San Francisco Bay Conservation and Development Commission
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State of California | Gavin Newsom – Governor | info@bcdc.ca.gov | www.bcdc.ca.gov

April 26, 2024

TO: Commissioners and Alternates

FROM: Lawrence J. Goldzband, Executive Director (415/352-3653; larry.goldzband@bcdc.ca.gov)
Katharine Pan, Shoreline Development Program Manager (415/352-3650; katharine.pan@bcdc.ca.gov)

SUBJECT: **Richmond-San Rafael Bridge Public Pathway Pilot Project**
(For Commission consideration on May 2, 2024)

Summary

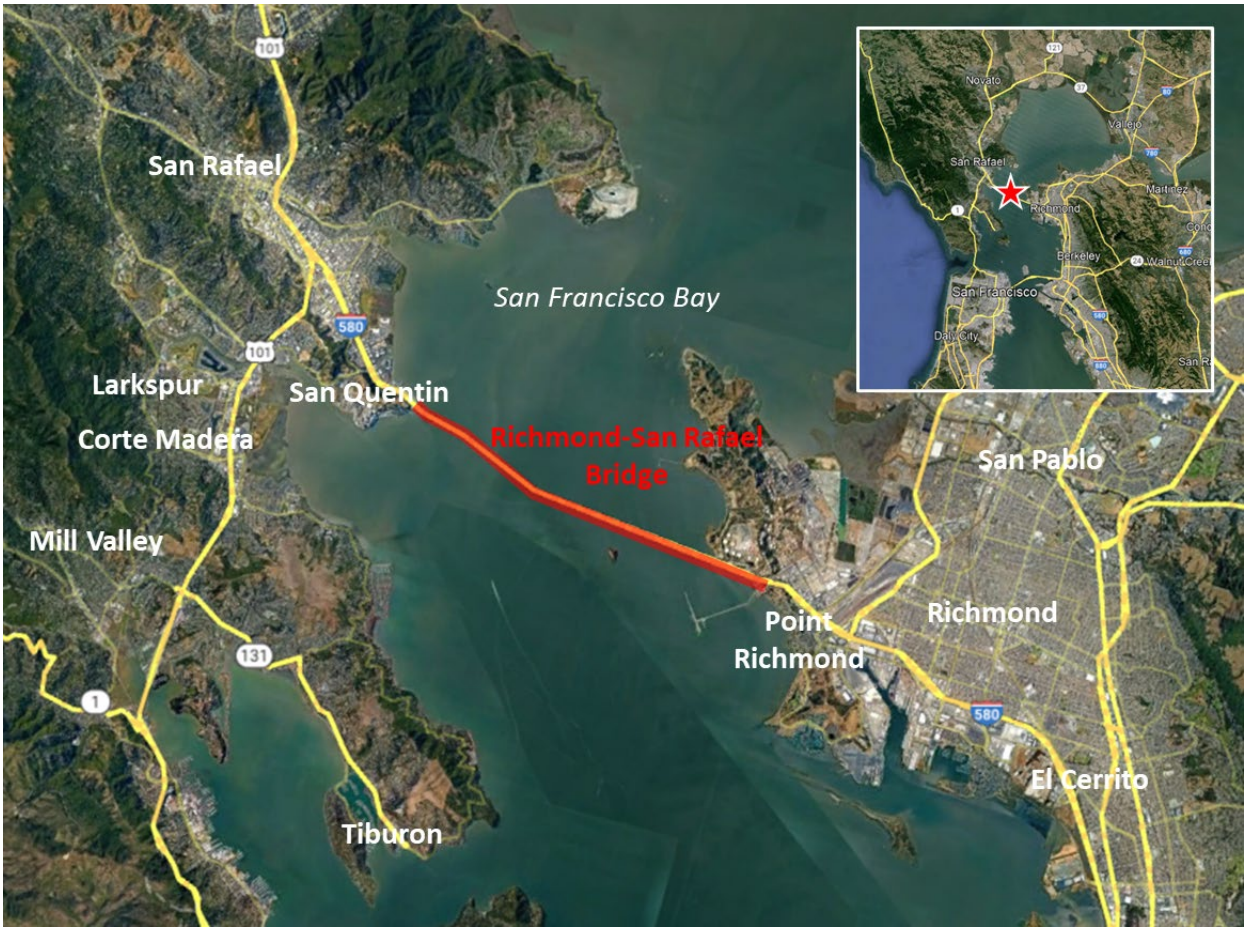
On September 20, 2016, the Commission issued Material Amendment No. Four of BCDC Permit No. 1997.001.04 to the California Department of Transportation (Caltrans), which authorized a four-year pilot project to evaluate the use of a separated Class I public pathway on the shoulder of the westbound upper deck of the Richmond-San Rafael Bridge and use of the shoulder of the eastbound lower deck as a vehicular travel lane. The conditions of the permit amendment required the permittee to provide a written and verbal report to the Commission on the status of the public pathway, including, but not limited to, an analysis of public usage and benefits, an assessment of any operational and safety issues, and the need for any future changes to the facilities, including removal or making them permanent. Caltrans and the Metropolitan Transportation Commission (MTC) Bay Area Tolling Authority (BATA) will present a verbal report at the May 2, 2024, Commission meeting and their written report is attached to this staff report.

Staff Report

Project Location

The Richmond-San Rafael Bridge is a Caltrans facility spanning the San Francisco Bay between Point Richmond in Contra Costa County and San Quentin in Marin County and is a segment of Interstate 580 (I-580) as well as a designated segment of the Bay Trail.

Figure 1. Regional Location



Richmond-San Rafael Bridge Pilot Project

On September 20, 2016, the Commission issued Material Amendment No. Four of BCDC Permit No. 1997.001.04 (Exhibit 1 of this staff report) to the California Department of Transportation (Caltrans), which authorized a four-year pilot project to evaluate the use of a separated Class I public pathway on the shoulder of the westbound upper deck of the Richmond-San Rafael Bridge and use of the shoulder of the eastbound lower deck as a vehicular travel lane. The authorized pilot project includes the following components on the bridge decks and approaches (Authorization Sections I.A.1.g and I.A.1.f of the amended permit):

1. **Westbound Upper Deck.** On the upper deck, the pilot project includes a 4-mile long, 10-foot-wide bi-directional Class I accessible public pathway on the northern shoulder, separated from vehicle traffic by a 42-inch-tall, 18-inch-wide moveable barrier. It also includes an outer safety railing on the north side of the pathway, as well as informational signage and usage instrumentation. At the westbound approach to the bridge, the pilot project includes a 0.19-mile-long segment of the same Class I pathway and moveable barrier in the shoulder of I-580. These improvements are also required as a condition of the pilot project by Special Condition II.H of the amended permit.

2. **Eastbound Lower Deck.** On the lower deck, the pilot project converts a 4-mile segment of the 12-foot-wide shoulder to a vehicle travel lane during peak commute hours only, and includes signage as well as traffic-monitoring cameras on both decks. At the eastbound approach to the bridge, the pilot also converts a 0.65-mile-long segment of the I-580 shoulder for use as a vehicle travel lane.

Caltrans' purposes in piloting these uses of the bridge shoulders were to seek a means of reducing congestion and travel time in the eastbound direction and to provide pedestrian and bicycle facilities across the bridge, the latter of which is related to the provision of public access contemplated in the findings of the original permit. Caltrans intended to evaluate the performance and use of these uses to determine whether they should be made permanent.

Permit History

BCDC Permit No. 1997.001.00 was originally issued on September 10, 1997, to authorize the seismic retrofit of the bridge as part of Caltrans' Toll Bridge Seismic Retrofit Program. The retrofit project included approximately 55,800 square feet of new solid and cantilevered Bay fill; 270,00 square feet of pile-supported replacement fill; 197,000 square feet of temporary fill for construction; and dredging and backfill to enable the bridge to withstand collapse from a major seismic event.

The bridge was originally constructed in the late 1950s, predating the Commission, and was not designed to accommodate public access. At the time the original permit was issued, non-vehicular access was prohibited on the bridge, but it was designated as a "proposed [planned] Bay Trail segment" by the California Coastal Conservancy and the Association of Bay Area Government's Bay Trail project. The original permit contemplated the addition of a new bicycle and pedestrian pathway (Findings Section III.C), finding that the provision of bicycle and pedestrian access across the bridge was desirable and would maximize the public access benefits of the retrofit project, and that the Commission's laws and policies stated that such access should be provided wherever feasible. However, due to the urgent timing of the retrofit project and the need for further study as to whether such facilities could be provided safely, the original permit did not require that Caltrans construct any new public pathway across the bridge as part of the retrofit project. Instead, Caltrans voluntarily agreed to use its best efforts to provide public access across the bridge by completing a study by 1998 to determine the feasibility of providing pedestrian, bicycle, and wheelchair access across the bridge. If such access was found to be feasible, Caltrans would, by the end of 1999, submit an implementation plan to the Commission to ensure that such access is provided as soon as the retrofit work is done and no later than 2003. This commitment was detailed in the permit findings, but not included as a special condition.

Feasibility of Bicycle and Pedestrian Access

Since 1997, Caltrans, MTC, BCDC, and others have worked together to continue to study and discuss the feasibility of providing non-motorized public access across the bridge, and the Commission has received numerous briefings on the topic from Caltrans and BATA.

In 1998, Caltrans completed the feasibility study described in the original permit, which included a long-term recommendation for a cantilevered bicycle and pedestrian facility and an interim recommendation to use the shoulders of both decks for bicycle and pedestrian access (Richmond-San Rafael Public Access Feasibility Study). That study, however, cited deficiencies in available data that precluded a definitive safety analysis. To address the deficiencies, Caltrans commissioned the Mineta Transportation Institute to conduct a statewide safety study of bicycle and pedestrian use of freeways, toll bridges and tunnels, completed in 2001. However, Caltrans found the statewide study to be inconclusive on the issues of capacity, operations, safety, and enforcement.

In November 2007, BATA prepared a project study report seeking to develop alternatives for bicycle and pedestrian access across the bridge. The project study report identified a preferred public access alternative consisting of a bi-directional multi-use path on the westbound deck of the bridge separated from traffic by a moveable barrier. The alternative required use of the shoulder, which was considered a non-standard feature that required a Caltrans exception. Caltrans denied the exception based on safety concerns related to the loss of the shoulder for use as recovery space for errant vehicles and the moveable barrier, after which the Commission requested additional information to support its conclusions. In 2009, BATA proposed a pilot program similar to the one ultimately authorized by Material Amendment No. Four, though Caltrans continued to hold the same safety concerns. The Commission requested that Caltrans study the feasibility of undertaking a pilot program, and, in 2016, Caltrans requested to amend the BCDC permit to authorize the pilot project.

Permit Status

Special Condition II.H of the amended permit requires that the permittee provide a written and verbal report to the Commission at or around the end of the third year of the pilot project regarding the status of the public pathway. The status report is required to include, but is not limited to, an analysis of public usage and benefits, an assessment of any operational and safety issues, and the need for any future changes to the facilities, including removal or making them permanent. Although the pilot project has already ended, the status briefing to be provided at the May 2, 2024, Commission Meeting and the attached Report on the Richmond-San Rafael Bridge Access Improvement Pilot Project (Exhibit 2) are intended to fulfill this permit requirement.

The report describes a forthcoming proposal to extend and modify the pilot project (Page 9) to move the barrier on a weekly basis to maintain the multi-use path on days with less commute traffic and higher path usage and revert it to an emergency shoulder on the remaining days, with a bicycle shuttle to serve users impacted by the path closure. Caltrans and BATA propose to use the modified pilot project to further evaluate use of the facility; the effect of the emergency shoulder on incident rates, incident response, and travel time reliability; and the effect of the public access facility on social equity. During implementation of the modified pilot project, Caltrans and BATA would also continue to assess any structural improvements to the bridge required to accommodate a permanent public pathway and work to implement other

related projects that are expected to affect transit, carpooling, and congestion on the bridge. Caltrans anticipates returning to the Commission in late summer 2024 with a material amendment request to authorize the modified pilot.

Additionally, the permit specifically prohibits the alteration or removal of the pilot project facilities without a permit amendment. Caltrans is therefore working with BCDC staff to obtain a time extension for the existing facilities so that they can remain in place until the next steps can be determined and implemented.

Relevant BCDC Law and Policies

McAteer-Petris Act

Section 66602 of the McAteer-Petris Act states, in part, "that existing public access to the shoreline and waters of the San Francisco Bay is inadequate and that maximum feasible public access, consistent with a proposed project, should be provided."

San Francisco Bay Plan

- **Transportation Policy No. 1.** Because of the continuing vulnerability of the Bay to filling for transportation projects, the Commission should continue to take an active role in Bay Area regional transportation and related land use planning affecting the Bay, particularly to encourage alternative methods of transportation and land use planning efforts that support transit and that do not require fill. The Metropolitan Transportation Commission, the California Department of Transportation, the California Transportation Commission, the Federal Highway Administration, county congestion management agencies and other public and private transportation authorities should avoid planning or funding roads that would require fill in the Bay and certain waterways.

- **Transportation Policy No. 4.** Transportation projects on the Bay shoreline and bridges over the Bay or certain waterways should include pedestrian and bicycle paths that will either be a part of the Bay Trail or connect the Bay Trail with other regional and community trails. Transportation projects should be designed to maintain and enhance visual and physical access to the Bay and along the Bay shoreline.

- **Public Access Policy No. 1.** A proposed fill project should increase public access to the Bay to the maximum extent feasible, in accordance with the policies for Public Access to the Bay.

- **Public Access Policy No. 2.** In addition to the public access to the Bay provided by waterfront parks, beaches, marinas, and fishing piers, maximum feasible access to and along the waterfront and on any permitted fills should be provided in and through every new development in the Bay or on the shoreline, whether it be for housing, industry, port, airport, public facility, wildlife area, or other use, except in cases where public access would be clearly inconsistent with the project because of public safety considerations or significant use conflicts, including unavoidable, significant adverse

effects on Bay natural resources. In these cases, in lieu access at another location preferably near the project should be provided. If in lieu public access is required and cannot be provided near the project site, the required access should be located preferably near identified vulnerable or disadvantaged communities lacking well-maintained and convenient public access in order to foster more equitable public access around the Bay Area.

- **Public Access Policy No. 5.** Public access that substantially changes the use or character of the site should be sited, designed, and managed based on meaningful community involvement to create public access that is inclusive and welcoming to all and embraces local multicultural and indigenous history and presence. In particular, vulnerable, disadvantaged, and/or underrepresented communities should be involved. If such previous outreach and engagement did not occur, further outreach and engagement should be conducted prior to Commission action.

- **Public Access Policy No. 8.** Public access improvements provided as a condition of any approval should be consistent with the project, the culture(s) of the local community, and the physical environment, including protection of Bay natural resources, such as aquatic life, wildlife and plant communities, and provide for the public's safety and convenience. The improvements should be designed and built to encourage diverse Bay-related activities and movement to and along the shoreline, should provide barrier free access for persons with disabilities, for people of all income levels, and for people of all cultures to the maximum feasible extent, should include an ongoing maintenance program, and should be identified with appropriate signs, including using appropriate languages or culturally-relevant icon-based signage.

Questions for Commission Consideration

In reviewing the findings of the attached report on the pilot project, and in anticipation of a future amendment request that would extend and modify the pilot project, BCDC staff requests that the Commission consider the following questions to provide direction for staff and the permittee.

1. Is there sufficient information at this time to determine whether to a) remove the public access improvements, b) make them permanent, and/or c) alter them?

2. At the time an amendment request for a modified pilot project is presented to the Commission, what information (quantitative or qualitative) would the Commission like to be included in the application and/or staff analysis to support a determination of whether the proposed modifications are appropriate?

3. At the conclusion of the pilot project, including any possible extended and/or modified pilot, what information should be provided to support a determination of whether non-motorized public access is feasible on the bridge?

4. At the conclusion of the pilot project, what information should be provided to support a determination of whether any proposed permanent project would represent maximum feasible public access on the bridge?

Conclusion

Staff would like Commissioners to consider and provide comments on the results of the pilot project and the permittee's proposal to extend and modify the project to further study feasibility of public access on the Richmond-San Rafael Bridge in advance of an anticipated forthcoming material amendment request.

Exhibit 1
BCDC Permit No. 1997.001.04
Permittee: California Department of Transportation

San Francisco Bay Conservation and Development Commission
455 Golden Gate Avenue, Suite 10600, San Francisco, California 94102 tel 415 352 3600 fax 415 352 3606

September 20, 2016

California Department of Transportation
111 Grand Avenue
P.O. Box 23660
Oakland, CA 94623-0660

ATTENTION: Melanie Brent

SUBJECT: Material Amendment No. Four to BCDC Permit No. 1997.001.04

Dear Ms. Brent:

Enclosed please find an original of BCDC Amended Permit No. 1997.001.04, stamped "BCDC Original," two copies stamped "Recorder's Copy," and one stamped "Permittee's Copy;" all executed by the Executive Director, incorporating the amendment requested in your letter dated March 24, 2016. In the amended permit, deleted language has been ~~struck through~~ and added language has been underlined.

I am issuing this amendment, which is included in the attached amended permit, on behalf of the Commission and upon the following findings and declarations:

1. This amendment to the permit is a material alteration, as defined in Regulation Section 10824.

2. The amendment to the permit is consistent with the San Francisco Bay Plan and the McAteer-Petris Act because the proposed project will not adversely affect the Bay nor public access to and enjoyment of the Bay consistent with the project.

You must (1) **complete**, before a notary, the acknowledgment sections of the amended permit stamped "BCDC Original," and "Recorder's Copy," which indicates that you have read and that you understand all of the terms and conditions of the amended permit, and (2) **return** that entire executed "BCDC Original" to the Commission's office within the ten-day time period. Within thirty days, you must submit proof that the "Recorder's Copy" was recorded in Marin County and Contra Costa County to the Commission's office. The copy stamped "Permittee's Copy" should be retained by you for your records along with the Notice of Completion and Declaration of Compliance form which you must return to the Commission upon project completion.

Furthermore, your permit contains special conditions which require you to take certain specific actions. Please understand that **no** work may commence on the project until the permit stamped "BCDC Original" is executed and returned to the Commission. Until the Commission

receives the executed permit, the California Department of Transportation does not have the necessary authorization for the work authorized under the permit. The commencement of any work within the Commission's jurisdiction without the necessary authorization from the Commission is a violation of the McAteer-Petris Act and could subject you to substantial fines.

If you should have any questions regarding the amended permit or the procedure outlined above, please contact Jhon Arbelaez-Novak of our staff at 415-352-3649 or jhon.arbelaez@bcdc.ca.gov.

Very truly yours,

LAWRENCE J. GOLDZBAND
Executive Director

Enc.
LG/JAN/ra

PERMIT NO. 1997.001.04
(Issued Originally on September 10, 1997, As Amended Through September 20, 2016)
MATERIAL AMENDMENT NO. FOUR

CALIFORNIA DEPARTMENT OF TRANSPORTATION

CERTIFICATION OF CONTRACTOR REVIEW

San Francisco Bay Conservation
and Development Commission
455 Golden Gate Avenue, Suite 10600
San Francisco, CA 94102

Ladies and Gentlemen:

You are hereby informed that prior to commencing any grading, demolition, or construction authorized by the above referenced amended permit, I personally reviewed and understand the terms and conditions of the permit, the final plans approved by or on behalf of the Commission, particularly as they pertain to the public access, open space, and environmentally sensitive areas required herein, for those portions of the work for which I am in charge.

I, _____, hereby declare under penalty of perjury that the foregoing is true and correct and that if called upon to testify to the contents of this notice, I would so testify.

Executed on this _____ day of _____,

20_____, at _____, California.

_____
Contractor Name and Company

_____
(Title)

PERMIT NO. 1997.001.04
(Issued Originally on September 10, 1997, As Amended Through September 20, 2016)
MATERIAL AMENDMENT NO. FOUR

CALIFORNIA DEPARTMENT OF TRANSPORTATION

NOTICE OF COMPLETION AND DECLARATION OF COMPLIANCE

San Francisco Bay Conservation
and Development Commission
455 Golden Gate Avenue, Suite 10600
San Francisco, CA 94102
Ladies and Gentlemen:

You are hereby informed that the work authorized by the above-referenced amended permit was completed on _____.

I have personally reviewed the terms and conditions of the amended permit, the final plans approved by or on behalf of the Commission, and the completed project and hereby certify that the project is in compliance with all terms and conditions of the amended permit and conforms to the plans previously reviewed and approved by or on behalf of the Commission. I further certify that all conditions of the amended permit, particularly with regard to plan review, public access areas and improvements, recordation, open space restrictions and other special conditions have been met.

I, _____, hereby declare under penalty of perjury that the foregoing is true and correct and that if called upon to testify to the contents of this notice, I would so testify.

Executed on this _____ day of _____, 20_____,

at _____, California.

_____
(Permittee)

_____
Title

San Francisco Bay Conservation and Development Commission
455 Golden Gate Avenue, Suite 10600, San Francisco, California 94102 tel 415 352 3600 fax 415 352 3606

PERMIT NO. 1997.001.04
(Issued Originally on September 10, 1997, As Amended Through September 20, 2016)
MATERIAL AMENDMENT NO. FOUR

California Department of Transportation
District Four
111 Grand Avenue
Oakland, California 94612

ATTENTION: Melanie Brent, Deputy District Director,
Division of Environmental Planning and Engineering

Ladies and Gentlemen:

On August 7, 1997, the San Francisco Bay Conservation and Development Commission, by a vote of 22 affirmative, 0 negative, and 0 abstentions, approved the resolution pursuant to which the original permit had been issued. Moreover, on January 23, 2001, ~~and~~ November 2, 2005, and September 19, 2006 pursuant to Commission Regulation Section 10822, the Executive Director approved Amendment Nos. One, Two, and Three, respectfully, pursuant to which this amended permit ~~is~~ had been ~~hereby~~ issued. On September 15, 2016, the San Francisco Bay Conservation and Development Commission, by a vote of 19 affirmative, 0 negative, and 0 abstentions, approved Material Amendment No. Four pursuant to which this amended permit is hereby issued:

I. Authorization

A. Subject to the conditions stated below, the permittee, the California Department of Transportation, District Four, is granted permission to do the following work at the Richmond-San Rafael Bridge (Interstate 580), which stretches between Point San Quentin in San Rafael, Marin County, and Castro Point in Richmond, Contra Costa County:

1. **In the Bay:**

a. Main Structure:

(1) Excavate approximately 64,000 cubic yards of Bay muds from around the base of the piers and dispose of the material at the designated Alcatraz dredged material disposal site (SF-11), and backfill around the base of the retrofitted piers with approximately 14,000 cubic yards of rock armor (Original Authorization);

(2) Install new piles, pile caps, and steel casings on the pier bells on piers 19 through 38 and 41 through 49, totaling approximately 41,000 square feet of solid fill (Original Authorization);

(3) Install new piles, precast concrete jackets, and steel casings on piers 39, 40, and piers 50 through 60, excluding pier 55, totaling approximately 2,400 square feet of solid fill (Original Authorization); and

(4) Install modified fenders on the main navigation channel, piers 34, 35, 47 and 48, and replace the fenders on the side navigation channel, piers 33, 36, 46 and 49 (Original Authorization).

b. East Approach Structure:

(1) Excavate approximately 4,700 cubic yards of Bay muds from around the base of the piers, dispose of approximately 1,380 cubic yards of material at the designated Alcatraz dredged material disposal site (SF-11), and approximately 3,320 cubic yards at a suitable upland location and backfill around the base of the retrofitted piers with approximately 4,500 cubic yards of rock armor (Original Authorization);

(2) Install new piles (16-inch-diameter piles) on piers 62 through 77 (Original Authorization);

(3) Install grade beam/footing strengthening elements on piers 66 through 74 (Original Authorization);

(4) Install new concrete and/or steel shaft casings on piers 62 through 77, totaling approximately 23 square feet of solid fill (Original Authorization);

(5) Install for the duration of construction thirteen work platforms, totaling approximately 65,000 square feet of temporary fill, and up to two access trestles, totaling approximately 37,000 square feet of temporary fill (Original Authorization); and

(6) Install for the duration of construction fourteen coffer dams about 5 feet away from the new pier foundations at piers 62 through 65 and piers 75R through 77R, and half of the coffer dams at piers 73R and 74R, totaling approximately 15,000 square feet of temporary fill (Original Authorization).

c. West Approach Structure:

(1) Excavate approximately 7,900 cubic yards of Bay muds from around the base of the piers and dispose of the material at the designated Alcatraz dredged material disposal site (SF-11), and backfill around the base of the retrofitted piers with approximately 3,500 cubic yards of rock armor (Original Authorization);

(2) Install new piles (approximately 12-inches-in-diameter) through the existing bell pier footings and install new pre-cast concrete shaft jackets on piers A through 18 (Original Authorization);

(3) Install new steel casings around the sides of the pier bells on piers A through 18, totaling approximately 664 square feet of solid fill (Original Authorization);

(4) Install new steel casings, piles and a pile cap on pier 19, totaling approximately 2,236 square feet of solid fill (Original Authorization); and

(5) Extend the existing diaphragm walls on piers A through 18 (Original Authorization).

d. Concrete Trestle Section:

(1) Completely remove the existing trestle, which consists of 50-foot-long spans supported by five, 2-foot-in-diameter, hollow concrete piles, totaling approximately 270,000 square feet of pile-supported fill, and remove the existing 2-foot in diameter piles at the mud line (Original Authorization);

(2) Install a new trestle along the existing alignment with 100-foot-long spans supported by two 5-foot-in-diameter cast-in-drilled-hole concrete piles with permanent steel casings, totaling approximately 270,000 square feet of replacement pile-supported fill and 10,800 square feet of new pile-supported fill (Original Authorization);

(3) Excavate approximately 135,000 cubic yards of Bay muds for barge access to facilitate the replacement of the concrete trestle and dispose of the material at the designated Alcatraz dredged material disposal site (SF-11) (Original Authorization); and

(4) Install a temporary trestle between the two sections of the existing Concrete Trestle Section to facilitate pile driving and other construction activities. This trestle would extend from land at Point San Quentin for approximately 2,856 feet with an area of approximately 72,000 square feet (Original Authorization).

e. Temporarily use and moor barges adjacent to the bridge to facilitate construction as coordinated and approved by the U.S. Coast Guard (Original Authorization); ~~and~~

f. Remove abandoned wooden piles, steel pipes and concrete and asphalt debris under the East Approach section of the bridge within the existing Caltrans Right-of-Way (Original Authorization)~~.~~; and

g. Westbound (Upper) and Eastbound (Lower) Bridge Decks (Material Amendment No. Four):

(1) Use and maintain in-kind a 4.0-mile-long, 12-foot-wide shoulder on the eastbound (lower) deck as a vehicle travel lane during peak commute hours only for a period of up to four years;

(2) Install, use and maintain in-kind up to 60 signs to inform motorists of third travel lane availability on the lower deck, and up to 34 closed-circuit TV cameras (CCTV) on the upper and lower bridge decks to monitor traffic for a period of up to four years; and

(3) Install, use and maintain in-kind: a 4.0-mile-long, 10-foot-wide Class I, bi-directional and universally accessible public pathway at the northern side of the westbound upper deck; an adjoining 42-inch-tall, 18-inch wide barrier separating the pathway from vehicle traffic, and an outer safety railing (north of the public pathway) measuring between 42 and 62-inches above the upper bridge deck and consisting of 2.5-inch diameter vertical members and horizontal cables; and associated informational signage and usage instrumentation for a period of up to four years.

2. **Within the 100-foot Shoreline Band:**

a. Main Structure:

(1) Install new, eccentrically-braced frames within the steel towers (Original Authorization);

(2) Install new friction dampers, seismic isolation joints and bearings on the towers and the deck (Original Authorization); and

(3) Install new structural elements in the superstructure and deck to strengthen the deck, truss members, and superstructure (Original Authorization).

b. East Approach Structure:

(1) Install new structural elements in the superstructure and deck to strengthen the superstructure and deck (Original Authorization);

(2) Install for the duration of construction portions of the access platforms, trestles and coffer dams, temporarily covering approximately 35,500 square feet of area (Original Authorization);

(3) Temporarily close the existing bike path which travels underneath the east end of the bridge for a maximum three-month period and install improvements including a new bench and interpretive signs as described in Special Condition II-E below (Original Authorization);

(4) Remove abandoned wooden piles, steel pipes and concrete and asphalt debris under the East Approach section of the bridge (Original Authorization); and

(5) Install and maintain (after-the-fact) approximately 760 linear feet of security barrier and fencing at ground-level on the north and south sides of the eastern bridge approach, consisting of a K-rail concrete barrier approximately 30 inches-tall and an adjacent six-foot-tall chain link fence (Amendment No. Two).

c. West Approach Structure:

(1) Install new structural elements in the superstructure and deck to strengthen the superstructure and deck (Original Authorization);

d. Concrete Trestle Section: Install approximately 2,000 lineal feet of temporary, concrete vehicle barriers (K-rails) for traffic management during construction (Original Authorization); ~~and~~

e. On the Marin County shoreline, north of the freeway and east of the San Rafael Rod and Gun club: Construct, use and maintain a new 23,971-square-foot public access area, consisting of six parking spaces, a picnic table and benches, a trash receptacle, two benches on a pedestrian bridge over a seasonal wetland, and landscaping, as shown in Exhibit A (Amendment No. Three)~~.~~; and

f. Westbound (Upper) and Eastbound (Lower) I-580 Bridge Approaches (Material Amendment No. Four):

(1) Use and maintain in-kind a 0.65-mile-long section of I-580 eastbound southern shoulder as a 12-foot-wide vehicular travel lane for a period of up to four years; and

(2) Install, use and maintain in-kind a 0.19-mile-long section of I-580 westbound northern shoulder as a ten-foot-wide Class I, bi-directional, universally-accessible public pathway and an adjoining 0.16-mile-long section of a 42-inch-tall, 18-inch-wide barrier to separate public path from vehicle traffic for a period of up to four years.

3. **Within the Bay and 100-foot Shoreline Band:**

a. Remove remaining cement riprap and place approximately 226 lineal feet of new rock slope protection adjacent to the public access at the western end of the bridge, including the installation of 290 cubic yards of quarry rock in the Bay, covering approximately 1,960 square feet, and the installation of quarry rock in the shoreline band that covers approximately 1,890 square feet, as shown in Exhibit A (Amendment No. Three).

B. This amended authority is generally pursuant to and limited by the permittees' application received February 14, 1997, your letter dated November 6, 2000, requesting Amendment No. One for a time extension, ~~a~~ your letter dated August 18, 2005, requesting Amendment No. Two for an after-the-fact security barrier, ~~and a~~ your letter dated December 30, 2005, requesting Amendment No. Three, and your letter dated March 24, 2016, requesting Material Amendment No. Four, including all accompanying and subsequently submitted correspondence and plans, and subject to the modifications required by the conditions herein.

C. The work authorized by the original permit was to commence by June 30, 1999, and with the time extension authorized by Amendment No. One, was to be diligently pursued to completion by December 31, 2005, unless the terms of this authorization ~~are~~ were changed by a further amendment of this amended permit. The security fence authorized by Amendment No. Two ~~is~~ was an after-the-fact authorization. Authorizations providing for the public access facility that is described in Special Condition II-G and modified by Amendment No. Three, shall extend to May 31, 2007.

The construction activities authorized in Material Amendment No. Four shall commence by September 2018, and be diligently pursued to completion by September 1, 2020, unless an extension of time is granted by amendment of this amended permit. Following installation and commencement of use, the facilities

authorized in Amendment No. Four shall remain in place and maintained for a four-year period only unless an extension of time or other action is granted through further amendment of this amended permit. The removal of the facilities authorized in Amendment No. Four is not authorized herein, and such activity requires further amendment of the subject permit.

D. **Original Authorization.** Overall, the project ~~will~~ resulted in approximately 55,800 square feet of new solid and cantilevered fill, approximately 270,000 square feet of pile-supported fill replacement, approximately 197,000 square feet of temporary, pile-supported and solid fill, and approximately 219,000 cubic yards of dredging and 22,000 cubic yards of backfill. The retrofit of the existing bridge will enable the bridge to withstand collapse from a major seismic event (estimated at a 7.25 Richter Scale earthquake with a 20-second duration on the Hayward fault, which is approximately 5 miles from the bridge, or an 8.0 Richter Scale earthquake with a 40-second duration on the San Andreas fault, which is approximately 10 miles from the bridge). The major public benefit of the project is the increased protection of people, property and transportation services from the dangers of a major earthquake and the potential for possibly opening up of the bridge to some form of public access. Further, the project includes mitigation measures to minimize the project's adverse impacts on public access, shoreline areas, fish and wildlife, water quality and the loss of Bay surface area and water volume such that the public detriments of the project do not exceed the benefit of the project to the public's health, safety and welfare (Original Authorization).

E. **Amendment No. Four.** Overall, the project will result in approximately 200,000 square feet of public access on the Richmond-San Rafael Bridge, and a new vehicular travel lane during peak traffic hours for a four-year-long pilot program. All improvements will be installed on or over existing Bay fill and will, thus, not result in any net increase of fill in the Bay. The project will not impact Bay resources nor will it affect the structural stability of the bridge designed to withstand a significant seismic event. Furthermore, it has no impacts on public access, shoreline areas, fish and wildlife, water quality, or the loss of Bay surface area and water volume such that the public detriments of the project do not exceed the benefit of the project to the public's health, safety and welfare.

II. Special Conditions

The amended authorization made herein shall be subject to the following special conditions, in addition to the standard conditions in Part IV:

A. **Specific Plans and Plan Review**

1. **Bridge Public Pathway and Associated Improvements (Material Amendment No. Four).** The improvements authorized in Material Amendment No. Four shall be built generally in conformance with the figures entitled "Project Plans for Construction on State Highway—In Contra Costa and Marin Counties in and near Richmond and San Rafael from the Richmond-San Rafael Bridge Toll Plaza to 0.1 mile east of Sir Francis Drake Boulevard in San Rafael dated June 10, 2016, and Project Plans for Construction on State Highway—in Contra Costa and Marin Counties in and near Richmond and San Rafael from Castro Street in Richmond to Sir Francis Drake Boulevard in San Rafael," dated May 25, 2016, and prepared by HNTB Corporation. No substantial changes shall be made to these plans without prior review and written approval by or on behalf of the Commission. No further plan review is required for the work authorized in Material Amendment No. Four.

~~1.~~2. **Plan Review** (Original Authorization). Work authorized herein may be completed under multiple construction contracts. No work shall commence, except for the security barrier and fence authorized in Amendment No. Two, under an individual construction contract until final plans and specifications for each specific contract have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The specific drawings and information required will be determined by the staff. To save time, preliminary drawings should be submitted and approved prior to final drawings.

a. **Site, Shoreline Clean-up, Architectural, Public Access, and Landscaping Plans**. Site, shoreline clean-up, architectural, public access and landscaping plans shall include and clearly label the Mean High Tide Line, the line 100 feet inland of the Mean High Tide Line, property lines, the boundaries of all areas to be reserved for public access purposes and open space, shoreline clean-up, details showing the location, types, dimensions, and materials to be used for all structures, irrigation, landscaping, drainage, seating, parking, signs, lighting, fences, paths, trash containers, utilities and other proposed improvements.

Plans submitted shall be accompanied by a letter requesting plan approval, identifying the type of plans submitted, the portion of the project involved, and indicating whether the plans are final or preliminary. Approval or disapproval shall be based upon:

(1) completeness and accuracy of the plans in showing the features required above, particularly the Mean High Tide Line, property lines, and the line 100-feet inland of the Mean High Tide Line, and any other criteria required by this amended authorization;

(2) consistency of the plans with the terms and conditions of this amended authorization;

(3) the provision of the amount and quality of public access to and along the shoreline and in and through the project to the shoreline required by this amended authorization;

(4) consistency with legal instruments reserving public access and open space areas; and

(5) assuring that any fill in the Bay does not exceed this amended authorization and will consist of appropriate shoreline protection materials as determined by or on behalf of the Commission.

b. **Rip Rap Plans**. No work whatsoever shall be commenced on the shoreline protection improvements authorized herein until final riprap plans have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The plans shall consist of appropriate diagrams and cross-sections that (1) show and clearly label the elevation of the mean high tide line and the datum used for the plans, property lines, grading limits, and details showing the location, types, and dimensions of all materials to be used, (2) indicate the source of all materials to be used, and (3) indicate who designed the proposed shoreline protection improvements and their background in coastal engineering and familiarity with the Commission's concerns. Approval or disapproval of the plans shall be based upon (1) completeness and accuracy of the plans in showing the features required above, (2) consistency of the plans with the terms and conditions of this permit, (3) assuring that the proposed fill material does not exceed this permit, (4) the appropriateness of the types of fill material and their proposed manner of placement, and (5) the preparation of the plans by professionals knowledgeable of the Commission's concerns, such as civil engineers experienced in coastal processes. All improvements constructed pursuant to this permit shall conform to the final approved plans. No

changes shall be made thereafter to any final plans or to the constructed shoreline protection improvements without first obtaining written approval of the change(s) by or on behalf of the Commission.

c. **Engineering Plans**. Engineering plans shall include a complete set of contract drawings and specifications and design criteria. The design criteria shall be appropriate to the nature of the project, the use of any structures, soil and foundation conditions at the site, and potential earthquake-induced forces. Final plans shall be signed by the professional of record and be accompanied by:

(1) Evidence that the project design complies with all applicable Caltrans design standards;

(2) Evidence that an independent or in-house peer review panel has reviewed the project (except that such evidence may be waived by the staff, upon consultation with the Chair of the Engineering Criteria Review Board (ECRB), if peer review is determined not to be necessary); and

(3) Written certification of the professional of record that the final PS&Es satisfy the recommendations of the ECRB.

~~2.~~3. **Conformity with Final Approved Plans**. All work, improvements, and uses shall substantially conform to the final approved plans. Upon completion of seismic retrofit of the facilities authorized herein, the appropriate design professional(s) of record shall certify in writing that, through personal knowledge, the work covered by the amended authorization has been performed in accordance with the approved design criteria and in substantial conformance with the approved plans. No noticeable changes shall be made thereafter to any final plans or to the exterior of any outside fixture, lighting, landscaping, signage, landscaping, parking area, or shoreline protection work without first obtaining written approval of the change(s) by or on behalf of the Commission.

~~3.~~4. **Discrepancies between Approved Plans and Special Conditions**. In case of any discrepancy between final approved plans and Special Conditions of this authorization or legal instruments approved pursuant to this amended authorization, the Special Condition or the legal instrument shall prevail. The permittee is responsible for assuring that all plans accurately and fully reflect the Special Conditions of this authorization and any legal instruments submitted pursuant to this authorization.

Plan review shall be completed by or on behalf of the Commission within 45 days after receipt of the plans to be reviewed. Because of the importance of expediting the review of change orders once construction has commenced, the Commission will complete plan review of change orders within 15 days.

4.5. **Security Barrier and Fence.** The security barrier and fencing authorized in Amendment No. Two shall be built generally in conformance with the drawing entitled "Richmond San Rafael Bridge Land Based Pier 68," dated September 9, 2004, provided and prepared by Caltrans staff (Amendment No. Two).

6. **Riprap Placement.** Riprap material adjacent to the public access area shall be placed in general accordance with the preliminary plans entitled "Rock Slope Protection DD-1 and DD-2" dated March 29, 2006, so that a permanent shoreline with a minimum amount of fill is established by means of an engineered slope not steeper than two (horizontal) to one (vertical). The slope shall be created by the placement of a filter layer protected by riprap material of sufficient size to withstand wind and wave generated forces at the site (Original Authorization).

B. **Temporary Construction Access.** Any fill placed for construction access and work platforms shall be pile-supported or floating only, and shall be approved prior to their installation pursuant to Special Condition II-A. The permittee is strictly prohibited from using solid fill in the Bay for construction access and work platform purposes with the exception of the minimum amounts necessary of earthen fill to create the minimum necessary grade transitions from the land to pile-supported work platforms.

C. **Temporary Structures.** All temporary structures placed pursuant to this amended permit shall be completely removed from the Commission's jurisdiction upon completion of each individual project and the area(s) restored to its previous condition. Clean, untreated wooden, concrete or steel piles can be cut or broken off at the mud line.

D. **Temporary Bicycle and Pedestrian Pathway Closure Plan.** For the activities authorized in the original permit, at least 15 days prior to the authorized closure of the existing pathway the permittee shall, pursuant to Condition II-A above, submit for approval by or on behalf of the Commission a plan(s) for the temporary closure of the existing bicycle and pedestrian pathway under the east end of the bridge. Such plan(s) shall include: (1) a schedule which minimizes the time during which the temporary closure will occur; (2) specific dates for when the closed pathway will be re-opened for public use; and (3) a program for informing the public of the temporary closure. Plan review shall be completed by or on behalf of the

Commission within 5 days after receipt of the plans to be reviewed. Further, the permittee is responsible for any and all damage to the existing public facilities and shall fully repair all damage prior to the return of the pathway to public use.

E. **Improvements to Existing Public Access Facilities.** For the activities authorized in the original permit, prior to the closure of the bicycle and pedestrian pathway, the permittee shall install improvements near the existing public access bicycle and pedestrian pathway, pursuant to Condition II-A and II-D, above. These improvements shall include, at a minimum, one new bench on the north side of the bridge and two new informational signs, one at each point on the path where it will be temporarily closed. The information on these signs shall include, at a minimum, the information necessary to inform the public of the temporary closure as required in Special Condition II-~~D~~E above and interpretive information on the seismic retrofit of the bridge. The signs shall remain in place after project completion and be maintained by the permittee or its assignee, provided such assignee is first approved by or on behalf of the Commission, to provide information to the public which is related to the history, natural environment and/or coastal recreation opportunities of San Francisco Bay.

F. **Public Access Enhancement on the Eastern Shoreline.** For the activities authorized in the original permit, prior to any construction authorized herein, the permittee shall create a fund in the Commission's name and deposit the sum of $40,000.00 in an interest bearing account to be dispersed, in its entirety including principal and interest, solely to the City of Richmond for the purpose of improving public access in the vicinity of the bridge, between Pt. Molate and the Miller/Knox Regional Shoreline. Funds shall be dispersed from the account at the discretion of the Commission's Executive Director, based on proposal(s) submitted by the City of Richmond, who will be the lead agency. The East Bay Regional Park District, acting on behalf of the City of Richmond, may also submit a proposal(s) for improving public access in the vicinity of the bridge if such action and proposal(s) is first reviewed and approved by City of Richmond.

This fund shall be used to cover the costs of either securing property or access easements, and/or installing new public access improvements such as pathways, benches, trash containers, landscaping and signage. The fund may also be used for habitat enhancement adjacent to the public access improvements in the project vicinity. In the event that the public access improvements or enhancements desired between Pt. Molate and the Miller/Knox Regional Shoreline are not feasible, the Executive Director may disperse the funds to the City of Richmond to improve public access and wildlife habitat elsewhere along the City of Richmond or West Contra Costa shorelines.

G. **New Public Access Area ~~on the Western Shoreline~~**

On the Western Shoreline (Original Authorization)

1. **Area.** The approximately 23,971-square-foot area along approximately 226 lineal feet of shoreline north of the bridge and east of the Marin Rod and Gun Club, ~~as~~ shown in Exhibit A and revised by Amendment No. Three, shall be made available exclusively to the public for unrestricted public access for walking, bicycling, sitting, viewing, fishing, picnicking, and related purposes. Public access to this site can be restricted during retrofit construction because this site will likely be used as a staging area and/or for construction equipment. If the permittee wishes to use the public access area after construction for other than public access purposes, it must obtain prior written approval by or on behalf of the Commission.

2. **Permanent Guarantee**. Prior to the completion of the public access improvements described above, but in no case later than December 31, 2005, (as described in the Commission's September 22, 2004 letter to the permittee) the permittee shall by instrument or instruments acceptable to counsel for the Commission dedicate to a public agency or otherwise permanently guarantee such rights for the 23,971 square-foot public access area, shown in Exhibit A, for walking, bicycling, sitting, viewing, fishing, picnicking and related purposes. The instrument shall create rights in favor of the public which shall commence no later than after completion of construction of any public access improvements required by this amended authorization and prior to the use of any structures authorized herein. Such instrument shall be in a form that meets recordation requirements of Marin County and shall include a legal description of the property being restricted and a map that clearly shows and labels the Mean High Tide Line, the property being restricted for public access, the legal description of the property and of the area being restricted for public access, and other appropriate landmarks and topographic features of the site, such as the location and elevation of the top of bank, any significant elevation changes, and the location of the nearest public street and adjacent public access areas. Approval or disapproval of the instrument shall occur within 30 days after submittal for approval and shall be based on the following:

   a. Sufficiency of the instrument to create legally enforceable rights and duties to provide the public access area required by this amended authorization;

   b. Inclusion of an exhibit to the instrument that clearly shows the area to be reserved with a legally sufficient description of the boundaries of such area; and

c. Sufficiency of the instrument to create legal rights in favor of the public for public access that will run with the land and be binding on any subsequent purchasers, licensees, and users.

3. **Recordation of the Instrument.** Within 30 days after approval of the instrument, the permittee shall record the instrument and shall provide evidence of recording to the Commission. No changes shall be made to the instrument after approval without the express written consent by or on behalf of the Commission.

4. **Improvements Within the Total Public Access Area**. As described in the Commission's September 22, 2004 letter to the permittee, the permittee shall install the following improvements by no later than December 31, 2005, as shown in Exhibit A:

   a. An approximately 173-foot-long and 10-foot-wide, all-weather shoreline trail, including a pedestrian bridge with two benches, which crosses over a 323-square-foot seasonal wetland at the shoreline;

   b. Six parking spaces, including one handicapped space;

   c. One picnic table with two benches, and one trash receptacle;

   d New, drought tolerant landscaping throughout the new public access area. Native plant species are desirable; however, in no case shall the landscaping include exotic plant species which are known to be invasive; and

   e. No fewer than four public access signs whose location and design is approved by the Commission, including way-finding signs for west-bound bridge traffic and Francisco Boulevard travelers. If all-day commuter or other parking problems are identified after the public access is completed, the permittee shall post signs to limit the number of hours the public may park at the site.

   Such improvements shall first be reviewed and approved pursuant to Condition II-A of this amended authorization.

5. **Maintenance**. The areas and improvements within the new public access area shall be permanently maintained by and at the expense of the permittee or its assignee. Such maintenance shall include, but is not limited to, repairs to all path surfaces; replacement of any trees or other plant materials that die or become unkempt; repairs or replacement as needed of any public access amenities such as signs, benches, trash containers and lights; periodic cleanup of litter and other materials deposited within the access areas; removal of any encroachments into the access areas; and assuring that the public access signs remain in place and visible. Within 60 days after notification by staff, the permittee shall correct any maintenance deficiency noted in a staff inspection of the site.

