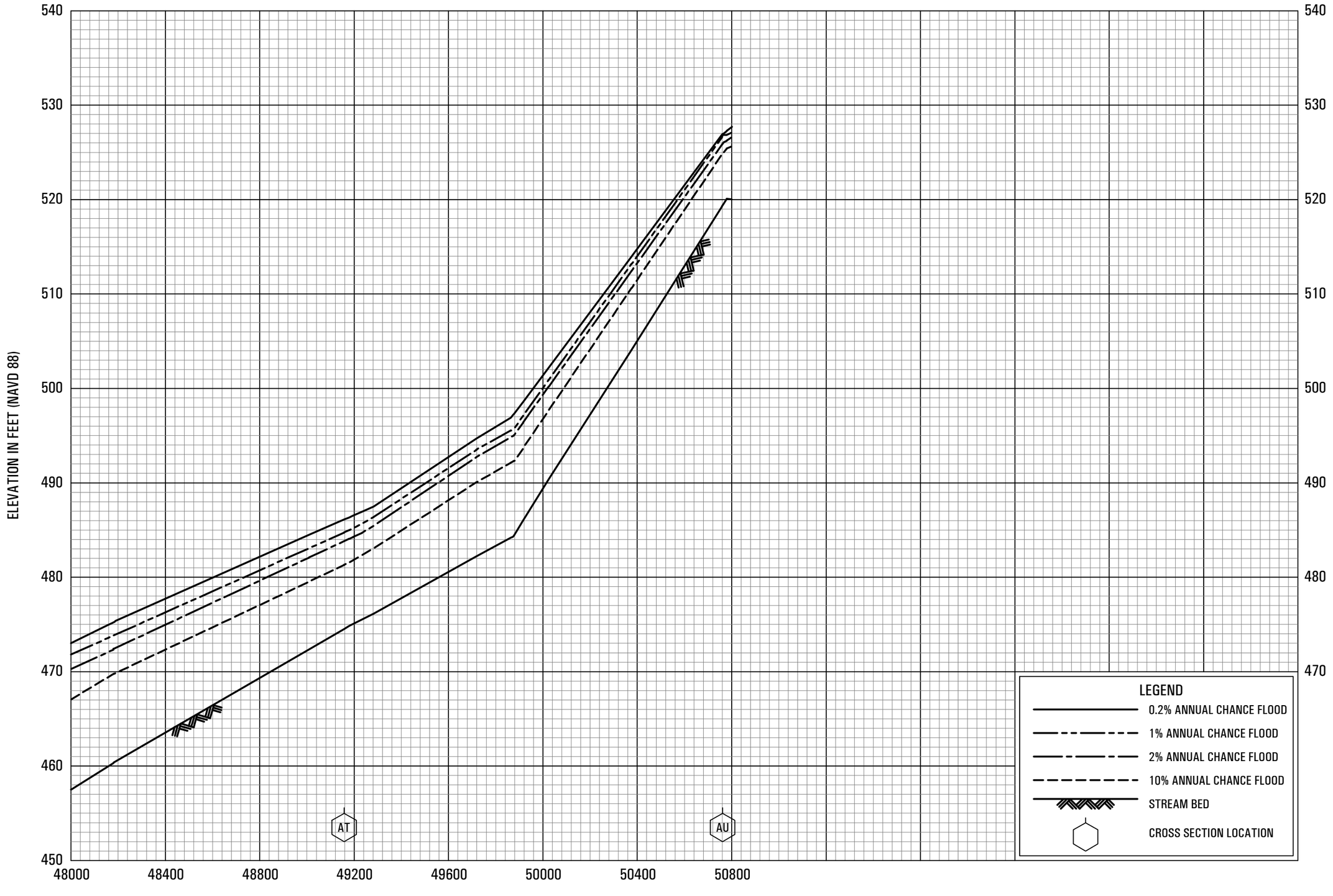
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06013C0428F

EFFECTIVE DATE
JUNE 16, 2009

Federal Emergency Management Agency

Appendix B Federal Emergency Management Agency Water Surface Profile of Las Trampas Creek