~~6. **Riprap Placement.** Riprap material adjacent to the public access area shall be placed in general accordance with the preliminary plans entitled "Rock Slope Protection DD-1 and DD-2" dated March 29, 2006, so that a permanent shoreline with a minimum amount of fill is established by means of an engineered slope not steeper than two (horizontal) to one (vertical). The slope shall be created by the placement of a filter layer protected by riprap material of sufficient size to withstand wind and wave generated forces at the site. Final plans must be submitted and approved, in accordance with Special Condition II-A-1-b.~~

H. **Public Pathway on Westbound (Upper) Richmond-San Rafael Bridge Deck and Adjoining I-580 Sections (Material Amendment No. Four).**

1. **Area.** For up to a four-year period, the approximately 202,463 square foot (4.6-acre) area at a 4.0-mile section of the westbound (upper) Richmond-San Rafael Bridge deck and adjoining 0.19-mile (total) sections of I-580 (within the Commission's 100-foot shoreline band jurisdiction) shall be made available exclusively to the public for unrestricted access for pedestrians, bicycles, and wheelchairs. If the permittee wishes to use the public access area for other purposes, it must obtain prior written approval by or on behalf of the Commission.

2. **Improvements Within the Public Access Area**. Prior to the use of any facility authorized herein, the permittee shall install the following improvements to be consistent with the plans approved pursuant to Special Condition II.A of this amended authorization, and substantially conform to plans including those entitled *Sign Plan* (Sheets S-1 though S-14 dated June 13, 2016) prepared by HTNB Corporation.

   a. An approximately 4.0-mile long and 10 -foot-wide path on the upper deck of the Richmond-San Rafael Bridge, and a 0.19-mile long path at adjoining sections of I-580 within the Commission's 100-foot shoreline band;

   b. An approximately 3.96-mile-long moveable barrier system on the upper (westbound) deck of the bridge to separate the above-referenced public path from vehicular traffic;

   c. An approximately 4.0-mile-long, between 42 and 62-inches above the bridge deck cable railing along the northern outer railing of the upper bridge deck;

   d. No fewer than 36 public access-related informational signs, including at the entry and exit points of the bridge public path; and

   e. Instrumentation for counting public use of pathway on bridge located at entry and exit points of the bridge.

3. **Maintenance**. The areas and facilities authorized in Material Amendment No. Four shall be maintained by and at the expense of the permittee and its assignees of this specific responsibility, such as the Bay Area Toll Authority (BATA). Such maintenance shall include, but is not limited to, repairs to all path surfaces; repairs or replacement as needed of any public access amenities such as signs and safety barriers; periodic cleanup of litter and other materials deposited within the access areas; and removal of any encroachments into the access areas. Within 30 days after notification by staff, the permittee and its assignees shall correct any maintenance deficiency noted in a staff inspection of the site.

4. **Report to Commission and Future Commission Consideration.** At or around the end of the third year period of the four-year pilot program for the facilities authorized in Material Amendment No. Four, the permittee shall provide a written and verbal report to the Commission on the status of the bridge public pathway, including, but not limited to, an analysis of public usage and benefits, an assessment of any operational and safety issues, and the need for any future changes to the facilities, including removal or making them permanent. The permittee shall not remove the movable barrier system or traffic operation system (TOS) associated with the third travel lane, substantially alter, or make permanent the facilities authorized in Amendment No. Four without prior authorization by or on behalf of the Commission, through a further amendment of this amended permit.

5. **Assignment.** The permittee shall transfer maintenance responsibility to another party acceptable to the Commission but only provided that the transferee agrees in writing, acceptable to counsel for the Commission, to be bound by all terms and conditions of this permit.

~~H.~~I. **Reasonable Rules and Restrictions.** The permittee may impose reasonable rules and restrictions for the use of the public access areas required pursuant to Special Condition II-G to correct particular problems that may arise. Such limitations, rules, and restrictions shall have first been approved by or on behalf of the Commission upon a finding that the proposed rules would not significantly affect the public nature of the area, would not unduly interfere with reasonable public use of the public access areas, and would tend to correct a specific problem that the permittee has both identified and substantiated. Rules may include restricting hours of use and delineating appropriate behavior.

1. **Closure of the bridge access path due to flooding.** In the event of flooding during and after major storm events at the land approaches of the bridge, which may cause serious harm or danger to path users, the permittee may close the path, and shall inform the public via the 511 and 511.org systems, as soon as feasible. The path shall remain closed as long as necessary to protect users from flooding. When flooding recedes, the permittee shall immediately open and inspect the safety of the public path, and inform users via the above mentioned systems.

~~I.~~J. **Water Quality.** At least 20 days prior to the commencement of dredging authorized herein, the permittee shall inform the Executive Director that the water quality certification (Resolution No. 97-053) from the California Regional Water Quality Control Board, San Francisco Bay Region, is still effective. Revocation of such certification shall terminate the Commission's amended authorization for that dredging. Any amendments to the water quality certification shall be approved by the California Regional Water Quality Control Board, San Francisco Bay Region, and submitted to the Executive Director at least 20 days before the start of the amended work (Original Authorization).

~~J.~~K. **Dredging Authorization.** The approximately 219,000 cubic yards or less of new dredging authorized by this amended permit shall be completed within 60 months of the date of issuance or by December 31, 2005, whichever is earlier. No further dredging is authorized by this amended permit (Original Authorization).

~~K.~~L. **Upland Disposal of Material Unsuitable for Aquatic Disposal.** The approximately 3,320 cubic yards of material from piers 71 through 77, which was determined to be unsuitable for aquatic disposal by the Dredged Materials Management Office and the Regional Water Quality Control Board, shall be disposed of in an appropriate manner at an upland location outside the Commission's jurisdiction. Prior to the disposal of the 3,320 cubic yards of material, the permittee shall submit to the Commission documentation which contains the proposed date and location for the disposal of this material. After the disposal, the permittee shall submit evidence that the material was disposed of in an appropriate manner (Original Authorization).

~~L.~~M. **Dredging and Disposal Notice.** At least 20 days prior to the commencement of the dredging and disposal authorized herein, the permittee shall notify the Executive Director of the planned start and duration of these activities. The permittee shall permit the Commission staff or representatives of other state or federal agencies to come aboard the dredge or barge associated with the dredging or disposal episode and observe the operation to ensure that the dredging or disposal activity is consistent with the dredging report required herein and the other terms and conditions of this amended permit (Original Authorization).

~~M.~~N. **Timing.** To protect important fisheries or migrating anadromous fish species, including the Pacific herring *(Clupea harengus)*, the winter-run chinook salmon *(Oncorhynchus tshawytscha)*, and the steelhead trout *(Oncorhynchus mykiss)*, no open water suction dredging shall occur in water shallower than 20 feet pursuant to this permit between January 1 and May 31 of any year during the duration of this amended permit unless written approval of this dredging technique during this period is provided by or on behalf of the Commission and after approval by appropriate wildlife agencies prior to the commencement of the dredging during the closure. Within the cofferdams and piles there are no restrictions on reasonable dredging techniques. Clamshell dredging is allowed year-round provided a professional biologist, or other individual sufficiently competent to identify herring spawning activity, shall inspect the project site during the dredging operations occurring between December 1 and March 1 of any year, and if herring spawning is detected by the on-site biologist or qualified individual, Department of Fish and Game personnel, or the Commission staff, all dredging outside of coffer dams and piles will cease for a minimum of 14 days within a 200-meter limit or until it can be determined that the herring hatch has been completed and larval herring concentrations have left the site. To facilitate rapid and efficient communication under these circumstances, the permittee shall provide the Commission staff and Department of Fish and Game personnel with all necessary telephone, FAX, and pager numbers. Dredging may be resumed thereafter at the sole discretion of the permittee and the Commission staff, but shall be terminated if further spawning takes place at the site (Original Authorization).

~~N.~~O. **Barge Overflow Sampling and Testing.** Results of any effluent water quality or other testing required by the San Francisco Bay Regional Water Quality Control Board shall be submitted in writing to the Commission's office at the same time that such testing is submitted to the Regional Board (Original Authotrization).

~~O.~~P. **Dredging Operation Plan and Updates** (Original Authotization)

1. **Dredging Operation Plan.** A dredging operation plan shall be submitted at least 30 days before the start of the initial dredging operations. The plan shall contain: (a) the overall location of the area authorized to be dredged and to what depth based on Mean Lower Low Water (MLLW); (b) the proposed area to be dredged and to what depth based on MLLW; (c) a vicinity map showing the proposed disposal site; and (d) the proposed volume of material to be dredged and disposed.

2. **Updates.** Every 90 days after the start of dredging operations, the permittee shall submit to the Executive Director updates of the dredging operation plan which describe the dredging activities that occurred within the previous

reporting period, including: (a) the location of the area authorized to be dredged and to what depth based on MLLW; (b) the actual area dredged and to what depth based on MLLW, and any dredging which occurred outside the area authorized to be dredged or below the authorized depths; (c) the actual volume of the material dredged; (d) a vicinity map showing the disposal site; and (e) the volume of the material disposed in the Bay. In addition, the updates of the dredging operation plan required herein shall include a plan, as described in Special Condition II-~~O~~P-1 above, for the proposed dredging activities to occur during the next reporting period.

3. **Changes.** The Executive Director shall be notified of any proposed changes in the dredging operation plan 14 days in advance of the proposed change.

4. **Final Dredging Operation Plan.** Within 60 days of completion of all dredging activities authorized herein, the permittee shall submit to the Executive Director a report which contains: (a) the location of the area authorized to be dredged and to what depth based on MLLW; (b) the actual area dredged and to what depth based on MLLW, and any dredging which occurred outside the area authorized to be dredged or below the authorized depths; (c) the actual volume of the material dredged; (d) a vicinity map showing the disposal site; and (e) the volume of the material disposed in the Bay.

5. **In-Bay Disposal.** The permittee shall only dispose of dredged material in the Bay that has been recommended for approval for in-Bay disposal by the Dredged Materials Management Office and authorized by the San Francisco Bay Regional Water Quality Control Board. Any material not approved for in-Bay disposal shall be disposed upland or in the ocean in accordance with disposal plans approved by the responsible agencies.

It is the intent of the Commission that the reports, maps and information required herein would be the same as those required by the Dredged Materials Management Office and the other applicable public agencies that manage the dredging and disposal of material in San Francisco Bay. All dredging authorized herein can be considered a single episode.

~~P.~~Q. **Protection of the Seal Haul-out Area**. Prior to any construction authorized herein, the permittee shall submit for review and concurrence by or on behalf of the Commission, evidence that will ensure that the final construction plans and specifications for the project include mitigation measures which will minimize impacts to the harbor seals *(Phoca vitulina)* and their haul out site. The mitigation measures shall include a restricted access and a monitoring plan approved by the National Marine Fisheries Service. The permittee shall submit a copy of the

Incidental Harassment Authorization issued by National Marine Fisheries Service. In addition, the name and phone number of the individual(s) at the National Marine Fisheries Service, and the parties responsible for ensuring that the restricted access and monitoring plan is followed, must be submitted to the Executive Director (Original Authorization).

~~Q.~~R. **Coordination with Appropriate Wildlife Agencies to Minimize Impacts to Birds.** Prior to any construction authorized herein, the permittee shall submit for review and concurrence by or on behalf of the Commission, evidence, such as a contract and/or agreement with the U.S. Fish and Wildlife Service, the U.C. Santa Cruz Predatory Bird Research Group and/or the Point Reyes Bird Observatory, that will ensure compliance with the terms of the Biological Opinion issued by the U.S. Fish and Wildlife Service with respect to the peregrine falcon.

In addition, prior to any construction activities authorized herein, the permittee shall submit for review and concurrence by or on behalf of the Commission, evidence that a plan, such as handling procedures approved by the California Department of Fish and Game, in consultation with the Point Reyes Bird Observatory, designed to minimize adverse impacts to the double-crested cormorant *(Phalacrocorax auritus)* colony which exists on the support beams and scaffolding underneath the bridge, and other migratory birds nesting and breeding on the structure, is in place. Such evidence shall include the name and phone number of the individual(s) at the California Department of Fish and Game and the Point Reyes Bird Observatory, and the parties responsible for ensuring that the handling procedures are followed (Original Authorization).

~~R.~~S. **Coordination with Appropriate Wildlife Agencies to Minimize Impacts to Eelgrass Beds.** Prior to any construction authorized herein, the permittee shall submit for review and concurrence by or on behalf of the Commission, evidence that a plan designed to minimize adverse impacts to the existing eelgrass *(Zostera marina)* beds has been reviewed and approved by the National Marine Fisheries Service, the California Department of Fish and Game, and/or the U. S. Fish and Wildlife Service. The approved plan shall include pre- and post-monitoring surveys of the existing eelgrass beds and an experimental transplanting and relocation program if determined necessary by the wildlife agencies. Such evidence shall include the name and phone number of the individual(s) at the National Marine Fisheries Service, the California Department of Fish and Game or the U. S. Fish and Wildlife Service responsible for reviewing and approving the plan and the parties responsible for ensuring that the plan is adhered to. Any monitoring reports prepared pursuant to the approved plan shall be sent to the Commission, as well as the final report which assesses the results of the eelgrass mitigation measures (Original Authorization).

~~S.~~T. **Placement and Use of the Construction Barges and Coordination with the U.S. Coast Guard**. Prior to the use of any barges in the Bay, the permittee shall first submit evidence that their use complies with the U. S. Coast Guard Checklist and the Dredging Operation Plan and updates required pursuant to Special Condition II-~~O~~P (Original Authorization).

~~T.~~U. **Mitigation to Offset the Placement of Fill in the Bay**. Prior to any construction authorized herein, the permittee shall prepare a mitigation program which will ensure the creation of new Bay surface area and water volume in the Central Bay, and shoreline clean-up adjacent to the bridge, all of which will be sufficient to offset the fill placed in the Bay as part of the project. The total cost of this mitigation program shall not exceed $1,500,000.00 dollars, and shall include the following:

1. At the project site, the mitigation program shall create at least 1,005 cubic yards, over at least 6,176 square feet, of new Bay as the result of shoreline clean up, removal of abandoned piles or other structures, and/or by not backfilling around the newly retrofitted piers on the East Approach section of the bridge. All shoreline clean-up and fill removal is subject to final plan review approval pursuant to Special Condition II-~~A~~B above.

2. To create new Bay surface area and/or water volume off-site, the permittee shall create a fund in the Commission's name and deposit the initial sum of $750,000.00 in an interest bearing account to be dispersed, in its entirety including principle and interest, solely to remove approximately one acre of dilapidated, pile-supported structure or other fill from the Central Bay. Funds shall be dispersed from the account at the discretion of the Commission's Executive Director, based on proposal(s) submitted by an owner of such filled lands in the Central Bay. The amount of this fund may be adjusted depending upon the relationship between costs and environmental benefits associated with the improvements in the Bay required under Special Condition II-~~T~~U.

   This fund shall be used to cover the costs of planning, environmental assessments, demolition and appropriate disposal of the dilapidated fill. The fund may also be used for habitat enhancement in the areas disturbed by the fill removal and in the project vicinity. Priority shall be given to fill removal projects located near the Richmond-San Rafael Bridge and secondly in the Central Bay. In the event that fill removal projects are not feasible in the Central Bay, the Executive Director may disperse the funds to another entity for use outside the Central Bay, provided that the entity first proves that it has a feasible fill removal project, sufficient legal interest over the fill to be removed, and that it is capable and competent to carry out the subject fill removal project (Original Authorization).

~~U.~~V. **Creosote Treated Wood**. No pilings or other wood structures that have been pressure treated with creosote shall be used in any area subject to tidal action in the Bay or any certain waterway, in any salt pond, or in any managed wetland within the Commission's jurisdiction as part of the project authorized herein (Original Authorization).

~~V.~~W. **Bridge Railings**. Any new or replacement bridge railings on the concrete trestle section of the bridge shall not exceed 32 inches in height unless a higher bridge railing is necessary to accommodate pedestrian, bicycle or wheelchair access across the bridge. Bridge railings shall be designed to provide motorists with views of the Bay. The design of the bridge railings must be reviewed by or on behalf of the Commission to ensure this objective is achieved and shall not be installed until the design is approved in writing.

1. **Material Amendment No. Four.** This amended permit authorizes the permittee to install a cable railing that is between 42 and 62-inches in height on the upper bridge deck adjacent to the public path. The height of the railing is necessary to protect the safety of public path users. Any changes in design must be reviewed by or on behalf of the Commission to ensure views of the Bay are protected, and shall not be installed until the design is approved in writing.

~~W. **Debris Removal.** All construction debris shall be removed to a location outside the jurisdiction of the Commission. In the event that any such material is placed in any area within the Commission's jurisdiction, the permittee, its assigns, or successors in interest, or the owner of the improvements, shall remove such material, at its expense, within ten days after it has been notified by the Executive Director of such placement.~~

X. **Notice to Contractor**. The permittee shall provide a copy of this amended permit and final PS&Es to any contractor or person working in concert with the permittee to carry out the activities authorized herein and shall point out the special conditions contained herein (Original Authorization and Amendment No. Four).

Y. **Certification of Contractor Review.** Prior to commencing any grading, demolition, or construction, the general contractor or contractors in charge of that portion of the work shall submit written certification that s/he has reviewed and understands the requirements of the permit and the final BCDC-approved plans, particularly as they pertain to any public access or open space required herein, or environmentally sensitive areas.

~~Y. **Construction Operations.** All construction operations shall be performed to prevent construction materials from falling into the Bay. In the event that such material escapes or is placed in an area subject to tidal action of the Bay, the permittee shall immediately retrieve and remove such material at its expense.~~

Z. **Commission Jurisdiction Over Fill Area.** Notice is hereby given that, under the McAteer-Petris Act, the area of the approved project that is within the Commission's jurisdiction under Section 66610(a) remains within that jurisdiction even after fill or substantial change in use, authorized by the Commission, may have changed the character of the area; so that the permittee or the permittee's successors in interest will require further action by or on behalf of the Commission prior to any future change of use or work within areas filled pursuant to this authorization.

AA. **Recording**. The permittee shall record this document or a notice specifically referring to this document or the amended permit with Marin County and Contra Costa County~~ies~~ within 30 days after execution of the amended permit issued pursuant to this amended authorization and shall, within 30 days after recordation, provide evidence of recordation to the Commission.

III. Findings and Declarations

This amended permit is issued based on the Commission's findings and declaration that the authorized work is consistent with the McAteer-Petris Act, and the *San Francisco Bay Plan*, the California Environmental Quality Act, and the Commission's amended management program for the San Francisco Bay segment of the California coastal zone for the following reasons:

Original Authorization

A. **Use.** The basic purpose of the new fill is for the seismic retrofit of the existing Richmond-San Rafael bridge. As stated in the McAteer-Petris Act, bridges are considered a water-oriented use. Thus, the fill involved in this project is consistent with the use requirements of the McAteer-Petris Act.

B. **Fill.** Section 66605 of the McAteer-Petris Act, in part, provides that "further filling of San Francisco Bay should be authorized only when public benefits from fill clearly exceed public detriment from the loss of the water areas and should be limited to water-oriented uses (such as...water-oriented recreation...) or minor fill for improving shoreline appearance or public access to the Bay....That the fill in the Bay should be authorized only when no alternative location is available for such

purposes....That the water area...to be filled should be the minimum necessary to achieve the purpose of the fill....That public health, safety and welfare require that fill be constructed with sound safety standards which afford reasonable protection to persons and property...."

The project will result in approximately 55,800 square feet of new solid and pile-supported fill, approximately 270,000 square feet of pile-supported replacement fill, and approximately 197,000 square feet of temporary, pile-supported and solid fill.

1. **Alternative Upland Location.** Because the retrofit will occur along the same alignment of the existing bridge, no alternative upland locations exist for the project. Further, mass transit alternatives will not achieve the basic purpose of the project, which is to improve public safety of an existing bridge.

2. **Minimum Necessary Fill.** In designing the project, Caltrans needs to reduce the probability that the bridge will collapse in a major earthquake. During the seismic modeling and analysis of the existing bridge, Caltrans determined that the retrofit must limit the displacement of the pile-supported foundations during an earthquake. Therefore, the majority of new solid fill, approximately 45,000 square feet, is necessary to enlarge the approximately 70 sets of piers with new piles, pile caps and casings. Caltrans also determined that the existing, approximately 3,250-foot-long, concrete trestle section of the bridge should be replaced rather than retrofitted, largely because of persistent concrete deterioration and because the additional costs and time for retrofit of the existing trestle are outweighed by the benefits of a new trestle. The replacement of the existing concrete trestle is responsible for the remainder of the new fill associated with the project, resulting in approximately 10,800 square feet of pile-supported fill. (The existing trestles currently cover approximately 270,000 square feet of Bay surface area, the new trestles will cover approximately 280,800 square feet of Bay surface area). Each new trestle will have two, 22-inch-wide safety barriers; two, 12-foot-wide travel lanes; one, 10-foot-wide shoulder on the outside; and one new, 6-foot wide shoulder on the inside for a total trestle width of 43 feet, 8 inches. The existing trestles have two, 12-foot-wide travel lanes; one, 12-foot-wide shoulder on the outside; two, 39-inch-wide safety barriers; and no shoulder on the inside lane for a total trestle width of 42 feet, 6 inches. Therefore, the increase in cantilevered fill is the result of a one-foot, 2-inch increase in the width of the concrete trestle sections along their entire length.

   The increase in cantilevered fill over the Bay is not significant given the scope of the entire project. The narrower safety barriers will further increase the roadway width on the trestle which could also improve public access possibilities on this

section of the bridge. Still, to ensure the fill does not exceed this amended authorization, the Commission finds that Special Condition II-A, for final plan review, is needed. Therefore, as conditioned, the Commission finds that the retrofit of the existing bridge constitutes the minimum necessary fill needed to serve the project purpose.

3. **Safety of Fills.** Section 66605(e) of the McAteer-Petris Act, in part, provides "[T]hat public health, safety and welfare require that fill be constructed in accordance with sound safety standards which will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions..." In addition, the Bay Plan includes findings and policies to ensure the safety of all new fills in the Bay. The Bay Plan states, in part, "[T]o reduce risk of life and damage to property, special consideration must be given to construction on filled lands in San Francisco Bay .... A proposed project should be approved by the Commission if its Engineering Criteria Review Board (ECRB) determines that the proposed project is in accordance with the [Bay Plan] policies for Safety of Fills....Even if the Bay Plan indicates that a fill may be permissible, no fill or building should be constructed if hazards cannot be overcome adequately for the intended use in accordance with the criteria prescribed by the Engineering Criteria Review Board." The Commission relies on the advice of the ECRB to assure that approved projects are consistent with Bay Plan policies on safety of fills.

   The project was reviewed by the Commission's ECRB at its January 31, 1996 and May 29, 1996 meetings. The performance criteria presented to the Board targeted a "no collapse" scenario for the bridge in a 7.25 Richter Scale earthquake with a 20-second duration on the Hayward fault, which is approximately 5 miles from the bridge, or an 8.0 Richter Scale earthquake with a 40-second duration on the San Andreas fault, which is approximately 10 miles from the bridge. Under these criteria, the bridge would provide limited emergency vehicle and repair equipment access within days and full service within months, possibly a year. Significant damage to the superstructure was considered acceptable as this bridge is not classified by the California Department of Transportation as a "lifeline structure."

   The soil characteristics at the site were described as ranging from Franciscan Bedrock at the east end of the bridge (Castro Rock and Red Rock being examples of where the bedrock is at or above the surface of the Bay) to extremely soft Bay muds up to 75 feet deep at the west end of the bridge. Additional layers of silty clay sands and gravel, including the San Antonio Formation, Merritt sands, (which have high liquefaction potential), and the Alameda Formation, are

between the Bay muds and the bedrock ranging from depths of 25 feet to 100 feet, and in a few cases up to 280 feet deep. The anticipated ground motions expected at the site were discussed by the ECRB members in detail, including the target rock response spectra, the rock motion and mudline time history, and the soil/foundation interaction time history. Analysis of the site characteristics demonstrated that the motions coming from the rock into the structure generally will create the greatest vertical loads on the bridge, while the motions from the muds generally will create the greatest horizontal loads on the bridge.

The philosophy behind the bridge structure itself and its retrofit was also discussed by the ECRB members in detail. One aim of the retrofit is to create predictable and reliable ductile "fuses" which will protect the superstructure (the cantilevered and truss sections of the bridge). This will involve controlling tower rocking by strategically adding isolation bearings, dampers and hinges on the towers as well as strengthening the towers themselves. In addition, a number of new structural elements will be added to strengthen the superstructure. In response to questions asked by the ECRB, the permittee stated that concrete and steel plates will be added and overlapped at all the tower legs to distribute the loads vertically, thereby preventing failure at the tower legs. Further, in response to the ECRB, the permittee stated that liquefaction, the anticipated mud loads and the varying time histories across the length of the bridge were analyzed, and that the performance criteria and retrofit philosophy were regularly reviewed at a State level peer review group once a month.

Based on the presentation given by the permittee, the ECRB found that, in its opinion, it is reasonable to conclude that the project will be constructed to a level of seismic safety and tidal flood protection consistent with and appropriate to its intended use.

To ensure the final project plans metet the criteria approved by the ECRB, the Commission finds that Special Condition II-A, for final plan review, is needed. Therefore, as conditioned, the Commission finds that the retrofit of the existing bridge will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions.

4. **Mitigation.** In part, Section 66605 of the McAteer-Petris Act requires that the public benefits of the project clearly outweigh the detriments caused by any Bay fill. In order to make the legal findings necessary to authorize a development requiring fill, the Commission has occasionally found it necessary to require mitigation to assure that the public benefits of the fill clearly exceed the adverse impacts of the fill.

The *San Francisco Bay Plan* requires that a permittee offset the unavoidable adverse impacts of fill through a variety of mitigation techniques. In part, the Bay Plan, states: "Whenever mitigation is needed, the mitigation program should be provided as part of the project. Mitigation should consist of measures to compensate for the adverse impacts of the fill to the natural resources of the Bay, such as to water surface, volume or circulation, fish and wildlife habitat or marshes or mudflats. Mitigation is not a substitute for meeting the other requirements of the McAteer-Petris Act concerning fill. When mitigation is necessary to offset the unavoidable adverse impacts of approvable fill, the mitigation program should assure: (a) that benefits from the mitigation should be commensurate with the adverse impacts on the resources of the Bay and consist of providing area and enhancement resulting in characteristics and values adversely affected; (b) that the mitigation would be at the fill project site, or if the Commission determines that on-site mitigation is not feasible, as close as possible; (c) that the mitigation measures would be carefully planned, reviewed, and approved by or on behalf of the Commission, and subject to reasonable controls to ensure success, permanence, and long-term maintenance; (d) that the mitigation would, to the extent possible, be provided concurrently with these parts of the project causing adverse impacts; and (e) that the mitigation measures are coordinated with all affected local, state, and federal agencies having jurisdiction or mitigation expertise to ensure, to the maximum practicable extent, a single mitigation program that satisfies the policies of all the affected agencies...."

Further, a report prepared by the Commission, entitled "Commission Mitigation Practices," dated 1987, states, in part, that nearly all permits issued by the Commission for bridges have provided mitigation. The report explains that, in addition to the shading of tidal environments, bridges can present a significant barrier to wildlife. Further, environmental impacts resulting from submerged and pile-supported fill include changes in substrate which affect the kinds and numbers of benthic organisms that live in an area, alteration of currents and water circulation, sometimes leading to the creation of underwater mounds.

The project will result in approximately 55,800 square feet of new solid and pile-supported fill, approximately 270,000 square feet of pile-supported replacement fill, and approximately 197,000 square feet of temporary, pile-supported and solid fill. Because of the size of the project, its many components, and the length of time (40 years) in which the natural environment has become acclimated to the bridge, the adverse impacts to the Bay, fish and wildlife and water quality from the project were analyzed independently. Potential adverse impacts to fish

and wildlife and associated mitigation measures are discussed in the "Fish and Wildlife" Section below. Similarly, the potential adverse impacts to water quality and associated mitigation measures are discussed in the "Dredging and Water Quality" section below.

In terms of the loss of Bay surface area and water volume, the largest impact is from the retrofitting the approximately 70 sets of bridge piers, nearly all of which would occur below the surface of the water. The loss of water surface area would occur primarily from the "casing" of the existing shafts stemming from the enlarged footings. In addition, the replacement of the concrete trestle section of the bridge will result in a net decrease of the Bay's surface area (by approximately 10,800 square feet) from new pile supported fill. The largest loss of Bay surface area will result from the temporary fill for work platforms and coffer dams, which totals approximately 197,000 square feet of pile-supported and "solid" fill (while coffer dams are not actually the complete replacement of water area with solid fill, they effectively exclude the Bay from the area within the coffer dam, creating a similar impact). While the permittee cannot predict at this time the length of time the temporary fill will remain in place, the project is not anticipated to be completed for at least 4 or 5 years and it is not unreasonable to expect much of the temporary fill to be in place for the duration of the project. However, portions of the temporary fill are proposed to be removed once construction activities are complete, and all the temporary fill may not have be in place at the same time or for the same duration. Still, there is no standard measurable way to quantify how the placement of the temporary fill will impact the environment of the Bay.

The mitigation package to offset the unavoidable adverse impacts resulting from the loss of Bay surface area and water volume, as proposed by the permittee, includes increasing the water area and volume adjacent to the newly retrofitted piers, a financial contribution to the Commission for the purposes of removing approximately one acre of pile-supported or other fill from the Bay and the clean-up of wooden piles, steel pipes and asphalt and concrete debris on the shoreline and in the Bay underneath the East Approach of the bridge. This clean-up work will result in the removal of approximately 901 square feet, or 15 cubic yards, of fill from the Bay, and the new Bay created adjacent to the newly retrofitted piers will equal approximately 7,280 square feet, or 830 cubic yards of new Bay. Because final shoreline clean-up plans are not available at this time, the Commission finds that Special Condition II-A is needed to ensure that the clean-up and fill removal portions of the project are successful.

The permittee explored the possibility of removing fill in the Bay near the project site and found that there were no practicable fill removal projects, primarily due to ownership, contamination and environmental review reasons. Further exploration of fill removal possibilities away from the project site revealed that the Port of San Francisco has some dilapidated pile supported fill structures which could be removed at a cost of approximately $10.00 to $25.00 a square foot. Still, because of the ownership, contamination and environmental review issues which would need to be resolved before any fill could be removed, it is impracticable at this time to specify an exact fill removal project. The permittee has proposed and is required herein to spend approximately $1,500,000.00 to mitigate for the fill placement, of which $750,000.00 will be deposited in an account solely for fill removal. It is estimated that $750,000.00 to $1,000,000.00 will be sufficient to remove approximately one acre of pile supported fill in the Bay. One acre of pile supported fill removed from the Bay, in combination with the other mitigation measures proposed and required herein adequately offsets the loss of Bay surface are and water volume resulting from the project.

To ensure the financial contribution portion of the mitigation program is carried out adequately, the Commission finds that Special Condition II-~~T~~U, which requires the permittee to create an interest bearing account in the Commission's name for the purposes of removing fill, is needed. Therefore, as conditioned, the Commission finds that the retrofit of the existing bridge includes an adequate mitigation program which compensates for the adverse impacts of the fill to the water surface, volume and circulation of the Bay.

5. **Conclusion.** In conclusion, based on the above discussions and as conditioned herein, the Commission finds the public benefits of the original project clearly outweigh the detriments caused by the Bay fill, and the project is consistent with the Commission's laws and policies on the placement of fill in San Francisco Bay.

C. **Maximum Feasible Public Access**. Section 66602 of the McAteer-Petris Act states that: "...existing public access to the shoreline and waters of the...[bay]...is inadequate and that maximum feasible public access, consistent with a proposed project, should be provided...."

The *San Francisco Bay Plan* also includes findings and policies that require public access to and along the shoreline of the Bay. The Bay Plan, in part, states: "...maximum feasible public access to and along the waterfront should be provided in and through every development in the Bay or on the shoreline...except in cases where public access is clearly inconsistent with the project because of public safety considerations or significant use conflicts. In these cases, access at other locations, preferably near the project should be provided....Federal, state, regional and local

jurisdictions...should cooperate to provide new public access, especially to link the entire series of shoreline parks and existing public access areas....[A]gencies should assure that provisions for public access to and along the shoreline are included as conditions of approval and that the access is consistent with the Commission's requirements and guidelines." Further, Bay Plan Map No. ~~11~~ 4 designates the Richmond-San Rafael Bridge as a scenic highway.

1. **Public Access Across the Bridge**. Generally, to meet the requirements of Section 66602 of the McAteer-Petris Act, the Commission has required that new bridges and major improvements to existing bridges across the Bay include a bicycle and pedestrian pathway. Further, the Richmond-San Rafael Bridge is designated as a "proposed [planned] Bay Trail" by the California State Coastal Conservancy and the Association of Bay Area Government's Bay Trail project. The Bay Plan's findings and policies on Transportation also recognize the heavy use of the automobile in the Bay Area and its attendant environmental problems and, therefore, the Plan recommends that a primary goal in transportation planning, from the point of view of preserving and properly using the Bay, should be a substantial reduction in the dependence on the automobile and the development of new systems of transportation that can carry large volumes of people.

   Likewise, Section 888.2 of the Streets and Highways Code (which is administered by Caltrans) states, in part, "The department shall incorporate non-motorized transportation facilities...where non-motorized facilities do not exist, upon the finding that the facilities would conform to the California Recreational Trails System Plan..." Furthermore, Section 885.2 of California's Streets and Highways Code finds and declares, in part, that "[t]he design and maintenance of many of our bridges and highways present physical obstacles to the use of bicycles....[t]he bicycle is a legitimate transportation mode on public roads and highways.... [and] [b]icycle transportation can be an important, low-cost strategy to reduce reliance on the single passenger automobile and can contribute to a reduction in air pollution and traffic congestion." Section 30112 of the Streets and Highways Code also states, in part, "It is the intent of the Legislature, in enacting this section, to provide for the use of toll bridges by both pedestrians and bicycles, whenever this is economically and physically feasible."

   It should be noted, however, that these sections of the Streets and Highways Code, while indicating the State's desire to provide for bicycle and pedestrian access over a toll bridge like the Richmond-San Rafael Bridge, they do not apply directly to the seismic retrofit of existing structures and are aimed more at the construction of new facilities. Other civic organizations which actively support

the addition of some form of access over the bridge include the East Bay Regional Park District and the Bay Area Air Quality Management District. In fact, the *Bay Area '94 Clean Air Plan*, adopted by the Bay Area Air Quality Management District, includes policies and transportation control measures to improve bicycle access and facilities which state, in part, "[e]ncourage Caltrans to accommodate bicycles on all bridges," and "[provide direct access for bicycles on any new or modified bridge construction." Many bicycle organizations, including the Regional Bicycle Advisory Committee of the San Francisco Bay Area, the East Bay Bicycle Coalition, the International Mountain Bicycling Association, the Bicycle Friendly Berkeley Coalition, the San Francisco Bicycle Coalition, the Bicycle Friendly Kid Coalition and the Bike the Bridge! Coalition, strongly support the addition of unrestricted bicycle access across the bridge and state that such access would help achieve many of the goals and objectives of agencies and organizations listed above.

The existing bridge was built in the late 1950's, before the Commission was created, and was, therefore, not designed to accommodate public access. Pedestrian and bicycle use on the bridge is currently prohibited for safety reasons. The original project, which is the retrofit of the existing structure to withstand collapse in a future earthquake, will not change the existing road configuration on the bridge (other than re-striping the lanes to create a new two-foot shoulder on the inside and a 10-foot shoulder on the outside), will not change the use or capacity of the bridge, and will not include any improvements for pedestrian and bicycle use on the bridge. One exception is the replacement of the concrete trestle portion of the bridge. The replacement of the trestle represents approximately one-half mile of new bridge across the Bay. However, the new trestle will be put back in the same location and will have an almost identical road configuration as the portion to be removed. Simply stated, the original project would have no impact on existing bicycle or pedestrian access across the bridge or on the potential for providing such access across the bridge in the future (It should be noted that the project considered and authorized in Material Amendment No. Four of this permit results in a temporary change to public access on the bridge, as discussed later in this amended permit).

Under the new retrofit laws, the strengthening of these vital transportation structures have been deemed to be an emergency and any special condition which could potentially significantly hinder or delay the retrofit of such structures should not be imposed by a permitting agency as it would be detrimental to the public's health, safety and welfare.

When the Commission reviewed the original project, probably the biggest reason for prohibiting bicycle and pedestrian access across the bridge is that it has not been studied to address issues, associated with motorist and non-motorists sharing a lane on a toll bridge. Vehicle speeds on the bridge often exceed 65 m.p.h. and the bridge is often buffeted by gusty winds throughout the year. There is also concern about the hazards the existing expansion grates create for skinny-tired bicycles and that the railing design may not be adequate to keep a bicyclist or pedestrian from accidentally falling off the side of the bridge. The addition of such access could therefore create new safety considerations for motorists as well as non-motorists and could create new liability issues for the permittee unless the new access were designed and constructed to meet the rigorous safety standards adopted by Caltrans and the Federal Highways Administration. In addition, any new access would also have to meet the requirements of the Americans with Disabilities Act.

Unlike other bridges in the Bay Area, the Richmond-San Rafael Bridge has an extra lane which is not used as a vehicle travel lane. This lane would be a logical place to provide public access. However, this lane still serves important roadway functions, such as acting as a breakdown lane and a maintenance lane, and the permittee states that these uses would still have serious safety implications for pedestrians or bicycles using the lane. This lane is also used illegally by impatient commuters who pass waiting vehicles on the right; this activity could potentially be very dangerous to bicycles and pedestrians if they were in the lane. Lastly, the permittee states that since the bridge was not originally designed to provide non-motorized access, the existing entrance and exit ramps of the bridge would need to be studied and possibly re-designed to make them safe for non-motorized access on the bridge.

On the other hand, there are numerous reasons for providing access across the bridge. Non-motorized travel in the vehicle breakdown lane and maintenance lane would be similar to non-motorized travel on the shoulder of countless miles of roadway throughout the State of California. According to a representative of the Caltrans Bicycle Facilities Division, over 1,000 miles of the 4,000 miles of the State's freeway shoulders are open to bicycles. The accident ratio between vehicles and bicyclists is estimated to be very low; however, no statistics are kept on the number of bicyclists who use the freeways.

Perhaps the greatest reason for providing access on the bridge is the availability of the existing 12-foot-wide curb lane which is not used for vehicle travel. It provides a big "shoulder" which can be used for non-motorized travel. The curb lane was used for vehicle travel up until the late 1970's when an emergency

water pipeline from the East Bay to Marin County was installed during the severe drought years. After the rains returned and it was determined that the emergency water pipeline was no longer necessary, the pipeline was removed. The curb lane was not reopened because the traffic volumes did not require it, and it was determined that the curb lane serves the functions of the bridge better as maintenance and breakdown lane. Still, many people look at the "unused" lanes in each direction on the bridge as a non-motorized vehicle and recreational opportunity.

Whenever possible, Caltrans and the Federal Highway Administration prefer highway shoulders to be at least 10 feet wide. Exceptions to this shoulder width can be found throughout the State. For instance, the Antioch Bridge has only a 4-foot, 6-inch-wide shoulder adjacent to the vehicle travel lanes and this shoulder is open to bicycles. The Caltrans' standard for the width of Class I separated bike path is 3.6 meters, or approximately 12 feet. The Bay Trail standard for the width of the Bay Trail is 12 feet. The standard width for a Class II bike lane on a roadway where parking is prohibited is 1.2 meters, or approximately 4 feet. Class III bikeways are shared facilities with motor vehicles where bicycle usage is secondary and this width is dependent on many factors. Because the existing curb lane is 12 feet wide, it exceeds the preferred shoulder width standards for highways as well as the preferred bike path and bike lane width standards. As evidenced elsewhere in the State, and as pointed out in the public testimony at the public hearing for the project, bicyclists and pedestrians often share a roadway shoulder with the occasional broken down vehicle or maintenance activity, and this shared use is not in itself prohibitive to access along highways.

Still, improvements to the curb lane on the bridge could only make it safer for bicycles and pedestrians. Such improvements, in no particular order, include new steel plates placed over the existing expansion grates in the roadway, increased railing heights, new signs alerting drivers to the presence of bicyclists or pedestrians on the bridge and cautioning cyclists and pedestrians to proceed at their own risk, new road surface painting which would clearly delineate the curb lane for non-motorized travel, new pylons further delineating the curb lane, and a solid concrete barrier running the length of the bridge or another technique to completely separate a bicycle and pedestrian facility from the vehicle travel lanes. These improvements, with the exception of the separated bicycle and

pedestrian facility, are mostly inexpensive and could likely be constructed with materials left over from retrofit project construction. It is possible that the total cost for providing minor safety improvements on the bridge for bicyclists and pedestrians could cost less than one percent of the entire total project cost.

Another argument for providing access across the bridge is that there are generally no alternatives for bicycles and pedestrians to travel between Marin County and Contra Costa County. One would have to ride across the Golden Gate Bridge and take BART underneath the Bay to get from one side of the Bay to the other. A trip from Richmond to San Rafael over the bridge would cover approximately 10 miles. The trip via the Golden Gate Bridge and BART would be approximately 30 miles. If one were to travel north around San Pablo Bay, the journey could be as long as 40 to 50 miles. Shuttle service for bicycles across the bridge was recently discontinued. Caltrans argues that a low demand for the shuttle service by bicycles prompted it to discontinue its use, while the bicyclists argue that the service was very inconvenient and unreliable and, therefore, led to cyclists having to use other methods for crossing the Bay between Richmond and San Rafael. Bus service across the bridge has also been considered inadequate by the bicycling community in large part because of its infrequent scheduling and limited service on weekends and nights. In addition, bicyclists have also complained that, when the busses are full and there is no room for their bicycles, they are unable to board the bus.

Even though there is no direct pedestrian and bicycle access across the bridge now there is still evidence of a demand for such access. This has been shown by the numbers of people who continue to cross the bridge on bicycles even though it is illegal and the large number of people who turned out at the public hearing and have written letters in support of such access. It has also been suggested that if such a facility is built, it would increase the demand for it. The addition of such access will provide a new recreational opportunity desired by region which is consistent with the goals and objectives of numerous agencies and organizations throughout the Bay Area. It would also open up new recreational opportunities for the underprivileged communities in Richmond and San Rafael, and it would especially cater to people without automobiles. Further, it would provide excellent bicycle and pedestrian links to the planned Pt. Molate park and recreational opportunities just to the north of the bridge on the eastern shoreline.

Bicycles are a proven, effective and efficient form of transportation in the Bay Area. Multi-modal transportation is consistent with many of the goals and objectives of local and regional planning agencies, and bicycle trans-portation is one of the key elements of multi-modal transportation. It is widely known that bicycle travel can be good for one's health, does not waste non-renewable sources of energy, is non-polluting and can reduce traffic congestion.

After the retrofit work is done on the Richmond-San Rafael Bridge, it is unlikely that Caltrans would need to undertake another project on the bridge which would allow the Commission to analyze the need to provide bicycle and pedestrian access over the bridge. The retrofit work would ideally extend the life of the bridge structure 50 or more years. In addition, because of the existing land use patterns in Marin County and Contra Costa County, the likelihood for increased vehicle trips over the bridge in the near future that would require expanding the capacity of the bridge is very low. Therefore, now is the opportune time to pursue bicycle and pedestrian access across the bridge.

The Commission finds that there are many laws and policies, including laws and policies which Caltrans operates under, and especially the Commission's laws and policies, which state that bicycle and pedestrian access should be considered in transportation projects and should be provided wherever feasible. If another project were proposed for the Richmond-San Rafael Bridge of this cost ($305,000,000.00), the Commission would likely require the permittee to provide a Class I bike path across the bridge which would link with the Bay Trail on each side of the Bay as part of the project.

The Commission has analyzed the public access issue and found that the provision of bicycle and pedestrian access across the bridge is desirable and would maximize the project's public access benefits. However, at the August 7, 1997, Commission meeting the permittee voluntarily stated that it would use its best efforts to provide public access across the Richmond-San Rafael Bridge, as follows:

<u>The original permit contained a finding that stated, as follows:</u>

By December 31, 1997, but in no event later than December 31, 1998, Caltrans will submit to the Commission a study, prepared by or on behalf of Caltrans in consultation with the Metropolitan Transportation Commission (MTC) and the Commission staff, which will determine the feasibility of providing pedestrian, bicycle and wheelchair access across the bridge. Provided the study determines that some access is feasible, Caltrans will, by December 31, 1999, submit to the Commission an implementation program which will ensure that such access is

provided on the bridge as soon as the retrofit work is done, but in any event no later than December 31, 2003. Further, if the study determines that some access is feasible, Caltrans will, by December 31, 1999, submit to the Commission evidence that the processes for obtaining the necessary funding and securing the necessary authorizations for providing such access on the bridge have been initiated.

While developing the study (and implementation program if necessary), Caltrans will also consult with the Federal Highway Administration, the Bay Trail Project, interested regional bicycle, pedestrian and disabled persons organizations, the Cities of Richmond and San Rafael, the Golden Gate Bridge, Highway and Transportation District, and the Counties of Contra Costa and Marin.

The study (and implementation program if necessary) will address, at a minimum, the following: (a) safety issues related to motorized and non-motorized travel on the same roadway and any standards associated with these safety issues, both on the bridge and on the bridge approaches; (b) removing all legal impediments which make it against the law to ride a bicycle or walk across the bridge; (c) installing the minimum safety improvements for bicycle access across the bridge, such as signs (which alert drivers of the presence of bicycles on the bridge and caution cyclists to proceed at their own risk), new painted stripes in the curb lane to delineate a bike lane, new cones, pylons or similar improvements, new steel plates across the expansion grates to prevent skinny-tired bicycles from getting stuck, and/or new or modified bridge railings; (d) installing the minimum necessary safety improvements for pedestrian and wheelchair access across the bridge; (e) obtaining the funding necessary, and the funding sources that may be available for any of the access alternatives developed; (f) establishing the time period, including the preparation of any environmental documents required by the California Environmental Quality Act, for implementing any of the alternatives developed; (g) potential bicycle, pedestrian and wheelchair patronage on the bridge; and (h) designed standards for bicycle facilities as outlined in the Highway Design Manual Chapter 1000, *Bikeway Planning and Design*.

Therefore, for all the foregoing reasons, the Commission finds that the project is consistent with the Commission's mandated responsibility of ensuring that maximum feasible public access consistent with this project is provided, as required by Section 66602 of the McAteer Petris Act. This finding is not based on the opinion of the California Attorney General's Office regarding the scope of the Commission's legal authority to include specific public access conditions in this permit in lieu of making this finding.

2. **Impacts to Existing Public Access at the Bridge**. A bicycle and pedestrian pathway exists on the easterly shoreline, traveling along the eastbound lane of I-580 from Point Richmond, underneath the East Approach Section of the bridge, and connecting to Western Drive on the north side of the bridge. The portion of the path which travels underneath the bridge will be closed for approximately three months to facilitate the retrofit of the supports in this location.

   The permittee explored the possibility of building a temporary structure which would allow for continued access under the bridge during the retrofit. Such a structure was estimated to cost approximately $35,000 to $40,000. However, the benefits of providing a temporary structure would not likely be worth this amount of money, and that this amount of money will provide better public benefits by creating permanent improvements to the limited public access on the east side of the bridge.

   The permittee investigated enhancements that could be made to improve public access along the Richmond shoreline between Pt. Molate Beach Park to the north of the bridge and the Miller/Knox Regional shoreline to the south to help offset this impact. The Bay Trail Project, the City of Richmond and the East Bay Regional Park District have expressed their desire to improve this section of shoreline because Western Drive, on the north side of the bridge, could become a gateway to new, spectacular public access and coastal recreation opportunities at Point Molate and Point San Pablo.

   The permittee's investigation found that the proposed route follows a Southern Pacific railroad spur. The Bay Trail Project staff, appointed to the Blue Ribbon Advisory Committee of the City of Richmond, is actively pursuing the conversion of the spur to a trail. Concerns about converting the spur relate to public safety as the trail would cross property formerly used by a chemical industry. The property is owned by Chevron Refining Company and the U.S. Navy. A schedule for conversion of the rail spur has not been set. Extending the existing bike path would require a joint agreement with Bay Trail, the City of Richmond, and property owners along the permittee's right-of-way. This will likely be a long and involved process, one which will not be completed prior to permit issuance. Additionally, the bike trail extension proposal has not undergone environmental review. Therefore, the permittee and the Commission do not find it feasible to extend the bike path at this time as part of this project. However, the permittee has indicated its willingness to work with staff of the Bay Trail Project as the bike

trail plans continue to develop. Therefore, the Commission finds that Special Condition II-F, which requires the permittee to make a financial contribution consistent with the project impact to help develop this desired east shore Bay access, is needed to offset the adverse impacts of the construction.

Further, the permittee is required, pursuant to Special Conditions II-D and II-E, to install informational signs at the path describing the seismic retrofit project and other bicycle and pedestrian options in the vicinity. There is also informal access on the westerly shoreline prior to the point where the concrete trestle section of the bridge begins out over the water. In addition, on the southerly side of the western approach there are approximately 20 Caltrans parking spaces and a public access concrete pier just east of San Quentin Village. Although the publicly-used shoreline areas on the westerly end of the bridge are within the project boundary, they would not be impacted by the project with the exception of the construction of a new public access and Park-and-Ride facility.

3. **Public Access on Marin County Shoreline**. To increase the public benefits associated with the project, the permittee proposed and is required, pursuant to Special Condition II-G, to construct an approximately 23,971 square-foot public access facility on the northerly shoreline at the west end of the bridge, just east of the Marin Rod and Gun Club. This facility will be designed to provide~~,~~ a public access area that includes a shoreline path, parking for shoreline access, landscaping, and benches to take advantage of the views of the Bay. To ensure that the public access area remains maintained and available to the public in the future, the public access area is required, pursuant to Special Condition II-G-2, to be permanently guaranteed.

~~Amendment No. Three authorizes the removal of existing cement riprap and installation of approximately 226 lineal feet of new rock slope protection adjacent to the public access at the west end of the bridge, authorizes a revised design for that public access, and revision of Exhibit A. The changes to the public access design are consistent with the 2004 agreement between BCDC and the permittee, which was memorialized in BCDC's September 22, 2004 letter to the permittee from Brad McCrea. Accordingly, the permittee agreed, to offset its delay in installing the required public access improvements, to replace the Park and Ride lot with shoreline access parking, upgrade the signage requirement, increase the total public access area by 20,571 square feet, and to complete this work by December 31, 2005. The revisions to the public access described above do not materially alter the project authorized by the permit and, thus, this~~

~~amendment is was similar to a minor repair or improvement for which the Executive Director may issue an amendment to a permit, pursuant to Government Code Section 66632(f) and Regulation Section 10622(a).~~

In addition, the Commission is also concerned with preserving and enhancing views to the Bay in new roadway projects whenever possible. Visual access to the Bay from the roadway will not be adversely impacted from the project because no changes are proposed to the bridge railings on the East Approach, West Approach and Main Span sections of the bridge. The exception is on the concrete trestle section because the existing railings would be removed and replaced with new 32-inch-high, concrete safety barriers which would increase views of the Bay from the bridge over the existing barriers. Generally, the Commission has found that the standard 32-inch-high barriers used by Caltrans are low enough so that they do not impact views to the Bay. To ensure that any new railings on the bridge do not exceed 32-inches in height, Special Condition II-~~V~~W is needed (It should be noted that the project considered and authorized in Material Amendment No. Four of permit authorizes a cable railing that is between 42 and 62-inches in height; however, the cable railing has been specially chosen as it will not impact views to the Bay, as discussed later in this amended permit).

In conclusion, because the project is a retrofit of an existing bridge, the Commission finds, as conditioned herein, the project includes a maximum feasible public access component consistent with the project, and that the project would not create significant adverse impacts to existing public access areas.

D. **Fish and Wildlife**. Section 66605 of the McAteer-Petris Act states, in part, that: "...the nature, location and extent of any fill should be such that it will minimize harmful effect to the Bay Area, such as the reduction or impairment of the...fertility of marshes or fish and wildlife resources."

The *San Francisco Bay Plan* also includes findings and policies protecting the fish and wildlife resources of the Bay. The Bay Plan, in part, states: "The benefits of fish and wildlife in the Bay should be insured for present and future generations of Californians. Therefore, to the greatest extent feasible, the remaining marshes and mudflats around the Bay, the remaining water volume and surface area of the Bay, and adequate fresh water inflow into the Bay should be maintained. Specific habitats that are needed to prevent the extinction of any species, or to maintain or increase any species that would provide substantial public benefits, should be protected, whether in the Bay or on the shoreline behind dikes...."

The project has the potential to create adverse impacts to a number of birds, marine mammals, fish and their habitats. One such species is the peregrine falcon, a state and federal government endangered species. No falcon nesting has been observed on the Richmond-San Rafael Bridge, only nesting behavior. Still, to minimize impacts on the falcon, the permittee has been consulting with the USFWS to develop a mitigation program to avoid and/or offset any adverse impacts to the falcon. In this program, which is required by Special Condition II-~~Q~~R, Caltrans will help fund a program at the U.C. Santa Cruz Predatory Bird Research Group which will raise peregrine falcon chicks for ultimate release into the wild based upon the U.S. Fish and Wildlife Service Biological Opinion.

The winter-run chinook salmon is also listed as endangered fish species. Of concern is the addition of suspended particle matter in the water resulting from the construction activities that would temporarily affect these fishes' foraging and food resources. In addition, the temporary work platforms on the easterly end of the bridge could potentially create adverse impacts to existing eelgrass beds by compacting and/or disrupting the eelgrass substrate. Eelgrass beds are important rearing habitat for juvenile fish, including Pacific Herring, providing nesting sites, food and shelter. Past efforts in San Francisco Bay to plant and transplant eelgrass have not proven successful. To minimize the impacts on the eelgrass beds, the permittee ~~has~~ agreed, and is required, pursuant to Special Condition II-B, to use pile-supported work platforms instead of solid fill. These pile-supported work platforms could potentially have detrimental impacts on the eelgrass beds as resuspended sediments and the shade from the platforms decrease photosynthesis of the plants and inhibit their growth. Therefore, to protect and restore the eelgrass beds to the greatest extent feasible, as well as protect steelhead, herring and salmon foraging and their food resources, the permittee has developed and is required to implement mitigation measures, pursuant to Special Condition II-~~M~~N and II-~~R~~S, with the NMFS, the CDFG, the USFWS and the RWQCB to: (1) minimize turbidity in the water from construction activities; (2) prohibit open water suction dredging in waters shallower than 20 feet between January 1 and May 31 and limit other dredging and construction activities during significant fish migration or spawning activities as directed by the NMFS or the CDFG; and (3) perform pre-and post-project surveys of the eelgrass beds. In addition, because of the potential loss of eelgrass habitat, the permittee is required, pursuant to Special Condition II-~~R~~S, to continue to work with the wildlife agencies (USFWS and NMFS) to develop an experimental eelgrass planting program in the project area if determined necessary.

Other species of concern, while not officially listed as rare or endangered, that still receive special protection by law include harbor seals and the Pacific herring. The harbor seals, which haul out at Castro Rocks about 50 feet south of the bridge, are protected by the Marine Mammal Protection Act. Potential adverse impacts to the seal haul out resulting from the construction of the project are expected to be minimized since pier 55, the closest pier, is founded on rock and would not need dredging or new piles. Mitigation measures to protect the seals have been developed in consultation with the NMFS, as required pursuant to Special Condition II-~~P~~Q, to include work restrictions on piers 54, 55 and 56 from March through June, the pupping and molting season of the seals, as well as establishment of an exclusion zone around Castro Rocks. In addition, the permittee ~~has~~ developed and is required to implement, pursuant to Special Condition II-~~M~~N, mitigation measures developed in consultation with the NMFS and the CDFG to protect the Pacific herring from the construction activities during spawns. The Pacific herring's peak spawning season is from December 1 to March 1 and suspended particle matter can suffocate the eggs. Therefore, the permittee has agreed to halt construction activities within 200 meters of a spawning site upon notification from the CDFG for approximately 2 weeks, which should allow enough time for the eggs to hatch.

Last, the project could potentially create adverse impacts to other fish and bird species which use the bridge, most notably the double crested cormorant colony existing underneath the bridge. The project could result in the loss of one year of breeding habitat for the cormorants; however, according to the CDFG, the potential loss of breeding habitat for one year would not be considered a significant adverse impact. Similarly, the loss of breeding habitat for other, more common bird species, such as seagulls, for one year is not considered a significant adverse impact. Still, the permittee will~~,~~ pursuant to Special Condition II-~~Q~~R, implement protocols established by the CDFG or the Point Reyes Bird Observatory for handling of these birds during the construction activities. The project would also impact benthic organisms in the Bay muds and on the existing bridge footings. However, it is anticipated that these organisms would quickly recolonize the project site after the dredging episodes and the footing retrofit work are completed. In addition, the new and enlarged piles and piers can provide valuable habitat, food and cover for fish once they are recolonized by benthic organisms.

In conclusion, the Commission finds that, as conditioned, the project minimizes adverse impacts to the fish and wildlife resources of San Francisco Bay and is therefore consistent with the McAteer-Petris Act and the *San Francisco Bay Plan* which require a project to minimize harmful effects to the fish and wildlife.

E. **Dredging and Water Quality**. Section 66605 of the McAteer-Petris Act states, in part, that: "...the nature, location and extent of any fill should be such that it will minimize harmful effects to the Bay Area, such as the reduction or impairment of...water quality...." Further, the McAteer-Petris Act states, in part, that "dredging is essential to establish and maintain navigational channels for maritime commerce, which contributes substantially to the local, regional, and state economies...." In this case, the dredging associated with the retrofit of the Richmond-San Rafael Bridge, while not dredging a navigation channel, can be viewed as dredging necessary for the maintenance of a significant transportation facility that contributes substantially to the local, regional, and state economies.

The *San Francisco Bay Plan* Dredging Policy No. 1 states: "[d]redging should be authorized when the Commission can find: (a) the permittee has demonstrated that the dredging is needed to serve a water-oriented use or other important public purpose; (b) the materials to be dredged meet the water quality requirements of the San Francisco Bay Regional Water Quality Control Board; (c) important fisheries and Bay natural resources would be protected; and (d) the materials would be disposed of in accordance with [Dredging] Policy 2...." The Bay Plan Dredging Policy No. 2 states: "[d]isposal of dredged materials should be encouraged in non-tidal areas where the materials can be used beneficially, or in the ocean. Disposal in tidal areas of the Bay should be authorized when the Commission can find that: (a) the permittee has demonstrated that non-tidal and ocean disposal is infeasible; because there are no alternate sites available or likely to be available for use in a reasonable period, or the cost of disposal at alternate sites is prohibitively expensive; (b) disposal would be at a site designated by the Commission; (c) the quality and volume of the material to be disposed is consistent with the advice of the San Francisco Bay Regional Water Quality Control Board; and (d) the period of disposal is consistent with the advice of the Department of Fish and Game and the National Marine Fisheries Service...." The Bay Plan Dredging Policy No. 5 states: "[o]nce non-tidal or ocean disposal sites have been secured or designated, and prior to completion of the LTMS, the maximum feasible amount of dredged material should be disposed of at non-tidal sites or in the ocean. Until non-tidal upland disposal sites are secured and ocean disposal sites designated, aquatic disposal in the Bay should be authorized at sites designated by the U.S. Army Corps of Engineers and the Commission. Dredged materials disposed of aquatically in the Bay, particularly at the Alcatraz Island disposal site, should be carefully managed to ensure that the amount and timing of disposal does not create navigational hazards, adversely affect Bay currents or natural resources of the Bay, or foreclose the use of the site by projects critical to the economy of the Bay Area...."

As mentioned above, the Richmond-San Rafael Bridge is considered a water-oriented use under the McAteer-Petris Act. On April 2, 1997, the multi-agency Dredged Material Management Office (DMMO) reviewed the sediment quality chemical and toxicity analyses for this project and made the recommendation that the majority of sediments to be dredged were suitable for unconfined aquatic disposal. The exception applied to Richmond Composite 13 material located adjacent to piers 71 through 77. In these locations, the DMMO recommended that the entire volume of material which would be removed from piers 71 through 74 (approximately 1,690 cubic yards) and the upper 6 feet of material from piers 75 through 77 (approximately 1,630 cubic yards) be disposed in an appropriate manner at an upland location outside of the Commission's jurisdiction. Subsequently, the staff of the San Francisco Bay Regional Water Quality Control Board (Regional Board) recommended approval of a Water Quality Certification for this project at its April 16, 1997, Board meeting. This recommendation was adopted by the Regional Board as Resolution No. 97-053 which allows the permittee to dispose of dredged materials from the project site at the Alcatraz Dredged Material Disposal Site (SF-11), a site designated by BCDC for in-bay disposal.

The permittee can dispose up to approximately 215,700 cubic yards in the Bay. The remaining approximately 3,320 cubic yards of material that was determined unsuitable for aquatic disposal will be disposed at an upland location, pursuant to Special Condition II-~~K~~L. The permittee briefly explored alternative disposal options other than the in-Bay option, but they were found infeasible primarily due to cost. In addition, because the project is considered an "emergency project" pursuant to the Seismic Retrofit Bond Act of 1996, the permittee does not have unlimited time to explore and develop disposal alternatives.

To prevent navigational hazards, adverse impacts to water quality, and adverse impacts to fish and wildlife resources, the Commission finds that Special Conditions II-~~I~~J, II-~~J~~K, II-~~L~~M, II-~~M~~N, II-~~N~~O and II-~~O~~P are necessary to manage the amount and timing of the dredged materials and their disposal at the Alcatraz dredged materials disposal site. These special conditions include the requirement for water quality analysis, maps of the dredging sites, monitoring of the dredging and disposal activities, and abiding by the annual and monthly disposal targets for the Alcatraz disposal site. As conditioned, the Commission finds that the dredging and dredged material disposal associated with the project serve a water-oriented use, meet the requirements of the RWQCB, minimize adverse impacts to fish and wildlife resources as much as possible, and dispose of the materials unsuitable for aquatic disposal in an appropriate manner in an upland location.

In conclusion, the Commission finds the dredging and dredged material disposal activities are consistent with the Commission's laws and policies governing water quality, dredging and disposal of dredged materials in San Francisco Bay.

F. **Priority Land Use Area**. Section 66602 of the McAteer-Petris Act states that: "...certain water-oriented land uses along the Bay shoreline are essential to the public welfare of the Bay Area, and these uses included...water-related industry...." The *San Francisco Bay Plan* also includes findings and policies which protect lands adjacent to the Bay for "priority land uses," such as water-related industry. As shown on Bay Plan Map No. 4 ~~11~~, the easterly portion of the project site, the Chevron refinery property, is designated as a water-related priority land use site.

The project is not located in an area critical to the operations of the Chevron facility. The permittee has also discussed with Chevron the use a portion of the site to access the temporary work platforms and for construction staging areas. In addition, because the bridge already exists and the project would not substantially change the size or use of the bridge, the project will not adversely impact the ability of the site to remain available for water-related industrial purposes.

Therefore, the Commission finds the project will not adversely impact the existing or future use of this designated water-related industry priority use site.

G. **Non-Material Permit Amendments. ~~No. Two.~~**

1. Amendment No. One to the permit involved a time extension to the original authorization. Further, Amendment No. Two authorizes the installation of a security barrier, as required by the California Highway Patrol, at ground-level on the north and south sides of the eastern bridge approach within the Commission's 100-foot shoreline band. The barrier consists of a 30-inch-high concrete barrier and an adjacent six-foot-tall chain link fence. While the fence makes the access area less appealing and attractive, it does not physically interfere with use of the adjacent public access path and was determined by the California Highway Patrol to be necessary to maintain the security of the bridge. Therefore, the project involves the placement of a small amount of material that does not affect public access, the environment, or conflict with a priority use designation, and thus is a "minor repair or improvement," as defined by Regulation Section 10601(b)(1), for which the Executive Director may issue an amendment to a permit pursuant to Regulation Section 10810. Amendment No. Two was issued after-the-fact pursuant to an Enforcement investigation. The issuance of this amendment does not preclude future enforcement action for violations of this permit.

Amendment No. Three authorizes the removal of existing cement riprap and installation of approximately 226 lineal feet of new rock slope protection adjacent to the public access at the west end of the bridge, authorizes a revised design for that public access, and revision of Exhibit A. The changes to the public access design are consistent with the 2004 agreement between BCDC and the permittee, which was memorialized in BCDC's September 22, 2004 letter to the permittee from Brad McCrea. Accordingly, the permittee agreed, to offset its delay in installing the required public access improvements, to replace the Park and Ride lot with shoreline access parking, upgrade the signage requirement, increase the total public access area by 20,571 square feet, and to complete this work by December 31, 2005. The revisions to the public access described above do not materially alter the project authorized by the permit and, thus, this amendment ~~is~~ was similar to a minor repair or improvement for which the Executive Director may issue an amendment to a permit, pursuant to Government Code Section 66632(f) and Regulation Section 10622(a).

H. **Material Amendment No. Four for Public Access Improvement Project.** The subject of the material amendment involves activities on the Richmond-San Rafael Bridge (in the Bay) and at adjoining sections of I-580 (within the 100-foot shoreline band), which will remain in place for up to a four-year period and result in a change to traffic operational patterns on the eastbound (lower) deck and a multi-use public pathway on the westbound (upper) deck. In the original permit (1997) for the bridge seismic retrofit, the Commission found that a public pathway on the bridge could maximize public access consistent with the project, but did not require Caltrans to provide such an improvement due to a variety of reasons, including safety and operational concerns.

Following issuance of the original permit, Caltrans undertook a multi-year study to assess the feasibility of public access on the bridge. The study identified a preferred pathway design: a bi-directional path on the westbound (upper) deck of the bridge separated from traffic by a moveable barrier. However, Caltrans expressed concerns with implementation of the "preferred" alternative, including that highways without shoulders provide less recovery space for errant vehicles, and over the potential costs to support and maintain a public path. Subsequently, the Commission requested that Caltrans provide additional information to support its conclusions and, in 2009, asked Caltrans to further study the feasibility of undertaking a public access pilot program on the bridge, similar to the one which is the subject of Material Amendment No. Four.

1. **Fill.** Section 66605 of the McAteer-Petris Act provides, in part, that fill: "should be limited to water-oriented uses" or for "minor fill for improving public access to the Bay;" be "the minimum amount necessary to achieve the purpose of the fill"; "the nature, location, and extent of any fill should be such that it will minimize harmful effects to the Bay area..."; be built "in accordance with sound safety standards;" and on property to which the applicant has valid title.

   The project involves converting a maintenance/emergency vehicle shoulder at the lower eastbound bridge deck into a regular vehicle travel lane as needed during peak traffic times, and converting a similar shoulder at the upper west-bound deck into a public pathway with an adjacent concrete barrier and outer safety railing. In addition, the project involves the placement of associated facilities, including signage, and safety cameras. All of these improvements will be placed on the existing, seismically-retrofitted bridge and result in no additional coverage of the Bay. Bridges are defined in the McAteer-Petris Act as water-oriented use and the public pathway and related improvements authorized by Amendment No. Four are components of the existing Richmond-San Rafael Bridge. The pedestrian/bicycle/wheelchair pathway is a use that is commonly seen on bridges spanning the Bay and Bay tributaries. The fill will not result impact Bay resources nor will it affect the structural stability of the bridge.

   The Commission finds that the public pathway and related improvements on the existing bridge are consistent with the Commission's laws and policies on Bay fill.

2. **Public Acess and Views.** Section 66602 of the McAteer-Petris Act states, in part, that "public access to the shoreline and waters of the Bay is inadequate and that maximum feasible public access, consistent with a proposed project, should be provided." The Bay Plan Transportation Policy No. 4 states, in part, "transportation projects on the Bay shoreline and bridges over the Bay...should include pedestrian and bicycle paths that will either be part of the Bay Trail or connect the Bay Trail with other regional and community trails."

   The Bay Plan policies on public access further state, in part, "...maximum feasible public access to and along the waterfront...should be provided in and through every new development in the Bay or on the shoreline...." Policy No. 7 states, in part, "public access improvements...should be designed and built to encourage diverse Bay-related activities and movement to and along the shoreline, should permit barrier free access for persons with disabilities to the maximum feasible extent, should include an ongoing maintenance program, and should be identified with appropriate signs." Policy No. 8 states, in part, "a small amount of fill may be allowed if the fill is necessary and is the minimum absolutely required to develop the project in accordance with the Commission's public access

requirements." Policy No. 9 states, in part, "access to and along the waterfront should be provided by walkways, trails, or other appropriate means and connect to the nearest public thoroughfare where convenient parking or public transportation may be available." Policy No. 12 states, "the Public Access Design Guidelines should be used as a guide to siting and designing public access consistent with a proposed project. The Design Review Board should advise the Commission regarding the adequacy of the public access proposed."

Bay Plan Appearance, Design, and Scenic Views Policy No. 2 states, in part, "All bayfront development should be designed to enhance the pleasure of the user or viewer of the Bay. Maximum efforts should be made to provide, enhance, or preserve views of the Bay and shoreline, especially from public areas, from the Bay itself, and from the opposite shore." Policy No. 6 states, in part, "guard rails and bridge supports should be designed with views in mind." The Public Access Design Guidelines advise applicants, in part, to "make public access usable by...maximizing user comfort by designing for the weather and day and night use...and...provide basic public amenities, such as trails, benches...trash containers...lighting...that are designed for different ages, interests, and physical abilities."

Over a four-year pilot period, Caltrans will provide public access on the bridge and adjoining highway connections and associated facilities. The width and design of the pathway will encourage movement by all users, including those with disabilities. A traffic barrier and an outer safety cable railing will be installed—the design of the outer railing will maximize views of the Bay for pathway visitors. Caltrans will install signage to guide users to nearby parking, including distances to destinations and landmarks. Public parking is available at vista points near the bridge approach to Marin County, the Bay Business Park, and at Point Molate Beach in Contra Costa County. Public transportation is available in Richmond and San Rafael, connecting the paths to larger public transportation systems, including the Larkspur ferry terminal. All project elements will be maintained by Caltrans and BATA.

At the bridge pathway connections immediately outside the Commissions jurisdiction, and at connecting pathways and facilities located nearby in Contra Costa County and Marin County in Caltrans right-of-way, the permittee: will permanently realign the proposed bridge pathway to East Francisco Boulevard from Main Street and Grange Avenue; will permanently widen Main Street (Marin County) at the area located between the RSR eastbound and westbound ramps to accommodate two 4-foot-wide Class II striped bike lanes and one 5-foot-wide sidewalk; will permanently install a solid barrier at East Standard Avenue in the

City of Richmond (Contra Costa County) to separate bicycle, and pedestrian traffic from vehicles and to link existing bicycle paths on Tewksbury Avenue and Marine Street located in Point Richmond; will permanently install a Class I, bi-directional bicycle and pedestrian path separated from vehicle traffic by a solid barrier along the north side of westbound I-580, from the Marine Street interchange (Contra Costa County) to Stenmark Drive and the Toll Plaza; will permanently widen the I-580 off-ramp to Stenmark Drive (Contra Costa County) to accommodate a 10-foot-wide bi-directional bicycle and pedestrian path separated from vehicle traffic by a concrete barrier; will install a crosswalk at Stenmark Drive to connect to a trail to Point Molate; and will permanently replace safety railings with a screen to block adjacent fuel pipelines at the Scofield Avenue undercrossing in Richmond (Contra Costa County), providing connections to San Francisco Bay Trail segments located in the City of San Rafael, and proposed Bay Trail extensions to Point Molate. Bicycle/pedestrian counters would be installed on both sides of the bridge to collect usage data.

On January 11, 2016, the Commission's Design Review Board (DRB) reviewed the Project. The DRB asked the permittee to: (1) consider the proposed bridge pathway and its connections from a regional perspective, and to map present and future pedestrian and bicycle routes within this region of the Bay to learn how the project will best fit within this network; (2) make clear and safe connections to the bridge pathway on both sides of the bridge in order to "position the project for success," and work with the surrounding jurisdictions to create safe connections; (3) decrease the size of the vertical posts as much as possible, and provided positive feedback on the cable railing; (4) provide amenities for pathway users, including seating, signage, shelter, water and parking; (5) explore the possibility of including some lower lighting closer to the pathway to supplement the tall pole lights that exist now; (6) provide a transparent top portion of moveable barrier in order to maintain views for drivers, bicyclists and pedestrians in addition to increasing the sense of personal safety for pathway users; and (7) add mile markers for safety and orientation purposes on the bridge, and add color or patterns on the pavement of the landside connections leading to the bridge. Following the advice from the DRB, the permittee made revisions to the design of the project, including signage, seating, connections, parking, and the railing. Because of the temporary nature of the pilot program, other amenities, such as lighting, will not be installed at present, but will be revisited if the project becomes permanent.

To ensure that the final project is consistent with the Commission's authorization, final plans, including amenities and signage, were reviewed by the BCDC staff in accordance with Special Condition II-A. Because of the temporary nature of the pilot program, a permanent guarantee, as required in Bay Plan policies on public access, is not required in this amended permit. However, the permittee is required to install instruments to measure usage of the path, maintain the path for the entirety of the pilot program, report to the Commission at the end of the third year of the pilot program, and seek Commission authorization to make changes to the path, as required in Special Conditions II-G.2, II-G.3, and II-G.4. These Special Conditions will enhance the public benefits associated with the project, and position the project for success, as advised by the Commission's DRB.

To ensure the safety of pedestrians, bicycles, and other path users during and after flood events, and to maximize the amount of time the path is open to users, Special Condition II-H.1 has been included. Special Condition II-W.1 allows the installation of a cable railing, which is higher than authorized in the original permit. The new cable railing is necessary to protect the safety of path users, while protecting views of the Bay. After four years, the bi-directional bicycle and pedestrian path on the Richmond-San Rafael Bridge may be made permanent or may return to function as a shoulder for vehicles. Therefore, the Commission finds that the project, as conditioned, is consistent with the Commission's laws and policies on public access, and appearance, design, and scenic views.

~~H~~I. **Public Trust.** The approximately 55,800 square feet of new solid and pile-supported fill, approximately 270,000 square feet of pile-supported replacement fill, and approximately 197,000 square feet of temporary, pile-supported and solid fill authorized herein are for the retrofit of an existing bridge, a water-oriented use as defined by Section 66605 of the McAteer-Petris Act. Water-oriented uses are consistent with the public trust. Further, the retrofit work would provide for increased safety of persons and property using the bridge. The project associated with Amendment No. Four will not result in any net increase of Bay fill, is temporary in nature, and facilitates public access to the Bay and shoreline. Thus, the Commission finds that the fill is consistent with the public trust.

~~I~~J. **Title**. The project is located with the California Department of Transportation right-of-way for the Richmond-San Rafael Bridge. This right-of-way was secured by lease from the California State Lands Commission for the life of the bridge plus one year.

~~J~~K. **Environmental Review.** Pursuant to the Seismic Retrofit Bond Act of 1996, the original project ~~is~~ was statutorily exempt from the California Environmental Quality Act (CEQA) (Public Resource Code). Further, Senate Bill 131, Chapter 15, Section

180.2, specifies that qualifying projects shall be considered to be activities under the CEQA, Section 21080(b)(4), which states that CEQA does not apply to "[s]pecific actions necessary to prevent or mitigate an emergency."

Pursuant to the California Environmental Quality Act (CEQA), Section CCR 15061[b][3], and the National Environmental Policy Act (NEPA), Section 23 USC 327, the California Department of Transportation issued an exemption from environmental review on May 27, 2016 for the project that is the subject of Material Amendment No Four.

~~K~~L. **Conclusion.** For all of the above reasons, the benefits of the revised project clearly exceed the detriment of the loss of water areas, the impacts to water quality and the impacts to fish and wildlife. Further, the project does not adversely affect current or future maximum feasible public access to and along the shoreline of the Bay, and the project provided~~s~~ maximum feasible public access to the Bay and its shoreline consistent with the project. Therefore, the project is consistent with the *San Francisco Bay Plan*, the McAteer-Petris Act, the Commission's Regulations, and the Commission's amended management program for the San Francisco Bay segment of the California coastal zone.

IV. Standard Conditions

~~A. This amended permit shall not take effect unless the permittee executes the original of this amended permit and returns it to the Commission within ten days after the date of the issuance of the amended permit. No work shall be done until the acknowledgment is duly executed and returned to the Commission.~~

~~B. The attached Notice of Completion and Declaration of Compliance form shall be returned to the Commission within 30 days following completion of the work.~~

~~C. The rights, duties, and obligations contained in this amended permit are assignable. When the permittee transfers any interest in any property either on which the authorized activity will occur or which is necessary to the full compliance of one or more conditions to this amended permit, the permittee/transferor and the transferee shall execute and submit to the Commission a permit assignment form acceptable to the Executive Director (*call for a copy of the form or download it from our website*). An assignment shall not be effective until the assignee executes and the Executive Director receives an acknowledgment that the assignee has read and understands the amended permit and agrees to be bound by the terms and conditions of the amended permit, and the assignee is accepted by the Executive Director as being reasonably capable of complying with the terms and conditions of the amended permit.~~

~~D. Unless otherwise provided in this amended permit, the terms and conditions of this amended permit shall bind all future owners and future possessors of any legal interest in the land and shall run with the land.~~

~~E. Unless otherwise provided in this amended permit, any work authorized herein shall be completed within the time limits specified in this amended permit, or, if no time limits are specified in the amended permit, within three years. If the work is not completed by the date specified in the amended permit, or, if no date is specified, within three years from the date of the amended permit, the amended permit shall become null and void. If an amended permit becomes null and void for a failure to comply with these time limitations, any fill placed in reliance on this amended permit shall be removed by the permittee or its assignee upon receiving written notification by or on behalf of the Commission to remove the fill.~~

~~F. All required permissions from governmental bodies must be obtained before the commencement of work; these bodies include, but are not limited to, the U. S. Army Corps of Engineers, the State Lands Commission, the Regional Water Quality Control Board, and the city and/or county in which the work is to be performed, whenever any of these may be required. This amended permit does not relieve the permittee of any obligations imposed by State or Federal law, either statutory or otherwise.~~

~~G. Work must be performed in the precise manner and at the precise locations indicated in your application, as such may have been modified by the terms of the amended permit and any plans approved in writing by or on behalf of the Commission.~~

~~H. Work must be performed in a manner so as to minimize muddying of waters, and if diking is involved, dikes shall be waterproof. If any seepage returns to the Bay, the permittee will be subject to the regulations of the Regional Water Quality Control Board in that region.~~

~~I. Unless otherwise provided in this amended permit, all the terms and conditions of this amended permit shall remain effective for so long as the amended permit remains in effect or for so long as any use or construction authorized by this amended permit exists, whichever is longer.~~

~~J. Any area subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission under either the McAteer-Petris Act or the Suisun Marsh Preservation Act at the time the amended permit is granted or thereafter shall remain subject to that jurisdiction notwithstanding the placement of any fill or the implementation of any substantial change in use authorized by this amended permit.~~

~~K. Any area not subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission that becomes, as a result of any work or project authorized in this amended permit, subject to tidal action shall become subject to the Commission's "bay" jurisdiction.~~

~~L. This permit reflects the location of the shoreline of San Francisco Bay when the permit was issued. Over time, erosion, avulsion, accretion, subsidence, relative sea level change, and other factors may change the location of the shoreline, which may, in turn, change the extent of the Commission's regulatory jurisdiction. Therefore, the issuance of this permit does not guarantee that the Commission's jurisdiction will not change in the future.~~

~~M. Except as otherwise noted, violation of any of the terms of this amended permit shall be grounds for revocation. The Commission may revoke any amended permit for such violation after a public hearing held on reasonable notice to the permittee or its assignee if the amended permit has been effectively assigned. If the amended permit is revoked, the Commission may determine, if it deems appropriate, that all or part of any fill or structure placed pursuant to this amended permit shall be removed by the permittee or its assignee if the amended permit has been assigned.~~

~~N. Unless the Commission directs otherwise, this amended permit shall become null and void if any term, standard condition, or special condition of this amended permit shall be found illegal or unenforceable through the application of statute, administrative ruling, or court determination. If this amended permit becomes null and void, any fill or structures placed in reliance on this amended permit shall be subject to removal by the permittee or its assignee if the amended permit has been assigned to the extent that the Commission determines that such removal is appropriate. Any uses authorized shall be terminated to the extent that the Commission determines that such uses should be terminated.~~

A. **Permit Execution**. This amended permit shall not take effect unless the permittee(s) execute the original of this amended permit and return it to the Commission within ten days after the date of the issuance of the amended permit. No work shall be done until the acknowledgment is duly executed and returned to the Commission.

B. **Notice of Completion**. The attached Notice of Completion and Declaration of Compliance form shall be returned to the Commission within 30 days following completion of the work.

C. **Permit Assignment**. The rights, duties, and obligations contained in this amended permit are assignable. When the permittee(s) transfer any interest in any property either on which the activity is authorized to occur or which is necessary to achieve full compliance of one or more conditions to this amended permit, the

permittee(s)/transferors and the transferees shall execute and submit to the Commission a permit assignment form acceptable to the Executive Director. An assignment shall not be effective until the assignees execute and the Executive Director receives an acknowledgment that the assignees have read and understand the amended permit and agree to be bound by the terms and conditions of the amended permit, and the assignees are accepted by the Executive Director as being reasonably capable of complying with the terms and conditions of the amended permit.

D. **Permit Runs With the Land**. Unless otherwise provided in this amended permit, the terms and conditions of this amended permit shall bind all future owners and future possessors of any legal interest in the land and shall run with the land.

E. **Other Government Approvals**. All required permissions from governmental bodies must be obtained before the commencement of work; these bodies include, but are not limited to, the U. S. Army Corps of Engineers, the State Lands Commission, the Regional Water Quality Control Board, and the city or county in which the work is to be performed, whenever any of these may be required. This amended permit does not relieve the permittee(s) of any obligations imposed by State or Federal law, either statutory or otherwise.

F. **Built Project Must Be Consistent with Application**. Work must be performed in the precise manner and at the precise locations indicated in your application, as such may have been modified by the terms of the amended permit and any plans approved in writing by or on behalf of the Commission.

G. **Life of Authorization**. Unless otherwise provided in this amended permit, all the terms and conditions of this amended permit shall remain effective for so long as the amended permit remains in effect or for so long as any use or construction authorized by this amended permit exists, whichever is longer.

H. **Commission Jurisdiction**. Any area subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission under either the McAteer-Petris Act or the Suisun Marsh Preservation Act at the time the amended permit is granted or thereafter shall remain subject to that jurisdiction notwithstanding the placement of any fill or the implementation of any substantial change in use authorized by this amended permit. Any area not subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission that becomes, as a result of any work or project authorized in this amended permit, subject to tidal action shall become subject to the Commission's "Bay" jurisdiction.

I. **Changes to the Commission's Jurisdiction as a Result of Natural Processes**. This amended permit reflects the location of the shoreline of San Francisco Bay when the amended permit was issued. Over time, erosion, avulsion, accretion, subsidence, relative sea level change, and other factors may change the location of the shoreline, which may, in turn, change the extent of the Commission's regulatory jurisdiction. Therefore, the issuance of this amended permit does not guarantee that the Commission's jurisdiction will not change in the future.

J. **Violation of Permit May Lead to Permit Revocation**. Except as otherwise noted, violation of any of the terms of this amended permit shall be grounds for revocation. The Commission may revoke any amended permit for such violation after a public hearing held on reasonable notice to the permittee(s) or their assignees if the amended permit has been effectively assigned. If the amended permit is revoked, the Commission may determine, if it deems appropriate, that all or part of any fill or structure placed pursuant to this amended permit shall be removed by the permittee(s) or their assignees if the amended permit has been assigned.

K. **Should Permit Conditions Be Found to be Illegal or Unenforceable**. Unless the Commission directs otherwise, this amended permit shall become null and void if any term, standard condition, or special condition of this amended permit shall be found illegal or unenforceable through the application of statute, administrative ruling, or court determination. If this amended permit becomes null and void, any fill or structures placed in reliance on this amended permit shall be subject to removal by the amended permittee(s) or their assignees if the amended permit has been assigned to the extent that the Commission determines that such removal is appropriate. Any uses authorized shall be terminated to the extent that the Commission determines that such uses should be terminated.

L. **Permission to Conduct Site Visit**. The permittee(s) shall grant permission to any member of the Commission's staff to conduct a site visit at the subject property during and after construction to verify that the project is being and has been constructed in compliance with the authorization and conditions contained herein. Site visits may occur during business hours without prior notice and after business hours with 24-hour notice.

M. **Abandonment**. If, at any time, the Commission determines that the improvements in the Bay authorized herein have been abandoned for a period of two years or more, or have deteriorated to the point that public health, safety or welfare is adversely affected, the Commission may require that the improvements be removed by the permittee(s), its assignees or successors in interest, or by the owner of the improvements, within 60 days or such other reasonable time as the Commission may direct.

N. **Best Management Practices**

1. **Debris Removal.** All construction debris shall be removed to an authorized location outside the jurisdiction of the Commission. In the event that any such material is placed in any area within the Commission's jurisdiction, the permittee(s), its assignees, or successors in interest, or the owner of the improvements, shall remove such material, at their expense, within ten days after they have been notified by the Executive Director of such placement.

2. **Construction Operations.** All construction operations shall be performed to prevent construction materials from falling, washing or blowing into the Bay. In the event that such material escapes or is placed in an area subject to tidal action of the Bay, the permittee(s) shall immediately retrieve and remove such material at its expense.

O. **In-Kind Repairs and Maintenance.** Any in-kind repair and maintenance work authorized herein shall not result in an enlargement of the authorized structural footprint and shall only involve construction materials approved for use in San Francisco Bay. Work shall occur during periods designated to avoid impacts to fish and wildlife. The permittee(s) shall contact Commission staff to confirm current restricted periods for construction.

Executed at San Francisco, California, on behalf of the San Francisco Bay Conservation and Development Commission on the date first above written.

LAWRENCE J. GOLDZBAND
Executive Director
San Francisco Bay Conservation and
Development Commission

LJG/JAN/ra

* *

Receipt acknowledged, contents understood and agreed to:

Executed at _____ California Department of Transportation
Applicant

On _____ By: _____

_____
Print Name and Title

cc: U. S. Army Corps of Engineers, Attn: Regulatory Functions Branch
San Francisco Bay Regional Water Quality Control Board,
Attn: Certification Section
Environmental Protection Agency
County of Marin Planning Department
Contra Costa Planning Department
City of Richmond Planning Department
City of San Rafael Planning Department

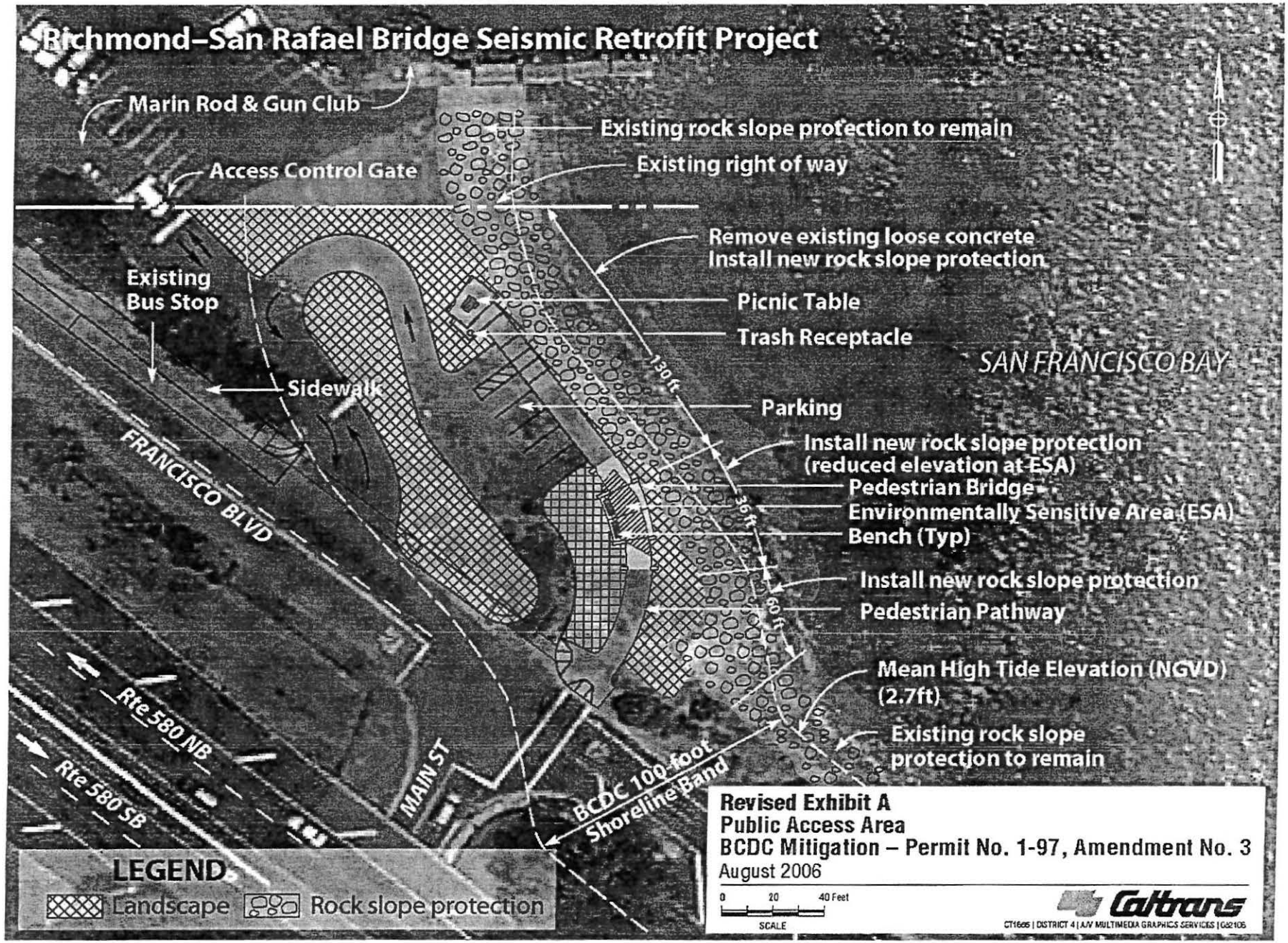

Richmond–San Rafael Bridge Seismic Retrofit Project
Marin Rod & Gun Club
Access Control Gate
Existing rock slope protection to remain
Existing right of way
Remove existing loose concrete
Install new rock slope protection
Existing
Bus Stop
Picnic Table
Trash Receptacle
SAN FRANCISCO BAY
130 ft
Sidewalk
Parking
FRANCISCO BLVD
Install new rock slope protection
(reduced elevation at ESA)
Pedestrian Bridge
Environmentally Sensitive Area (ESA)
36 ft
Bench (Typ)
Install new rock slope protection
60 ft
Pedestrian Pathway
Mean High Tide Elevation (NGVD)
(2.7ft)
Rte 580 NB
Existing rock slope
protection to remain
MAIN ST
Rte 580 SB
BCDC 100-foot
Shoreline Band
LEGEND
Landscape
Rock slope protection
Revised Exhibit A
Public Access Area
BCDC Mitigation – Permit No. 1-97, Amendment No. 3
August 2006
0
20
40 Feet
SCALE
Caltrans
CT1666 | DISTRICT 4 | A/V MULTIMEDIA GRAPHICS SERVICES | G82106

Exhibit 2
Report on the Richmond-San Rafael Bridge Access Improvement Pilot Project

May 02, 2024

Report on the Richmond-San Rafael Bridge Access Improvement Pilot Project

Introduction

The 5.5-mile-long Richmond-San Rafael (RSR) Bridge has served the needs of North Bay and East Bay travelers for over 65 years. The Bay Area Toll Authority (BATA) and Caltrans have been collaborating with partner agencies including Transportation Authority of Marin (TAM) and Contra Costa Transportation Authority (CCTA) on a series of projects and programs that work collectively to manage the bridge and improve multi-modal mobility in the corridor, including bicycle and pedestrian access. Efforts include the RSR Bridge Access Improvement Pilot Project (Pilot) the RSR Forward Program, and the Westbound Upper Deck Design Alternative Assessment.

In 2014, BATA took responsibility for funding and implementing the Pilot, a project undertaken in partnership with Caltrans, TAM, CCTA and local agencies (City of Richmond, City of San Rafael, Marin County, Contra Costa County) with the goals to address traffic congestion and provide bicycle and pedestrian access to and across the bridge, consistent with core strategies in Plan Bay Area 2050 including the San Francisco Bay Trail build-out.

The partners committed to a four-year pilot that converted the bridge lower deck emergency shoulder to a Part-time Third Travel Lane in April 2018, converted the upper deck emergency shoulder to a Multi-use Path in November 2019, and added permanent Multi-use Path improvements in the cities of Richmond and San Rafael. The purpose of the pilot is to provide bicycle and pedestrian access to improve multimodal circulation and connections to the RSR Bridge while also reducing traffic congestion and delay for

motorists. Because improvements on both decks are innovative uses of emergency shoulders, the partners committed to undertake the Pilot with an evaluation.

In 2016, BCDC approved Material Amendment No. 4 to the RSR Bridge Permit; this report satisfies the approved permit's requirement under Special Condition II.H.4, which requires a written and verbal report to the Commission at the end of the Pilot's third year on the status, including, but not limited to, an analysis of public usage and benefits, an assessment of any operational and safety issues, and the need for any future changes to the facilities, including removal or making them permanent.

The following Attachments provide supplemental information for the contents of this memo:

- Attachment A – Project Maps and Exhibits
- Attachment B – Caltrans / UC Berkeley PATH Phase I Pilot Study Report (2022)

Background

The Pilot consists of the following projects:

- **Multi-Use Bicycle and Pedestrian Path (Bridge Upper Deck)** – Convert the emergency shoulder to a two-way multi-use bicycle/pedestrian path in November 2019, creating a new route across the Bay and a link in the 500-mile San Francisco Bay Trail and connection in the region's continuous 3,244 mile All Ages and Abilities Active Transportation Network. The path is separated from vehicular traffic by a moveable concrete barrier system that accommodates bridge maintenance. (Approximately $10M capital cost)
- **Part-Time Third Travel Lane (Bridge Lower Deck)** – Convert the emergency shoulder to a Part-time Third Travel Lane (between 2 PM and 7 PM every day) in April 2018, to reduce traffic congestion and delays. (Approximately $6M capital cost)

In conjunction with the Pilot, the partners implemented permanent improvements on both bridge approaches in Marin and Contra Costa counties:

- **Bicycle and Pedestrian Access** – Improve the connections from the bridge to the existing pedestrian and bicycle networks in the cities of Richmond and San Rafael, including a sidewalk widening project that's currently under construction along East Francisco Blvd. in the City of San Rafael. (Approximately $17M capital cost)

- **Eastbound Improvements** – Widen and modify the on/off ramps along eastbound I-580 to accommodate the bridge lower deck improvements. (Approximately $30M capital cost)

Refer to Attachment A for Project Maps and Exhibits.