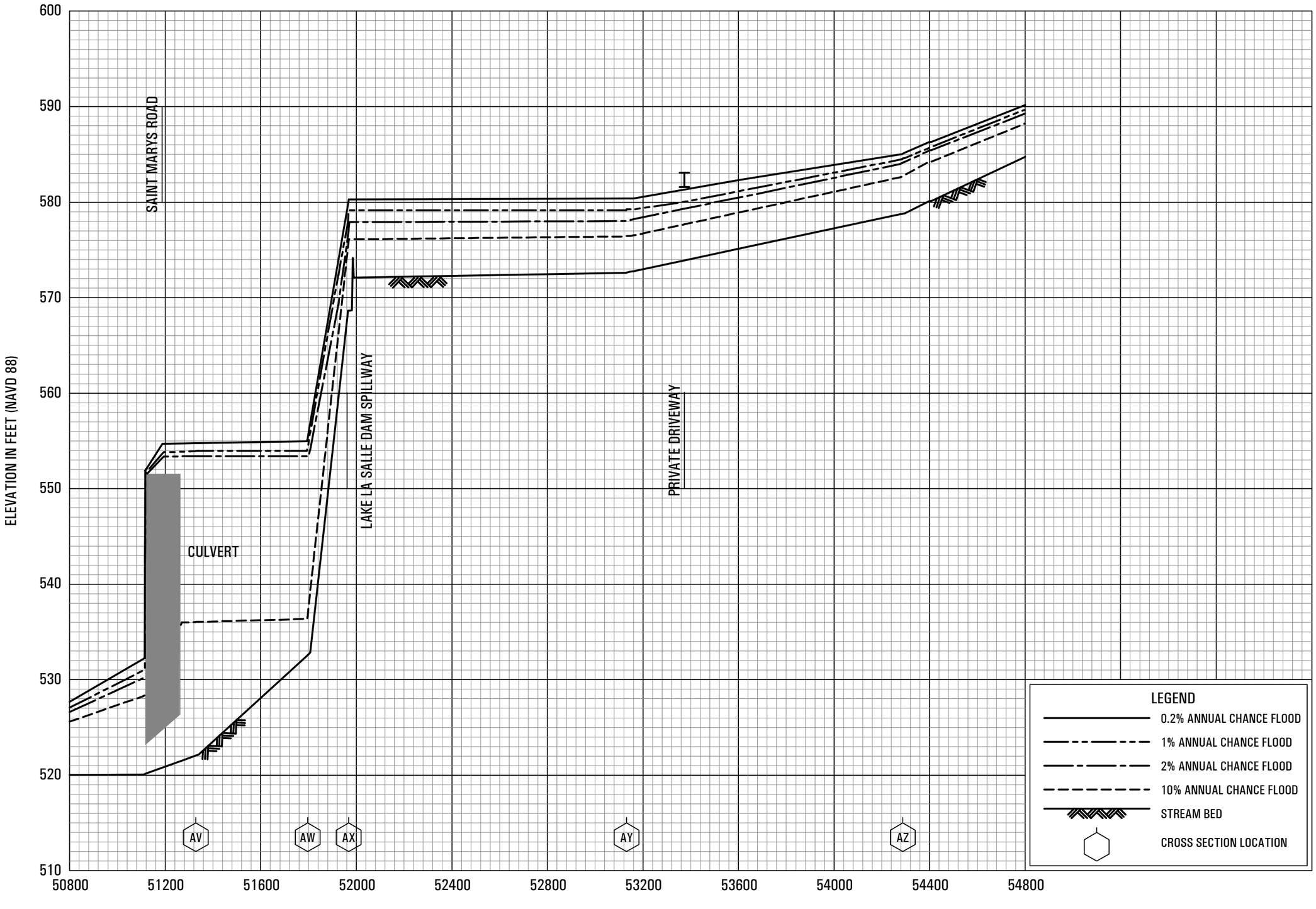
FLOOD PROFILES

LAS TRAMPAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CONTRA COSTA COUNTY, CA

AND INCORPORATED AREAS

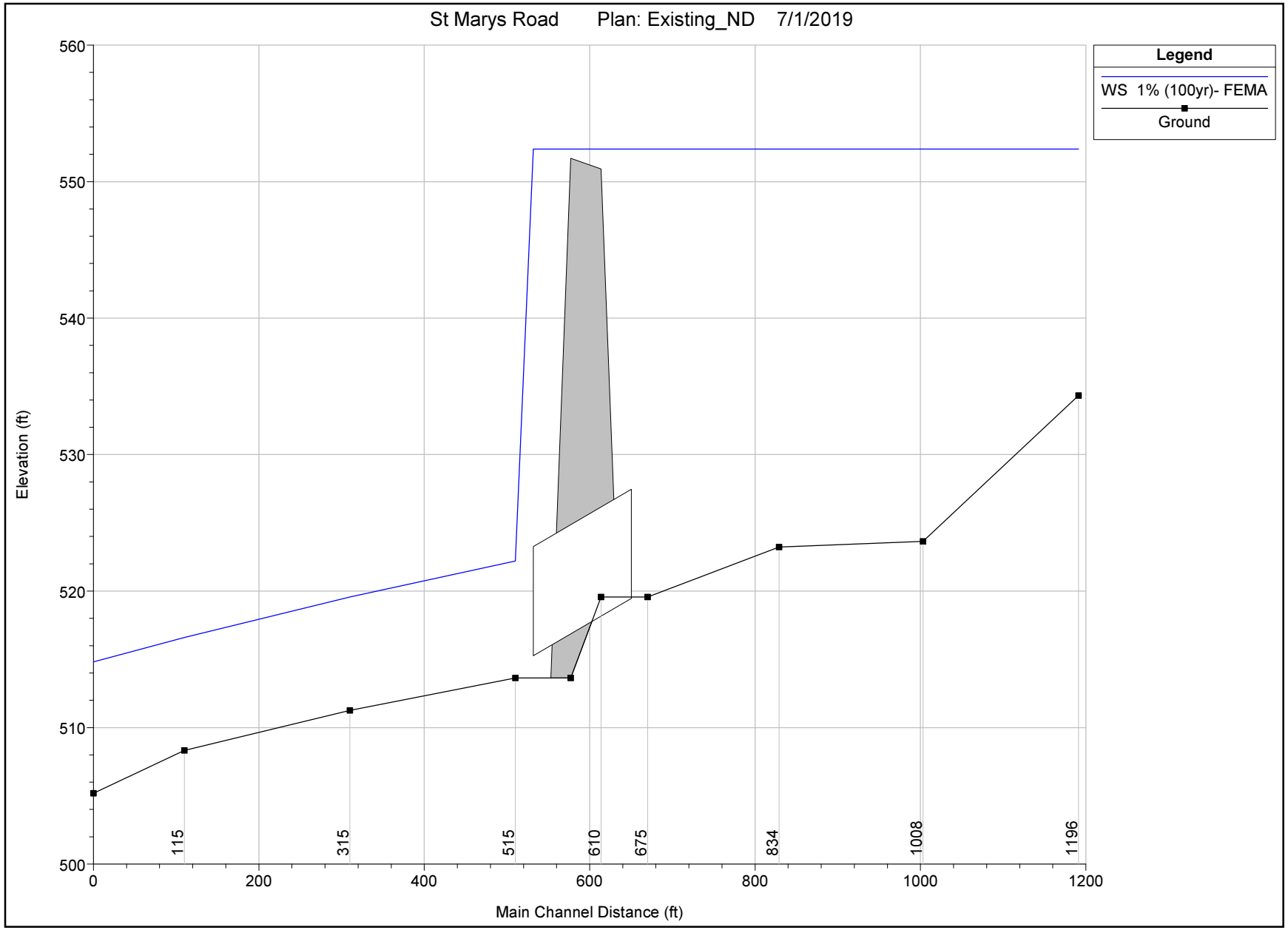


FLOOD PROFILES

LAS TRAMPAS CREEK

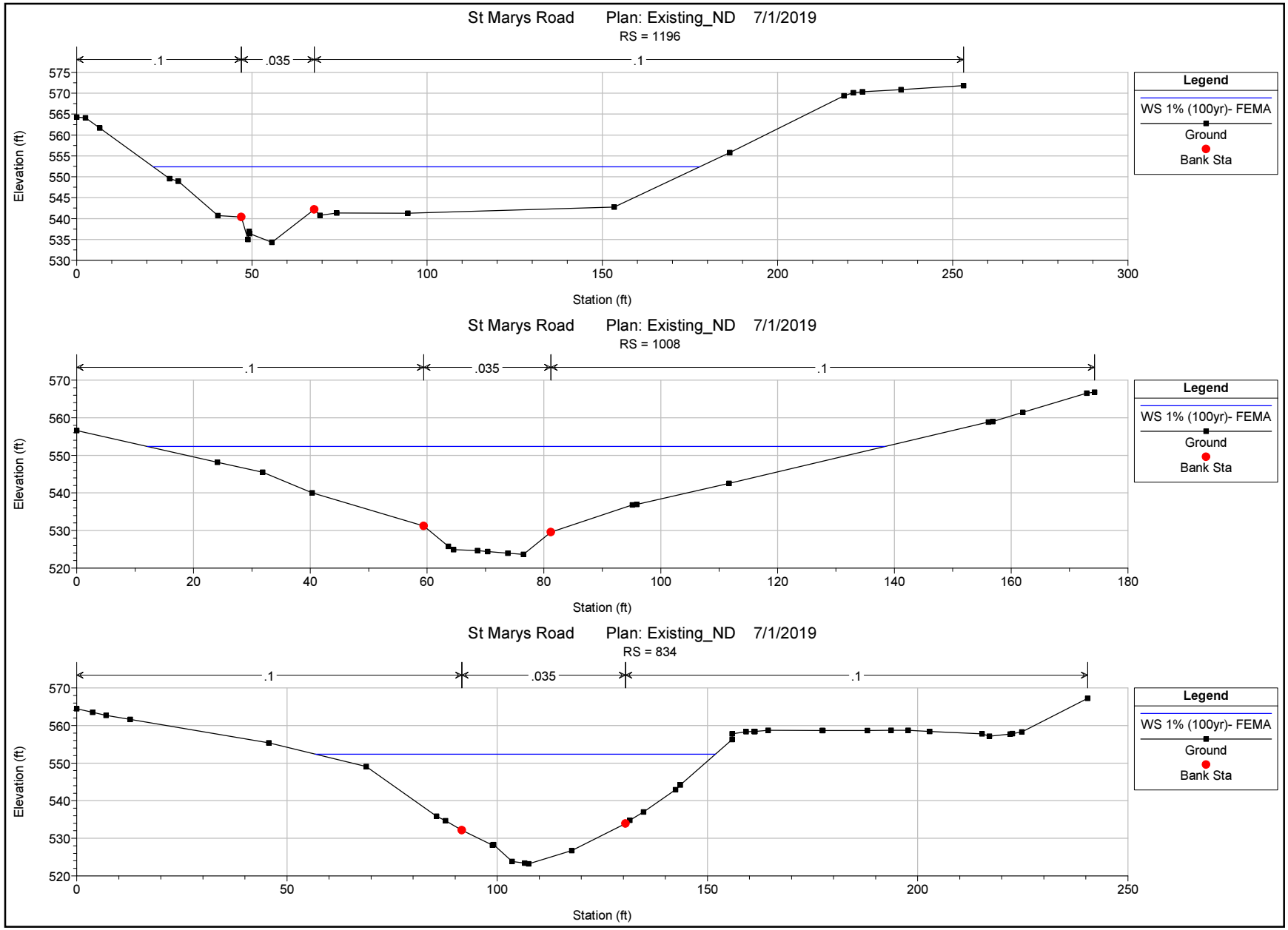
FEDERAL EMERGENCY MANAGEMENT AGENCY
CONTRA COSTA COUNTY, CA
AND INCORPORATED AREAS

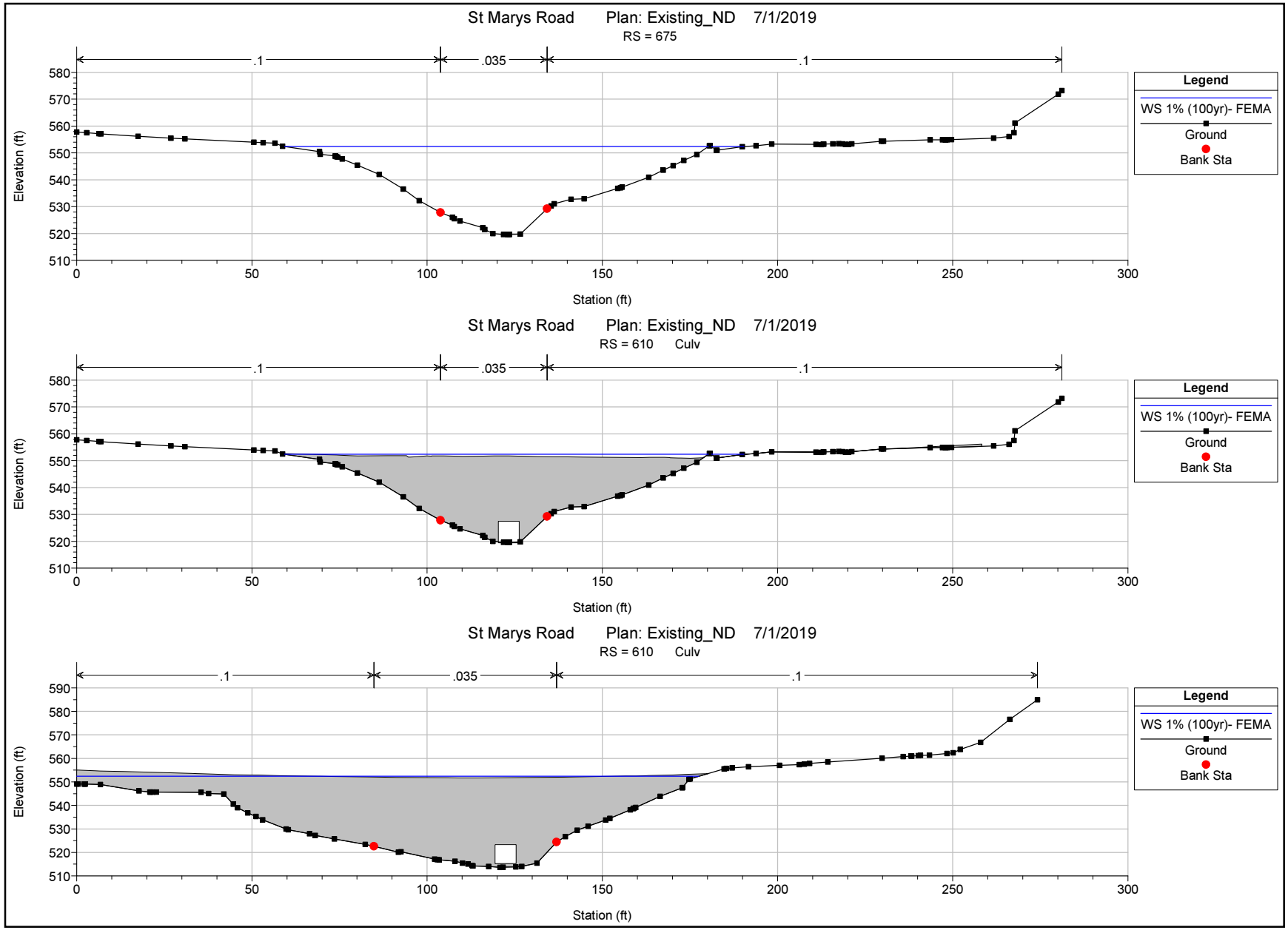
Appendix C Hydraulic Analysis Outputs: Existing Condition