BATA implemented a variety of infrastructure improvements and programs during the pilot period to support biking across the bridge corridor through e-bike purchase incentives and bike trips across the bridge, guided group rides, and local quick-build bike access improvement projects. Implemented programs and projects include: RSR Rides, which launched February 2020 and relaunched in Fall 2021 after being paused due to COVID; the Francisco Blvd East / Grange Ave. Quick Build bike path improvements, which opened in December 2020; Richmond Bike Share, which launched in June 2021; and the RSR Bridge E-Bike Commute Program, which launched in February 2023 and offered subsidies for e-bike purchases.

Caltrans employed UC Berkeley PATH (PATH) to conduct a study of the Pilot and to prepare the following Pilot After Study reports:

- **Phase I Pilot Study Report (Attachment B)** – published in Summer 2022 on the Caltrans website (Phase I Pilot Study Report).
- **Phase II Pilot Study Final Report** – to be published in May 2024. The Phase II Report will include updated evaluation of the Pilot reflecting an extended evaluation period incorporating data up to April 2024. It will also include the evaluation of the Sir Francis Drake Blvd. Overpass Bike Path in Marin County that opened in August 2020.

While the original plan anticipated the Part-Time Third Travel Lane and Multi-Use Path projects opening at approximately the same time, construction phasing and upper deck bridge repairs allowed the Part-Time Third Travel Lane to be completed earlier. The Phase I Pilot Study Report reflects almost three years following the opening of the Multi-use Path on the bridge, but much of the data was impacted by the COVID-19 lockdown and its slow emergence. In addition, the Project partners added TAM's connecting bicycle path project along Sir Francis Drake Overcrossing in the City of San Rafael (opened August 2020) to the Pilot After Study, and its results will be captured in the Phase II Pilot Study Report along with updated data for the RSR Bridge Pilot that better reflect post-COVID conditions.

In compliance with the BCDC permit, the pilot studies include an analysis of public usage and benefits (e.g., bicycle and pedestrian counts, impacts on local businesses and communities and quality of life) and an assessment of operational and safety issues

(e.g., user surveys on perceived safety of the Multi-use Path, comparing before and after traffic congestion, incident rates and response times).

The following sections summarize findings from the Phase I Pilot Study Report and include additional preliminary findings from the extended evaluation period and additional analysis in the Phase II Pilot Study Report as noted.

Findings: Multi-Use Path (Bridge Upper Deck)

Summary:

The Multi-use Path has demonstrated the importance of providing access across the San Francisco Bay and is particularly well-used weekends. Path usage is considerably lower on weekdays. The impact of the path on vehicular traffic safety and operations is not entirely clear; nor is there a clear public consensus about the path. Data on vehicular incident response and incident related congestion suggests there is value in further understanding bridge access needs and the role of the emergency shoulder.

Multi-Use Path Usage and Safety (Phase I Report Sections 6, 7, 9, and 13):

- Cyclist and pedestrian counts were collected from automated counters installed on the Multi-use Path:
    - Cyclist:
        - Weekend Averages: 190 cyclists per day in each direction. Seasonal highs and lows range between around 300 and 100, respectively. Peak daily use is on weekends, with Saturdays generally seeing the highest traffic. Findings in the preliminary Phase II Report shows slightly lower average usage of 180 cyclists per day in each direction with similar seasonal trends since January 2022. Summer (June-September) Saturdays show highest averages of 240 cyclists per day in each direction.
        - Weekday Averages: 68 cyclists per day in each direction. This is consistent with the findings in the preliminary Phase II Report.
    - Pedestrian:
        - Pedestrian use is lower than cyclists, likely due to the length of the bridge.
        - Weekend Averages: 20 pedestrians per day in each direction.
        - Weekday Averages: 10 pedestrians per day in each direction.

- These are consistent with the findings in the preliminary Phase II Report.

- A user survey was conducted from June 16, 2021, to August 13, 2021 to assess how users of the Multi-use Path view its usefulness and safety. It was an online survey, with QR codes and URL posted along the Multi-use Path and various social media platforms, which generated approximately 2,200 respondents. 29% of the respondents indicated that they do not use the path.
  - Perceived Safety rating by overall users is 8.2 out of 10 (with 10 being the safest).
  - Perceived Benefits rating by cyclists is 8.4 out of 10 (with 10 being most beneficial). Pedestrians responded 6 out of 10 and non-users responded 2.8 out of 10.
  - 85% of path users used it for recreation or exercise.
  - 14% of path users used it for commuting to work or locations other than work.
  - 1% used it for other, non-specified reasons.
- No incidents (such as crashes and near-miss collisions) involving bicyclists or pedestrians were recorded by the CHP or reported on the Street Story platform during the evaluation period. However, anecdotal evidence suggests that some incidents have occurred. This is consistent with the findings in the preliminary Phase II Report.

Vehicular Traffic Impacts (Phase I Report Section 8):

- Peak-hour travel time across the bridge has increased by less than a minute, due to slightly slower speeds on the bridge. Installing the Multi-use Path and barrier required shortening the merge downstream of the toll plaza and narrowing the bridge roadway, which reduced the maximum traffic flow across the bridge by 7%, on weekdays and 4% on weekends. This is consistent with the findings in the preliminary Phase II Report.
- Travel time has also been more variable due to the inability of disabled vehicles to move out of a traffic lane.
- However, these impacts have not translated into significantly increased congestion upstream of the bridge compared to the 2015 to 2018 average conditions. This appears to be due to traffic levels on the approach remaining 90% of 2018 levels. This is consistent with the findings in the preliminary Phase II Report.

Vehicular Safety / Incident Impacts (Phase I Report Sections 10 and 11):

The Phase I Report examined safety and traffic incidents in total, over the course of the full day. The Phase II Report examined trends during the congested AM peak period in more detail and further distinguished the COVID period from the post-COVID period, to provide context for the large volume of comments and concerns expressed during presentation of the Phase I report findings to BATA, Caltrans and the other partners by motorists, residents, and employers about their experiences in the corridor. This analysis conveys a complex picture and suggests there is more to learn about the impact on bridge operations of not having an emergency shoulder during the congested peak period. The following data considers incident data since 2016 and excludes incidents during the COVID-impacted period of April 2020 to June 2021 (unless otherwise noted). Therefore, excluding the COVID-impacted period, the Phase I Report data on incidents represents less than a full year and the preliminary Phase II report represents up to 3 years of data.

- All Incidents, Full Day:
    - On the bridge approach, the frequency (per million vehicle miles traveled) of traffic incidents (commonly rear-end collisions, sideswipes, and vehicles hitting objects) has reduced by 20% as reported in the Phase I report. Findings in the preliminary Phase II report show a reduction of 13%.
    - On the bridge itself, the frequency of traffic incidents has increased by 5%. Findings in the preliminary Phase II report show a reduction of 19%.
    - On the bridge, rear-ends (~50%) and sideswipes (~40%) represent about 90% of all reported incidents. The frequency of rear-ends decreased by 5% and sideswipes increased by 36%. Findings in the preliminary Phase II report show rear-ends decreased by 19% and sideswipes decreased by 12%.
    - On the bridge, incident severity such as “no injury” (~70%) and “complaint of pain” (~20%) represent about 90% of the reported incidents. The frequency of “no injury” increased by 9% and “complaint of pain” decreased by 23%. Findings in the preliminary Phase II report show “no injury” decreased by 17% and “complaint of pain” decreased by 23%.
    - Average incident response time (data includes COVID-impacted period) on the bridge decreased from 11.6 mins to 10.3 mins and the median response time decreased from 11.5 mins to 9.5 mins. In the preliminary Phase II Report (data excludes COVID-impacted period), average response time increased from 11.6 mins to 14.8 mins and the median response time increased from 11.5 mins to 12.0 mins.

- Weekdays 6am – 9am Only (from the preliminary Phase II Report)
    - On the bridge approach, the frequency of traffic incidents has increased by 18%.
    - On the bridge itself, the frequency of traffic incidents has increased by 33%.
    - Although the full day shows a decrease in frequency of various types of incidents on the bridge, the weekday AM data indicates increases. Frequency of rear-ends increased by 10% and sideswipes increased by 49%.
    - Similarly with incident severity on the bridge, frequency of "no injury" increased by 37% and "complaint of pain" increased by 1%.
    - Average incident response time (data excludes COVID-impacted period) on the bridge increased from 12.9 mins to 16.3 mins and the median response time decreased from 13.0 mins to 12.0 mins. Considering all the potential influencing factors, the relatively small number of incidents that have occurred on the upper deck of the bridge since 2016, makes it difficult to provide any clear conclusion on whether the modifications have significantly affected incident response times. Current data suggests only a small potential impact.

Other Considerations:

In response to the Pilot studies, Caltrans, BATA, TAM, and CCTA boards have received considerable public feedback, particularly about the upper deck Multi-use Path. There are strong and highly varied opinions and experiences. Many bicycle and Multi-use Path users are strong supporters of making the improvements permanent as demonstrated in their consistent usage over the last four years and letters of support for the Pilot. At the same time, a number of westbound motorist commuters and employers whose workers rely on the congested corridor have expressed concerns about persistent delays, the lack of an emergency shoulder during the morning commute hours and incident-related congestion. Furthermore, Point Richmond residents have observed overflows into city of Richmond neighborhoods from cut-through traffic, particularly during incidents.

In addition, Caltrans performed a preliminary analysis of the bridge structure and identified that if the moveable barrier were to be made permanent, then the bridge stringers on the upper deck would require strengthening to meet the latest codes. This analysis will need to be further developed to identify scope, cost, and budget needs.

Findings: Part-Time Third Travel Lane (Bridge Lower Deck)

Summary:

The Part-time Third Travel Lane has significantly reduced round trip commute time by effectively eliminating weekday afternoon congestion in the eastbound direction and has improved local street traffic in the City of San Rafael. The project has not evinced any safety or operational concerns and is widely embraced by the public and community.

Traffic Impacts (Phase I Report Section 8):

- Afternoon congestion on I-580 Eastbound in Marin County has disappeared, leading to a reduction of up to 14 minutes in peak-hour travel time from the US-101 interchange to the end of the RSR bridge. In the preliminary Phase II Report, findings show a reduction of up to 14 to 17 minutes in peak-hour travel time during the midweek days (Tuesday through Thursday).
- This has resulted in improved travel times and traffic flow along Sir Francis Drake Boulevard and has resulted in significantly fewer vehicles using local arterials (such as East Francisco Blvd. and Main St.) as a bypass to I-580 Eastbound traffic in the afternoon.
- On average, over 99% of traffic observed on the bridge before 2 PM and after 7 PM is compliant with the shoulder hours of operations. This is consistent with the findings in the preliminary Phase II Report.

Safety and Incident Impacts (Phase I Report Sections 10 and 11):

- On the bridge approach, the frequency of traffic incidents (commonly rear-end collisions, sideswipes, and vehicle hitting objects) has reduced by 70%. No significant impacts were further observed on the type, severity, duration, and location of incidents. This is consistent with the findings in the preliminary Phase II Report.
- On the bridge itself, the overall frequency of traffic incidents has reduced by 10%. Findings further show a reduction in rear-end collisions associated with lower traffic densities during the peak, despite a smaller increase in sideswipes associated with lane changes. This is consistent with the findings in the preliminary Phase II Report.
- There is no evidence that the modifications are producing longer incidents or changing the location where crashes tend to occur on the bridge, and there is no evidence that the bridge modifications are increasing the time needed to clear crash events. This is consistent with the findings in the preliminary Phase II Report.

Next Steps

As a result of the Pilot study findings and other considerations, Caltrans, BATA, TAM and CCTA staffs have developed the following proposal:

- **Multi-Use Bicycle and Pedestrian Path (Bridge Upper Deck)** – Extend the Pilot with modified operations until at least the end of 2025, with allowance for further extension as needed for proper evaluation. Modified operations would move the barrier weekly to allow a Multi-use Path on days with less commute traffic and higher path usage (e.g., weekends, Fridays, and Holidays) and revert to an emergency shoulder on days with more commute traffic and less path usage (e.g., remaining weekdays). On days when the Multi-use Path is not available, BATA and Caltrans would provide a bicycle shuttle operation that will pick-up and drop-off at designated stops at each end of the bridge to accommodate users impacted by the closure. The specific days for path operations and specific shuttle operations would be developed through additional review of data and discussion with stakeholders. Caltrans would continue to engage UC Berkeley PATH for evaluation of the Pilot extension.

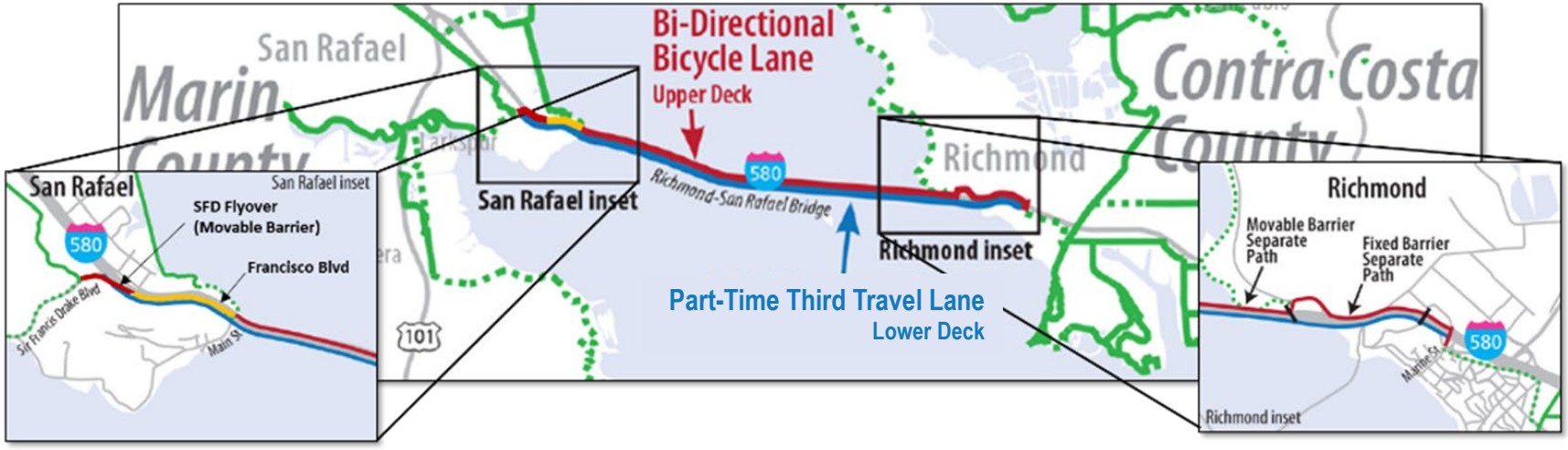
  Extending the pilot would continue to provide bike and pedestrian access across the bridge when there is the largest demand and would facilitate an ultimate decision on use of the shoulder in this multi-modal corridor. The extension would allow better understanding of access needs and non-motorized travel, the role of the emergency shoulder on incident rates, incident response and travel time reliability and how equity communities are affected. It also allows related work to progress. This includes completing the assessment of bridge structural strengthening required to retain the moveable barrier as well as constructing Richmond – San Rafael Forward Open Road Tolling and HOV Lane improvements, which are expected to greatly improve transit and carpooling options as well as improve, though not eliminate, general traffic congestion when they open around the end of 2025. In parallel, BATA and Caltrans will continue to examine opportunities to use the shoulder to balance bike and pedestrian access with transit and carpool priority such as through the Westbound Upper Deck Design Alternative Assessment now underway.
- **Part-Time Third Travel Lane (Bridge Lower Deck)** – Make permanent, keep operations as-is.

The proposal above would require a material amendment to the BCDC RSR bridge permit associated with the Pilot. BATA will present the Pilot recommendations at the BATA Oversight Committee Meeting on May 08, 2024, and seek the BATA's approval on

May 22, 2024 to pursue the proposal. If approved in May, this would allow BATA staff to work with Caltrans to request a BCDC bridge permit amendment this summer.

Pilot Project Vicinity Map

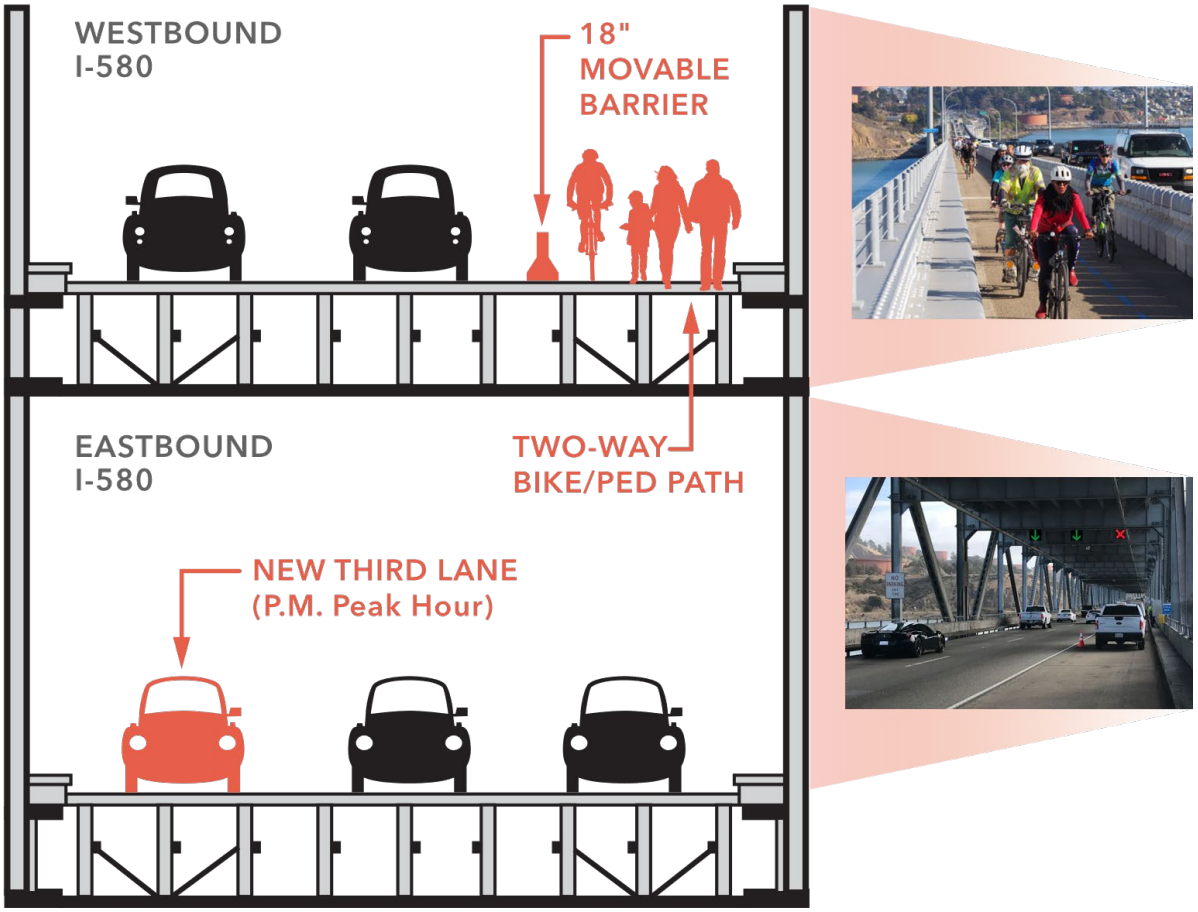
Pilot Project Location (Aerial)



Key:

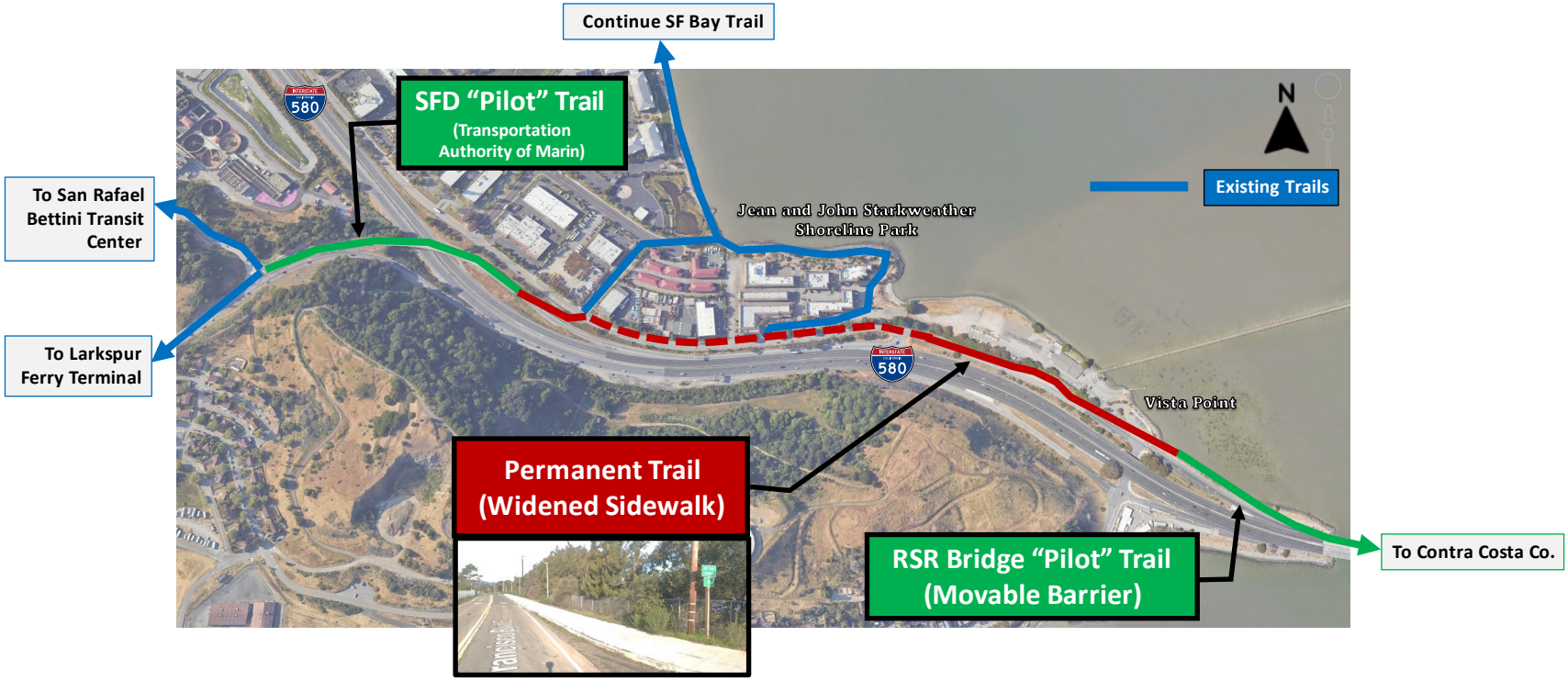
- Multi-Use Path
- Part-Time Third Travel Lane
- Sidewalk Widening (Under Construction)
- Bay Trail (Existing)
- Bay Trail (Proposed)

Richmond-San Rafael Bridge Pilot Project Cross-Section (looking West)



Contra Costa County Trail Connections

Marin County Trail Connections



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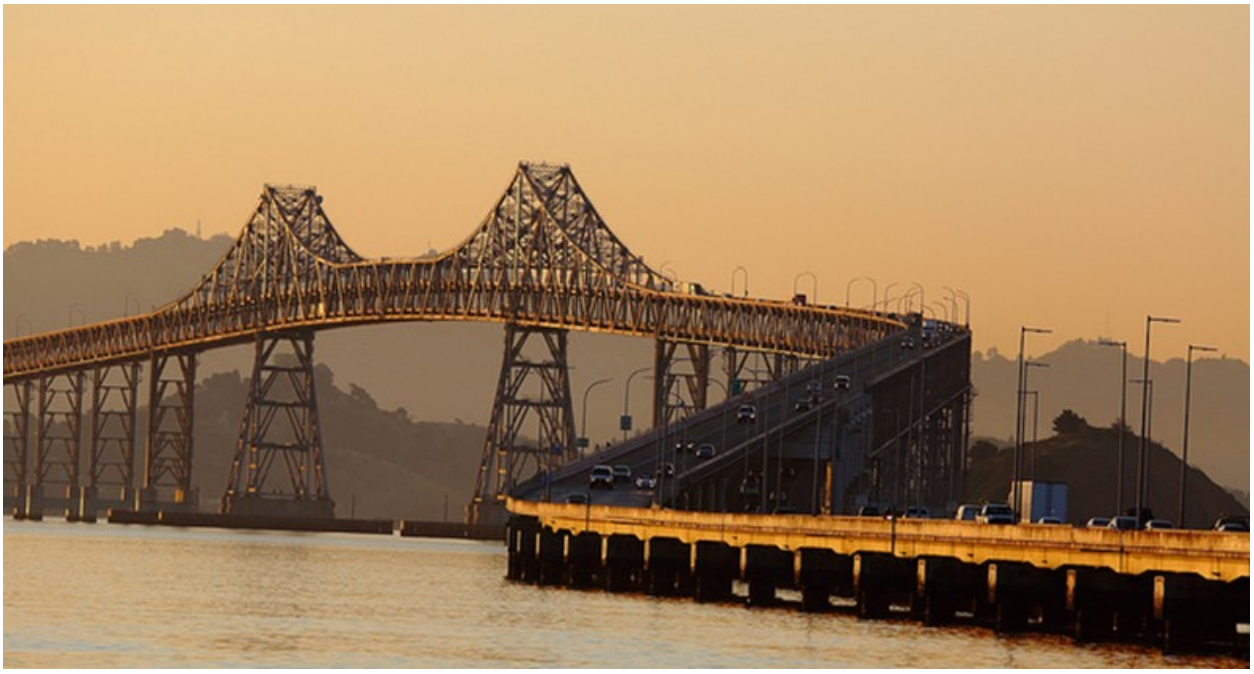
UNIVERSITY OF CALIFORNIA, BERKELEY

After Study for the Richmond-San Rafael Bridge (Phase I)

June 30, 2022



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16. ABSTRACT

This report presents an evaluation of impacts associated with the following changes that were made to the Richmond-San Rafael Bridge as part of a pilot project: (1) opening to traffic of the eastbound shoulder lane on the lower deck of the bridge between 2 PM and 7 PM every day (April 2018) and (2) conversion of the westbound shoulder lane on the upper deck of the bridge into a barrier-separated shared bike/pedestrian (November 2019). Specific elements evaluated include traffic compliance with the shoulder lane open/close periods, use of bridge paths by cyclists and pedestrians, impacts on eastbound and westbound traffic conditions, impacts on incidents, incident clearance times, maintenance activities, and quality of life in Marin County areas near the bridge. These elements are to be used by Caltrans to determine whether the changes should be kept, in whole or in part. Evaluations show that the opening of the eastbound shoulder to traffic has significantly reduced travel times and incidents in Marin County through the elimination of the congestion that used to affect the bridge's I-580 East approach. In terms of usage, between 150 and 300 cyclists are seen using the upper path in each direction on weekend days, and between 50 and 75 cyclists on weekdays. Pedestrian traffic is usually very low, at less than 25 individuals per day. While the addition of the path on the upper deck has slightly decreased peak bridge capacity and increased travel time variability on the Richmond approach, congestion on the approach remains close to historical averages. Some slight impacts were also found on incident response and maintenance activities. A user survey finally shows a positive perception of the path by cyclists, but a more negative view from motorists.

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BEFORE EVALUATION REPORT

The work documented in this report is a continuation of a multi-year project aiming to assess the impacts of the modifications made to the Richmond-San Rafael bridge on traffic, safety and bridge operations. Under contract 65A0529 - *Richmond-San Rafael Bridge Access Improvements Project Before Study Evaluation and Report*, a preliminary set of evaluations focusing on operational conditions that existed before the modifications were made in 2015-2016 and detailed in a 2018 report bearing the project name as its title (Report 18CA-2997). This report presents a comparative before/after evaluations of operational conditions around the bridge over the 2015-2022 timeframe.

PHASE II FUTURE WORK

Evaluation results presented in this document cover the first phase of the pilot modifications around the Richmond-San Rafael bridge. Evaluations for the after are to continue through a Phase II after assessment under Contract 65A0804 (Task 3839) - *Richmond San-Rafael Bridge and Sir Francis Drake Pilot (Phase II)*. This phase II assessment will update some of the Phase I evaluations and expand the study to cover modifications made to an existing bike path on a nearby I-580 West off-ramp overpass connecting the bridge path to the Sir Francis Drake Boulevard in Marin County. It may result in some updates in the data presented in this report.

DISCLAIMER

The research reported herein was performed by a research team within the California Partners for Advanced Transportation (California PATH) within the Institute of Transportation Studies at the University of California – Berkeley, for the Division of Research, Innovation and System Information (DRISI) at the California Department of Transportation.

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LIST OF ACRONYMS

ADT	Average Daily Traffic
BAIRS	Bay Area Incident Response System
BATA	Bay Area Toll Authority
Caltrans	California Department of Transportation
CCTA	Contra Costa Transportation Authority
CHP	California Highway Patrol
CHP-CAD	California Highway Patrol Computer-Aided Dispatch
DRISI	Division of Research, Innovation, and System Information
IMMS	Integrated Maintenance Management System
LCS	Lane Closure System
MIDB	Major Incident Database
MTC	Metropolitan Transportation Commission
NDS	National Data and Surveying Services
PeMS	Performance Measuring System
RSR	Richmond-San Rafael
SafeTREC	University of California Safe Transportation Research and Education Center
SWITRS	Statewide Integrated Traffic Report System
TAM	Transportation Authority of Marin
TASAS	Traffic Incident and Surveillance Analysis System
TIMS	Transportation Injury Mapping Systems
VMT	Vehicle miles traveled

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EXECUTIVE SUMMARY

This report presents an evaluation of the operational impacts associated with the following changes that were made to the Richmond-San Rafael bridge:

- Opening to traffic of the eastbound shoulder lane on the lower deck of the bridge between 2 PM and 7 PM every day (April 2018).
- Conversion of the westbound shoulder lane on the upper deck of the bridge into a barrier-separated shared bike/pedestrian (November 2019).

Specific elements that were evaluated include:

- Traffic compliance with the opening period of the eastbound shoulder lane
- Use of bridge paths by cyclists and pedestrians
- Impacts on eastbound and westbound traffic conditions on the bridge and its approaches
- Impacts on frequency, type, and severity of incidents occurring on and around the bridge
- Impacts on incident clearance times
- Impacts on maintenance activities on the bridge
- Impacts on quality of life in Marin County areas near the bridge

Below is a summary of the key findings from the study for the two bridge modifications evaluated.

IMPACTS OF SHOULDER LANE MODIFICATIONS ON BRIDGE LOWER DECK

- **OVERALL ASSESSMENT:**
    - The opening of the lower deck shoulder lane to traffic between 2 PM and 7 PM has had significant positive impacts on westbound traffic across the bridge. Afternoon congestion on I-580 East in Marin County has disappeared, resulting in up to 14 minutes travel time reductions from the US-101 to the toll plaza. Travel times and flow output have also improved along Sir Francis Drake Boulevard, and significantly less traffic is using other local arterials to bypass I-580 East.
    - From a safety standpoint, the frequency of incidents on the approach to the bridge has reduced by 70%. No significant impacts were further observed on the type, severity, duration, and location of incidents.

- **Compliance of traffic with shoulder open/close periods:**
    - On average, 99.6% of traffic observed on the bridge before 2 PM and after 7 PM is compliant with the shoulder closure.
    - Non-compliant use of the shoulder lane is highest 20 minutes before its opening and up to 30 minutes following its closure. Non-compliant use in the 20 minutes to opening varies between 0.3% and 0.6% of traffic, depending on the day of the week, while non-compliance 30 minutes after closing varies between 0.5% and 1.1%.
    - Some vehicles use the shoulder as a passing or travel lane when a red or yellow X is displayed above it. This suggests that current lane control signs, particularly the yellow X, may not be fully understood by all motorists.

- **Impacts on I-580 East and US-101 North traffic:**
    - The availability of an extra traffic lane during peak hours has increased the hourly flow across the bridge by 13-25%, from a range of 3,300-3,600 vehicles/hour before the modification to a range of 3,750-4,500 vehicles/hour after.
    - Less than 25% of traffic is using the shoulder lane during weekday peak periods, and less than 20% on weekends.
    - The added peak-hour capacity has ended congestion on the Marin County approach to the bridge, resulting in peak travel time reductions from the US-101 to the toll plaza by 13-14 minutes on weekdays, 10-14 minutes on Saturdays, and 6-8 minutes on Sundays. Peak travel times are also significantly less variable than before.
    - Traffic improvements along I-580 East may have partly contributed to the observed 1-2 minutes reduction in average peak weekday travel times on US-101 North between the Sir Francis Drake Boulevard and I-580 interchanges since 2017.
    - Fewer vehicles are using the Main Street off-ramp and on-ramp as a congestion bypass. Illegal use of the ramps during the afternoon peak has dropped from an average of 56 vehicles/hour in 2016 to 1 vehicle/hour in 2022.
- **Impacts on Marin County local arterials:**
    - Compared to 2016, weekday afternoon peak travel times along Sir Francis Drake Boulevard have dropped by up to 4 minutes, while traffic volumes have increased by over 300 vehicles/hour.
    - Fewer vehicles are using local arterials as a bypass to I-580 to save time while traveling towards the bridge in the afternoon. Peak traffic on Francisco Boulevard has for instance dropped from 730 to 227 vehicles/hour between May 2016 and March 2022.
- **Impacts on traffic safety on I-580 East:**
    - The opening of the eastbound shoulder lane has reduced by 72% the frequency of incidents occurring on the eastbound approach to the bridge. This includes significant reductions in rear-end collisions, sideswipes, and vehicle hitting objects. This is due to the elimination of the heavy congestion that used to affect traffic along I-580 East from the US-101 interchange to the entrance of the bridge.
    - On the approach, the absence of congestion on the approach to the bridge has resulted in an 82% reduction in the rate of rear-end collisions, a 60% drop in the rate of sideswipes, and a 63% reduction in the rate of vehicles hitting fixed objects.
    - On the bridge, the addition of a traffic lane has led to lower peak traffic densities and a 33% reduction in the rate of rear-end collisions. However, this change is also providing more opportunities for lane changes, which has translated into a 22% increase in the rate of sideswipes and a slight increase (+4%) in vehicles hitting objects.
    - In terms of severity, the modifications have resulted in a reduction from 41% to 32% of the proportion of incidents on the bridge or its approach with severe injury, a complaint of pain, or other visible injuries.

  - There is no evidence that the bridge modifications are producing longer crash-related incidents or changing the location where crashes tend to occur on the bridge.
  - There is no evidence that the bridge modifications are increasing the time needed to clear crash events. In this case, data measuring more precisely the period during which an incident affects traffic would be required to provide a more definitive answer.

- **Impacts on lower deck incident response times:**
  - Tow truck and CHP dispatch logs do not provide evidence that the modifications may have changed the time needed for responding to incidents on the bridge.

- **Impacts on lower deck maintenance activities:**
  - Because vehicles are occasionally seen using the lower deck shoulder when closed, maintenance crews must always treat it as an active lane to ensure their safety.

IMPACTS OF NEW PATH ON BRIDGE UPPER DECK

- **OVERALL ASSESSMENT:**
  - The upper bridge path has attracted a notable number of cyclists, particularly on weekends, and a relatively small number of pedestrians. Since January 2021, an average of 190 cyclists/direction/day have been traveling on Saturdays and Sundays on the upper deck path, with seasonal highs around 300 cyclists/direction/day and lows around 100. Average weekday use has been 68 cyclists/direction/day. Due to the length of the bridge, pedestrian use is much lower, averaging only 14-24 individuals/day/direction on weekends and 8-11 individuals on weekdays.
  - Due to the shorter merge downstream of the toll plaza and narrower roadway on the bridge, the maximum flow going across the bridge on weekdays has been reduced by 7%, and 4% on weekdays. Peak-hour travel times across the speeds have also increased by less than a minute, due to slightly slower speeds on the bridge and have been made more variable due to the inability of disabled vehicles to move out of a traffic lane. However, these impacts have not yet translated into increased congestion upstream of the bridge, likely because of reduced traffic demand due to lingering Covid-19 effects.
  - From a safety standpoint, the bridge path is generally perceived as being safe by its user, although some concerns exist about the risk of being hit by objects flung over from the adjacent traffic lanes. On the vehicular traffic side, the installation of the path has not affected the frequency, type, and severity of incidents, nor to have significantly affected incident responses.

- **Use of new bridge path by cyclists:**
  - Since January 2021, between 100 and 300 cyclists have been traveling in each direction on the upper deck path on Saturdays or Sundays, depending, with an average of 190 cyclists/direction/day. Saturday traffic is usually the highest.
  - On weekdays, bicycle traffic has ranged between 50 and 75 cyclists in each direction, with an average of 68 cyclists/direction/day.

- Weekend bicycle traffic follows an annual cycle, with the lowest demand during winter and the highest during summer months. Weekday traffic is relatively constant, with only minor seasonal variations.
- Path users mainly travel westbound in the morning and eastbound in the afternoon. On weekends, peak westbound traffic is between 10 AM and 11 AM, and eastbound traffic is between 1 PM and 2 PM. On weekdays, peak westbound traffic is also between 10 AM and 11 AM, but peak eastbound traffic is later, between 3 PM and 4 PM, with notable traffic between 12 Noon and 3 PM.
- A 2021 survey of path users indicated that 1.9% used the path more than four times per week, 10.7% up to four times per week, 29.8% up to four times a month, 31.8% less than once a month, and 25.8% less than four times since its opening.
- 85.1% of path users have indicated using the path for recreation (63.1%) or exercise (22.0%). Only 14.0% have used it for commuting, either to work (4.9%) or other locations (9.1%). The remaining 0.9% used it for other, non-specified, reasons.
- 83.9% of path users indicated having completed one or more round trips on the path while cycling or walking. Of these, 90.6% reported fully crossing the bridge both ways, 6.9% turning back mid-way, and 2.5% having both fully crossed the bridge or turned back mid-way depending on the occasion.
- Between 2015 and 2019, Golden Gate Transit buses typically carried between 465 and 829 bicycles per month across the bridge, depending on the season. Between April 2020 and December 2021, the number of bicycles carried over dropped 40-50% to a 227-466 range. However, between January and May 2022, monthly counts have increased significantly, to a 337-533 range, or 11-17 bicycles per day.
- It is still unclear which part of the drop in bicycles carried over by Golden Gate Transit is due to the opening of the path and which part is due to the Covid-19 pandemic.

- **Use of new bridge path by pedestrians:**
  - Observed pedestrian traffic is relatively low. On average, only 11 pedestrians are seen each weekday crossing the bridge eastbound, and 8 going westbound. Weekend traffic is slightly higher, with 24 pedestrians going eastbound and 14 westbound.
  - Pedestrian use is likely underestimated as the reported counts are based on a single sensor on the Richmond side. This sensor does not capture individuals accessing the path from Marin County and turning back midway.
  - The 4-mile length of the bridge likely explains the low pedestrian demand, and why less than 25% of pedestrians indicated completing a full round trip on the bridge and 57% turned around midway.
  - Fishermen have been observed using the path to access locations from where to cast fishing lines, either on the shore or the path itself. Such individuals are more often seen on the Marin County side, where they use the vista parking lot as a staging area.

- **Impacts on I-580 West traffic:**
  - Average weekday peak-hour flows across the bridge have dropped by 7% following the addition of the path, from a range of 3,500-3,850 vehicles/hour to a range of 3,250-

3,600 vehicles/hour depending on the day considered. Weekend peak-hour flows have similarly dropped by 4%, from 3,200-3,500 vehicles/hour to 3,100-3,300 vehicles/hour.

- The significantly shorter merge downstream of the toll plaza (325 ft instead of 850 ft) and the perceived narrowness of the roadway on the bridge causing some vehicles to slow down and others to move to the left lane may explain the maximum flow reductions across the bridge. These negative impacts may have partly been compensated by the elimination of the toll cash collection.
- The closeness of the path's barrier to the right traffic lane appears to have caused 1-2% of peak-hour traffic to shift to the left lane, and up to 20% of the evening and night traffic to do the same. This has resulted in an average 57%/43% split across the left and right lanes during weekday peaks, and a 55%/45% split during weekend peaks.
- Despite the slight capacity reduction, the extent of the congestion upstream of the toll plaza and average peak travel times from I-80 to the end of the bridge on weekdays, Saturdays, and Sundays have remained similar to the before conditions. This can be explained by traffic demands remaining slightly below before conditions, particularly at the start and end of the peak periods, due to lingering Covid-related factors.
- Before the modifications, upper deck traffic generally flowed on weekday mornings at or above 50 mph following the first mile of the bridge. In the fall of 2021, speeds between 40 and 50 mph were typically observed across the bridge, resulting in a slight increase in travel time of less than one minute. Some slight speed reductions were also observed on Saturdays and Sundays, but with negligible impacts on travel times.
- Peak weekday travel times on the bridge's approach are now more variable, i.e., less reliable, than before the path installation, mainly due to the barrier now preventing disabled vehicles to pull out of a traffic lane. The reliability of peak weekend travel times remains similar to before.
- Many of the traffic impacts described above may still be affected by lingering reductions in traffic caused by an increase in the proportion of individuals working from home following the Covid-19 pandemic.

- **Impacts on local Richmond arterials:**
  - The bridge modifications do not appear to have had significant impacts on local arterials on the Richmond side of the bridge.

- **Safety of new bridge paths for cyclists and pedestrians:**
  - No incidents involving bicyclists or pedestrians were recorded by the CHP or reported on the Street Story platform during the evaluation period. However, anecdotal evidence suggests that some incidents have occurred.
  - Users generally have a positive view of the safety offered by the path, as evidenced by a safety rating of 8.19 out of 10 assigned by users in the summer of 2021.
  - The low height of the barrier put path users at risk of being hit by debris flung from the adjacent traffic lanes, or being blinded at night by vehicle lights when traveling east.
  - Only 3% of surveyed path users commented on its narrowness.

- **Impacts on traffic safety on I-580 West:**
    - There is no straightforward evidence that the modifications have negatively impacted traffic safety on the approach of the bridge or the bridge itself despite the creation of a constrained roadway and a shorter merge downstream of the toll plaza. Scenarios including or excluding the April 2020 to June 2021 interval both point to a 20% reduction in accident rates upstream of the toll plaza but provide opposite conclusions regarding incidents on the bridge and downstream of it.
    - No clear impacts are observed on the types of incidents occurring around the bridge. Rear-end incidents remain dominant on the bridge before and after the modifications, at around 50-55% of all incidents. These are followed by sideswipes (33-42%) and vehicles hitting objects (8-9%). In particular, no increase is observed in the proportion of vehicles hitting a fixed object on the bridge, such as the path's barrier.
    - In terms of incident severity, the upper deck modifications seem to have caused a 23% reduction in the frequency of incidents with a complaint of pain on the bridge and a 71% on the approach. The rate of incidents without injury has further slightly increased on the bridge (+9%) but reduced on the approach (-14%), while no conclusive trend could be identified for incidents with other visible injuries.
    - Based on an analysis of CHP CAD logs, there is no evidence that the bridge modifications are producing longer crash-related incidents or changing the location where crashes tend to occur on the bridge.
    - The analysis of additional data is recommended to more clearly established impacts associated with the modification, the current data only include three quarters with minimal Covid-19 impact. A recommendation is to include at least one additional year of data (January to December 2022).

- **Impacts on upper deck incident response times:**
    - Tow truck and CHP dispatch logs do not provide evidence that the modifications may have changed the time needed for responding to incidents on the bridge.

- **Impacts on upper deck maintenance activities:**
    - The barrier may force maintenance crews to close the right traffic lanes when they need to do maintenance on the bridge.
    - Closing of a traffic lane for path maintenance mainly occurs for routine monthly cleanings, when the barrier must be moved. To minimize traffic impacts, this is typically done at night, with bulletins published by MTC/511 well ahead of time.
    - Emergency realignment to the barrier is only conducted if an accident causes the barrier to leave less than 10 feet of width on the path. This has only occurred twice between November 2019 and April 2022. In other cases, maintenance crews either try to use tools to manually realign the barrier or wait for the monthly machine re-alignment of the barrier to fix the issue.

OTHER ASSESSMENTS

- **Impacts on businesses in Marin County**
    - According to 8 surveyed businesses in March 2022, morning congestion on the Richmond side of the bridge continues to affect the ability of businesses in Marin County to hire and retain staff from the East Bay. This is a problem that pre-existed the upper bridge modifications. However, travel time reductions to access Richmond from the Marin side during the afternoon peak following the lower deck improvements may have helped reduce the impacts of the morning commute.
    - For one business, less traffic using local streets to bypass I-580 East in the afternoon is significantly easing fleet movements around San Rafael and Larkspur.
    - None of the few surveyed business managers were aware of employees using the new bridge bike path for commute purposes.

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1. INTRODUCTION

This report presents an evaluation of the operational impacts associated with changes that were made to the Richmond-San Rafael bridge in the northern portion of the San Francisco Bay Area between 2018 and 2020 as part of a four-year pilot project. Two specific changes are evaluated:

- The opening to traffic of the eastbound shoulder lane on the bridge lower deck between 2 PM and 7 PM every day in April 2018.
- The conversion of the westbound shoulder lane on the upper deck into a barrier-separated bike/pedestrian path in November 2019.

The impacts associated with the listed modifications are evaluated through a study comparing operational conditions around the bridge before and after the changes. Before conditions were assessed in 2015-2016, at the beginning of the project, while the after conditions were assessed between 2019 and 2022. Efforts were made to avoid conducting evaluations between March 2020 and June 2021 due to the significant impacts of the Covid-19 pandemic on business activities and travel.

Specific elements that were evaluated through the before/after study include:

- Level of utilization of the eastbound shoulder lane and upper deck multi-use path during typical weekdays and weekend days
- Changes in traffic conditions around the bridge during peak weekday and weekend traffic conditions
- Impacts on the number, type, and severity of incidents occurring within the study area
- Impacts on the ability to respond to incidents occurring on the bridge
- Impacts on bridge maintenance activities
- Impacts on business activities in Marin County

The results of the above evaluations are to be used by Caltrans at the end of the pilot project to determine whether the various modifications should be kept, modified, or removed. It is not the goal of this study to provide recommended courses of action. Its goal is simply to report on the impacts of the modifications.

The remainder of this report is divided into the following sections:

- **Section 2:** Project background
- **Section 3:** Evaluation objectives
- **Section 4:** Description of study area and roadways of interest
- **Section 5:** Description of data collected and analyzed
- **Section 6:** Bicycle traffic on new bridge path
- **Section 7:** Pedestrian traffic on new bridge path
- **Section 8:** Impacts on traffic conditions along I-580 and key nearby local streets
- **Section 9:** Safety of new bridge path and modified overpass path for cyclists and pedestrians
- **Section 10:** Impacts on traffic safety
- **Section 11:** Impacts on incident response activities
- **Section 12:** Impacts on maintenance activities
- **Section 13:** Evaluation of impacts on quality of life through business and user surveys
- **Section 14:** Summary of observations

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2. PROJECT BACKGROUND

This section provides background information about the pilot project that is the subject of the evaluations reported in this document. Specific elements covered include:

- Description of Richmond-San Rafael Bridge
- Initial traffic setup across the bridge
- Initial pedestrian/cyclist access to the bridge
- San Francisco Bay Trail project
- Pilot modifications to the bridge
- Project stakeholders

2.1. RICHMOND-SAN RAFAEL BRIDGE

Figure 2-1 shows the location of the Richmond-San Rafael Bridge within the context of the San Francisco Bay Area. The bridge connects the city of Richmond in Contra Costa County with the city of San Rafael in Marin County, through a narrow section of water between the San Francisco and San Pablo bays. It opened to traffic in September 1956 as the second-to-last major bridge to be constructed in the Bay Area. It remains the second-longest bridge in California, with a length of four miles, behind the San Mateo-Hayward crossing further south.

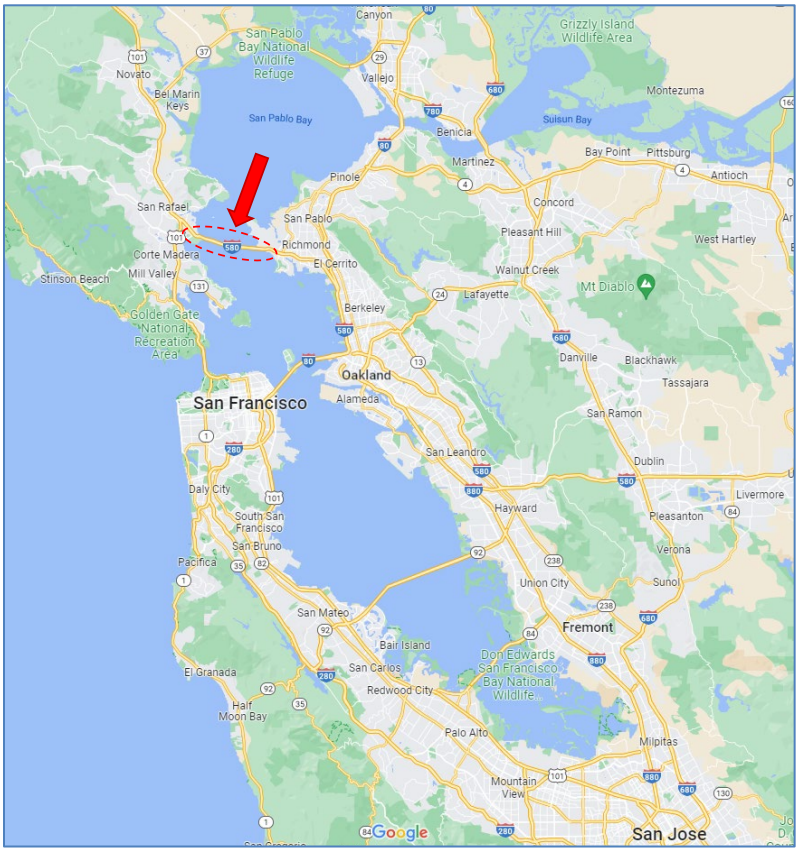

Figure 2-1: Location of Richmond-San Rafael Bridge within the San Francisco Bay Area

Figure 2-2 provides a picture of the bridge. The bridge features two identical cantilever spans with a lower section in between. Both spans are 1,070 feet long, with a 185-feet clearance over water at the highest point. For much of its length, the structure has upper and lower decks rather than side-by-side decks. Westbound traffic is carried on the upper deck while eastbound traffic is carried on the lower deck. As a result of these features, the bridge has often been compared aesthetically to a roller coaster, a sea serpent, or a bent coat hanger.

Figure 2-2: Richmond-San Rafael Bridge

2.2. INITIAL TRAFFIC SETUP ACROSS BRIDGE

Although the bridge was originally part of State Road 17, it is currently signed as Interstate 580. In 2015, it carried an average peak daily traffic flow (ADT) of approximately 82,000 vehicles. This increased to 87,000 vehicles in 2017. As indicated in Table 2-1, which compares AADT with other Bay Area bridges, this is noticeably lower than other bridges, in great part due to the lower number of lanes on the bridge and its location relative to the main traffic destinations in the region. During a typical weekday, travel demand on the bridge is highly directional, with traffic mainly moving westbound towards Marin County in the morning and eastbound towards the city of Richmond during the afternoon peak.

Table 2-1: ADT of Sample Bridges in the San Francisco Bay Area (North to South)

Bridge Name	Connections	Lanes per Direction	2015 Peak ADT	2017 Peak ADT
Carquinez Strait	Vallejo – Contra Costa County	4	123,000	131,000
Richmond-San Rafael	Richmond – San Rafael	2	82,000	87,000
San Francisco Bay	Oakland – San Francisco	5	268,000	290,000
Golden Gate	Marin County – San Francisco	3	119,000	125,000
San Mateo	Hayward – San Mateo	3	110,000	119,000
Dumbarton	Fremont – Palo Alto	3	71,000	76,000

(Source: 2015 and 2017 Caltrans Traffic Census)

Like other east-west Bay Area bridges, a toll is currently assessed for vehicles crossing in the westbound direction, while no toll is charged in the reverse direction. The toll is collected at a plaza located in Richmond, approximately 500 feet from the foot of the bridge. Figure 2-3 provides an aerial view of the plaza, while Figure 2-4 provides a close-up view of the toll booths. On the approach to the toll plaza, the

number of traffic lanes increases from three to seven. Before March 2020, the left lane within the toll booths was initially dedicated to high-occupancy vehicles with an electronic Fastrak toll transponder and the following two lanes to all vehicles equipped with an electronic transponder. The last four lanes on the right were dedicated to the general traffic and had toll collectors to handle cash payments. Since then, tollbooth operators have been eliminated and replaced with a license-plate reading electronic toll collection system. Downstream of the toll booths, the number of traffic lanes quickly drops from seven to two over 325 feet.

Figure 2-3: Aerial View of Richmond-Toll Plaza Before Modifications

Figure 2-4: Approach to Richmond-Toll Plaza before March 2020

The width of the bridge can accommodate three lanes of traffic in each direction with no emergency shoulder. For safety reasons, however, Caltrans had striped each direction for only two lanes, leaving the third lane for emergencies or maintenance vehicles. The extra shoulder lane proved particularly helpful during the 1976-1977 drought when the East Bay Water District was able to lay a temporary water pipe to Marin County without disrupting traffic.

Over time, increased volumes have led to increasing congestion on the westbound approach to the bridge. As indicated in Figure 2-5, the two main congestion-contributing factors were the toll collection activities and the fact that the bridge only carried two lanes of traffic while the freeway leading to it had three lanes. While it was often hypothesized that the toll collection activities were the primary cause of congestion, merging activities downstream of the plaza was the real culprit. Following a continuous

reduction in the number of vehicles paying the toll with cash, the expectation was that congestion upstream of the plaza would reduce. This is not what happened. By increasing the rate at which vehicles were able to go through the toll plaza, the adoption of electronically toll transponders by motorists resulted in more vehicles entering the merge area downstream of the plaza. This, in turn, caused increased frictions and slower speeds at the entrance of the bridge that propagated back through the toll booths.

The eastbound approach in Marin County, shown in Figure 2-6, had also experienced a significant increase in congestion during the PM peak period due to increased traffic. In this case, the congestion was primarily caused by a reduction in the number of traffic lanes from three to two as the right-most lane converts to an exit lane approximately 2,000 feet from the foot of the bridge. Traffic merging from Main Street merging onto the freeway through a very short acceleration lane also contributed to the problem.

Figure 2-5: Initial Conditions – Westbound Bridge Approach in Richmond

Figure 2-6: Initial Conditions – Eastbound Bridge Approach in Marin County

2.3. INITIAL PEDESTRIAN/CYCLIST BRIDGE ACCESS

Before the pilot project, there were no physical accommodations on the bridge for bicycles or pedestrians. To cross the bridge, the only option had been to take transit buses.

The only regular transit service across the bridge was, and is currently still, offered by Golden Gate Transit, a local transit agency serving servicing Marin and Sonoma counties, with limited service to San Francisco and Contra Costa County. To accommodate cycles, most Golden Gate Transit buses are equipped with exterior bike racks at the front of the bus or with underbelly bike racks, as shown in Figure 2-7.

Figure 2-7: Golden Gate Bus Carrying Bikes on Front Rack

Between 2015 and December 2021, primary service across the bridge was offered by buses on Route 40. As shown in Figure 2-8, this route provided service between the El Cerrito Del Norte BART Station on the east side of the bay to the San Rafael Transit Center on the west side. A Route 40X, running from the same origin to destination as Route 40 only during the afternoon peak, but with fewer stops, also existed. Before January 2016, two other routes also ran across the bridge: Route 42 and Route 580. Route 42 was merged with Route 40, while Route 580 was a pilot route that ran only from December 2014 to December 2015, from Emeryville to the San Rafael Transit Center via San Pablo Avenue in Berkeley and I-580, as shown in Figure 2-9.

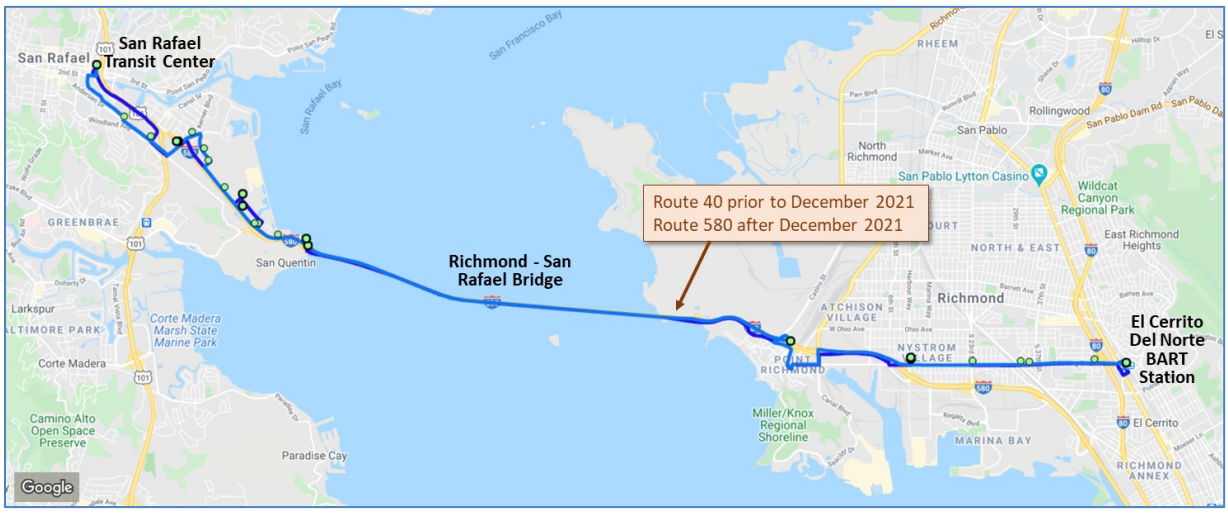

Figure 2-8: Golden Gate Transit Service across the Richmond-San Rafael Bridge

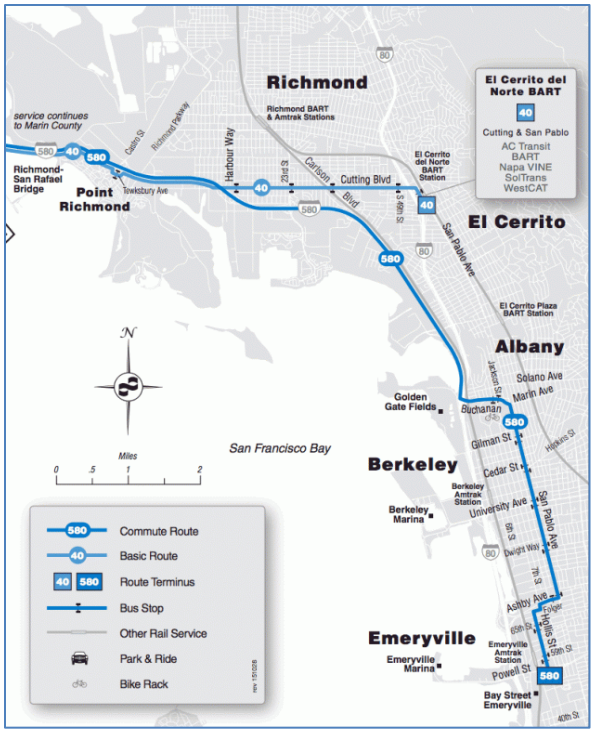

Figure 2-9: Golden Gate Transit Pilot 2015 Route 580 Service

In response to a significant drop in demand due to the Covid-19 pandemic, service on Route 40 was reduced in the summer of 2020, while route 40X was suspended. In December 2021, to help the customers better distinguish between routes offered by Golden Gate Transit and those offered by other Bay Area bus systems, Route 40 was renamed Route 580, without any service change. As of May 2022, Route 40x appears to have been permanently discontinued, likely because transit demand remains low, leaving only one route crossing the bridge.

2.4. SAN FRANCISCO BAY TRAIL PROJECT

The San Francisco Bay Trail is a project from the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments that calls for the development of a continuous 500-mile network of biking and hiking trails encircling the San Francisco Bay, San Pablo Bay, and Carquinez Strait. As of 2021, the development of about 350 miles of trails had already been completed. As shown in Figure 2-10, plans were made, if possible, to use all Bay Area bridges to connect various sections of the networks on each side of the bay. This vision provided strong advocacy for converting one of the shoulder lanes on the Richmond-San Rafael bridge into a bike/pedestrian path.

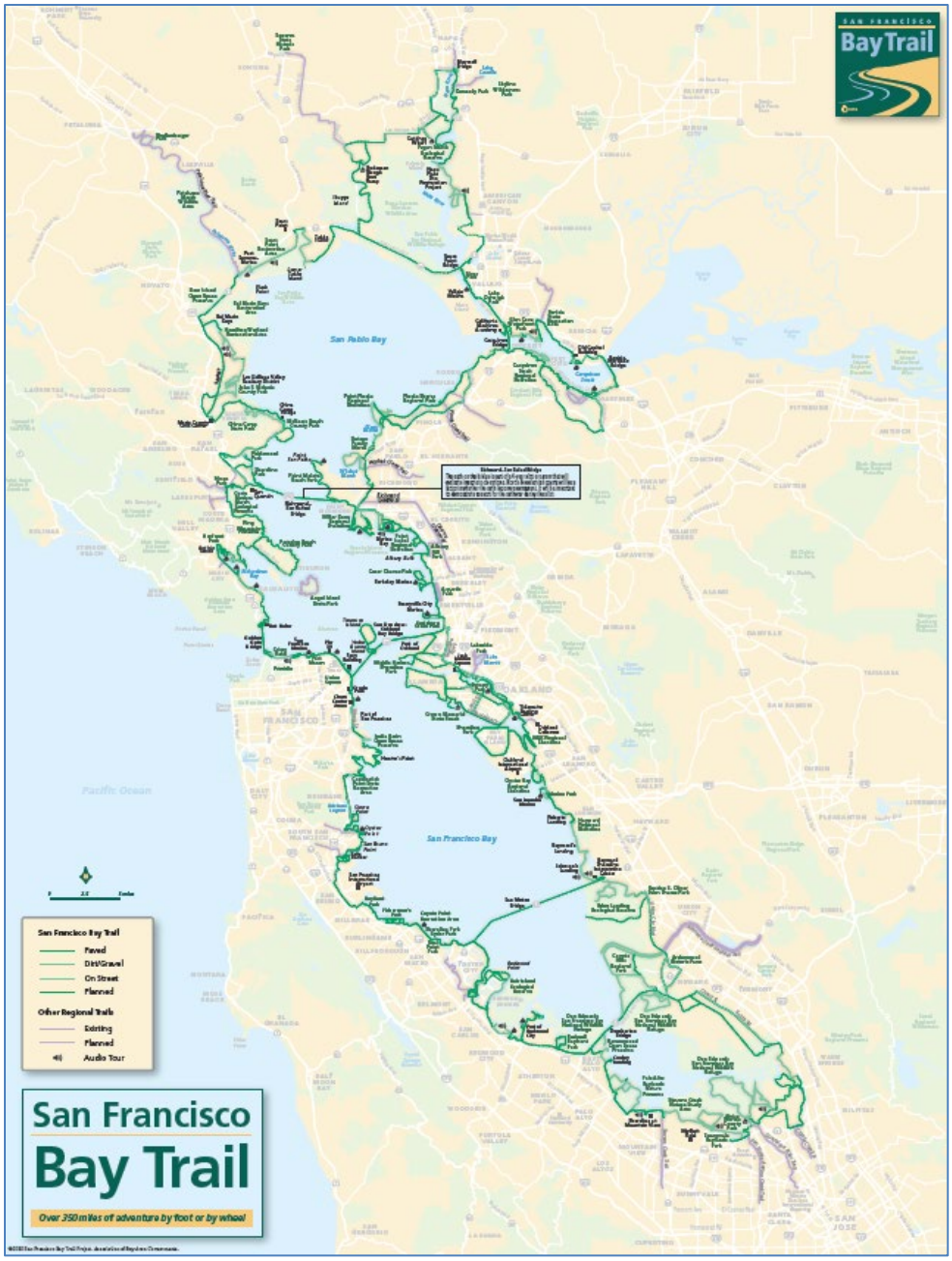

Figure 2-10: San Francisco Bay Trail Network (2020 Brochure)

2.5. BRIDGE MODIFICATIONS

To address the traffic and pedestrian/bicycle issues identified above, a consortium comprised of Caltrans, the Bay Area Transportation Authority (BATA), the Metropolitan Transportation Commission (MTC), and local jurisdictions started in 2014 formulating a pilot project that would allow for vehicular traffic to use the eastbound shoulder on the bridge lower deck during the afternoon peak periods while at the same time constructing a multi-use path for bicycles and pedestrians on the westbound shoulder on the upper deck. The objectives of this pilot were twofold: (a) to reduce congestion on eastbound I-580 and (b) to provide a bike/pedestrian link between the two counties.

The proposed pilot, known as the *Richmond-San Rafael Bridge Access Improvements Pilot Project*, was formally approved in the summer of 2015. As illustrated in Figure 2-11 and Figure 2-12, it included the following key modifications to be made to the bridge and its approaches:

- **Westbound direction (upper deck):**
  - Conversion of the existing shoulder into a two-way bike/pedestrian path.
  - Addition of a movable zipper barrier from the foot of the bridge in Richmond to the Main Street intersection in Marin County, to separate the multi-use path from the vehicular traffic while allowing maintenance vehicles to retain the ability to access the path.
  - Shortening of traffic merge area downstream of the toll plaza from 850 ft to 325 ft.
  - Construction of a connecting bike path separated by a fixed barrier between Marine Street in Richmond and the bridge, along the right side of the freeway and the Stenmark Drive off-ramp.

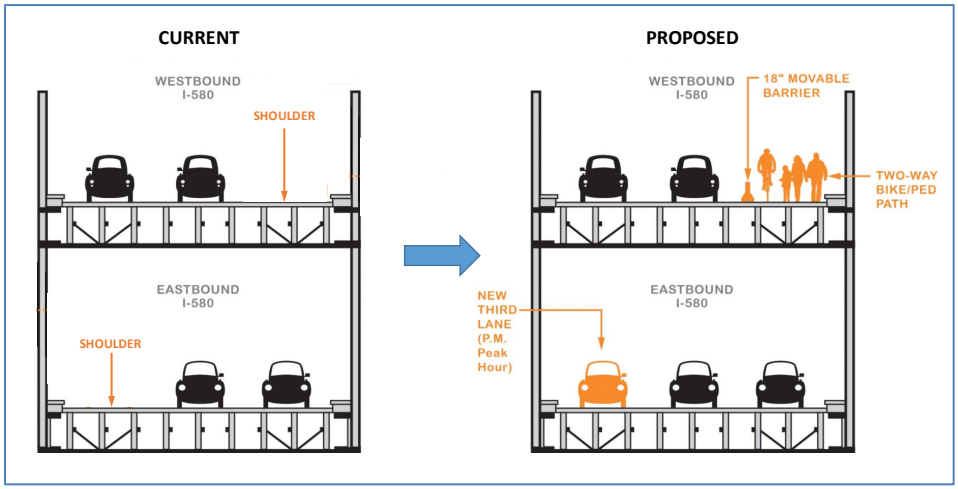

Figure 2-11: Proposed Bridge Modifications

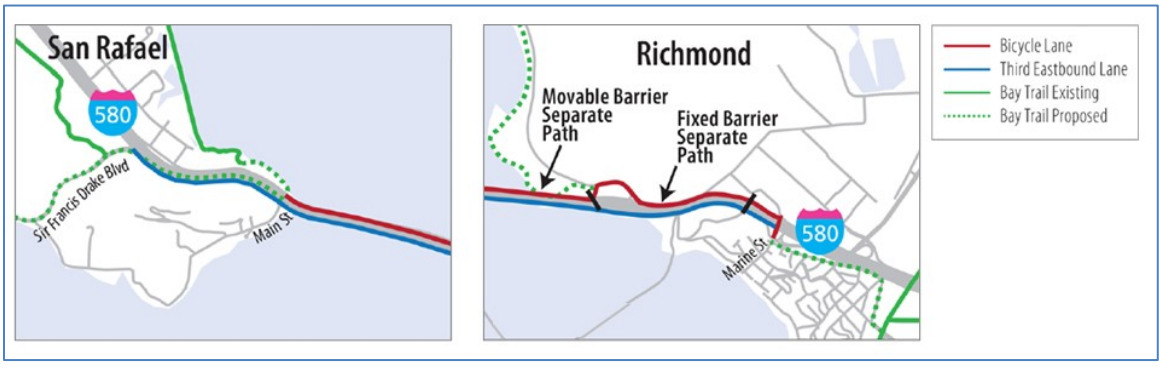

Figure 2-12: Bike Trail Modifications on Eastern and Western Bridge Approaches

- **Eastbound direction (lower deck):**
    - Conversion of the existing shoulder lane into a part-time regular traffic lane, opened each week and weekend day between 2 PM and 7 PM.
    - Installation of electronic traffic signs above the traffic lanes on the lower deck of the bridge indicating whether a lane is opened (green arrow), closed (red X), or still open at the entrance of the bridge but closed at some point further down (yellow X indicating that traffic should merge to the next lane).
    - Installation of electronic traffic signs on the bridge approach to indicate when the shoulder lane is opened.
    - Conversion of the exit lane between Sir Francis Drake and the Main Street off-ramp in Marin County into a regular traffic lane.
    - Addition of a third traffic lane between the Main Street exit in Marin County and the bridge.
    - Addition of a third traffic lane between the bridge and the Marine Street on-ramp in Richmond.

The eastbound modifications on the bridge were completed in early 2018, with the shoulder lane formally opening to traffic on Friday, April 20, 2018. Construction of the multi-use path on the upper deck was completed in March 2019, with the path officially opened for use on Monday, November 18, 2019.

Figure 2-13 through Figure 2-19 present illustrations of the completed work. Figure 2-13 provides a Google Street View snapshot of the bridge lower deck with the installed overhead lane control signs, while Figure 2-14 provides a snapshot of the roadside sign explaining the lane control symbols used. Figure 2-15 presents snapshots of the electronic message signs that have been installed on the eastbound approach to indicate whether the shoulder lane is open or closed. Figure 2-16 further presents a snapshot of the upper deck of the bridge with the bikeway and moveable barrier, while Figure 2-17 presents a snapshot of the western end of the path along the Main Street off-ramp in Marin County. Figure 2-18 and Figure 2-19, finally, highlight aerial pictures of the various modifications that were made to the eastern and western approaches to the bridge.

Figure 2-13: Electronic Lane Control Signs on Lower Deck

Figure 2-14: Sign Explaining Electronic Lane Control Displays

Figure 2-15: Dynamic Sign Indicating Shoulder Lane Open Status

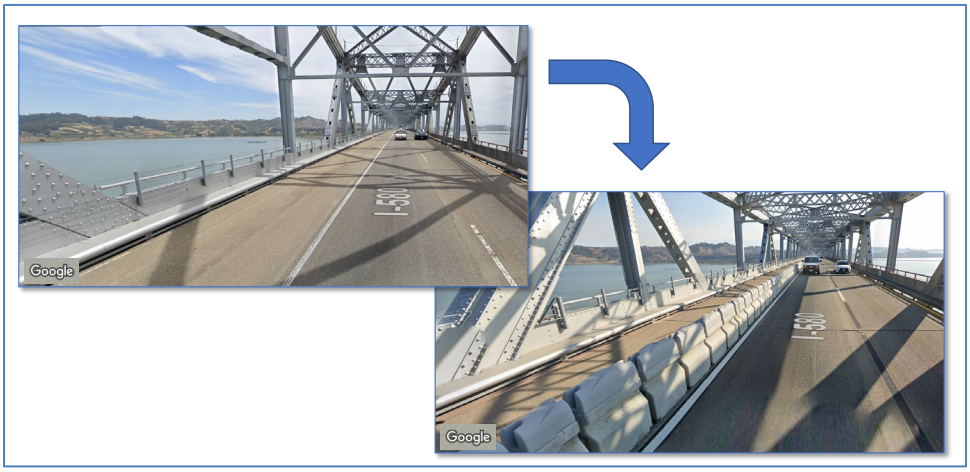

Figure 2-16: Upper Deck Modifications for Bike/Pedestrian path

Figure 2-17: Bike Path Western End Along Main Street Off-Ramp

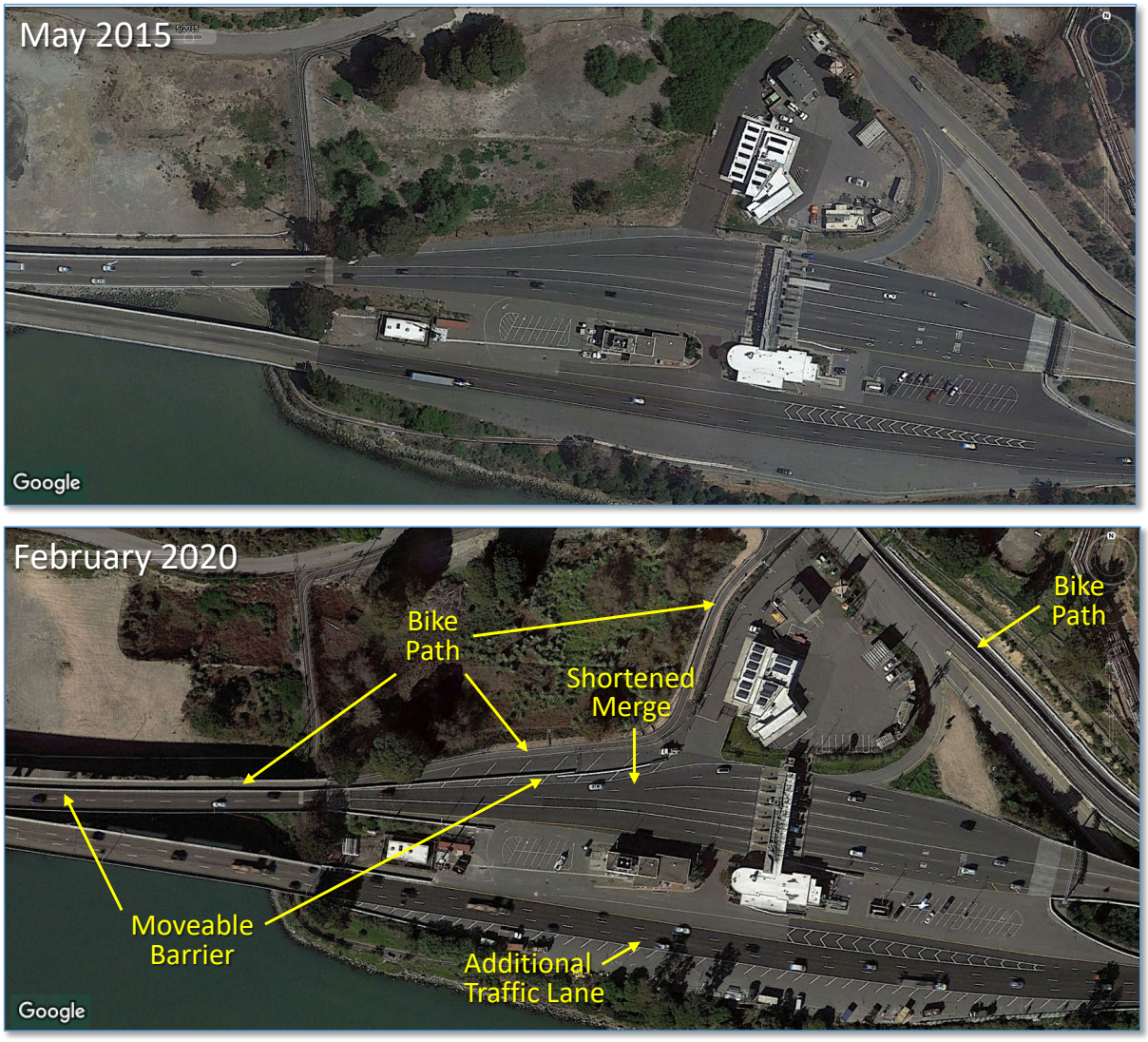

Figure 2-18: Modification of Richmond Approach

Figure 2-19: Modifications of Marin County Approach

2.6. PROJECT STAKEHOLDERS

In addition to the University of California being responsible for performing the evaluation study contained in this report, stakeholders in the pilot project included the following entities:

- **Project Proponents:** Bay Area Toll Authority (BATA), Contra Costa Transportation Authority (CCTA), and Transportation Authority of Marin (TAM). These organizations have provided the funding for the modifications, in addition to having expedited the permitting process.
- **Project Overseer:** Caltrans District 4, responsible for approving the design and providing quality assurance during construction.
- **Project Designer:** CH2M Hill (formerly HNTB Corporation), responsible for the design and implementation of the improvements.

3. EVALUATION OBJECTIVES

The conversion of the eastbound shoulder lane into an additional traffic lane and the conversion of the westbound shoulder lane into a barrier-separated bike/pedestrian path was expected to change how the bridge operates. In both directions, a key concern was the fact that the loss of the shoulder could significantly reduce bridge accessibility for emergency and maintenance vehicles. Another potential concern was that the installation of a physical barrier on the upper deck could cause the westbound traffic to travel slower on the bridge and thus lead to more congestion in the westbound direction. Finally, some individuals argued that opening the bridge to pedestrians and cyclists could also generate additional emergency responses on the bridge and negatively impact westbound traffic, particularly if the problems occur during peak traffic periods.

To assess the extent of these potential impacts, Caltrans commissioned the University of California, Berkeley to monitor the changes in bridge operations that may result from the modifications. Results of this evaluation are to be used by Caltrans to assess whether the improvements are to be kept, in whole or in part, at the end of the four-year evaluation period, or removed altogether. This meant first assessing operations before the changes and then reassessing them at various points in time after completion of the modifications.

Specific elements that were to be evaluated included:

- The utilization of the eastbound shoulder lane on the bridge lower deck during periods of authorized and unauthorized use
- Utilization by cyclists and pedestrians of the new multi-use path on the bridge's upper deck
- Congestion on the eastbound and westbound approaches to the bridge, as well as on the bridge itself
- Traffic on local arterials near the freeway
- Rate and severity of major traffic incidents occurring on the bridge and its approaches
- Clearance time of incidents occurring on the bridge
- Impacts on maintenance activities on the bridge
- Impacts on quality of life in Marin County areas near the bridge

A “before evaluation” report covering the first part of the evaluation was completed and released in September 2017. This report presents findings associated with the first phase of the “after evaluation,” which focuses on an assessment of impacts on bridge operations up to mid-2022. A later report is expected to update the assessments with observations from late 2022, 2023, and early 2024, and add an evaluation of impacts associated with additional modifications that were made to the Sir Francis Drake off-ramp overpass near the bridge along I-580 West in Marin County.

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4. STUDY AREA

The evaluation of the changes brought over by the bridge modifications was not strictly limited to what happened on the bridge itself and both its eastern and western approaches. It also included an assessment of potential impacts on important local arterials on both the Marin County and Richmond sides of the bridge. Below is a more detailed listing of the roadway segments that were considered in the evaluation:

- **I-580 segments (Figure 4-1):** Segment in Marin County from US-101 to bridge, the bridge itself, segment around the toll plaza, segment in Richmond from the Bridge to Cutting Boulevard, and segment in Richmond from Cutting Boulevard to I-80.
- **US-101 segments (Figure 4-1):** Segments from Madera Boulevard to Second Street interchanges, covering the I-580 and Sir Francis Drake Boulevard interchanges.
- **Local streets in Richmond (Figure 4-2):** Stenmark Drive, Marine Street, Castro Street, Richmond Parkway, Cutting Boulevard, and Harbour Way.
- **Local streets in Marin County (Figure 4-3):** Stenmark Drive, Marine Street, Castro Street, Richmond Parkway, Cutting Boulevard, and Harbour Way.

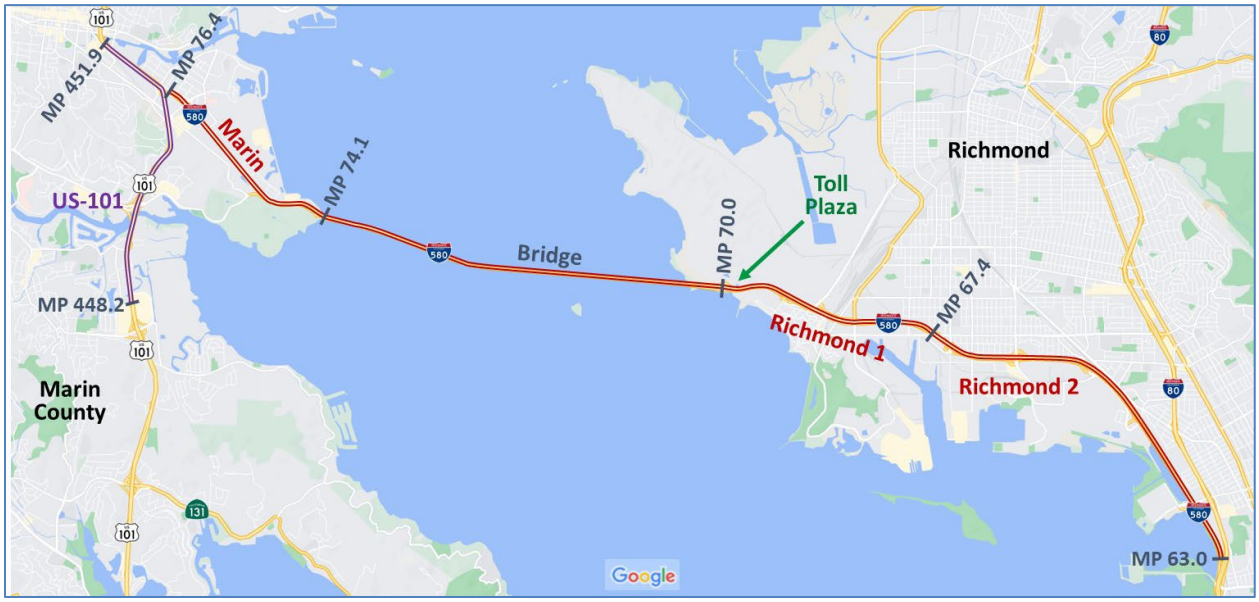


Figure 4-1: Freeway Segments of Interest

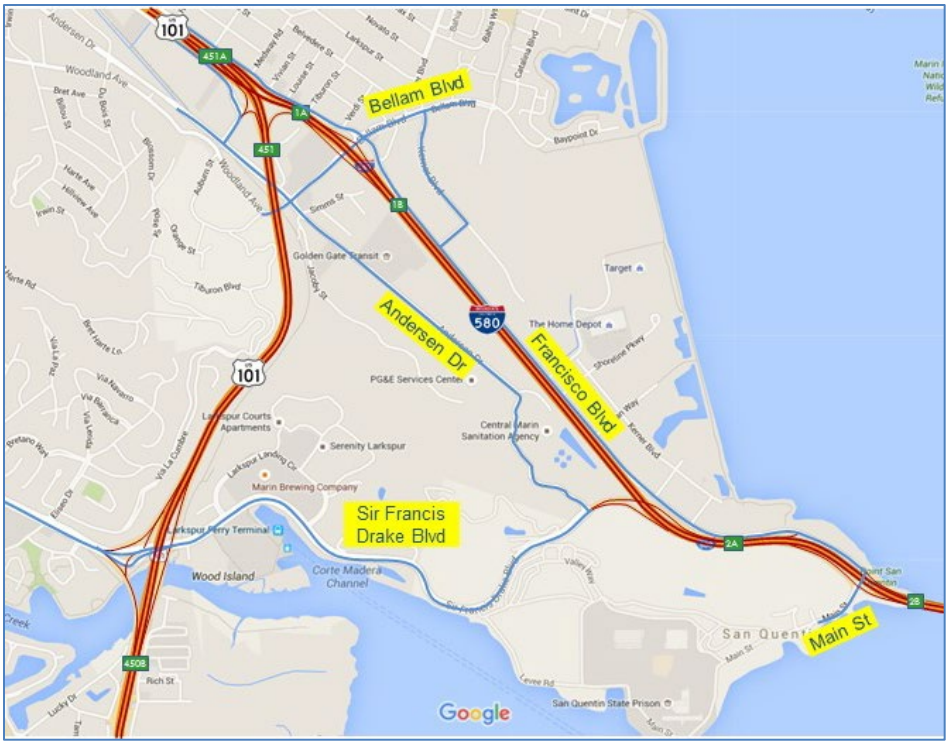


Figure 4-2: Arterials of Interest on Marin County Side

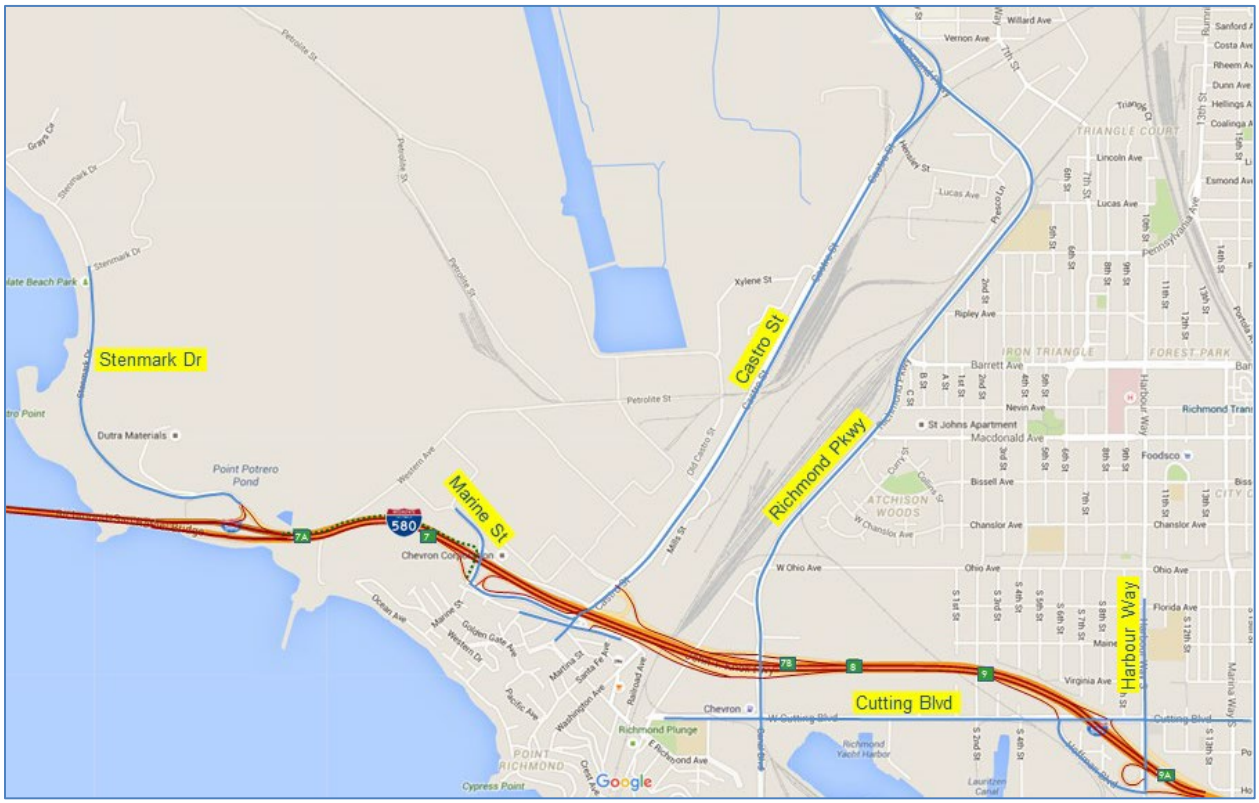


Figure 4-3: Arterials of Interest on the Richmond Side

5. DATA COLLECTED

This section presents a summary of the data that was collected to evaluate the impacts of the implemented modifications on traffic, safety, maintenance, and quality of life. The following sections provide more detailed information about:

- Data collection periods
- Traffic count data
- Travel time data
- Bike and pedestrian counts
- Incident data
- Incident response data
- Maintenance activity data
- Bike path user survey
- Business surveys

5.1. DATA COLLECTION PERIODS

With the beginning of construction initially scheduled to start in late 2016 or early 2017, the period between July 2015 and June 2016 was selected as the preferred period for assessing bridge operations before the implementation of the proposed changes. This was the closest one-year period during which bridge operations would not have been disturbed by construction activities. However, the selection of this period did not preclude the collection of additional data outside this period should the need arise.

For the after period, data collection was initially set to start approximately 6 months after completion of construction activities, to allow enough time for traveler behavior to settle following the introduction of the new elements. This evaluation was again set to cover at least one year. Based on the expected April 2018 shoulder lane opening, this meant starting data collection for the lower deck evaluation no earlier than October 2018. For the upper deck, this further meant starting data collection no earlier than May 2020 based on the path's anticipated November 2019 opening.

The above data collection plans were derailed by the Covid-19 pandemic. Following the imposition of a stay-at-home order in mid-March 2020, vehicle traffic across the bridge dropped by more than 50% in April and May 2020. This likely affected bicycle and pedestrian traffic across the bridge as well. Because of these unusual changes, the data collection for the after period had to be postponed until traffic would return close to pre-Covid conditions. By the end of June 2021, most work-related Covid restrictions had been lifted and both weekday and weekend peak time traffic had returned close to pre-Covid levels, even slightly exceeding them in some time intervals. However, off-peak traffic remained significantly below pre-Covid levels, with night traffic still being 30-50% below. This allowed considering any peak period data collection conducted after June 2021 to be deemed valid for the after evaluations.

5.2. TRAFFIC COUNTS

The following is a summary of the several types of traffic data that were gathered, or attempted to be gathered, to support the intended evaluations. These include:

- PeMS sensor data
- Toll plaza counts
- Traffic counts for local jurisdictions
- Manual traffic counts executed as part of the project

5.2.1. PEMS DATA

Vehicle counts were obtained from the Caltrans Performance Measurement System (PeMS) online application. While it was initially thought that PeMS could provide most of the data needed, an assessment of the data supplied by the system revealed several issues:

- Most of the stations along I-580 had significant reliability problems. This is illustrated in the diagrams in Figure 5-1, Figure 5-2, and Figure 5-3, which show the quality of the data supplied by each station within the study area between January 2016 and December 2021. Data quality is represented by the percentage of direct measurements, ranging from 0% (red) to 100% (green), as opposed to estimated data based on an analysis of information from surrounding sensors. Because of potential errors associated with estimated data, only counts having at least 80% observed data were considered valid.