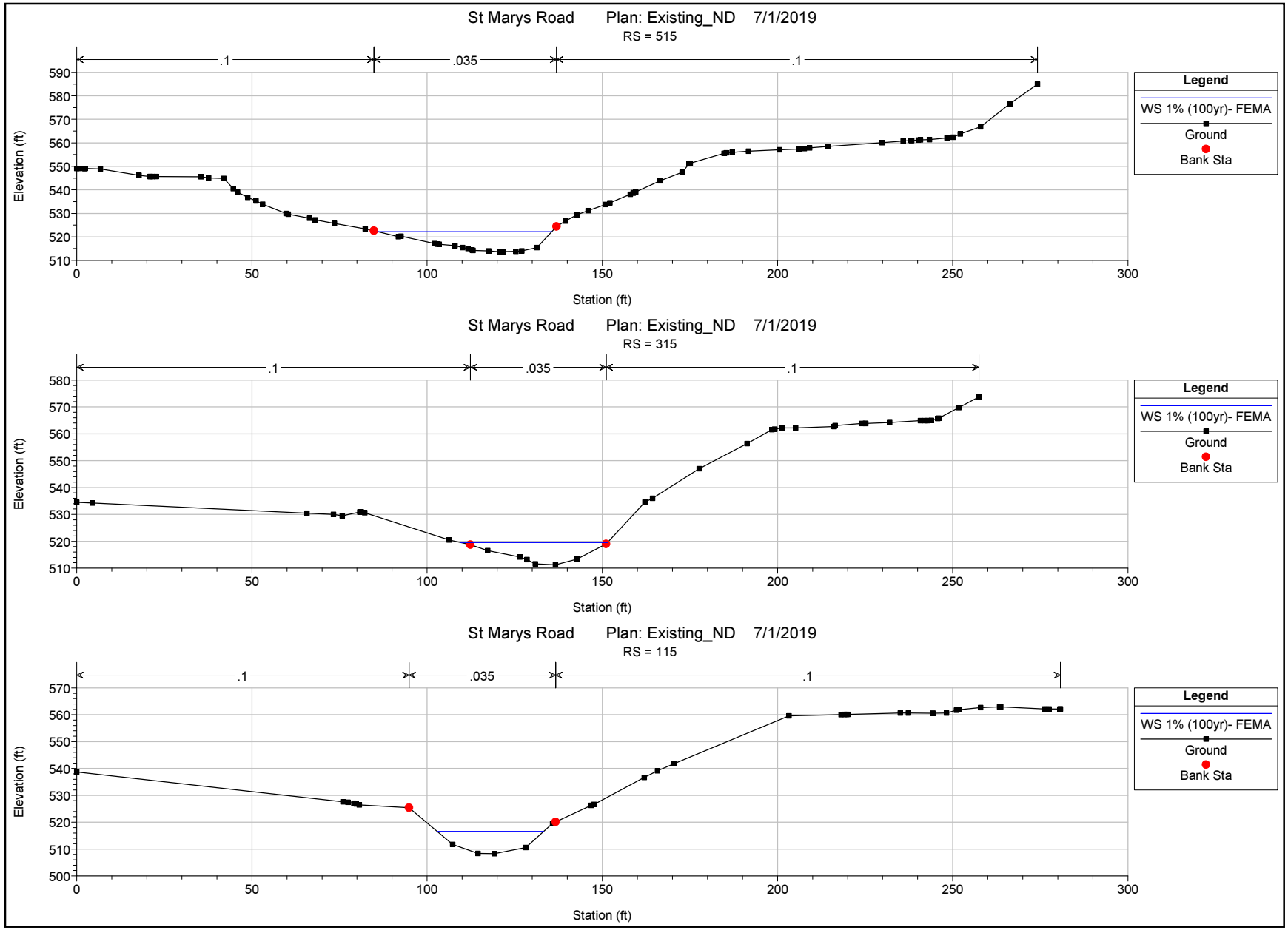

St Marys Road Plan: Existing_ND 7/1/2019
Legend
WS 1% (100yr)- FEMA
Ground
Elevation (ft)
560
550
540
530
520
510
500
0
200
400
600
800
1000
1200
Main Channel Distance (ft)
115
315
515
610
675
834
1008
1196

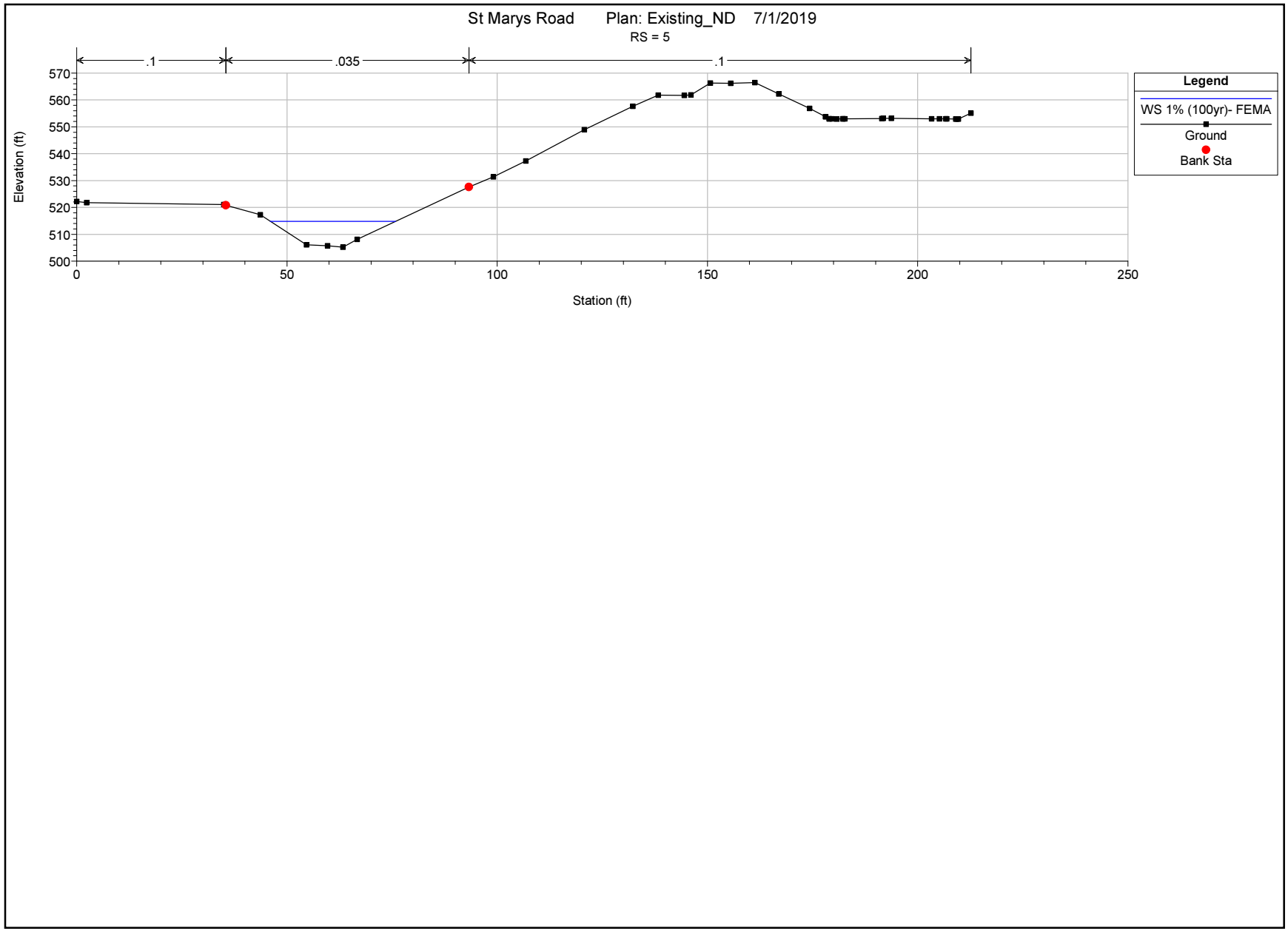
HEC-RAS Plan: Existing_ND River: THALWEG Reach: THALWEG Profile: 1% (100yr)- FEMA