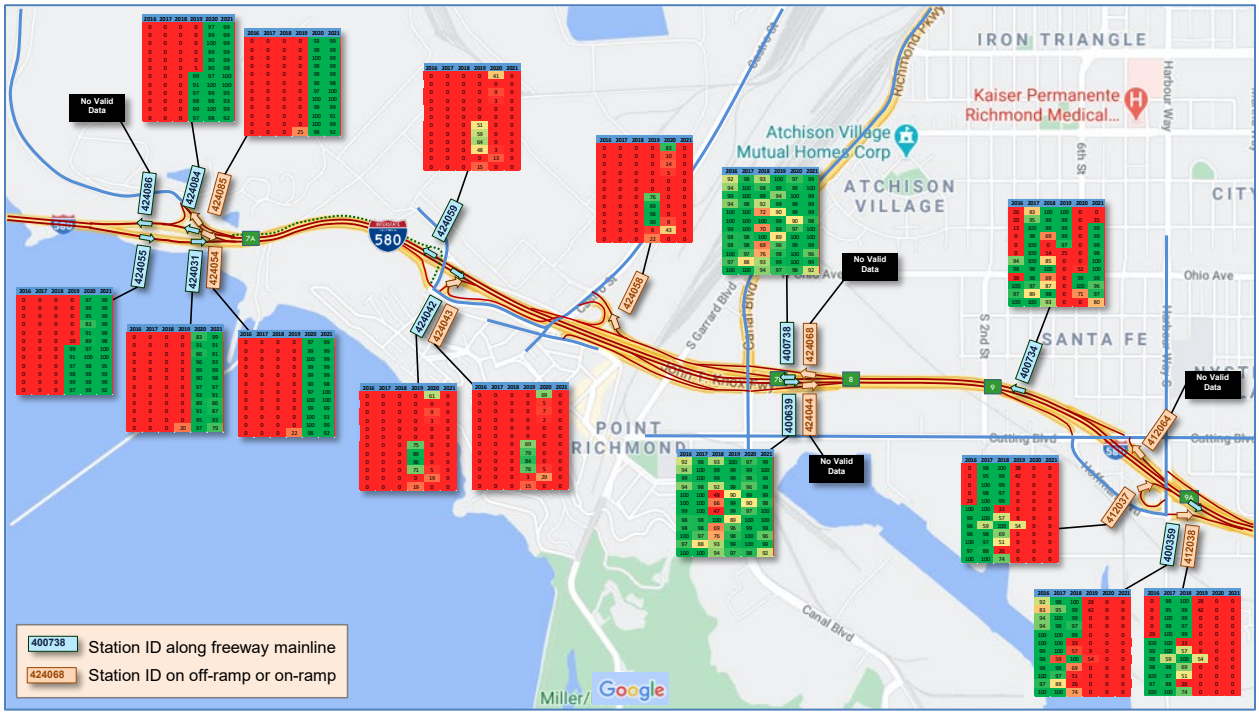


Figure 5-1: Percentable of Observed Data from PeMS Stations on I-580 in Richmond, 2016-2021

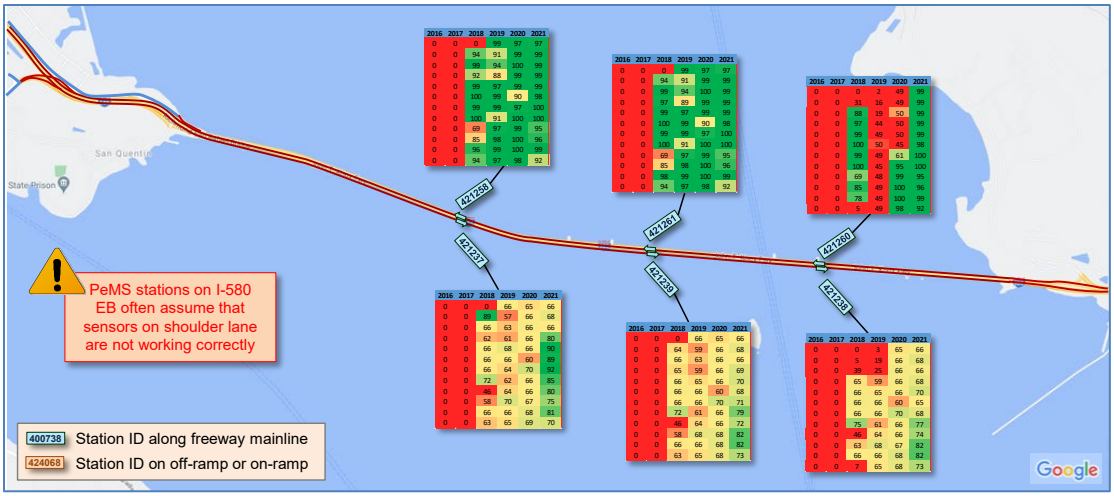


Figure 5-2: Percentable of Observed Data from PeMS Stations on Bridge, 2016-2021

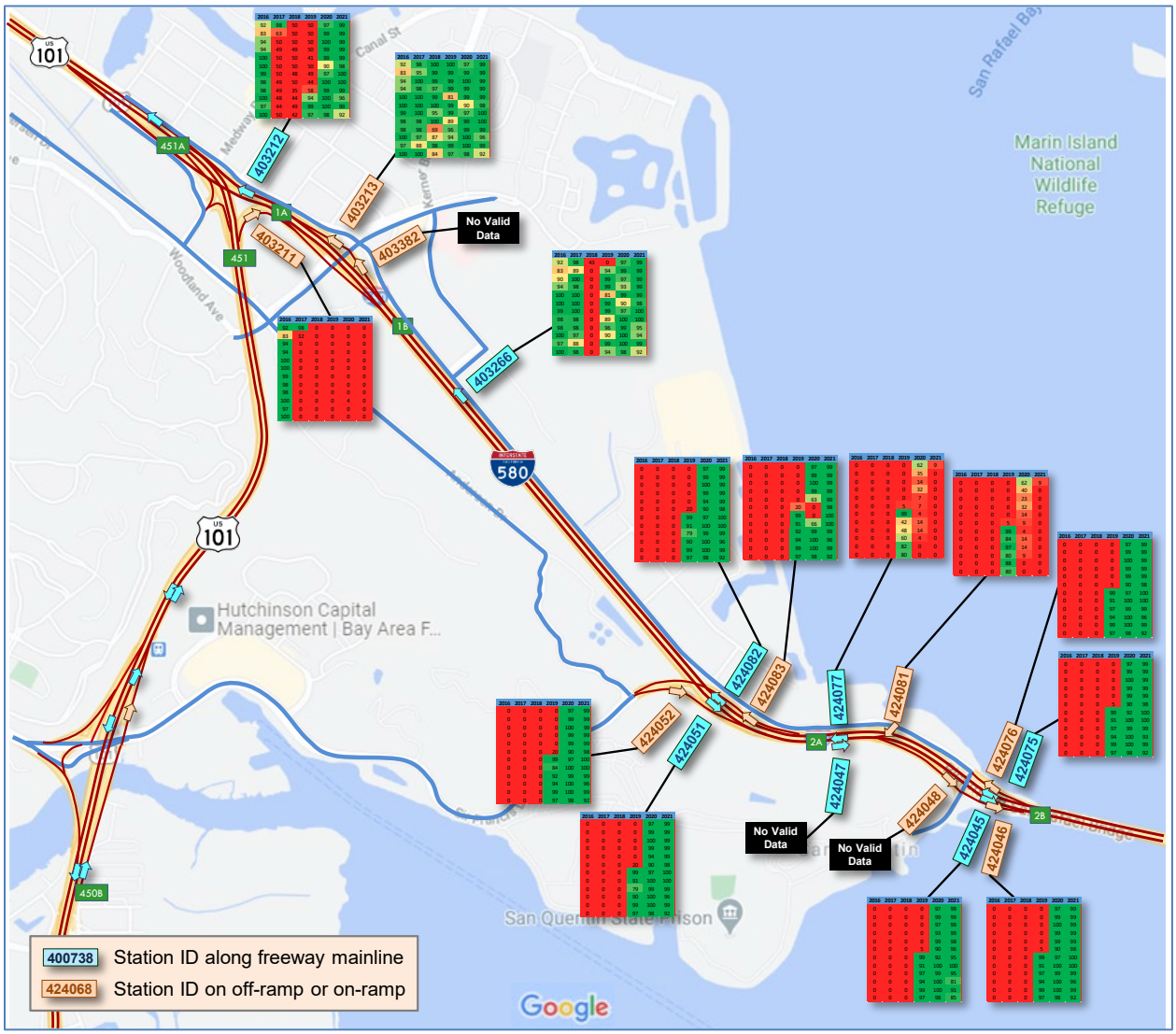


Figure 5-3: Percentable of Observed Data from PeMS Stations on I-580 in Marin County, 2016-2021

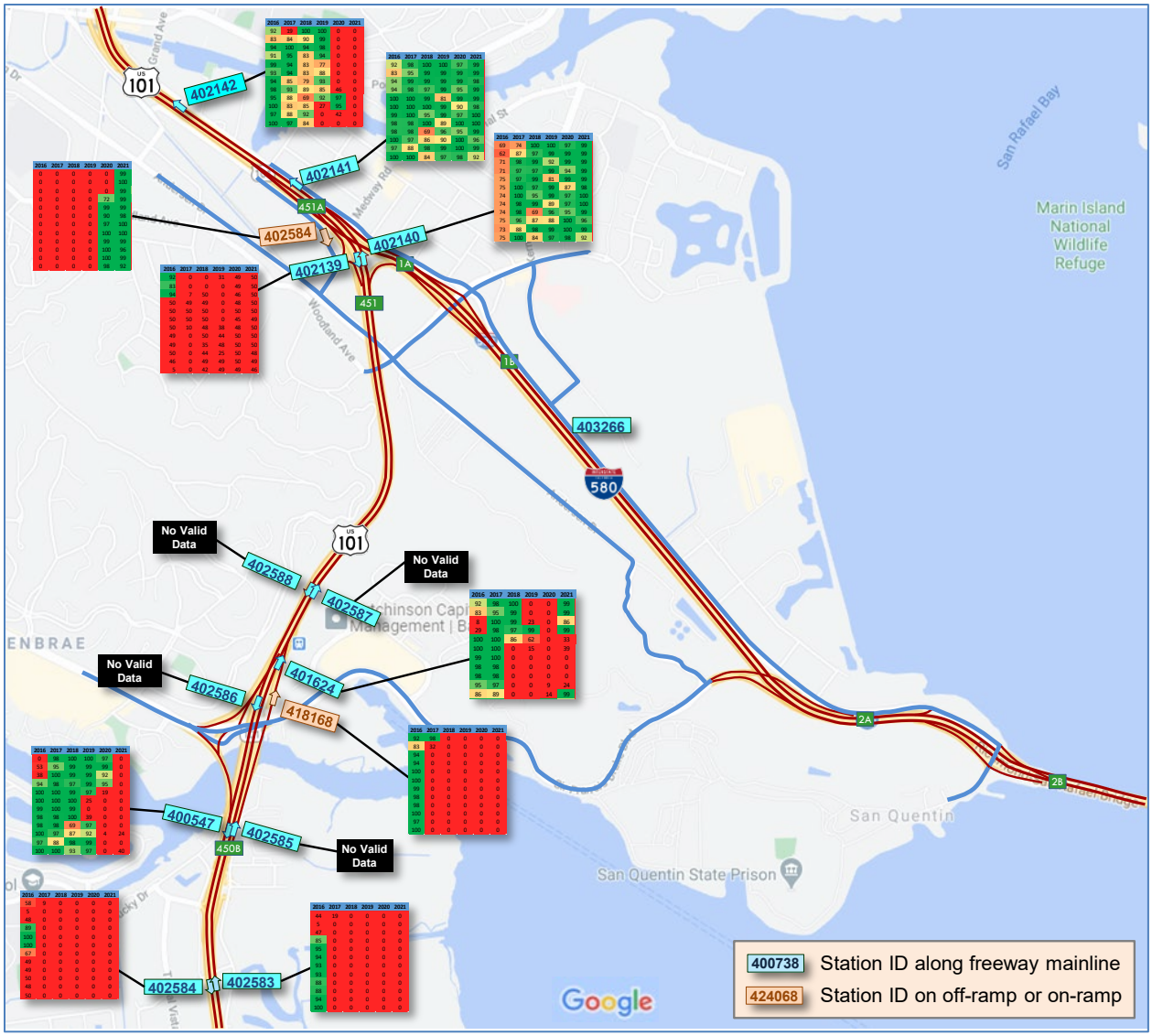


Figure 5-4: Percentable of Observed Data from PeMS Stations on US-101, 2016-2021

- The two mainline stations on I-580 near Canal Boulevard (stations 400638 and 400739) were found to be the only ones on the Richmond side to consistently provide reliable data. In Marin County, the station on I-580 West upstream of the Bellam Boulevard off-ramp (station 403266) was the only reliable one.
- The three new stations that were installed on the bridge as part of the pilot project only started to produce data in February 2018. This restricted the use of this data source to the after evaluation only.
- The detectors installed on the shoulder lane on the bridge lower deck have difficulty recognizing that the lane is opened to traffic only during specific periods. Since the system assumes that a zero volume might be an error, estimated flows are often provided for the lane when it is closed, resulting in an overestimation of the overall bridge traffic. This problem was remedied by retrieving and processing the raw data instead of the processed data.

- Stations along I-580 and US-101 that produced data in 2016-2017, during the before evaluation, generally ceased to produce data by 2019.
- As a result of the installation of new sensors along the I-580, several mainline and ramp stations on each side of the bridge started to produce data in the fall of 2019. Similar to the bridge sensors, this meant that the collected data could only support the after evaluation.

5.2.2. TOLL PLAZA COUNTS

The number of vehicles crossing the Richmond toll plaza on I-580 West for each hour of the day between January 2010 and mid-June 2022 was provided by the Bay Area Toll Authority. These counts are from the vehicle detection system used to detect and categorize vehicles across each of the seven toll lanes at the plaza. Because the data can be considered fully accurate, it was used as a reference for the assessment of the westbound traffic accessing the upper deck of the bridge.

5.2.3. TRAFFIC COUNTS FROM LOCAL JURISDICTIONS

Neither Richmond nor the multiple jurisdictions in Marin County had detailed information about traffic on local streets.

5.2.4. MANUAL TRAFFIC COUNTS

To supplement existing data and cover areas without information, National Data and Surveying Services (NDS) was contracted by PATH to conduct manual traffic counts at strategic locations within the study area. The same firm was used for both the before and after data collection as follows:

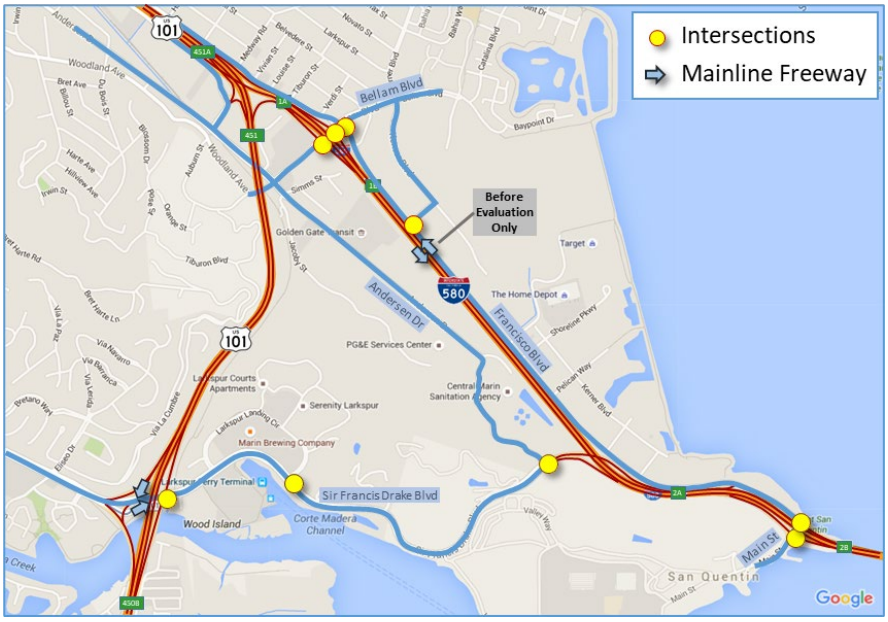


Figure 5-5: Before/After Marin County Manual Count Locations

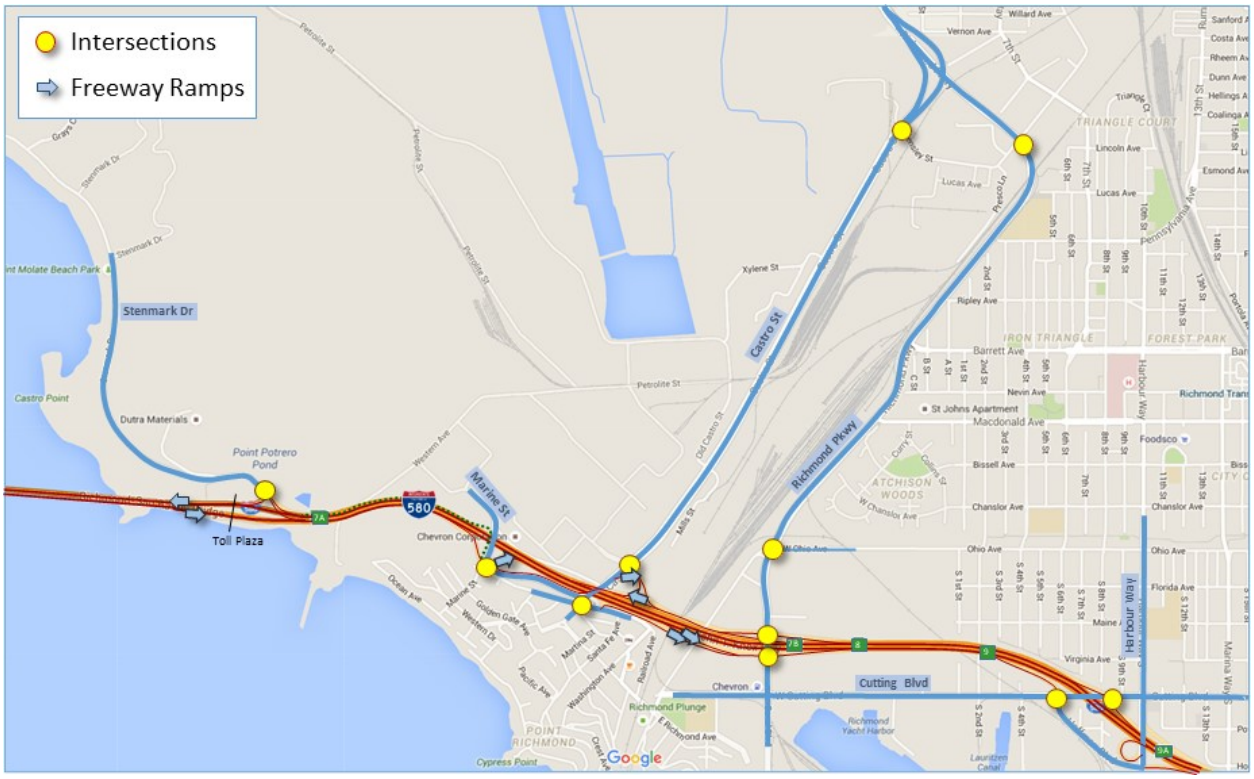


Figure 5-6: Before/After Richmond Manual Count Locations

- For the before evaluation, data were collected between May 10 and May 19, 2016, at the locations shown in Figure 5-5 and Figure 5-6. This included 9 intersections and 4 freeway ramps in Marin County, in addition to 11 intersections and 7 freeway ramps in Richmond.
- For the after evaluation, data were collected at the same locations shown in Figure 5-5 and Figure 5-6, except for the two I-580 mainline sites in Marin County, between March 22 and March 24, 2022. Data collection was not repeated at the two I-580 sites in Marin County as traffic detectors installed along the freeway mainline in the summer of 2019 near the Sir Francis Drake Boulevard and Main Street interchanges could provide the desired freeway volumes.

5.3. TRAVEL TIME DATA

Travel times along key freeway and arterial segments were obtained from the INRIX online data analysis platform through a login provided by the MTC. Specific segments for which travel times were collected are shown in Figure 5-7. This includes various segments along I-580, US-101, and key arterials within the study area.

While the project team initially hoped that Bluetooth data would be available to supplement speeds and travel times obtained from PeMS and INRIX, no such data were found to be available for the study area.

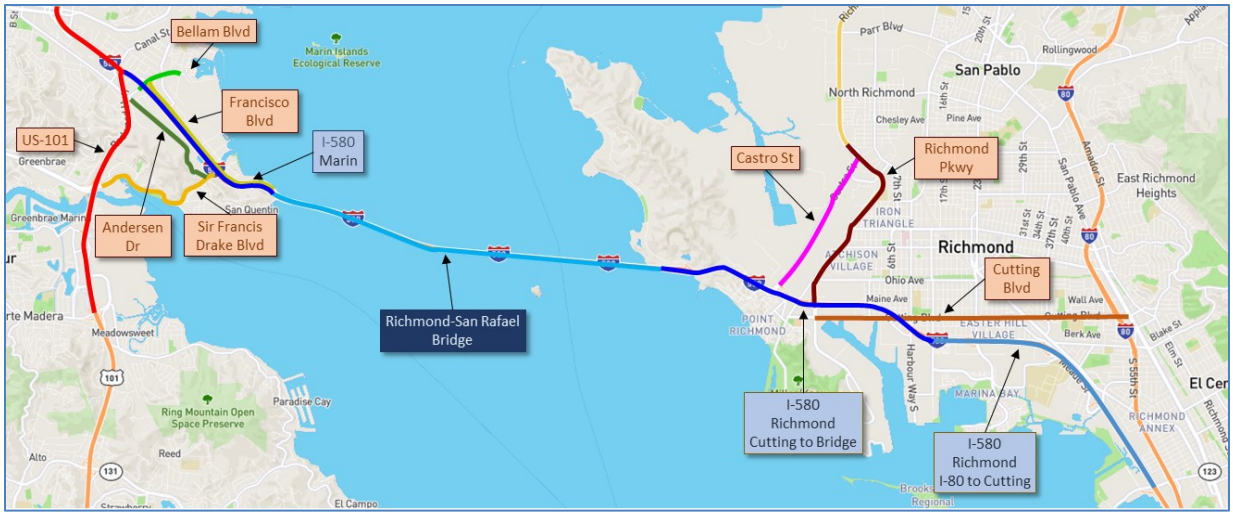


Figure 5-7: INRIX Travel Time Study Segments

5.4. BIKE/PEDESTRIAN DATA

The following data were collected to characterize the bike and pedestrian demand for the multi-use path on the upper deck of the bridge:

- **Automated bicycle and pedestrian counts:** Data from automated counters installed on the multi-use path as part of the pilot project (available only for the after portion of the evaluation).
- **Bicycle Counts from Golden Gate Transit:** Information about the number of bicycles that were carried over the bridge by Golden Gate Transit buses on their front rack (see Figure 2-7).

To measure bicycle and pedestrian traffic along the pilot corridor, Eco-Counter devices were installed at both ends of the bridge. Figure 5-8 indicates the location of the various sensors from which data were collected, while Figure 5-9 illustrates a typical sensor installation.

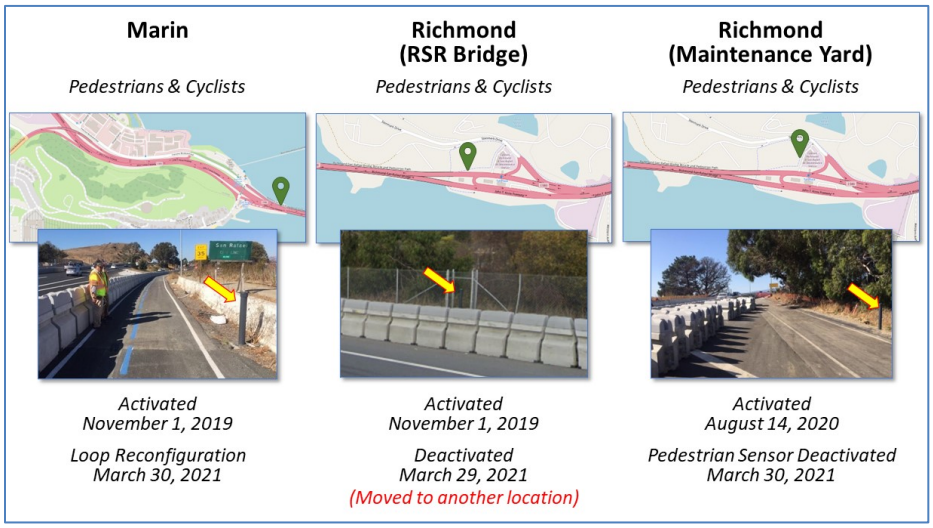


Figure 5-8: Locations of Bike/Pedestrian Eco-Counter Sensors

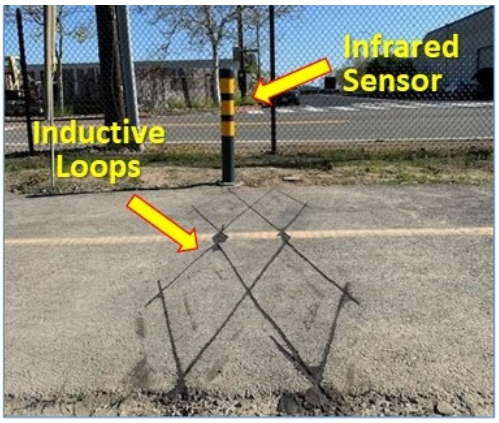


Figure 5-9: Typical Eco-Counter Sensor Installation

The Eco-Sensor devices rely on a combination of in-pavement loops and a passive infrared sensor to detector bicycles and pedestrians:

- Inductive loops embedded in the pavement are used to detect the metal in bicycles passing in front of them. Following a detection, an algorithm then analyzes the recorded bicycle's electromagnetic signal to determine whether a bicycle should be counted and its direction of travel. This is like systems using pavement loops to detect and count traffic.
- The passive infrared sensor is used to detect the heat of human bodies passing in front of the sensor. Like the bicycle data, an algorithm is then used to determine how many pedestrians have been observed and their direction of travel.

As indicated in the bottom of Figure 5-8, various changes were made to the layout of detectors around the bridge throughout the study:

- The first two Eco-Counter sensors, the "Marin" and "Richmond (RSR Bridge)" sensors, were installed on each side of the bridge in November 2019.
- In August 2020, an additional sensor was added near the Caltrans Maintenance Yard at the Richmond toll plaza.
- In March 2021, the initial Richmond sensor was removed to be used along another path going across the Sir Francis Drake of-ramp overpass on I-580 West in Marin County, leaving only the Maintenance Yard sensor on the east side of the bridge.
- During the March 2021 reconfiguration, the Marin sensor had its bicycle loop reconfigured to address an eastbound/westbound misdetection issue that was identified through the analysis of the collected data. The pedestrian sensor for the Maintenance Yard sensor was also deactivated, leaving the Marin sensor to be the only remaining one recording pedestrians.

A comparison of the sensor data to video recordings has shown that the sensors generally produce reliable counts. The only identified issue was a potential undercounting of bicyclists traveling in tight groups. This indicates that the actual number of cycles passing in front of each station may be slightly higher than what is reported, particularly on Saturdays and Sundays, when groups of cyclists are more frequently observed.

5.5. INCIDENT DATA

To assess the impacts of the bridge modifications on the frequency, type, and severity of incidents occurring on the bridge and its approaches, data were collected from the following sources:

- Statewide Integrated Traffic Report System (SWITRS)
- Traffic Incident and Surveillance Analysis System (TASAS)
- Transportation Injury Mapping Systems (TIMS)
- California Highway Patrol Computer-Aided Dispatch (CHP CAD) log data within PeMS
- Processed data from Bay Area Traffic Incident Management Dashboard
- Incident reports logged by travelers on the Street Story online platform

Attempts were also made to collect and use data from the following sources:

- Bay Area Incident Response System (BAIRS)
- Major Incident Database (MIDB)
- Call Box data
- Incident data from local police agencies

The subsections below describe in more detail the data collection efforts, or issues, associated with each of the above sources.

5.5.1. STATEWIDE INTEGRATED TRAFFIC REPORT SYSTEM (SWITRS) DATA

SWITRS is a CHP database containing information about highway incidents. This database essentially aggregates information about incidents that have been submitted by officers on Traffic Collision Reports. It is generally considered to be the definitive source of incident data for state highways. For each collision, this details its location, time of occurrence, severity, type, number of vehicles implicated, and roadway condition at the time of the incident, among many other parameters. However, incident duration is normally not included.

Where needed, information about specific incidents was retrieved from the CHP's iSWITRS online portal at https://iswitrs.chp.ca.gov/Reports/jsp/CollisionReports.jsp. A snapshot of the incident query page is shown in Figure 5-10. Access to this query tool is open to the public but requires obtaining login credentials from the CHP. It allows obtaining reports in PDF format detailing all the incidents occurring between specific dates, within a specific county, city, or police jurisdiction. However, it does not allow to perform queries for specific roads. To retrieve incidents associated with I-580, a manual scan of all reported incidents must be performed.

An element of note with this dataset is that a significant lag can exist between the time an incident occurs and the time it shows up in the database. This is due to the time taken by the CHP to verify all the submitted information. Information about incidents typically becomes public one to one-and-a-half years after their occurrences.

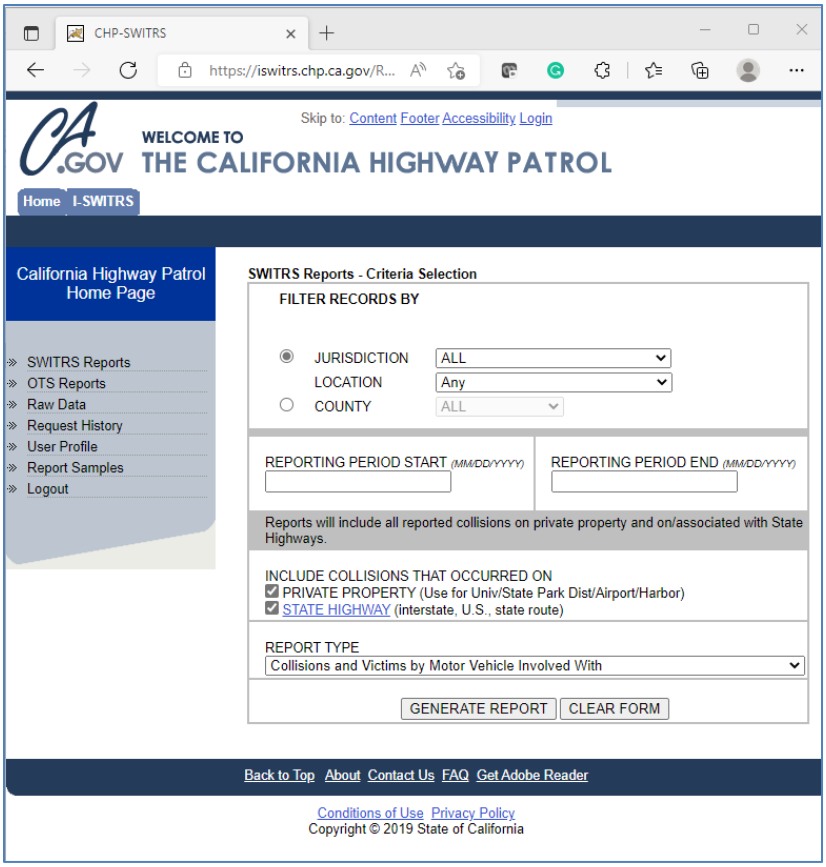


Figure 5-10: iSWITRS Incident Query Webpage

5.5.2. TRAFFIC ACCIDENT AND SURVEILLANCE ANALYSIS SYSTEM (TASAS) DATA

The Traffic Accident and Surveillance Analysis System (TASAS) is a database developed by Caltrans based on information contained in SWITRS. This database links incident data from SWITRS to a database of roadway features to facilitate the analysis of traffic impacts associated with incidents.

This is the primary database that was used to compile incident statistics for the project. Data for mainline and ramp incidents along sections of I-580 within Contra Costa County and Marin County between January 2016 and December 2021 were graciously compiled by Caltrans staff and provided to the research team in Excel format.

5.5.3. TRANSPORTATION INJURY MAPPING SYSTEM (TIMS) DATA

The Transportation Injury Mapping System (TIMS) is an online analytical tool developed by SafeTREC at the University of California, Berkeley to provide quick, easy, and free access to crash data contained in the SWITRS database and facilitate the display of incidents on maps. This tool can be accessed at https://tims.berkeley.edu, but requires obtaining login credentials from the manager of the site. Its focus is on crashes with injury. As such, it does not map crashes with no reported injuries. A particularly useful feature of this data source is that it allows mapping incidents that have occurred in a specific direction on a specific roadway, as illustrated in the snapshot of Figure 5-11.

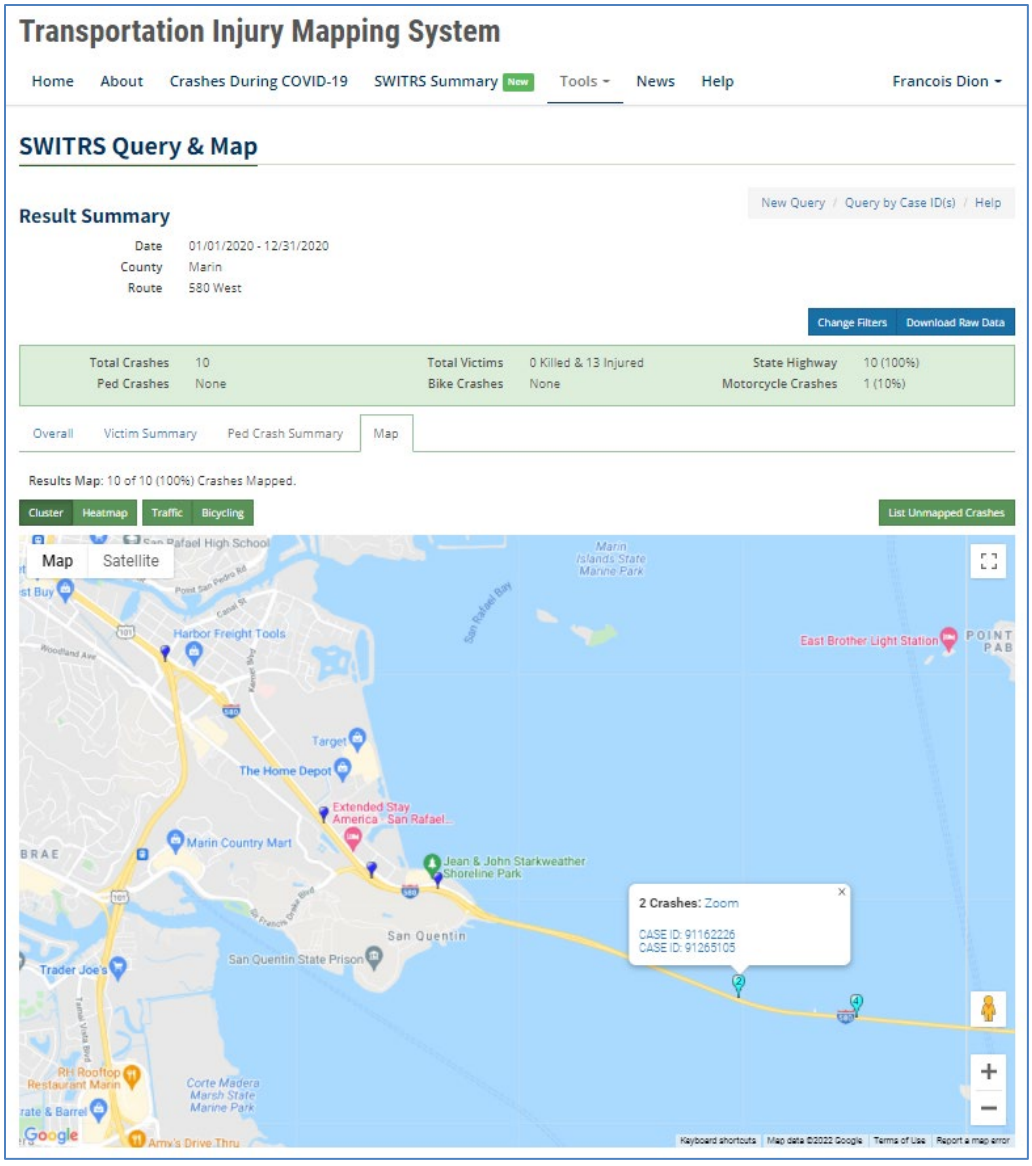


Figure 5-11: TIMS I-580 Incident Query Result Example

5.5.4. CALIFORNIA HIGHWAY PATROL COMPUTER-AIDED DISPATCH (CHP CAD) LOGS

Data from the CHP Computer-Aided Dispatch system (CAD) were used to supplement incident information obtained from the SWITRS and TASAS databases. This data can be retrieved from the California Performance and Monitoring System (PeMS), as illustrated in Figure 5-12. It details the time of occurrence, location, duration, and type of all events for which a dispatch log exists. This not only includes information about traffic collisions, but also information about roadway hazards, weather events, maintenance activities, and roadway closures that involved the dispatching of CHP officers.

An item of particular interest in this database is the ability to access the detailed messages that were posted to manage incidents. An example is shown in Figure 5-13. These message logs are used by various applications as the basis for estimating incident durations. In most cases, incident durations are simply estimated as the interval between the first and last recorded messages.

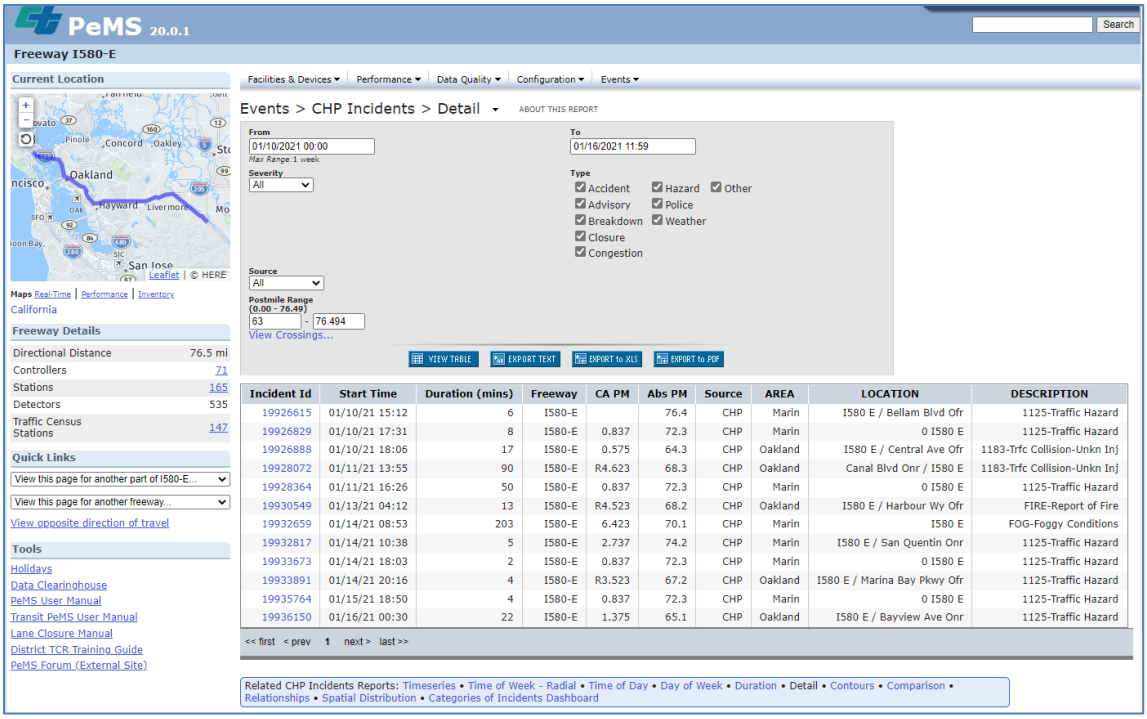


Figure 5-12: CHP-CAD Query Output Example

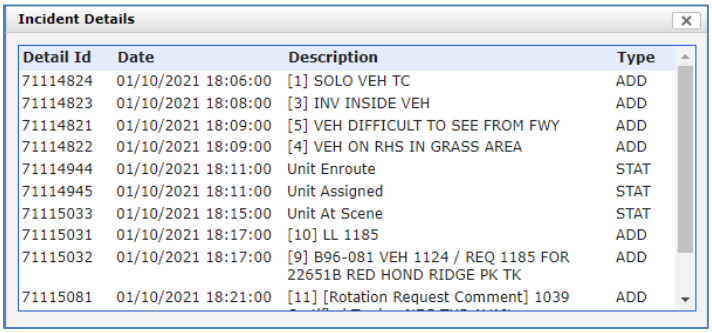


Figure 5-13: CHP-CAD Incident Log Example

While useful, the logs must always be considered carefully as their accuracy is subject to the diligence of CHP dispatchers in recording the various actions taken. For instance, actual event start times are generally not captured. The incident star time is usually the time a dispatcher was notified of an existing event. Event end times are also often missing or not clearly identified in the chain of messages, making it difficult to determine accurately the actual time taken to clear an incident. The last recorded message may correspond to the moment a note has been entered to indicate when the congestion generated by an incident has dissipated when the last incident-related message has been turned off on nearby changeable message signs, or to the last remark about the location where a vehicle has been towed. Some feeds also terminate abruptly, with no information about how an incident was cleared.

While the logs do not necessarily provide clear incident start and end times, they are the only source of information allowing to ascertain incident durations. To reduce possible biases, the message logs associated with all incidents considered in the analyses were reviewed to determine whether an adjustment should be made to the reported durations to more accurately reflect the period during which an incident affected traffic, particularly in the case of incidents with very long reported durations.

5.5.5. BAY AREA TRAFFIC INCIDENT MANAGEMENT DASHBOARD DATA

The Bay Area Traffic Incident Management Dashboard is a web-based application developed by the MTC to facilitate the viewing of crash-related data associated with various Bay Area corridors. Access to this dashboard requires obtaining credentials from the MTC. A snapshot of the page associated with the Richmond-San Rafael bridge corridor is shown in Figure 5-14, with the map at the bottom illustrating the area for which incident statistics are compiled.

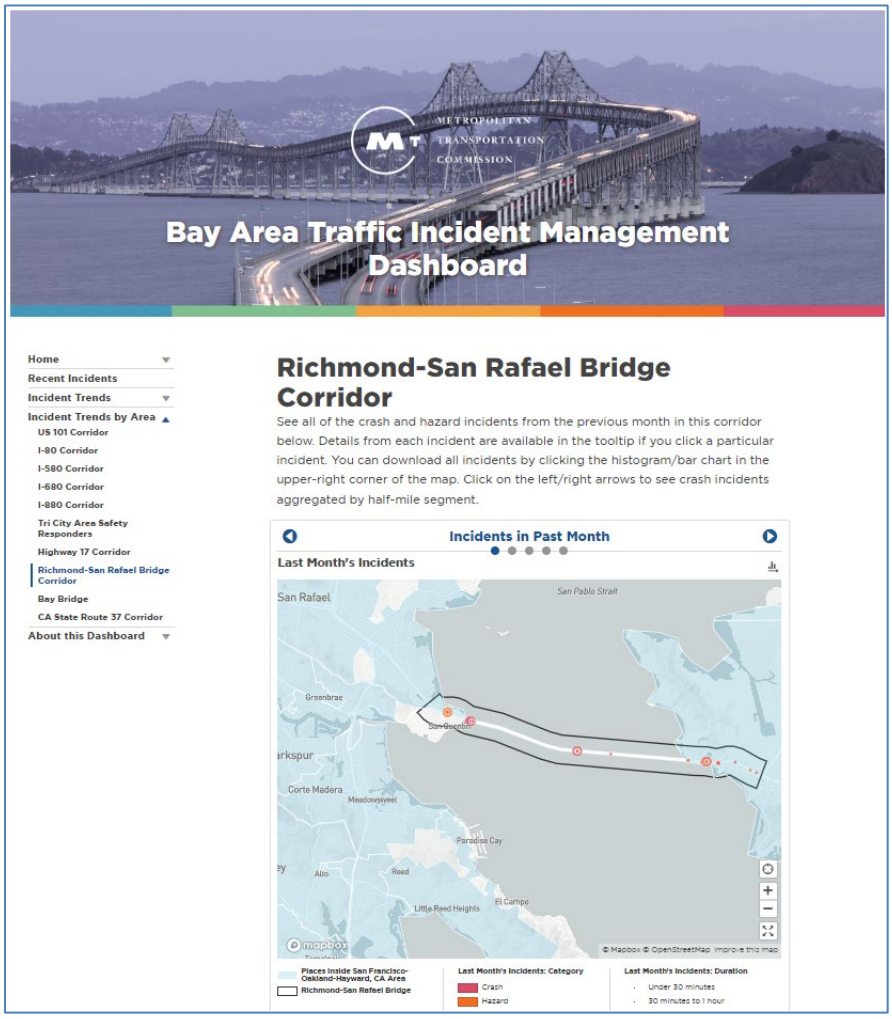


Figure 5-14: Bay Area Traffic Incident Management Dashboard

This dashboard uses CHP CAD data contained within PeMS to identify crash-related incidents within each corridor, estimate their clearance time, and produce summary monthly statistics. Similar to the CHP CAD data processed by PeMS, incident clearance times are estimated based on the first and last messages associated with a particular event. The first message generally corresponds to the time an incident is reported. While the last message often corresponds to a note that a unit has left the scene, this is not always the case. As indicated in the previous section, some incident feeds terminate abruptly while others may include messages posted after an incident has been cleared. As a result, the reported clearance times do not necessarily correspond to actual incident clearance times. To reduce potential large discrepancies, messages associated with all incidents lasting more than one hour were reviewed to verify the accuracy of their reported duration and adjust them if necessary.

5.5.6. STREET STORY ONLINE PLATFORM DATA

StreetStory is an online platform created by the University of California Safe Transportation Research and Education Center (SafeTREC) on the Berkeley campus. This tool allows residents, community groups, and agencies to collect community input about transportation crashes, near-misses, general hazards, and safe locations to travel. Figure 5-15 shows a screenshot of the page used to enter new reports, while Figure 5-16 shows the maps that can be used to explore logged reports. For the evaluations, all reports about the bridge logged between October 2018, when the site was activated, and February 2022 were retrieved and analyzed.

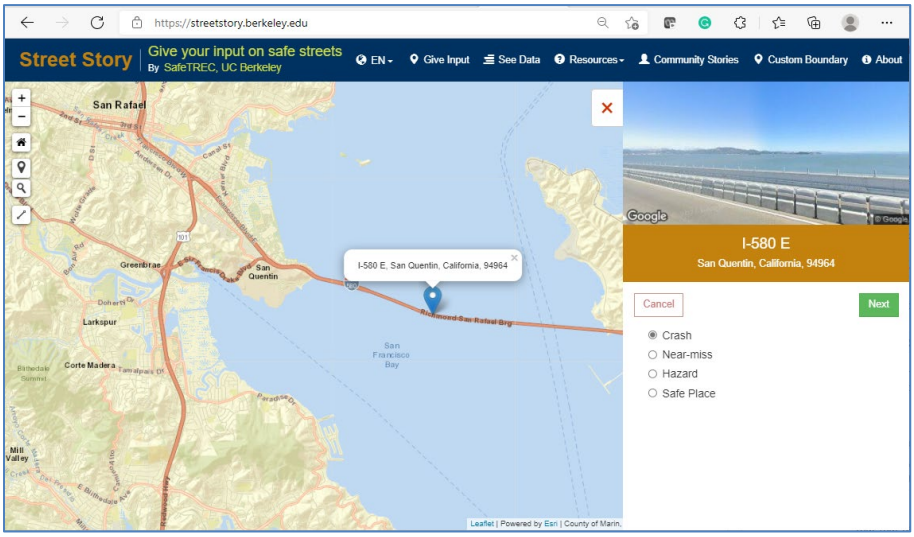


Figure 5-15: SafeTREC Street Story Incident Reporting Online Platform

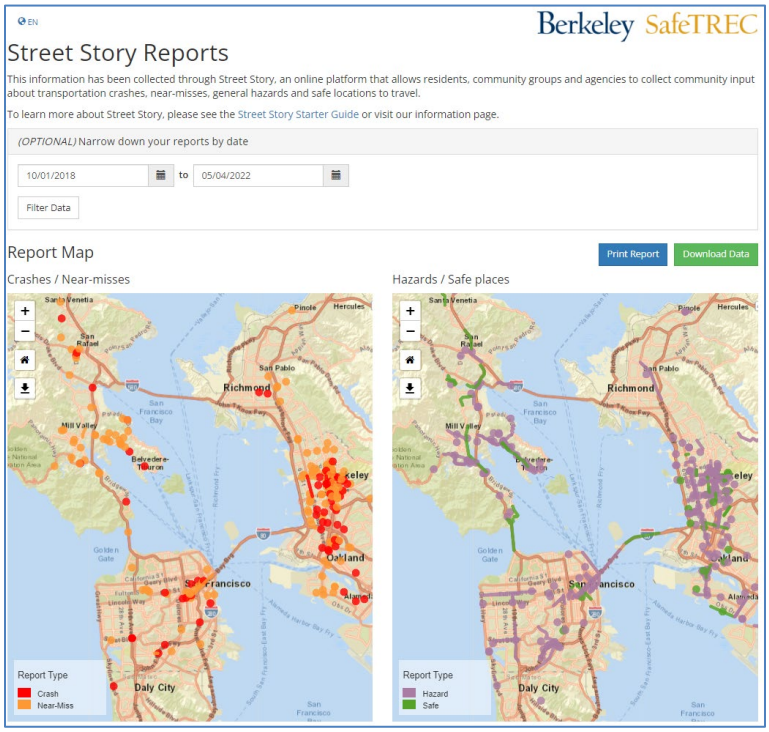


Figure 5-16: SafeTREC Street Story Online Platform for Exploring Reports

5.5.7. BAIRS DATA

BAIRS data were initially obtained for 2015 and 2016. After reviewing the data, it was determined that the information contained in this dataset often duplicated what could be retrieved from SWITRS and the CHP-CAD system. For this reason, no further data were collected from this dataset.

5.5.8. MIDB DATA

Attempts were made to retrieve data from the Major Incident Database (MIDB) in 2015 and 2016. However, these attempts were unsuccessful, in great part due to the difficulty of extracting electronic data from the system. Additional efforts to retrieve data were abandoned after it was determined that the SWITRS data would provide a comprehensive enough record of incidents occurring within the study area.

5.5.9. CALL BOX DATA

A summary of calls made from Call Boxes was obtained for 2011, 2012, 2013, and 2014. While the Call Box data provided information about how frequently the boxes were used to report incidents on each bridge within the Bay Area, the data was found of relatively little use as it did not provide information about the location of the specific box that was used to report each incident, or the type of incident reported. This made it difficult to try to correlate the incidents contained in the database with incidents included in other databases. For these reasons, no further effort was made to use this type of data in the analyses.

5.5.10. DATA FROM LOCAL POLICE DEPARTMENTS

To obtain information about incidents occurring outside the freeway, the police departments of the cities of Richmond and San Rafael as well as the Sheriff's Office of Marin County were contacted in 2016 and 2017. Since electronic data could only be obtained from the San Rafael Police Department, and since the primary focus of the evaluations was on incidents occurring on the freeway, this potential source of incident data was not pursued further.

5.6. INCIDENT RESPONSE DATA

In addition to information about the number and type of incidents, attempts were made to collect data characterizing the time taken by emergency or service vehicles to respond to incidents on the bridge. The goal was to collect data enabling an assessment of the difficulty that emergency services faced reaching incident locations under the various bridge configurations. Efforts were more specifically directed at exploring how such information could be retrieved from the following two sources:

- Caltrans tow truck activity logs
- CAH CAD log data

5.6.1. CALTRANS TOW TRUCKS LOGS

Tow truck activity reports were sought from Caltrans to obtain information about instances in which tow trucks were dispatched to help vehicles on the bridge. This did not include information about towing activities on the approaches to the bridge, as these activities would be provided by the Freeway Service Patrol and would not have been significantly impacted by the bridge modifications.

Collected data include tow truck activity reports for the following periods:

- Before modifications:
  - January to July 2016 (75 logs, 75 with dispatch times)
  - January to September 2018 (244 logs, none with dispatch times)
  - March 21-31, 2019 (26 WB logs, 12 with dispatch times)
- After modifications:
  - March 21-31, 2019 (100 EB logs, 9 with dispatch times)
  - January to February 2020 (119 logs, none with dispatch times)
  - February and March 2022 (645 logs, 77 with dispatch times)

Almost all collected log records include the time a vehicle arrive on the scene (10-97 code) and completed service (10-98 code). However, only a fraction of the logs also includes a dispatch time allowing to assess the time that was needed to reach the location of the requested service. While service locations were generally entered, there were often entered as a general reference location, such as “midspan bridge”, “just east of Toll Plaza”, “just west of San Quentin”, etc.

2019 to 2022 data were provided as scans of handwritten log sheets covering all bridges within the Bay Area. Each sheet had to be visually inspected to determine which logs were relevant. Identified relevant logs then had to be manually transcribed into an electronic format to enable further analyses.

5.6.2. CHP CAD LOGS

Explorations were made into the ability to use the CHP CAD logs to determine the time taken by response vehicles to reach an incident since many logs indicate when a unit has been assigned to an incident, is en route, and has arrived at the scene. As an example, in the log snapshot of Figure 5-13 presented earlier, it could be determined that a unit was assigned to the incident at 6:11 PM, started to travel towards it at that time, and reached the incident location four minutes later at 6:15 PM.

While the “Unit Assigned,” “Unit Enroute” and “Unit at Scene” logs provide some insights about response times, they do not indicate from where a unit has been being dispatched. This makes it difficult to assess whether long recorded travel times are due to difficult traffic conditions on the way to an incident or simply because of a farther starting point. For many incidents, multiple vehicle dispatches and arrivals are also recorded in short succession. Since the logs do not provide information about the specific vehicles being dispatched, it is often unclear to which dispatch each scene arrival corresponds, making it difficult to determine actual response times. Many logs also indicate an assignment but no subsequent arrival time, or an arrival without a prior logged assignment. As a result, estimated response times based on incident logs can only be viewed as crude, potentially inaccurate, estimates.

5.7. MAINTENANCE DATA

Maintenance activity data were sought to assess the frequency at which repairs would be required on the new barrier and, if possible, the time taken by maintenance crews to reach a given site and complete a given task. For this purpose, the following two data sources were considered:

- Caltrans Lane Closure (LCS) System
- Integrated Maintenance Management System (IMMS)

5.7.1. CALTRANS LANE CLOSURE SYSTEM (LCS) DATA

The LCS is used by Caltrans staff to report all approved closures planned for the next seven days, in addition to all lane, ramp, and road closures that are currently in place due to maintenance, construction, special event, or other reason. The system also retains a record of all past closures.

As shown in Figure 5-17, LCS data can be retrieved directly from PeMS. For each closure request, the data indicates whether the request was approved, rejected, or canceled, the proposed start and end locations, the proposed start and end times, the actual start and end times if implemented, as well as the number of lanes closed. The reason for the closure may also be provided in the remarks section.

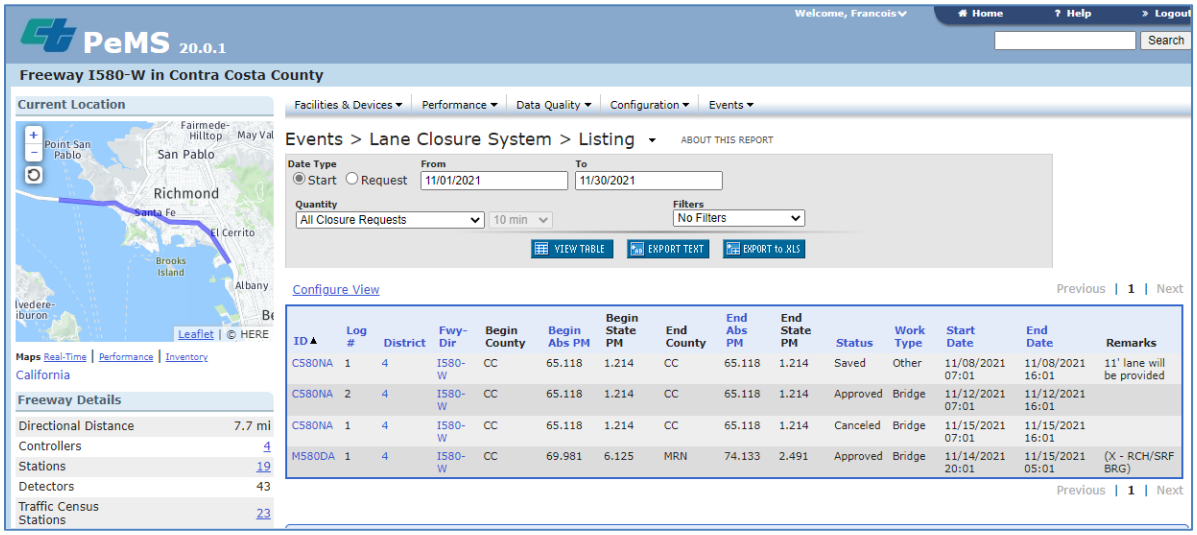


Figure 5-17: Lane Closure System Data Retrieval within PeMS

5.7.2. INTEGRATED MAINTENANCE MANAGEMENT SYSTEM (IMMS) DATA

The Caltrans Integrated Maintenance Management System (IMMS) is used to record, report, and monitor maintenance work planned and performed. A log is normally created for each incident for which maintenance is required. This includes an assessment of the damage to any state property.

An analysis of an IMMS data sample that was provided to the team in 2016 only showed the total number of hours needed to complete a given task and the associated cost to the agency. While this information could be used to assess the magnitude of maintenance work completed, there was no specific information about the time needed to reach a given site. For this reason, it was determined that data from this system would likely not provide useful information for the evaluation and no additional data were sought.

5.8. BIKE PATH USER SURVEY

This section provides information about a user survey that was conducted from June 16, 2021, to August 13, 2021, to assess how users of the new bike/pedestrian path on the bridge view its usefulness and safety. Specific information presented includes:

- Survey development
- Survey dissemination
- Survey results

5.8.1. SURVEY DEVELOPMENT AND DISSEMINATION

The user survey was developed in TypeForm, an application allowing for posting online surveys. A key criterion behind the setup was for path users to be able to answer questions on their mobile phones or at home. Table 5-1 and Table 5-2 detail the questions that were asked within the survey. The first set of

Table 5-1: Survey Questions Related to Improvements on the Richmond-San Rafael Bridge

Question	Answer Choices
1. Have you used the bike/pedestrian path on the upper deck of the Richmond-San Rafael Bridge since its opening in November 2019?	• Yes, as a bicyclist • Yes, as a pedestrian • Yes, as both a bicyclist and pedestrian • No
2. If yes, how frequently do you use the path?	• 1-4 times a week • More than 4 times a week • 1-4 times a month • Occasionally (less than once a month on average) • Seldom (Used only 1-4 times total since opening)
3. Which day(s) do you predominantly use the path (check all that apply)?	• Weekdays • Saturdays • Sunday
4. Which of the following is the most likely reason you currently use the ped/bike path?	• Commuting/traveling to or from work • Commuting/traveling to locations other than work • Recreation • Exercise • Other (please specify)
5. When using the bike/ped path, do you usually (check all that apply)	• Complete a round trip on the path • Use the path one way and return home on a different route • Use the path one way and use a motor vehicle or bus for the other way across the bridge to complete your trip • Do not go completely across the bridge, but turn around mid-way
6. How safe do you feel on the Richmond San Rafael Bike/Pedestrian Path?	• A number between 1 and 10, with 1 being not safe at all and 10 very safe
7. What is the primary factor you think of when considering your safety:	• Open text box
8. How beneficial do you think the Richmond San Rafael Bike/Pedestrian Path improvements are to you?	• A number between 1 and 10, with 1 being not beneficial at all and 10 very beneficial

Table 5-2: Additional Survey Questions

Question	Answer Choices
9. When making your trip across the Richmond-San Rafael Bridge, is your **starting destination** on the	• Richmond/Contra Costa side of the bridge • San Rafael/Marin side of the bridge
10. Please provide the closest intersection or neighborhood to describe your usual starting destination	• Open text box
11. When making your trip across the Richmond-San Rafael Bridge, is your **ending destination** on the:	• Richmond/Contra Costa side of the bridge • San Rafael/Marin side of the bridge
12. Please provide the closest intersection or neighborhood to describe your usual ending destination	• Open text box
13. Any comments you would like to add about your experience with the bike/pedestrian improvements?	• Open text box
14. Any comments you would like to add about your experience with Richmond-San Rafael Bridge?	• Open text box
15. How did you hear about the survey?	• Sign on bike/ped path • Social media post • Local news source • Caltrans or MTC press release • Bike advocacy groups or other community groups • Other

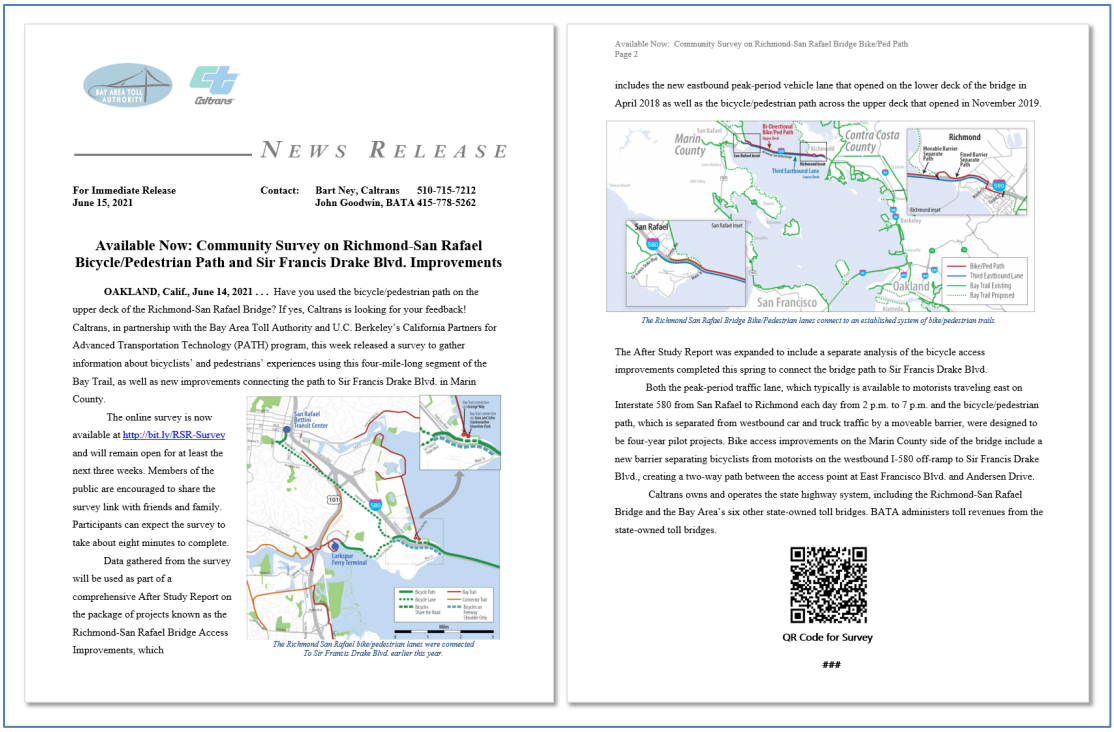
questions specifically pertained to the new bike/pedestrian path on the bridge, while the second set was included to gain some insights about the trips made on the bridge or overpass and how users have heard about the survey. Survey respondents did not necessarily have to answer all the questions. For instance, respondents who indicated on Question #1 that they did not use the new bridge path were not shown questions #2 to #7.

5.8.2. SURVEY DISSEMINATION

Information about the survey was disseminated to the public through:

- A formal Bay Area Toll Authority / Caltrans press release (Figure 5-18)
- Posts on websites maintained by the Metropolitan Transportation Commission/Association of Bay Area Governments and University of California Berkeley (Figure 5-19)`
- Mention of the survey on local news outlets, such as on Kron 4 television channel
- Email blast to bike advocacy groups
- Signs posted at various key locations along the path (Figure 5-20 to Figure 5-23)

A QR code linked to the survey was embedded in press releases and posters to facilitate access from mobile phones. On web pages, a hyperlink was used instead to bring users to the survey.



NEWS RELEASE

For Immediate Release
June 15, 2021

Contact: Bart Ney, Caltrans 510-715-7212
John Goodwin, BATA 415-778-5262

Available Now: Community Survey on Richmond-San Rafael Bicycle/Pedestrian Path and Sir Francis Drake Blvd. Improvements

OAKLAND, Calif., June 14, 2021 . . . Have you used the bicycle/pedestrian path on the upper deck of the Richmond-San Rafael Bridge? If yes, Caltrans is looking for your feedback! Caltrans, in partnership with the Bay Area Toll Authority and U.C. Berkeley's California Partners for Advanced Transportation Technology (PATH) program, this week released a survey to gather information about bicyclists' and pedestrians' experiences using this four-mile-long segment of the Bay Trail, as well as new improvements connecting the path to Sir Francis Drake Blvd. in Marin County.

The online survey is now available at http://bit.ly/RSR-Survey and will remain open for at least the next three weeks. Members of the public are encouraged to share the survey link with friends and family. Participants can expect the survey to take about eight minutes to complete.

Data gathered from the survey will be used as part of a comprehensive After Study Report on the package of projects known as the Richmond-San Rafael Bridge Access Improvements, which

The Richmond San Rafael bike/pedestrian lanes were connected To Sir Francis Drake Blvd. earlier this year.

includes the new eastbound peak-period vehicle lane that opened on the lower deck of the bridge in April 2018 as well as the bicycle/pedestrian path across the upper deck that opened in November 2019.

The Richmond San Rafael Bridge Bike/Pedestrian lanes connect to an established system of bike/pedestrian trails.

The After Study Report was expanded to include a separate analysis of the bicycle access improvements completed this spring to connect the bridge path to Sir Francis Drake Blvd.

Both the peak-period traffic lane, which typically is available to motorists traveling east on Interstate 580 from San Rafael to Richmond each day from 2 p.m. to 7 p.m. and the bicycle/pedestrian path, which is separated from westbound car and truck traffic by a moveable barrier, were designed to be four-year pilot projects. Bike access improvements on the Marin County side of the bridge include a new barrier separating bicyclists from motorists on the westbound I-580 off-ramp to Sir Francis Drake Blvd., creating a two-way path between the access point at East Francisco Blvd. and Andersen Drive.

Caltrans owns and operates the state highway system, including the Richmond-San Rafael Bridge and the Bay Area's six other state-owned toll bridges. BATA administers toll revenues from the state-owned toll bridges.

QR Code for Survey

###

Figure 5-18: BATA/Caltrans Press Release for the User Survey

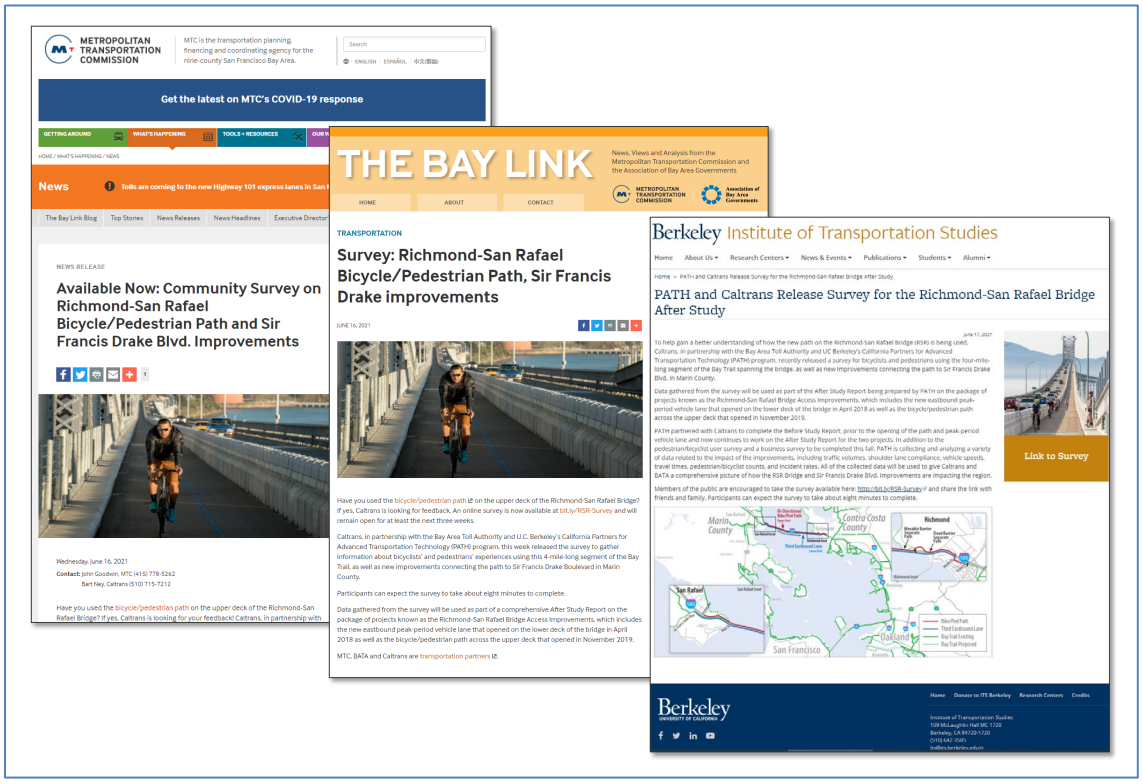


Figure 5-19: Online Posts for the User Survey

Figure 5-20: User Survey Signs Along Path – Richmond Side

Figure 5-21: User Survey Signs Along Path – Marin County Side

Figure 5-22: User Survey Signs Along Path – Vista Point on Marin County Side

Figure 5-23: User Survey Signs Along Path – Sir Francis Drake Overpass Access

5.8.3. SURVEY RESPONSE RATE

A total of 4,608 individuals viewed the survey splash page over its 8-week active period. Of these individuals, 2,833 started answering questions but only 2,166 individuals completed the survey. This means that 76% of respondents who started answering the survey completed it and 47% of individuals who became aware of it completed it.

A summary of the responses provided by the individuals who completed the survey is provided in Appendix A. More detailed discussions of the survey results are provided in Section 0

5.9. BUSINESS SURVEY

To assess the impacts on business activities associated with the bridge modifications, a series of interviews were conducted with businesses in Marin County located on local streets that were extensively used as alternate routes to the bridge before the modifications. These interviews focused primarily on assessing how congestion leading to the bridge affected the businesses and their employees. No interviews were conducted on the Richmond side as very few businesses were located on streets exhibiting significant bridge-related congestion.

Interviews for the before evaluation were conducted between April, August, and December of 2016. Interviews for the after-evaluation were conducted in the first week of May 2022. The following subsections provide more details about the businesses that were visited, and the questions asked.

5.9.1. BUSINESSES INTERVIEWED – BEFORE STUDY

A total of sixteen businesses were visited for the before study. Table 5-3 lists the various business visited and the date the visit occurred. These businesses were selected based on their high number of employees or customers and their location along key local arterials running parallel to I-580. In each case, efforts were made to talk to managers.

Table 5-3: Businesses Visited in 2016

Date of Visit	Name of Business	Street Location
April 21, 2016	Target	Shoreline / E. Francisco
April 21, 2016	Home Depot	Shoreline / E. Francisco
April 21, 2016	FedEx	E. Francisco
April 21, 2016	Ace Printing	E. Francisco
April 21, 2016	Bay Café	E. Francisco
August 3, 2016	Orchard Supply Hardware	Andersen
August 3, 2016	Smart and Final	Andersen
August 3, 2016	West America Bank	E. Francisco
August 3, 2016	Marin Airporter	Andersen
August 3, 2016	United Parcel Service (UPS)	Kerner
August 3, 2016	US Postal Service	Bellam
December 1, 2016	Extended Stay America	E. Francisco
December 1, 2016	Marin Honda	Shoreline / E. Francisco
December 1, 2016	U-Haul	E. Francisco
December 1, 2016	PG&E Service	Andersen
December 1, 2016	Central Marin Sanitary District	Andersen

5.9.2. QUESTIONNAIRE – BEFORE STUDY

The following questions were asked of each business during the before survey. Since some questions were repetitive or answered in another question, every question did not necessarily have complete information in the answer tables.

1. How do traffic on I-580 and the surrounding roads affect your business and customer/employee access?
2. What days/times are the worst (i.e., weekdays, weekends, specific days, and/or specific times)?
3. Does freeway traffic back up or divert onto local roads surrounding your business?
4. What, if any, types of comments do you hear from employees or customers regarding traffic issues?
5. Do you know where employees live and which on-ramps they use?
6. Do you know of any employees that may bicycle to work once the improvements on the bridge are constructed?

5.9.3. BUSINESSES INTERVIEWED – AFTER STUDY

For the after study, attempts were made to revisit the same businesses that were targeted for the before study. Visits were made in the first week of May 2022. As shown in Table 5-4, comments were obtained from only 8 businesses. First, not all businesses could be revisited as some had permanently closed since 2016. One was still listed as temporarily closed due to the Covid-19 pandemic. Two businesses where a questionnaire was dropped due to managers being unavailable ended up not responding to the survey. The remaining businesses that declined to participate in the after survey did so because of corporate policies preventing employees not working at a corporate office to comment on questions submitted to them.

Table 5-4: Businesses Visited in May 2022

Name of Business	Street Location	Response Provided
Target	Shoreline / E. Francisco	Yes
Home Depot	Shoreline / E. Francisco	No – Did not return the questionnaire
FedEx	E. Francisco	No – Did not return the questionnaire
Ace Printing	E. Francisco	No – Permanently closed
Bay Café	E. Francisco	No – Temporarily closed
Orchard Supply Hardware	Andersen	No – Permanently closed
Smart and Final	Andersen	No – No soliciting policy
West America Bank	E. Francisco	No – No soliciting policy
Marin Airporter	Andersen	Yes
United Parcel Service (UPS)	Kerner	Yes
US Postal Service	Bellam	Yes
Extended Stay America	E. Francisco	Yes
Marin Honda	Shoreline / E. Francisco	Yes
U-Haul	E. Francisco	Yes
PG&E Service	Andersen	No – No soliciting policy
Central Marin Sanitary District	Andersen	Yes

5.9.4. QUESTIONNAIRE – AFTER STUDY

The after survey was conducted more like a discussion than an administration of specific questions. The goal of the discussion was to try to obtain answers to the following questions:

1. Does traffic on I-580 and the surrounding roads affect your business and customer/employee access?
2. What days/times are the worst (i.e., weekdays, weekends, specific days, and/or specific times)?
3. Have there been noticeable changes in travel times to come from Richmond since the addition of the bike path on the upper deck (November 2019), particularly in the morning?
4. Have there been noticeable changes in travel times to get to Richmond since the opening of the lower deck shoulder lane (April 2018), particularly in the afternoon?
5. Does freeway traffic still back up onto local roads surrounding your business?
6. Do you know if some freeway traffic still uses local roads as a freeway bypass?
7. Do you know if some employees live on the Richmond side of the bridge?
8. What, if any, types of comments do you hear from employees or customers about traffic issues?
9. Do you have to consider potential delays due to bridge congestion when planning business activities or employee schedules?
10. Do you know of any employees using the bicycle path on the Richmond-San Rafael Bridge to come to work?
11. Any comments you would like to add about your experience with the bridge improvements?

Not all questions were necessarily answered with each discussion as some of the responses provided may have indicated that some questions were not relevant. Some businesses indicated for instance that they do not have employees coming from the Richmond side of the bridge or do not have business activities requiring them to use the bridge. In such cases, it would have been difficult for the businesses to comment on the impacts that the bridge modifications may have had on their activities or employees. The two-year covid-related delay in administering the after survey has also made it harder for interviewed individuals to recall all the specific conditions that existed in the corridor before the bridge modifications. Many businesses have also had a significant turnover of personnel in the past few years, resulting in many employees being unaware of previous traffic conditions in the corridor.

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6. BICYCLES TRAFFIC

This section presents the results of the evaluations assessing the demand for bicycle travel across the new path installed on the upper deck of the bridge. The following specific elements are discussed:

- Daily directional bicycle traffic on the bridge path
- Bicycles carried across the bridge on Golden Gate Transit buses
- Daily directional bicycle flow profiles on the bridge path
- Summary of observations

6.1. BICYCLE TRAFFIC - BRIDGE PATH

Figure 6-1 and Figure 6-2 illustrate the average daily eastbound and westbound bicycle traffic that was recorded by the sensors around the bridge between November 2019, when the path was opened, and mid-June 2022. Both figures distinguish three data collection periods based on the number of sensors used to calculate the average bicycle counts for each direction (see Figure 5-8):

- **November 2019 – August 2020:** Counts based only on the Richmond and Marin sensors.
- **August 2020 – March 2021:** Counts based on the Maintenance Yard, Richmond, and Marin sensors.
- **April 2021 – Present:** Counts based only on the Maintenance Yard and Marin sensors, as the Richmond sensor was relocated to another location in March 2021. This period also marks a change in the placement of in-pavement sensors at the Marin location in response to an analysis suggesting that the eastbound and westbound counts might be inverted.

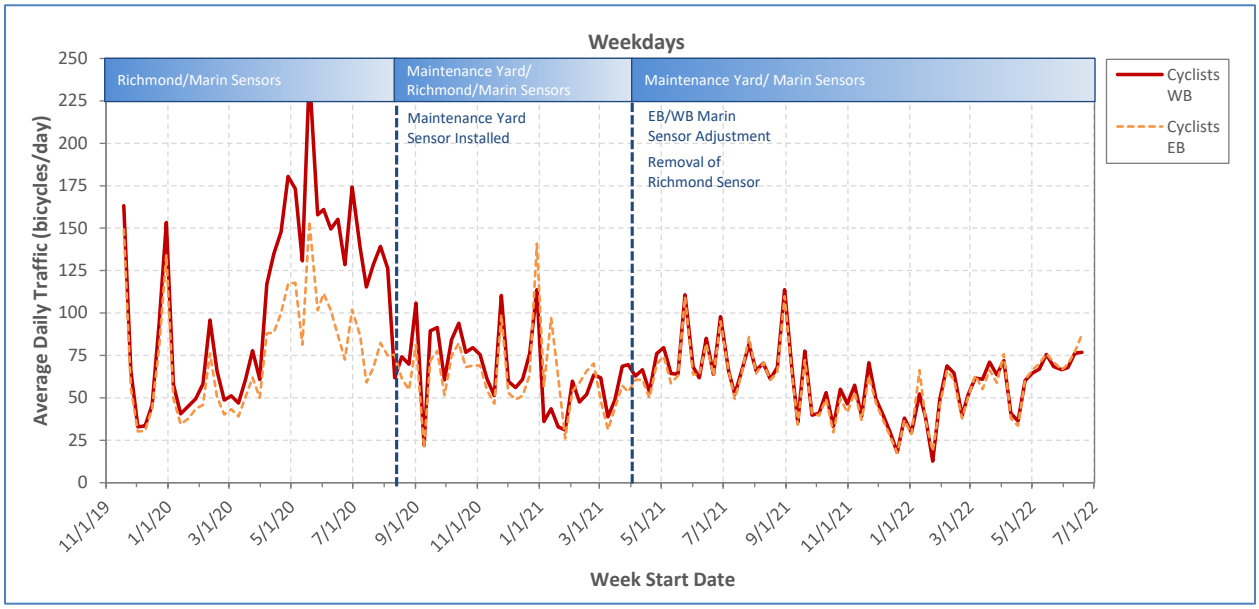

Figure 6-1: Daily Bicycle Traffic – Bridge Path – Weekdays, 2020-2022

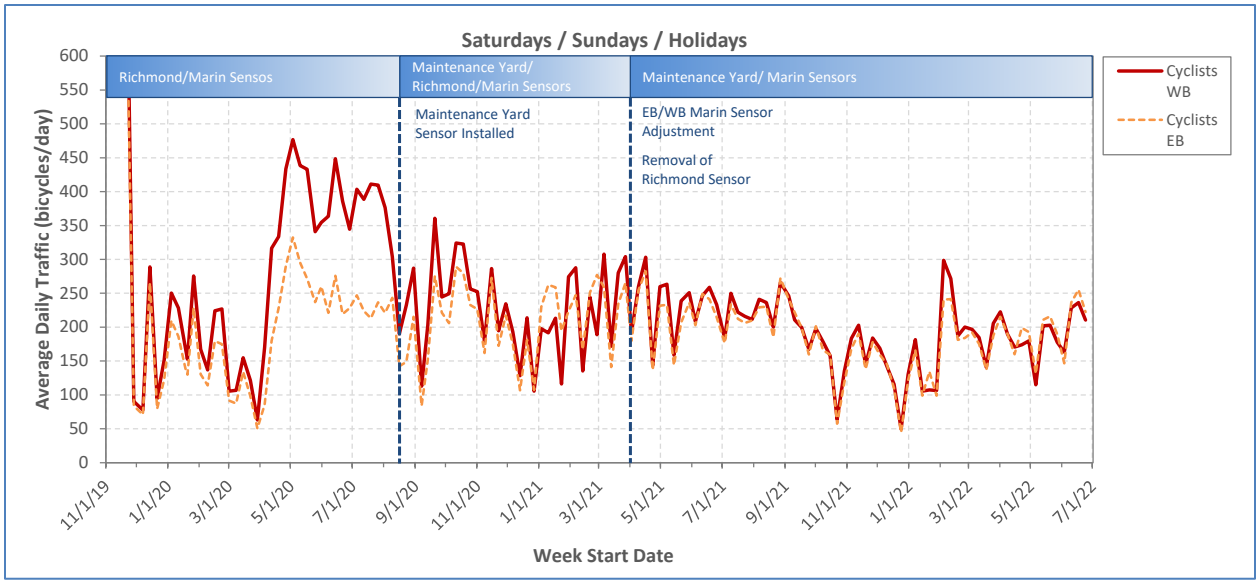

Figure 6-2: Daily Bicycle Traffic – Bridge Path – Weekends, 2020-2022

Based on the illustrated data, the following observations can be made regarding the path utilization by cyclists:

- Since January 2021, between 150 and 300 cyclists have been observed traveling in each direction on the bridge path on Saturdays, Sundays, and weekday holidays, for a westbound average of 235 cyclists and an eastbound average of 213 cyclists.
- Over the same period, between 50 and 75 cyclists have typically been observed crossing the bridge in each direction during weekdays, for a daily average of 68 cyclists in both directions.
- The highest reported weekday and weekend traffic occurred between April and August 2020, during the path's first summer. Initial curiosity may have contributed to this high traffic. Following the March 2020 Covid-19 stay-at-home order, some individuals may also have decided to go on bike rides to break the monotony of staying home. Sensor issues may have further affected the early measurements. This is suggested by the significant drop in measured traffic, particularly in the westbound direction, after the sensor at the Caltrans Maintenance Yard was activated and adjustments were made to the other sensors to reduce the capture of nearby vehicular traffic.
- Weekend traffic shows significantly more variations on a week-by-week basis than weekday traffic. This is likely due to variations in the nature of the bicycle traffic. During weekends, traffic is primarily recreational, and thus heavily influenced by the weather. During weekdays, a portion of path users may be individuals commuting to work. While the weather may still affect the decision to ride, weekday riders may be more accustomed to inclement weather and thus less inclined to ditch their bike on rainy or windy days.
- Following the March 2021 adjustments to the Marin sensor, eastbound and westbound counts generally appear to follow similar patterns. While some discrepancies remain, this may be due to some riders traveling only along a section of the bridge before turning back. This is likely to occur more often with recreational weekend riders than work-related weekday riders, thus explaining the larger observed weekend discrepancies compared to the weekday data.

- The more recent data suggests that there are generally slightly more riders traveling westbound towards Marin County than eastbound towards Richmond during the day. This imbalance is observed at all counting locations. Based on data collected from path users in the summer of 2021 (see Section 0) and the fact that morning trips tend to be westbound crossings, this unbalance can be explained by a proportion of riders following a circuit not taking them back to the bridge or using a different mode of transportation to return to their starting point.

6.2. BICYCLES CARRIED ON GOLDEN GATE TRANSIT BUSES

Before the opening of the bridge path, cyclists wishing to cross the Richmond-San Rafael bridge only had the option of using Golden Gate Transit buses to cross the bridge. To help assess the impact of the new bridge path on the need to use buses to cross the bridge, Golden Gate Transit provided monthly counts of bikes carried by buses on routes crossing the bridge between May 2015 and May 2022. These counts are summarized in Figure 6-3. Monthly counts before the opening of the bike path in November 2019 are linked by a solid line, while counts following the path opening are linked with a dotted line.

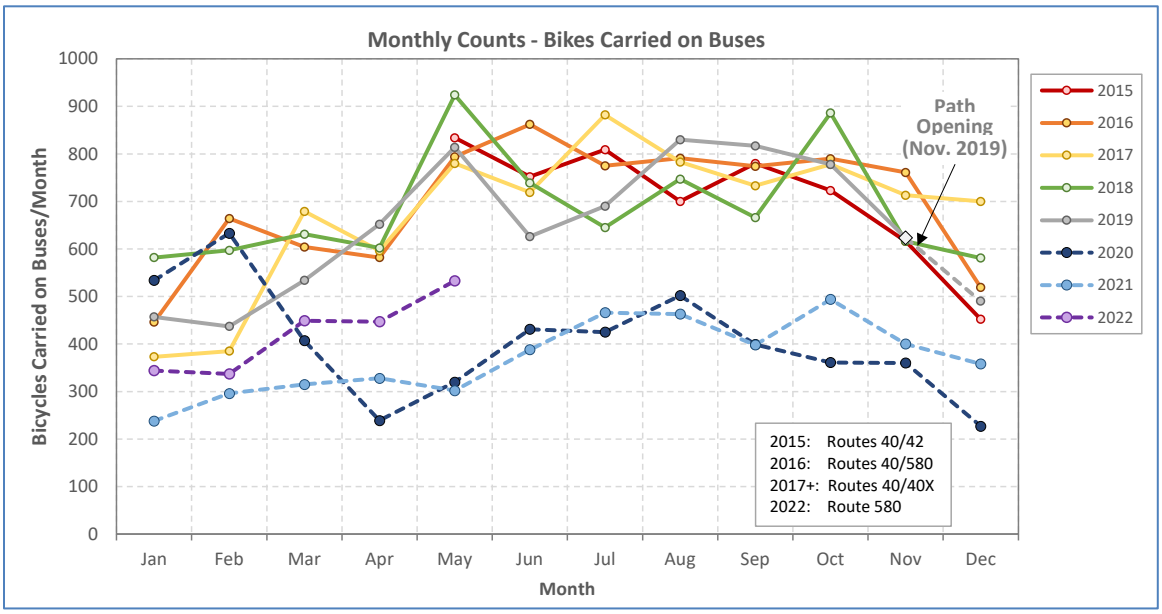

Figure 6-3: Bicycles Carried across Bridge on Golden Gate Transit Buses, 2015-2022

The following key observations can be made from the data:

- Before the bike path opened, buses crossing the bridge carried between 780 and 925 bikes during May, typically the month with the highest demand, and between 375 and 580 bikes in December/January. This corresponds to monthly averages ranging between 465 and 829 bicycles, or 15 to 28 bicycles per day.
- Following the bridge path opening in November 2019, the number of bikes carried across the bridge for December 2019, January 2020, and February 2020 appear to stay within the 2015-2019 historical range.
- A significant drop in counts occurred in March/April 2020, corresponding to the imposition of the first Covid-19 stay-at-home order. Following this drop, counts have remained below previous years while generally mirroring the previously observed annual cyclic pattern.

- Between April 2020 and December 2021, counts corresponded to 50-60% of the 2015-2019 average, with a range between 227 and 466 bicycles/month. However, counts from 2022 show a notable increase. While still being 35% below the 2015-2019 average, the 533 bikes carried in May 2022 represents a 76% increase over the May 2021 counts.
- Since a portion of the reduction in the monthly number of bikes carried over the bridge since 2019 can be associated with Covid-19 effects, it cannot yet be accurately ascertained what portion of the drop may be directly related to a shift in demand from buses to the bridge path. More data needs to be collected to reach a more definitive conclusion.

6.3. TIME-OF-DAY USE PROFILES – BRIDGE PATH

Figure 6-4 illustrates the daily eastbound and westbound bicycle traffic profiles across the bridge for an average weekday, Saturday, and Sunday between April 2021 and May 2022. This is an average of the data recorded by sensors at both ends of the bridge. For each day, the diagrams show the fraction of the total daily flow within each hour. The dotted line further represents the eastbound traffic and the solid line the westbound traffic.

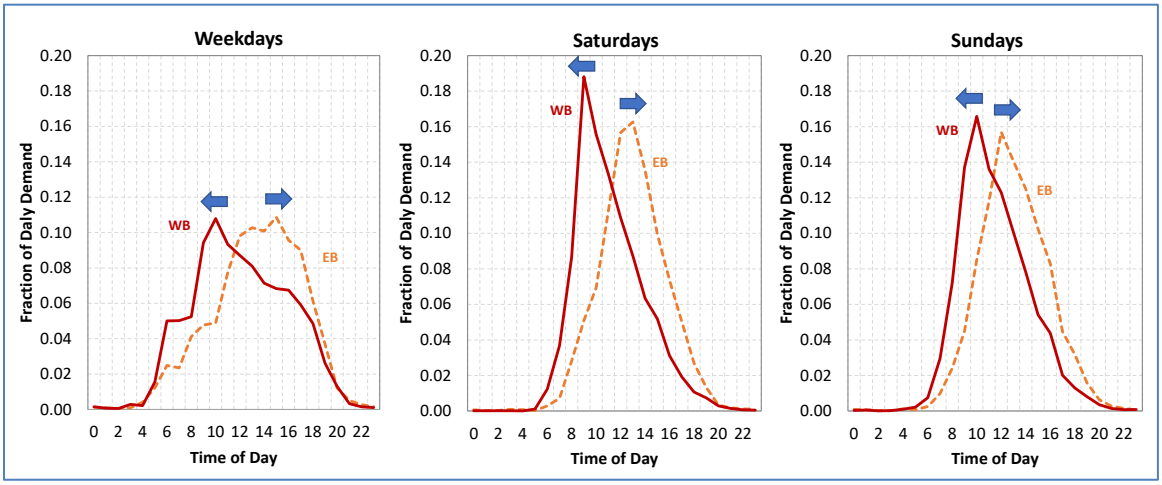

Figure 6-4: Time-of-Day Bicycle Traffic Profiles – Bridge Path

The following observations can be made from the illustrated data:

- On all day types, cyclists mainly travel westbound in the morning and eastbound in the afternoon.
- Westbound traffic generally peaks between 9 and 11 AM, while the eastbound traffic typically peaks around 3 PM on weekdays and around Noon on weekends.
- Weekday bicycle traffic is more spread out across the day, while both Saturday and Sunday traffic show very pronounced peaks.

6.4. SUMMARY OBSERVATIONS

The following are key summary observations from the analysis of bicycle counts:

- Since January 2021, an average of 235 cyclists have traveled eastbound across the bridge on Saturdays, Sundays, and weekday holidays while 213 cyclists have traveled westbound. Depending on the season, daily directional traffic could be as low as 150 or as high as 300 cyclists/direction. On weekdays, daily directional traffic is around 68 cyclists, with lows around 50 and highs around 75 cyclists/direction.
- Weekday traffic is relatively constant, with only minor seasonal variations. Weekend traffic is expectedly highest in summer and lowest during the winter months, and more noticeably affected by weather conditions.
- Path users generally appear to be traveling westbound in the morning and eastbound in the afternoon.
- Golden Gate Transit buses going across the bridge have carried between 337 and 533 bicycles per month from January to May 2022. This corresponds to between 11 and 17 bikes per day. While these counts represent 65-75% of the bikes typically carried over each month during the same period from 2015 to 2019, which averaged between 465 and 829, they are a significant increase over the 2021 counts, which ranged between 238 and 315 bicycles/month.
- While there has been a drop in the number of bicycles carried across the bridge by Golden Gate Transit buses, it is still unclear what part of this drop can be linked to the opening of the path and what part might be a byproduct of the Covid-19 pandemic.

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7. PEDESTRIAN TRAFFIC

This section presents the results of the evaluations assessing the pedestrian traffic across the bridge. The specific elements discussed include:

- Daily pedestrian traffic volumes on the bridge path
- Time-of-day pedestrian flow profiles on the bridge path
- Summary observations

7.1. PEDESTRIAN TRAFFIC – BRIDGE PATH

Figure 7-1 and Figure 7-2 illustrate the average daily eastbound and westbound pedestrian traffic that was recorded by the sensor near the Caltrans Maintenance Yard on the east side of the bridge between August 2020, and mid-June 2022. This is the only sensor that provides valid pedestrian data during the study. Both figures distinguish two data collection periods based on which sensors returned valid pedestrian data (see Figure 5-8):

- **November 2019 – Mid-August 2020:** No valid pedestrian data available.
- **Mid-August 2020 – Present:** Pedestrian counts from the Maintenance Yard counter only.

While pedestrian data were collected from both the initial Richmond and San Rafael sensors between November 2019 and Mid-August 2020, the counts that were returned during this period were unrealistically high, often in the thousands of pedestrians per day. This problem was attributed to placements that caused both sensors to capture some vehicles passing in the nearby traffic lane. The pedestrian counting capability was disabled are both stations in March 2021, leaving only data collected by the Maintenance Yard station from August 2020 onward.

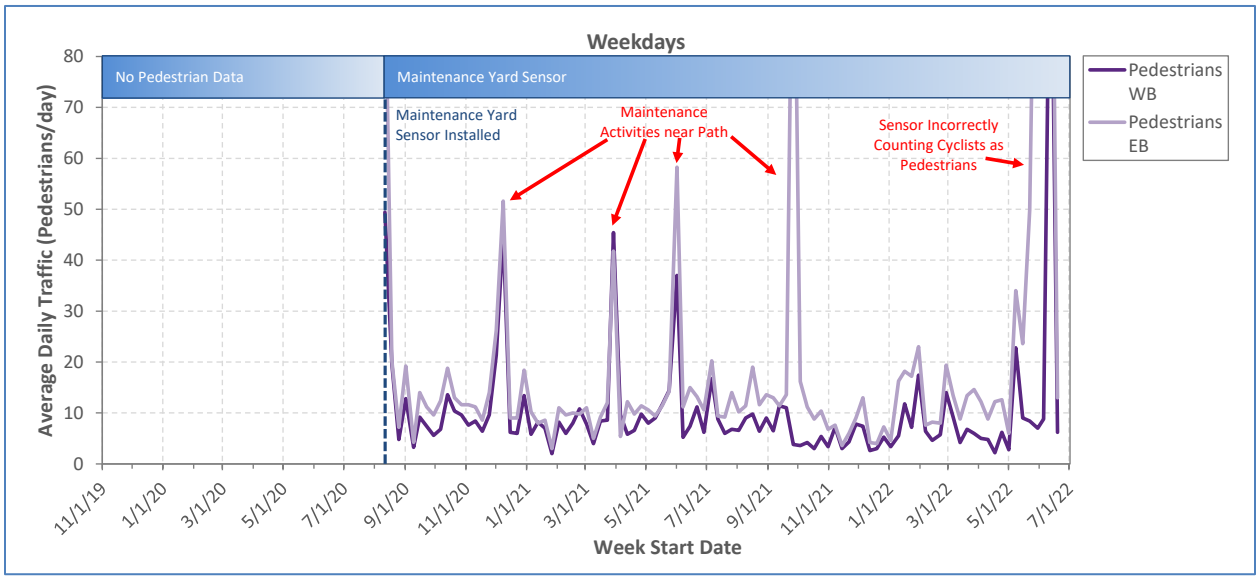

Figure 7-1: Daily Pedestrian Traffic – Richmond Bridge – Weekdays, 2020-2022

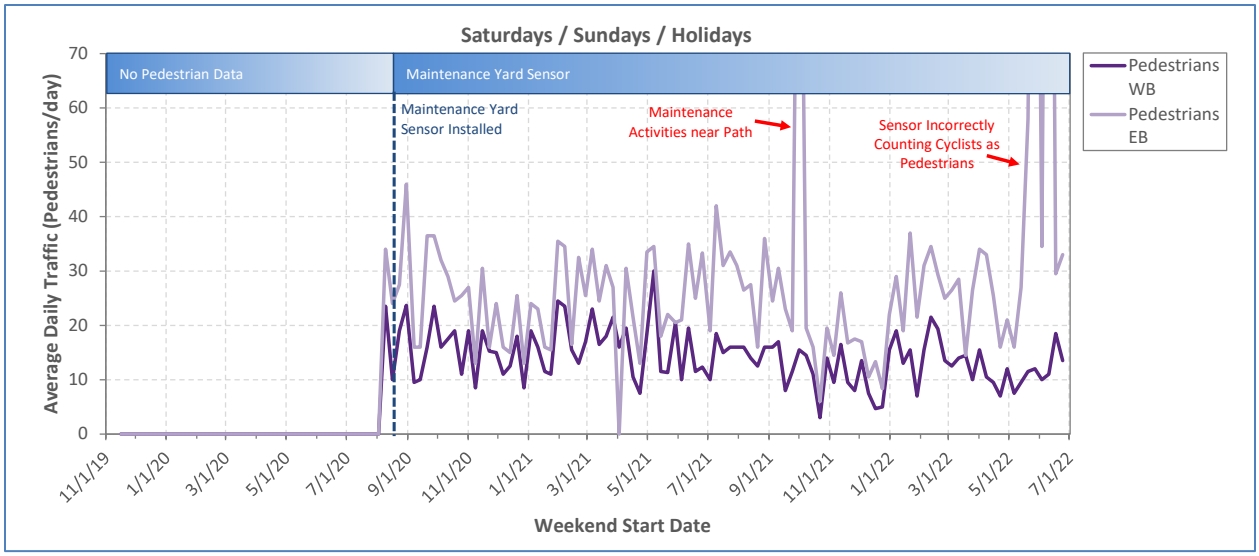

Figure 7-2: Daily Pedestrian Traffic – Richmond Bridge – Weekends, 2020-2022

Comparisons of the eastbound travel profiles captured by the Maintenance Yard counter to the eastbound profile extracted from the San Rafael counter in the fall of 2020 further suggested that the assumed travel direction might be incorrect at one of the two counters. This led to further adjustments being carried out at the end of March 2021 on both the Marin and Maintenance Yard stations to correct the recorded direction of travel and adjust the compiled data.