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
THALWEG	1196	1% (100yr)- FEMA	1500.00	534.33	552.39		552.43	0.000114	2.20	1520.18	155.98	0.10
THALWEG	1008	1% (100yr)- FEMA	1500.00	523.65	552.38		552.42	0.000033	1.87	1660.69	126.38	0.06
THALWEG	834	1% (100yr)- FEMA	1500.00	523.22	552.38		552.41	0.000019	1.43	1468.33	95.20	0.05
THALWEG	675	1% (100yr)- FEMA	1500.00	519.57	552.38	526.97	552.41	0.000015	1.37	1926.36	130.21	0.04
THALWEG	610		Culvert									
THALWEG	515	1% (100yr)- FEMA	2400.00	513.64	522.21		523.42	0.005183	8.84	271.52	49.75	0.67
THALWEG	315	1% (100yr)- FEMA	2400.00	511.25	519.56	519.40	521.87	0.010646	12.20	197.84	41.95	0.95
THALWEG	115	1% (100yr)- FEMA	2400.00	508.33	516.60	516.60	519.50	0.012627	13.65	175.84	30.39	1.00
THALWEG	5	1% (100yr)- FEMA	2400.00	505.18	514.81	514.81	517.75	0.013170	13.76	174.48	29.80	1.00

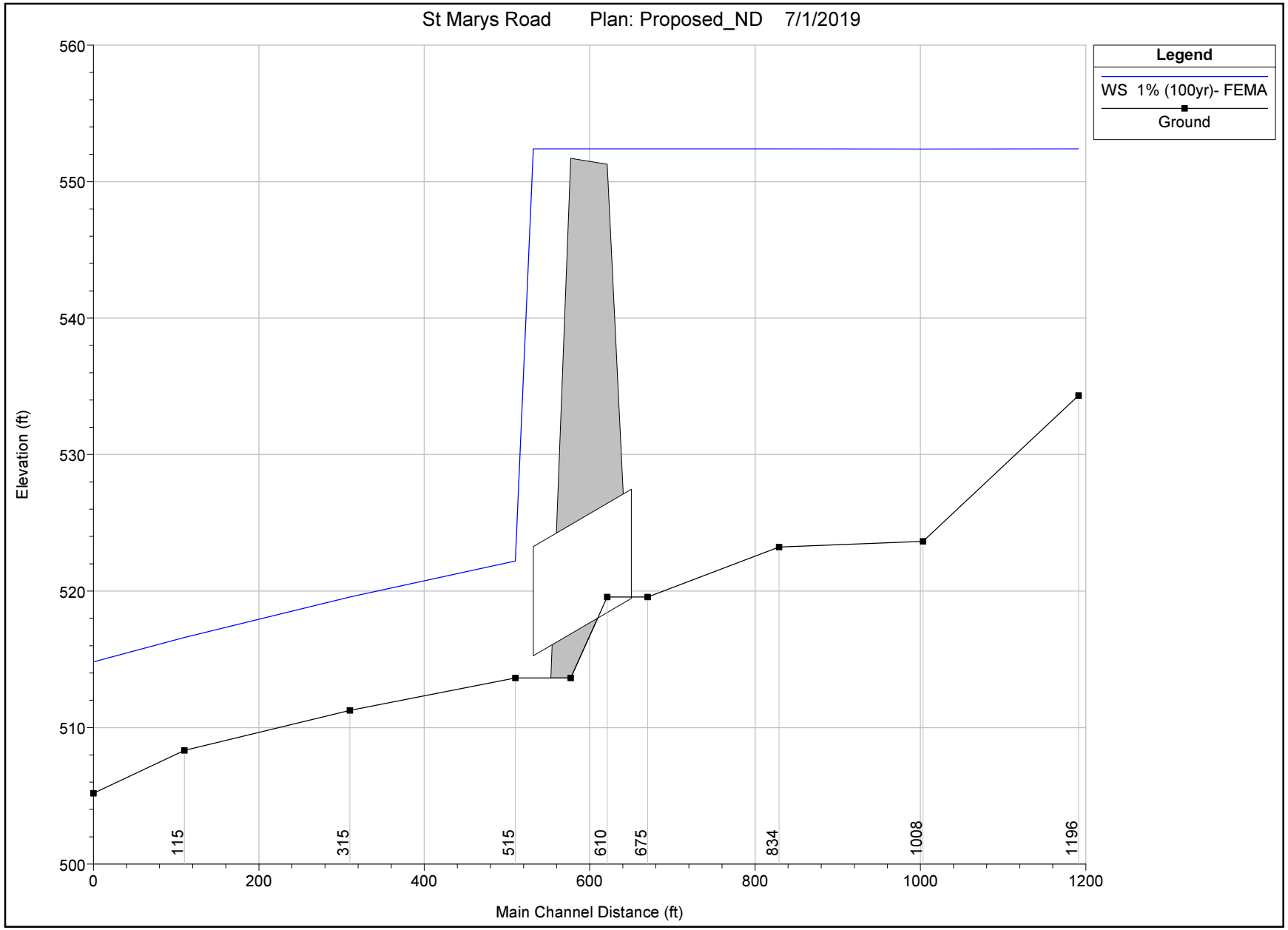

St Marys Road Plan: Existing_ND 7/1/2019
RS = 1196
.1
.035
.1
Elevation (ft)
575
570
565
560
555
550
545
540
535
530
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Existing_ND 7/1/2019
RS = 1008
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
0
20
40
60
80
100
120
140
160
180
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Existing_ND 7/1/2019
RS = 834
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
0
50
100
150
200
250
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta


St Marys Road Plan: Existing_ND 7/1/2019
RS = 675
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Existing_ND 7/1/2019
RS = 610 Culv
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Existing_ND 7/1/2019
RS = 610 Culv
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta


St Marys Road Plan: Existing_ND 7/1/2019
RS = 515
.1
.035
.1
Elevation (ft)
590
580
570
560
550
540
530
520
510
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Existing_ND 7/1/2019
RS = 315
.1
.035
.1
Elevation (ft)
580
570
560
550
540
530
520
510
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Existing_ND 7/1/2019
RS = 115
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
510
500
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta

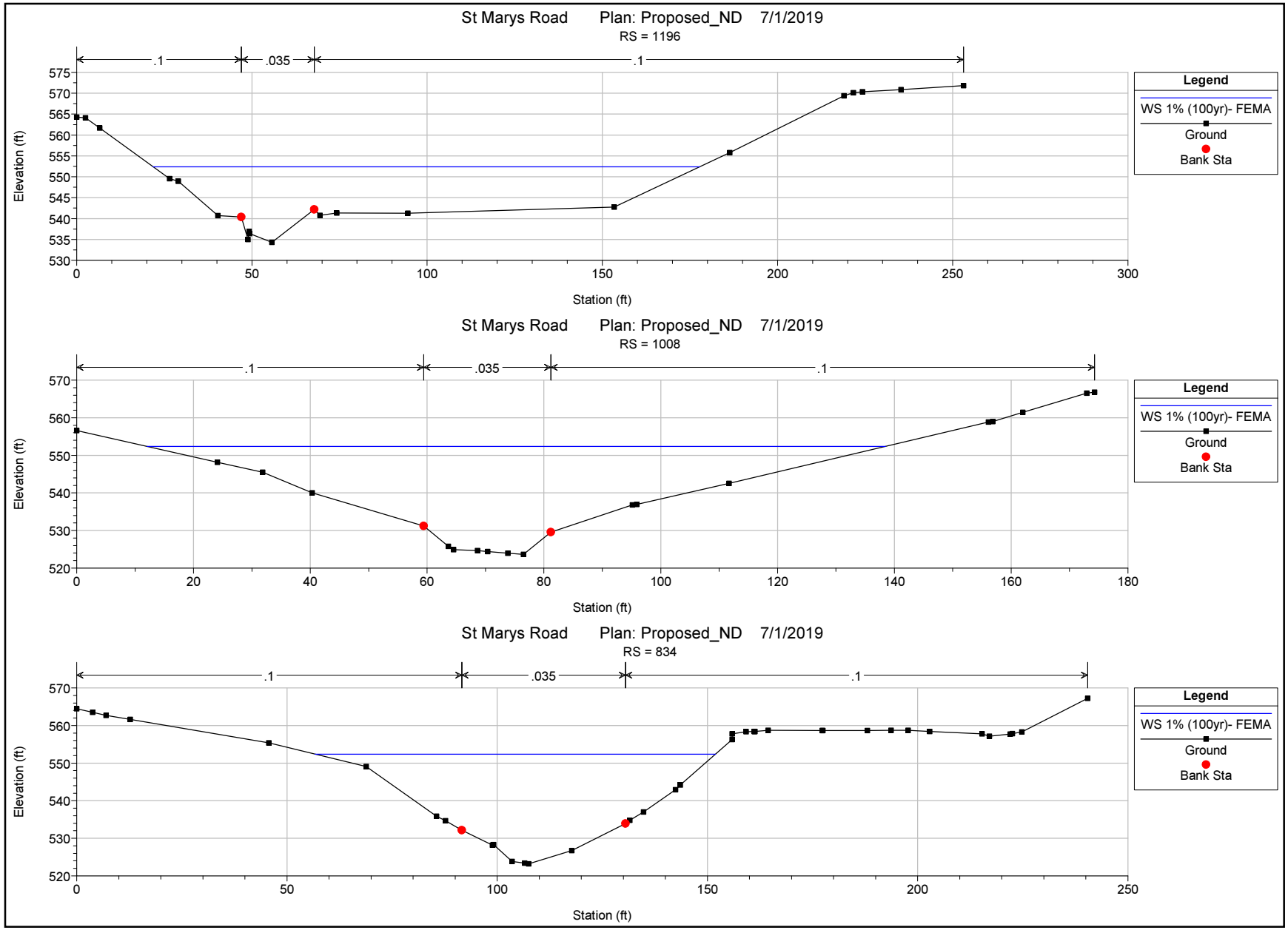

St Marys Road Plan: Existing_ND 7/1/2019
RS = 5
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
510
500
0
50
100
150
200
250
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta

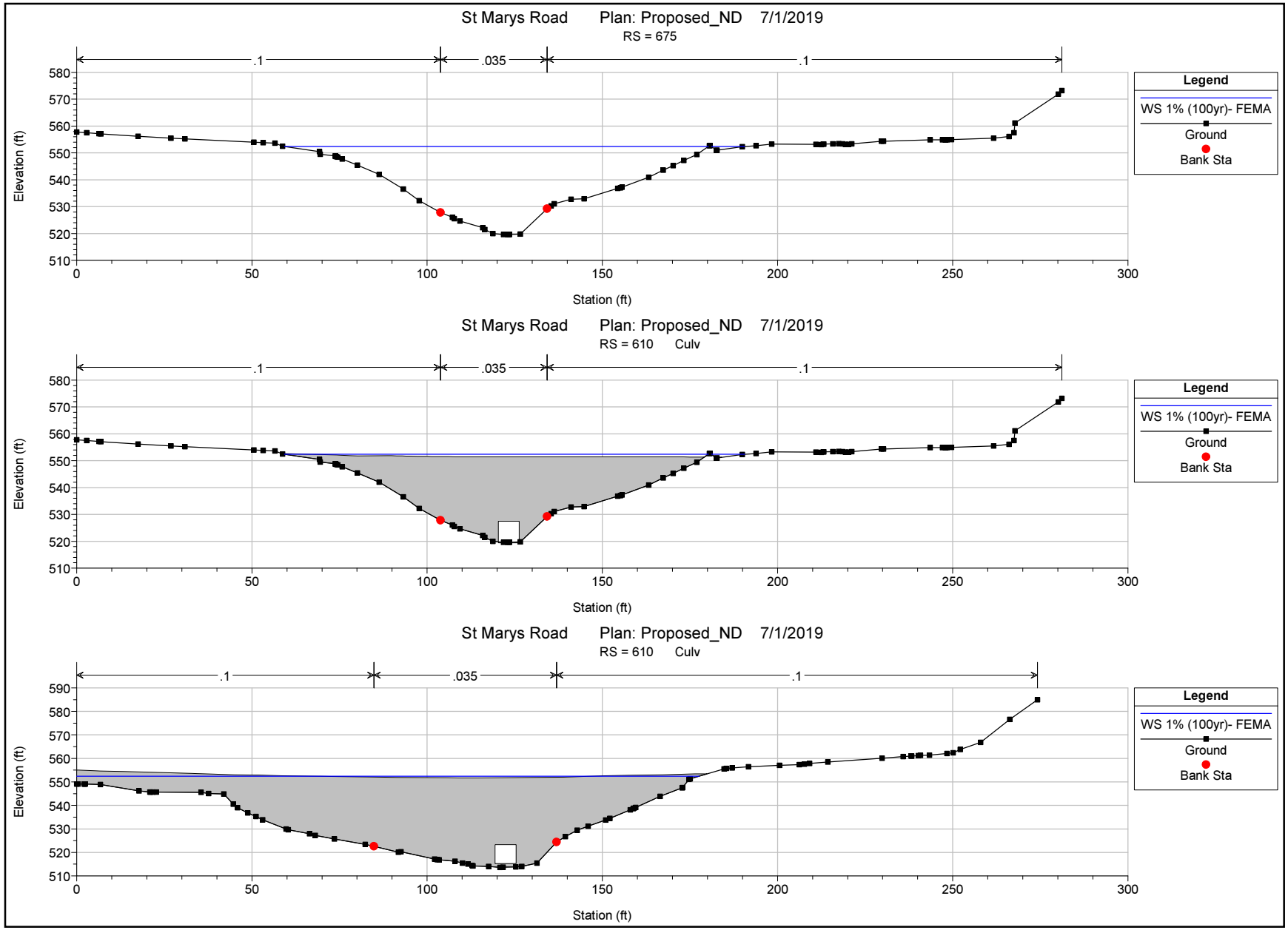
Appendix D Hydraulic Analysis Outputs: Proposed Condition

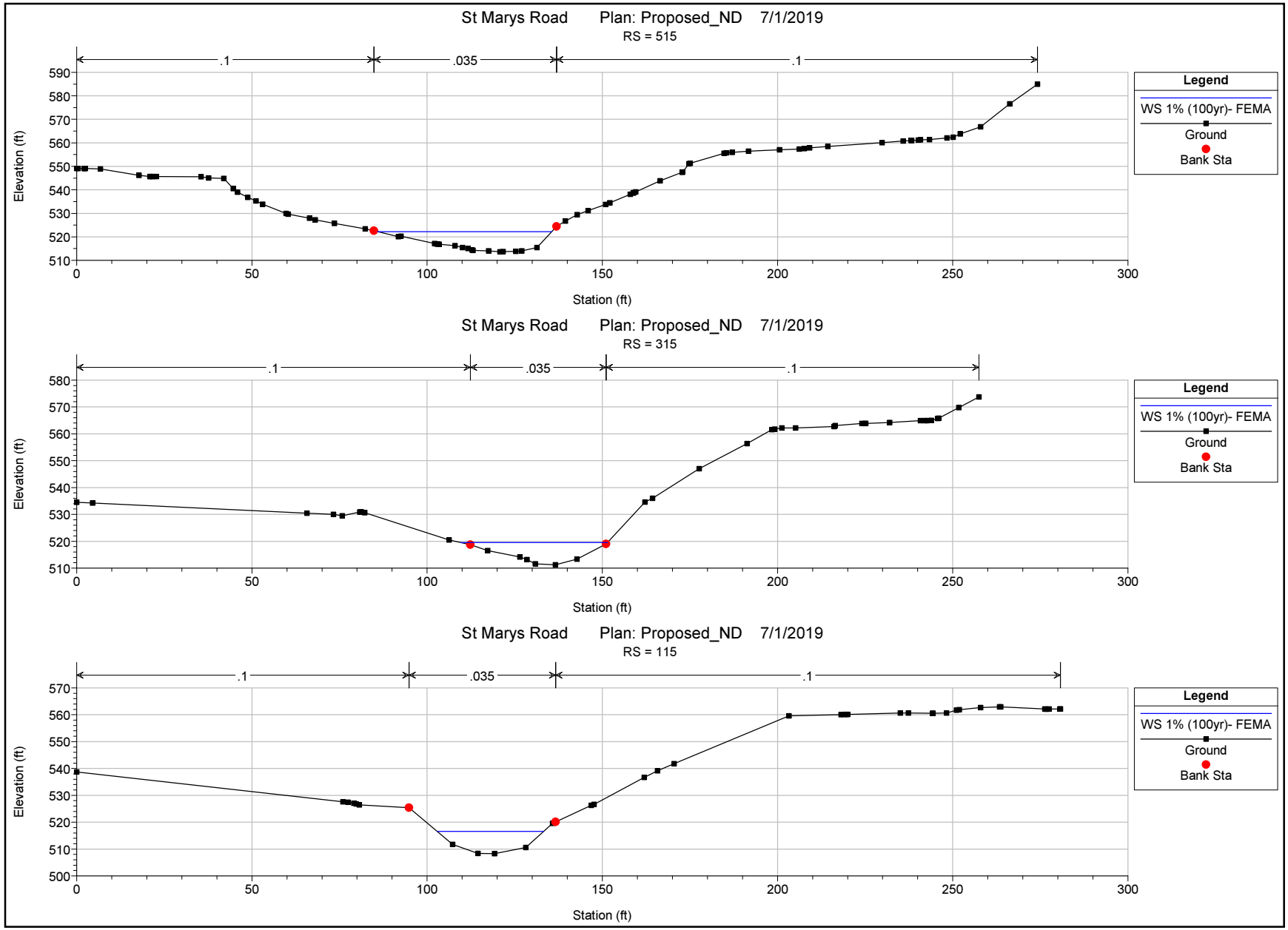

St Marys Road Plan: Proposed_ND 7/1/2019
Legend
WS 1% (100yr)- FEMA
Ground
Elevation (ft)
Main Channel Distance (ft)
560
550
540
530
520
510
500
0
200
400
600
800
1000
1200
115
315
515
610
675
834
1008
1196

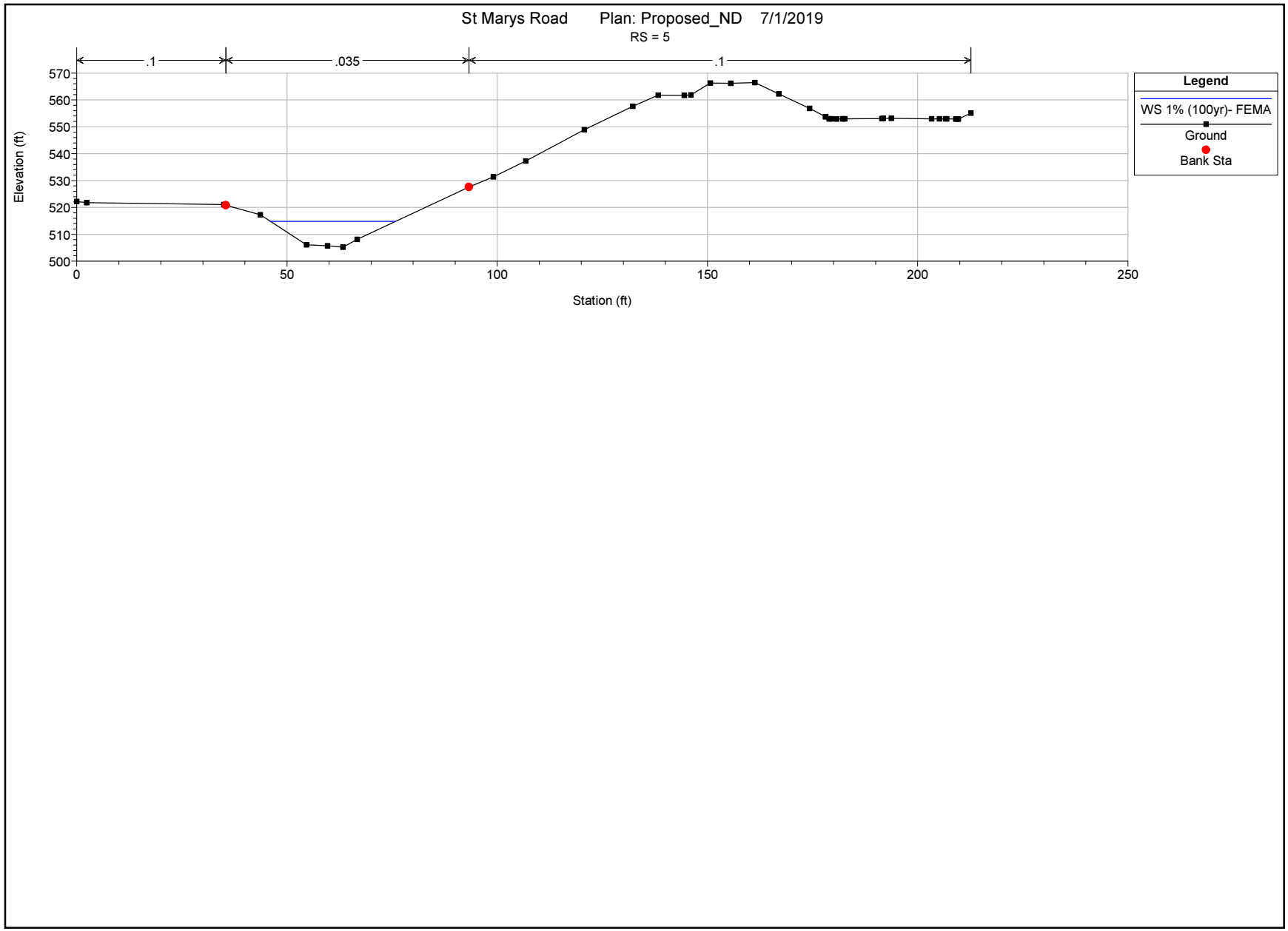
HEC-RAS Plan: Proposed_ND River: THALWEG Reach: THALWEG Profile: 1% (100yr)- FEMA

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
THALWEG	1196	1% (100yr)- FEMA	1500.00	534.33	552.41		552.44	0.000113	2.20	1522.55	156.04	0.10
THALWEG	1008	1% (100yr)- FEMA	1500.00	523.65	552.39		552.43	0.000033	1.86	1662.60	126.47	0.06
THALWEG	834	1% (100yr)- FEMA	1500.00	523.22	552.40		552.43	0.000019	1.43	1469.77	95.27	0.05
THALWEG	675	1% (100yr)- FEMA	1500.00	519.57	552.40	526.97	552.42	0.000015	1.37	1928.33	130.50	0.04
THALWEG	610		Culvert									
THALWEG	515	1% (100yr)- FEMA	2400.00	513.64	522.21		523.42	0.005183	8.84	271.52	49.75	0.67
THALWEG	315	1% (100yr)- FEMA	2400.00	511.25	519.56	519.40	521.87	0.010646	12.20	197.84	41.95	0.95
THALWEG	115	1% (100yr)- FEMA	2400.00	508.33	516.60	516.60	519.50	0.012627	13.65	175.84	30.39	1.00
THALWEG	5	1% (100yr)- FEMA	2400.00	505.18	514.81	514.81	517.75	0.013170	13.76	174.48	29.80	1.00


St Marys Road Plan: Proposed_ND 7/1/2019
RS = 1196
.1
.035
.1
Elevation (ft)
575
570
565
560
555
550
545
540
535
530
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Proposed_ND 7/1/2019
RS = 1008
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
0
20
40
60
80
100
120
140
160
180
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Proposed_ND 7/1/2019
RS = 834
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
0
50
100
150
200
250
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta


St Marys Road Plan: Proposed_ND 7/1/2019
RS = 675
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Proposed_ND 7/1/2019
RS = 610 Culv
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Proposed_ND 7/1/2019
RS = 610 Culv
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta


St Marys Road Plan: Proposed_ND 7/1/2019
RS = 515
.1
.035
.1
Elevation (ft)
590
580
570
560
550
540
530
520
510
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Proposed_ND 7/1/2019
RS = 315
.1
.035
.1
Elevation (ft)
580
570
560
550
540
530
520
510
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta
St Marys Road Plan: Proposed_ND 7/1/2019
RS = 115
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
510
500
0
50
100
150
200
250
300
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta


St Marys Road Plan: Proposed_ND 7/1/2019
RS = 5
.1
.035
.1
Elevation (ft)
570
560
550
540
530
520
510
500
0
50
100
150
200
250
Station (ft)
Legend
WS 1% (100yr)- FEMA
Ground
Bank Sta