Finally, the four spikes in pedestrian traffic highlighted in Figure 7-1 in addition to the one in Figure 7-2 are attributed to construction or maintenance activities occurring near the Caltrans Maintenance Yard. In all instances, the sensors likely captured workers walking nearby them. For this reason, data from all marked days have been excluded from all the analyses further reported.

Based on the illustrated data, the following observations can be made about the observed pedestrian use of the bridge path:

- Relatively few pedestrians use the path. Since August 2020, daily weekday traffic has typically ranged between 5 and 20 pedestrians/direction, for an eastbound average of 8 pedestrians/day and a westbound average of 11 pedestrians/day.
- Weekend traffic has ranged between 10 and 40 pedestrians/direction, with occasional higher and lower peaks in both cases. for an eastbound average of 14 pedestrians/day and a westbound average of 24 pedestrians/day.
- The 6-mile length of the bridge may explain the relatively low pedestrian use of the path, as this length may be longer than what most people are willing to walk. It may also explain why some pedestrians may only walk a portion of the bridge.
- Based on field observations, some of the travelers seen going in one direction may be the same individuals seen traveling in the opposite direction, such as individuals using the path to access fishing locations on the path or near the bridge.
- Eastbound pedestrian counts are generally higher than westbound counts. It is unclear whether this is due to different directional volumes or some sensor setup.

- Weekday pedestrian traffic appears to be relatively stable throughout the year, suggesting that a significant portion of the observed pedestrians may be regular users.
- Both weekday and weekend traffic exhibit some cyclical pattern, with slightly higher observed traffic in the summer than in winter. This may likely be due to weather effects.

In the above assessment, the number of pedestrians using the path is likely to be underestimated. This is because all the collected data is based on a single sensor located on the Richmond side of the bridge. Due to the presence of the vista point and its parking area, some individuals likely access the path from the Marin County side and walk a portion of the bridge before returning to the vista point. Unless they have reached the Caltrans Maintenance Yard on the other side of the bridge, none of these individuals were therefore captured in the statistics.

Another unknown is the proportion of individuals walking on the path to reach a fishing location near the foot of the bridge. On the Marin County side of the bridge, individuals are frequently observed walking along the path to go set up fishing stations along the shoreline, on or off the path. These individuals would usually park their vehicle at the nearby vista point and would rarely fully cross the bridge. Since the only pedestrian counter is located on the Richmond side, these individuals were likely not captured in the pedestrian statistics. Some fishermen are also observed walking on the path on the Richmond side but to a much lower frequency than on the Marin County side.

7.2. TIME-OF-DAY USE PROFILES – BRIDGE PATH

Figure 7-3 illustrates the average eastbound and westbound daily pedestrian traffic profiles near the Caltrans Maintenance Yard in Richmond for weekdays, Saturdays, and Sundays. This is based on data recorded between April 2021 and May 2022. As indicated in the previous section, no valid pedestrian data were collected from the other sensors around the bridge. For each day, the diagrams show the fraction of the total daily flow seen within each hour compared to the total daily flow.

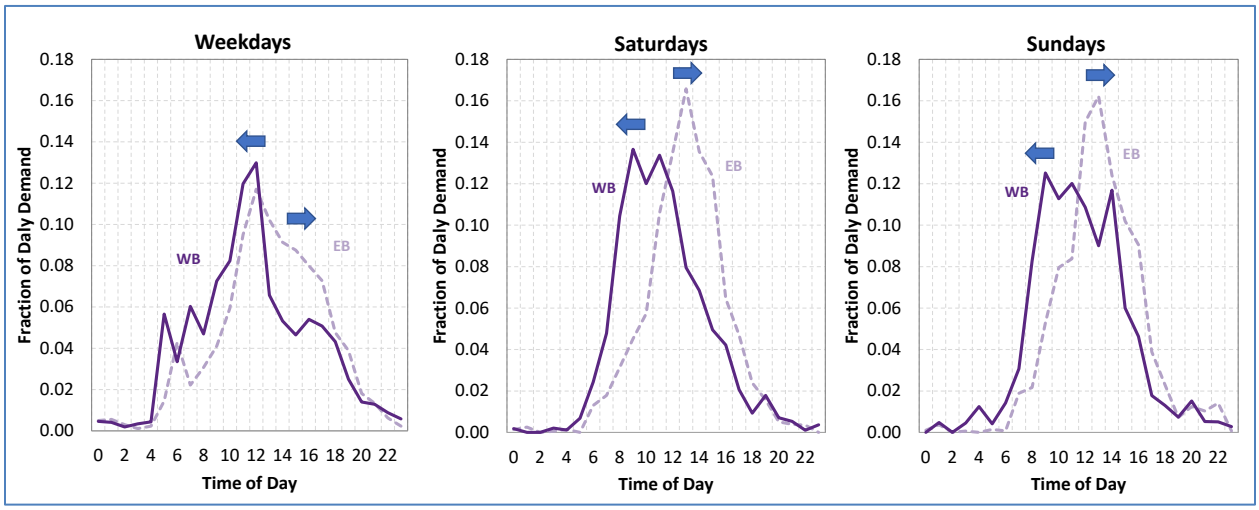

Figure 7-3: Average Daily Pedestrian Traffic Profiles, Maintenance Yard

The following observations can be made regarding the pedestrian traffic on the Richmond side of the bridge:

- More pedestrians travel westbound towards Marin County in the morning and eastbound towards Richmond in the afternoon. This is like the observed bicycle traffic.
- Westbound pedestrian traffic typically peaks around 11 AM on weekdays and around 9-10 AM on weekends, while eastbound traffic generally peaks around 1 PM.
- Pedestrian traffic is generally more spread out over time during weekdays than on weekends.

7.3. SUMMARY OBSERVATIONS

The following is a summary of key observations from the analysis of pedestrians counts on the Richmond side of the bridge:

- Pedestrian traffic on the bridge is relatively low. Average weekday eastbound traffic is only 11 pedestrians/day while westbound traffic is around 8 pedestrians/day. Weekend eastbound traffic averages 24 pedestrians/day while westbound traffic averages 14 pedestrians/day.
- A daily directional pattern appears to exist, with pedestrians mainly traveling westbound in the morning and eastbound in the afternoon.
- Both weekday and weekend traffic exhibit some cyclical pattern, with slightly higher observed traffic in the summer, compared to winter. This may likely be due to weather effects.
- The estimated pedestrian use is likely underestimated as the counts are based on a single sensor located on the Richmond side of the bridge. This sensor would not have captured individuals accessing the path from the vista point in Marin County and turning back before having fully crossed the bridge.
- The 4-mile length of the bridge may explain the low pedestrian demand.
- Fishermen have been observed using the path to access a location to cast their fishing lines, either on the shore or the path itself. Such individuals are more often seen on the Marin County side of the bridge, where they use the vista parking lot as a staging area.

8. TRAFFIC IMPACTS

This section presents the results of the evaluations that were conducted to assess the impacts on traffic of the modifications made to the bridge. Specific items covered in the section include:

- Observed changes in traffic demand over the evaluation period
- Impacts of opening the lower deck shoulder lane on eastbound traffic in Marin County
- Impact of converting the upper deck shoulder lane into a barrier-separated bike/pedestrian path on westbound traffic in Richmond and on the bridge

8.1. CHANGES IN BRIDGE TRAFFIC OVER THE EVALUATION PERIOD

Before evaluating the impacts of the various modifications made, traffic volumes around the bridge were reviewed to determine to which extent observed changes in speeds and travel times could be the result of underlying changes in traffic demand. Two specific aspects of traffic demands are evaluated below:

- Changes in daily total traffic volumes
- Changes in daily traffic profiles

8.1.1. DAILY TRAFFIC VOLUMES

Changes in traffic volumes were first analyzed using data from PeMS stations on I-580 near Canal Boulevard in Richmond (stations 400639 and 400738 in Figure 5-1), as these are the only stations having continuously provided good data between 2015 and 2021. While the data do not technically represent traffic on the bridge, most vehicles traveling at this location either come from it or travel towards it. Any changes in traffic there will thus be indicative of changes in traffic across the bridge. The westbound station is also sufficiently far from the bridge to be less affected by the congestion that frequently builds up upstream of the toll plaza.

Figure 8-1 to Figure 8-3 illustrates the eastbound and westbound daily flows that were measured near Canal Boulevard on weekdays, Saturdays, and Sundays from January 2015 to mid-December 2021. Data from 2022 are not included as the sensors stopped working in December 2021. In each figure, the dots represent specific day measurements while the solid lines represent moving averages across two weeks for weekdays and four weeks for Saturdays and Sundays. Only days with 90% or more observed data are included to avoid biasing results with less accurate estimates from the PeMS imputation process. Days affected by known major incidents are also ignored.

Before the Covid-19 pandemic, traffic volumes were slowly increasing year-over-year, with some seasonal patterns. Pre-pandemic volumes typically ranged between 30,000 and 43,000 vehicles/day, depending on the direction and day of the week. Through March and April 2020, daily traffic dropped by roughly 55% on weekdays and 66% on Saturdays and Sundays because of imposed Covid-19 travel restrictions. Following a quick partial rebound through June and July 2020, traffic demand went through another dip from December 2020 through February 2021 as the country experienced a second wave of Covid-19 infections. Since then, daily traffic volumes have rebounded significantly but have generally remained below pre-Covid levels, particularly on weekdays.

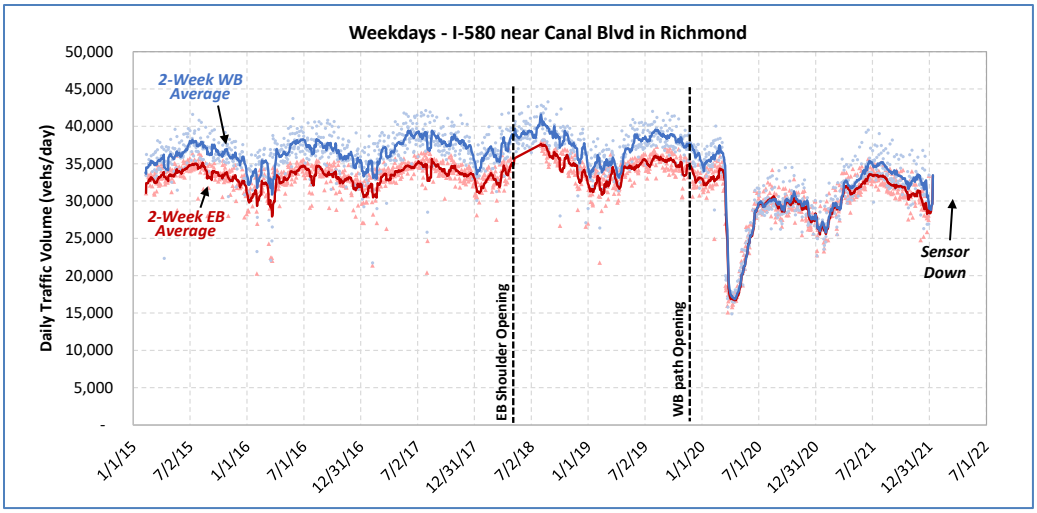

Figure 8-1: Traffic Volumes on I-580 near Canal Boulevard in Richmond – Weekdays, 2015-2022

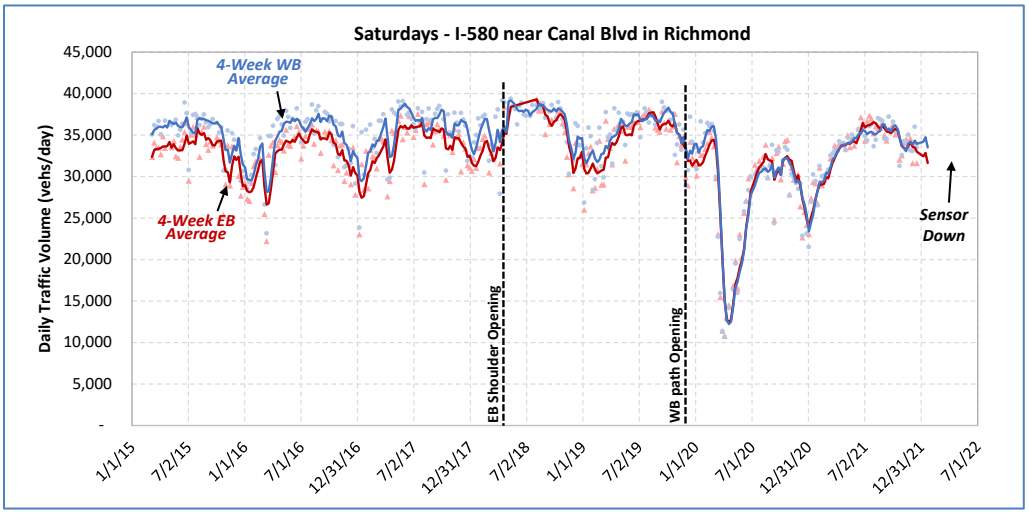

Figure 8-2: Traffic Volumes on I-580 near Canal Boulevard in Richmond – Saturdays, 2015-2022

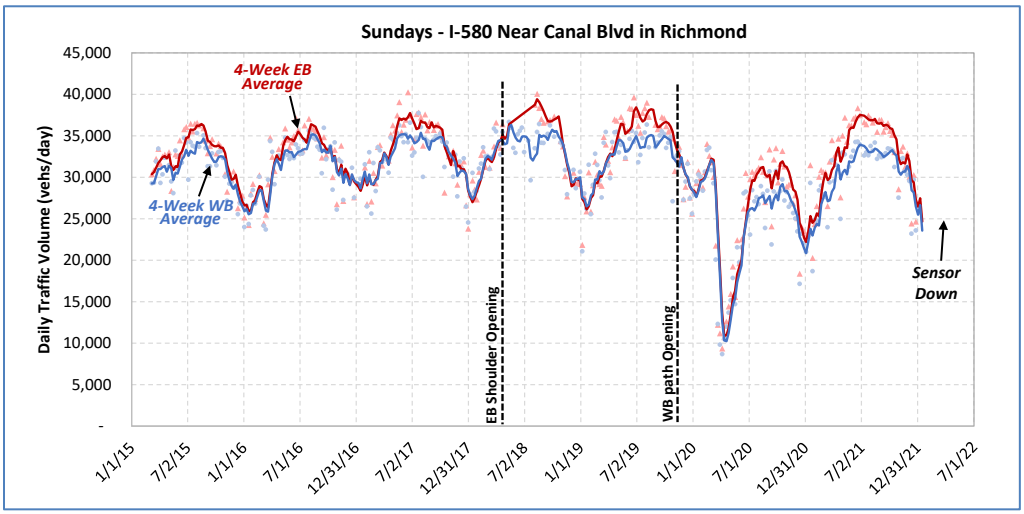

Figure 8-3: Traffic Volumes on I-580 near Canal Boulevard in Richmond – Sundays, 2015-2022

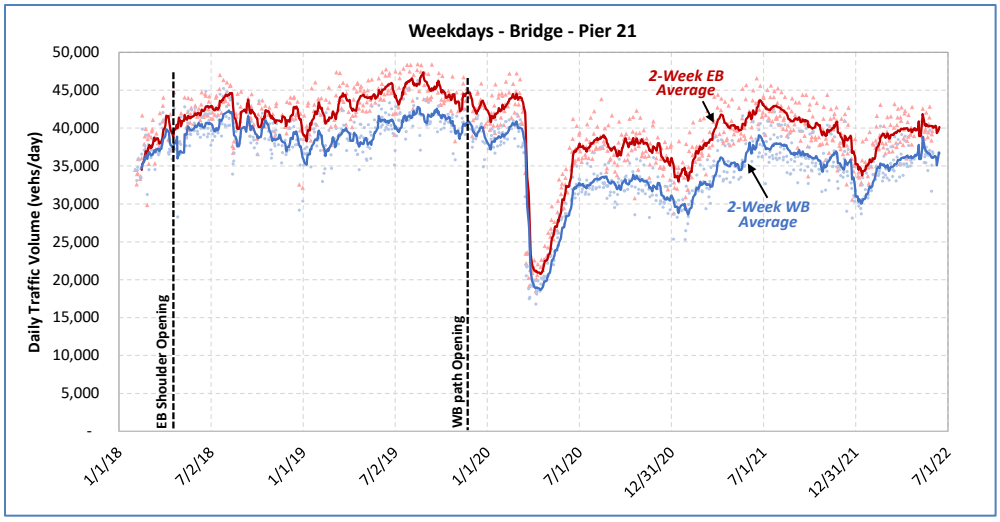

Figure 8-4: Traffic Volumes on Bridge – Weekdays, 2018-2022

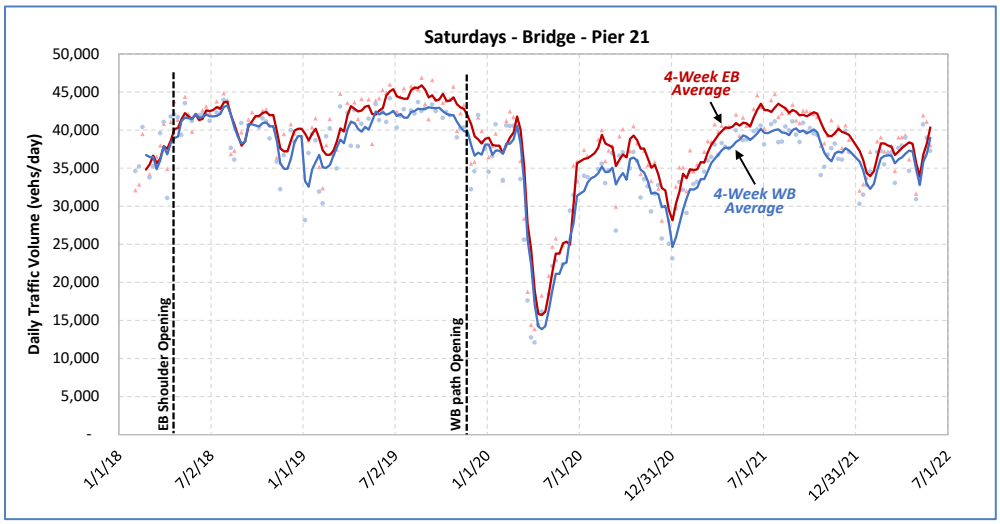

Figure 8-5: Traffic Volumes on Bridge – Saturdays, 2018-2022

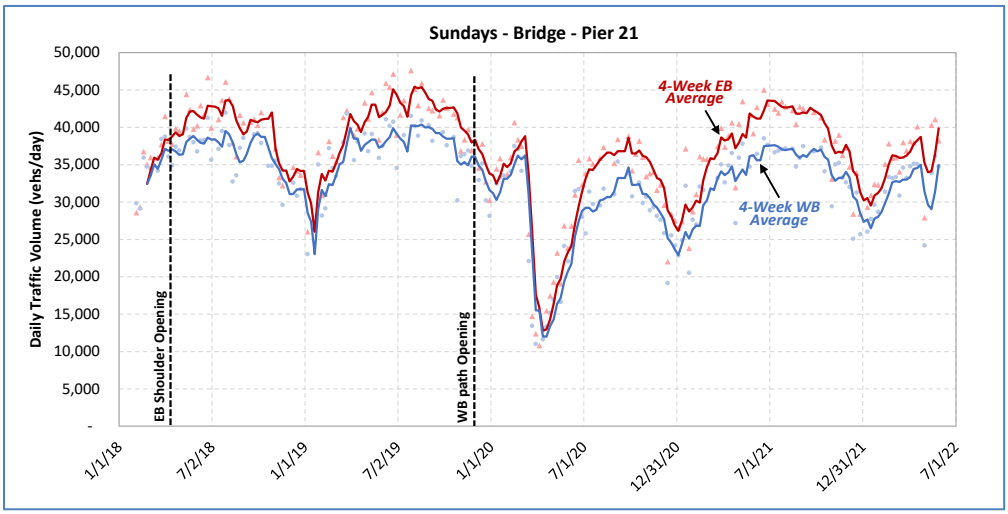

Figure 8-6: Traffic Volumes on Bridge – Sundays, 2018-2022

For comparison purposes, Figure 8-4 through Figure 8-6 illustrate observed traffic volumes near Pier 21 on the west end of the bridge between February 2018 and May 2022. Earlier data are not plotted as this is the only period for which data has been automatically collected by PeMS sensors on the bridge. While data from Pier 35 in the middle of the bridge were initially thought to be ideal for the assessment, a comparison to counts from the toll plaza revealed that sensors at this location were likely undercounting traffic, leading to the choice to use data from Pier 21 instead. Similar patterns to those observed near Canal Boulevard are observed, but with daily traffic ranging between 35,000 and 48,000 vehicles. This increase in traffic compared to the Canal Boulevard location is mainly the result of vehicles entering or exiting the freeway at the Castro Street/Richmond Parkway interchange.

8.1.2. TIME-OF-DAY TRAFFIC PATTERNS

Figure 8-7 to Figure 8-12 present average daily flow profiles across the bridge for weekdays, Saturdays, and Sundays for each year with available data between 2015 and 2022. For the eastbound direction, data are from the PeMS station in the middle of the bridge (Pier 35), which only started to produce data in February 2018. For the westbound direction, data are from the toll plaza counts. Each figure presents two average profiles: one covering February, March, and April, and the other covering late September, October, and early November. All profiles cover the same weeks year after year, except for Spring 2020, where data past March 15 were not considered to avoid including the sudden drop in traffic related to the newly imposed Covid-related stay-at-home order. In each diagram, dotted lines are further used to mark data associated with the before evaluation period and solid lines to mark data for the after period.

The following key observations can be made from the illustrated daily profiles:

- While data from Figure 8-1 to Figure 8-6 presented in Section 8.1.1 all indicate that 2021 and 2022 daily traffic volumes remain below pre-Covid levels, the profiles presented here indicate that this is largely due to off-peak flows remaining below pre-Covid levels.
- Daily peak traffic flows for 2021 and 2022 are generally back close to pre-pandemic levels, if not already exceeding them as in the case of the Saturday and Sunday profiles from February/March/April. The only exception is for westbound morning peak flows, which remain below the 2015-2019 historical averages.
- The fact that westbound weekday peak morning flows remain below levels observed before the November 2019 upper deck modifications will be explained in 8.3.2. This is likely a consequence of a reduced carrying capacity across the bridge due to effects associated with the installation of the multi-use path barrier and a shorter merge area at the foot of the bridge.
- The spring eastbound profiles show significantly higher afternoon peak flows for 2019-2022 than for 2016 and 2018, the only two years for which data is available before the lower deck modifications. This is due to the availability of an additional lane to cross the bridge. A similar observation cannot be made on the fall profiles as bridge sensors only started to produce data after the April 2018 modification. While some eastbound flow data were also collected at the toll plaza in May 2016 using radar detectors, these were deemed unrealistically too high in relation to the bridge carrying capacity and assumed to be invalid.

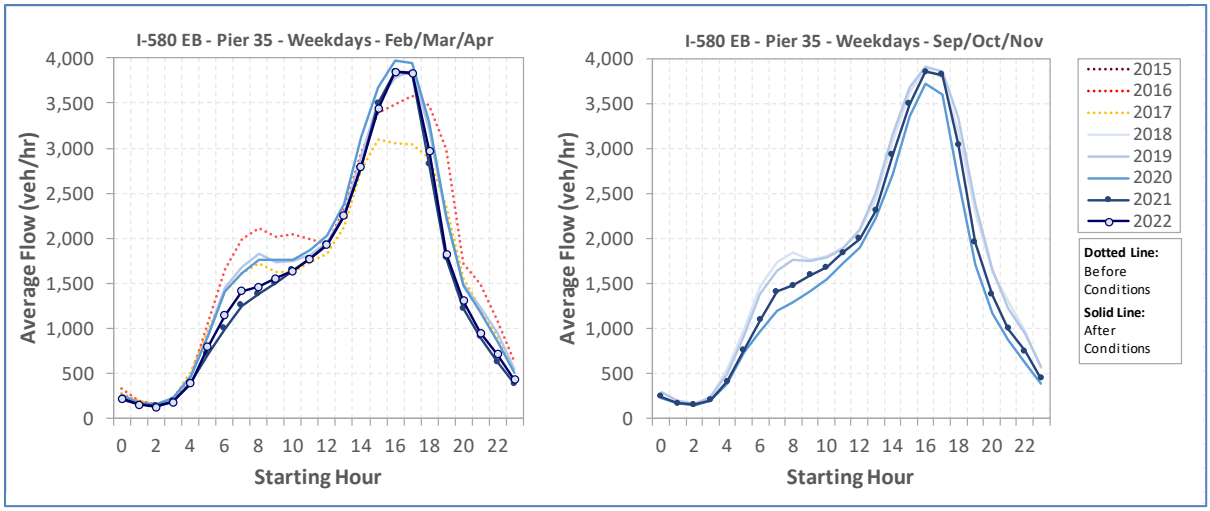

Figure 8-7: Daily Traffic Flow Profile – Bridge EB – Weekdays, 2015-2022

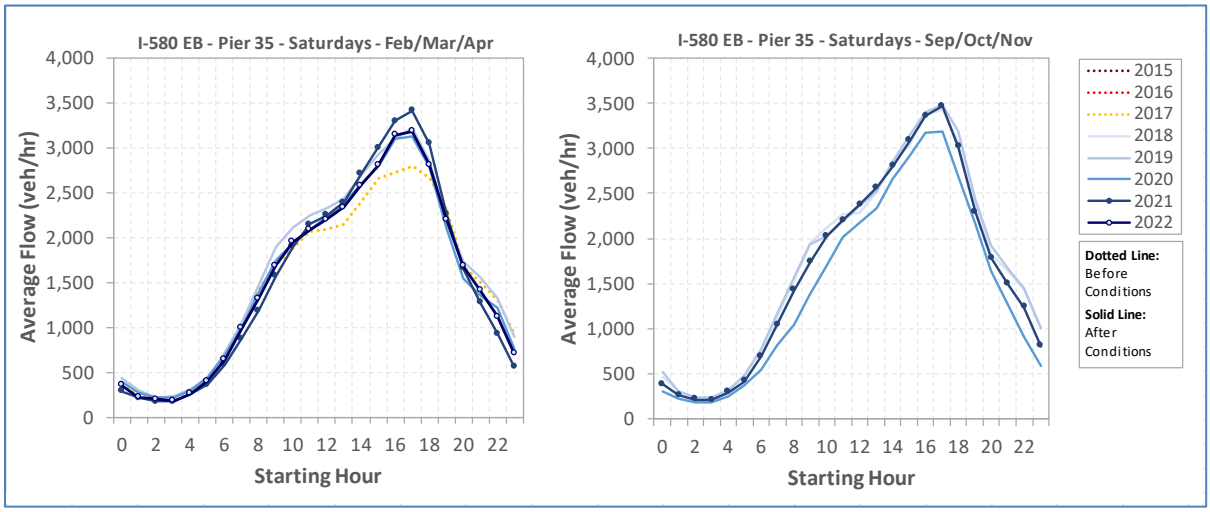

Figure 8-8: Daily Traffic Flow Profile – Bridge EB – Saturdays, 2015-2022

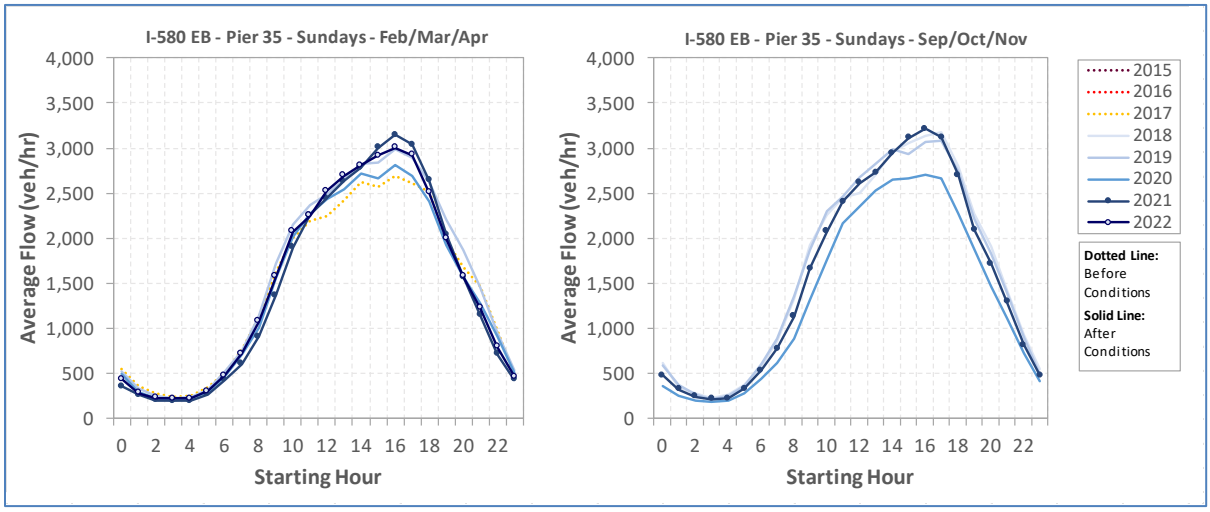

Figure 8-9: Daily Traffic Flow Profile – Bridge EB – Sundays, 2015-2022

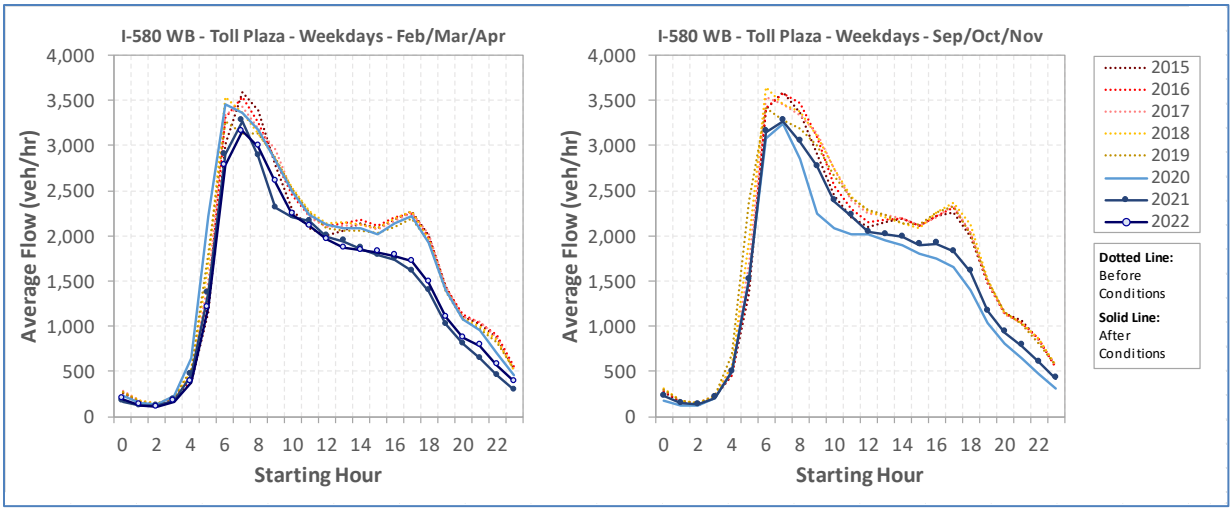

Figure 8-10: Daily Traffic Flow Profile – Bridge WB – Weekdays, 2015-2021

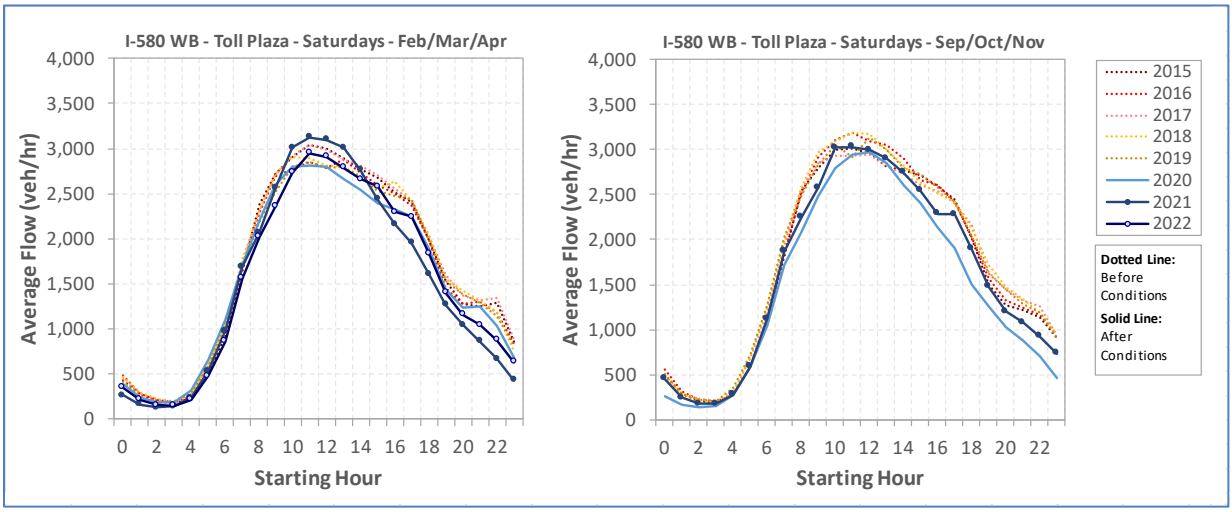

Figure 8-11: Daily Traffic Flow Profile – Bridge WB – Saturdays, 2015-2021

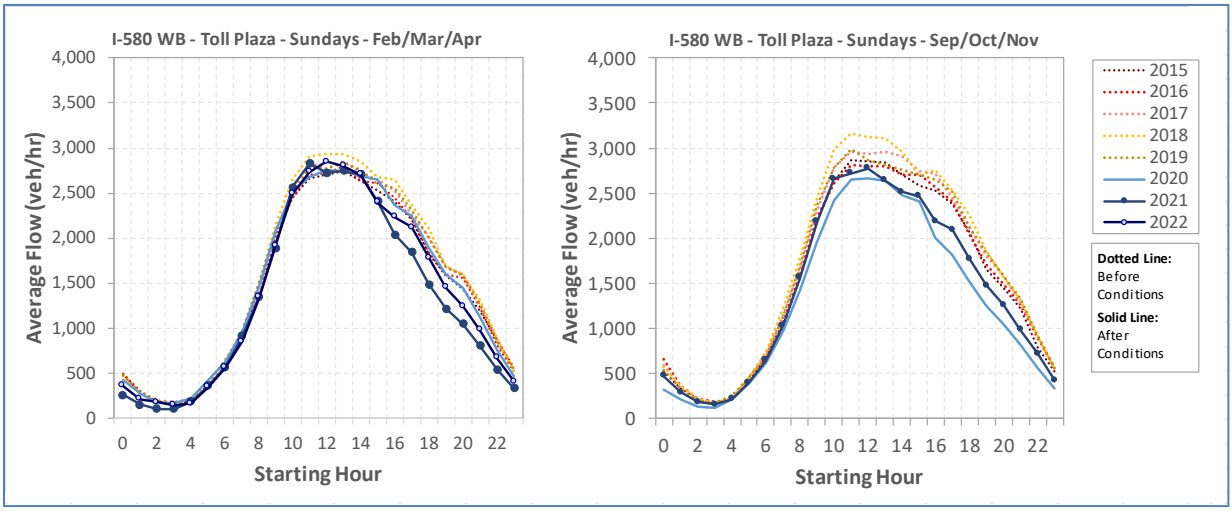

Figure 8-12: Daily Traffic Flow Profile – Bridge WB – Sundays, 2015-2021

8.2. IMPACTS ON EASTBOUND BRIDGE TRAFFIC

This section evaluates the impacts on traffic of the conversion of the eastbound lower deck shoulder lane into a part-time traffic lane. This evaluation covers the following elements:

- Eastbound freeway congestion before the modification
- Observed traffic on the shoulder lane when open
- Motorist compliance with the shoulder lane open/close periods
- Impacts of the new lane on the bridge carrying capacity
- Impacts on I-580 East traffic conditions between the US-101/I-580 interchange and the bridge
- Impacts on US-101 North travel times between Sir Francis Drake Boulevard and the I-580 interchange
- Impacts on Marin County arterials parallel to I-580 East, such as Sir Francis Drake Boulevard, Francisco Boulevard, and Andersen Drive
- Impacts on I-580 East ramp traffic at Bellam Boulevard and Main Street

8.2.1. INITIAL CONDITIONS

Figure 8-13 to Figure 8-15 illustrate the typical extent of the afternoon congestion before the shoulder lane opening on I-580 East in Marin County, the section of US-101 North south of the I-580 interchange, and the section of US-101 South north of the I-580 interchange. Data represents average observed speeds between mid-September and mid-November 2017, the last fall before the modification.

At that time, congestion along I-580 East was primarily caused by the number of traffic lanes reducing from three to two near the entrance of the bridge. As illustrated, congestion on I-580 East generally extended up to the US-101 interchange on weekdays, Saturdays, and Sundays. Weekday traffic on the

Figure 8-13: Extent of Congestion on I-580 East in Marin County before Bridge Modifications

Figure 8-14: Extent of Congestion on I-580 East in Marin County before Bridge Modifications

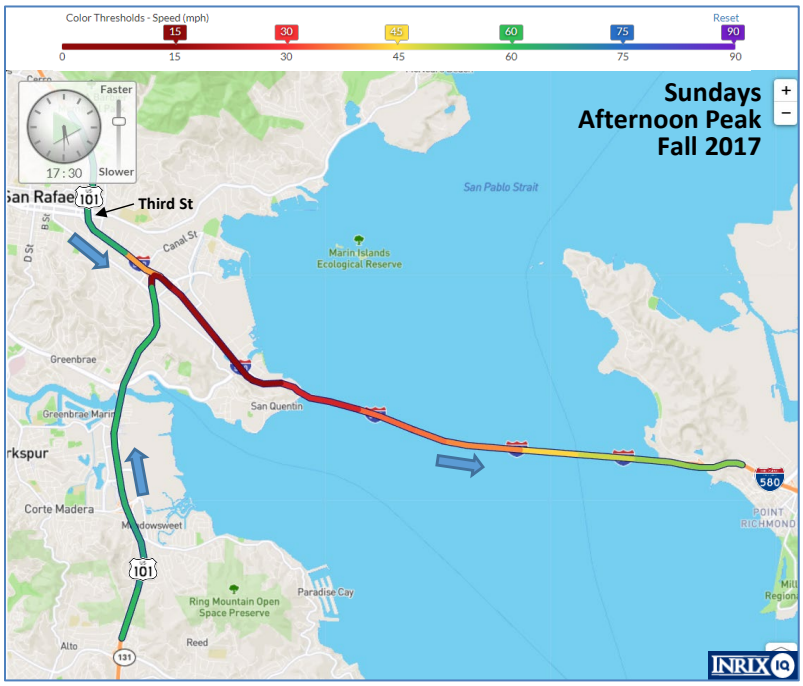

Figure 8-15: Extent of Congestion on I-580 East in Marin County before Bridge Modifications

US-101 North between Sir Francis Drake Boulevard and the I-580 interchange also appeared affected. While part of the US-101 congestion could be attributed to the I-580 East congestion, another part could also be explained by traffic frictions between the I-580 and Third Street interchanges caused by the merging of the US-101 North and I-580 West traffic. Congestion on Saturdays and Sundays also typically extended up to the US-101 interchange but did not appear to affect traffic along US-101 North.

8.2.2. SHOULDER LANE USE

Figure 8-16 illustrates the average flow rates on the shoulder lane between February and April 2021. More recent data are not used, as data for late 2021 and early 2022 are heavily affected by lane closures associated with bridge maintenance activities. As can be seen, vehicles typically start to use the lane at 2:00 PM, when it opens, and stop using it around 7:00 PM, when it officially closes. Weekday traffic typically peaked around 5:30 PM at a rate of about 1050 vehicles/hour, on Saturdays between 4:30 PM and 6:30 PM at a rate around 650 vehicles/hour, and Sundays around 5:00 PM at a rate around 600 vehicles/hour.

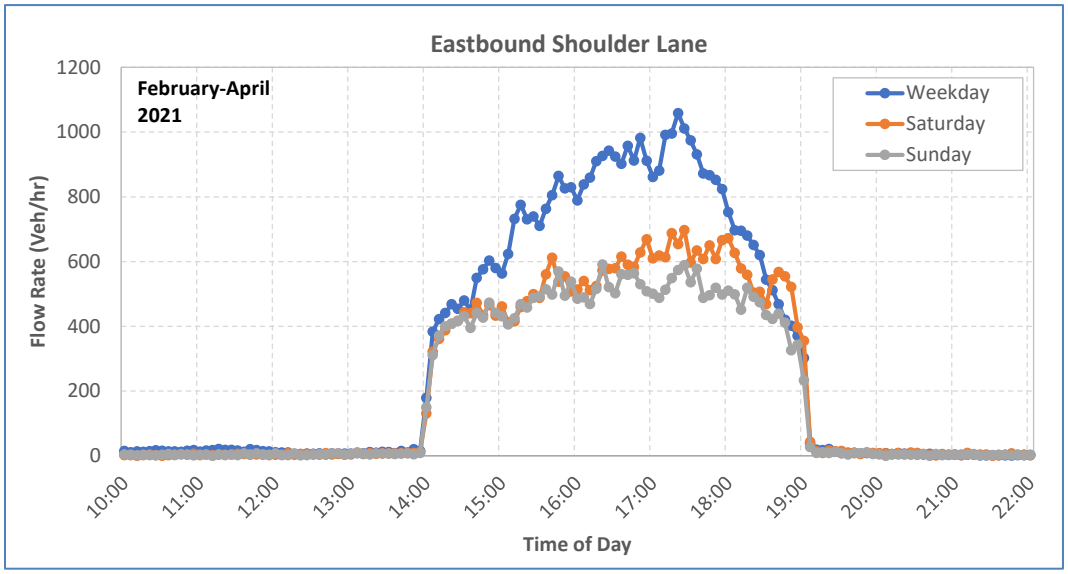

Figure 8-16: Lower Deck Shoulder Lane - Flow Rate

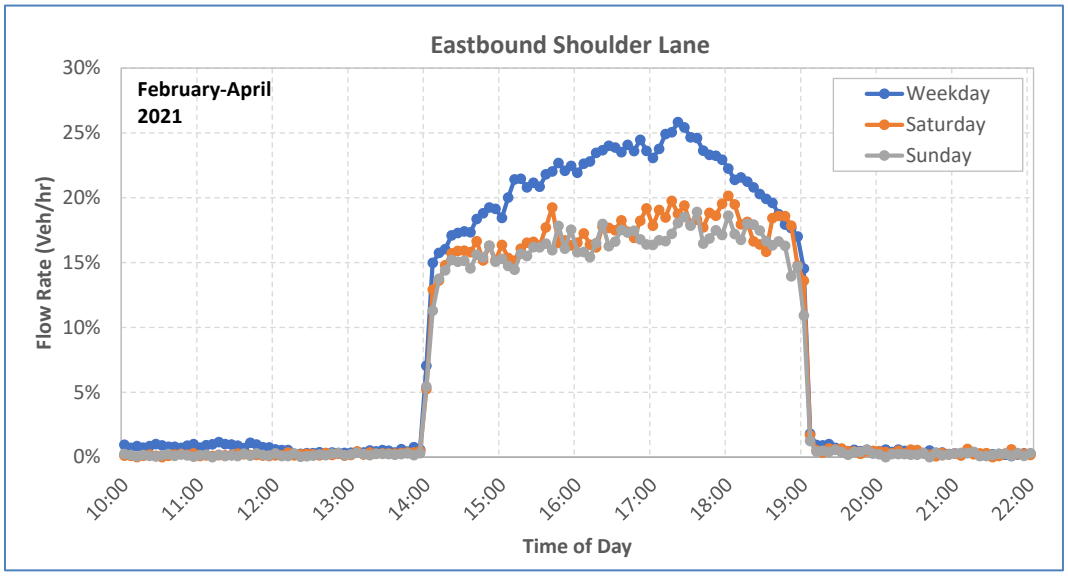

Figure 8-17: Lower Deck Shoulder Lane - Percent of Total Eastbound Flow

Figure 8-17 provides another view of the data Figure 8-16 by illustrating the percentage of vehicles on the lower deck using the shoulder lane. At its opening, about 15% of vehicles are on it. On weekdays, the proportion of traffic on the lane rose to about 25% between 5 PM and 6 PM before dropping again to 15% before its closure. On weekends, less than 20% of traffic is seen on the lane. If traffic were distributed equally among all eastbound lanes, we should instead have about 33% of traffic on each lane. The fact that utilization never roses above 25% indicates that motorists generally prefer to drive on the two regular lanes. This might be due to habits. The marking of the shoulder lane with a solid lane may also inadvertently entice motorists to stay on the two left lanes.

8.2.3. SHOULDER LANE COMPLIANCE

Based on the data in Figure 8-16, there appears to be relatively high compliance with the open/close periods of the shoulder lane. Relatively few vehicles are seen on the shoulder before 2 PM and after 7 PM when the two regular bridge traffic lanes are not affected by closures. On average, less than one vehicle per hour is observed using the shoulder at night, and between 5 and 16 vehicles per hour during other portions of the day when it is formally closed. These observations translate into a 99.6% compliance rate before 2 PM and after 7 PM on weekdays and Saturdays, and a 99.7% compliance rate on Sundays.

Some of the observed shoulder lane traffic outside its open period might be attributed to maintenance vehicles, tow trucks, and police vehicles. However, CHP officers have indicated observing vehicles using the lane to pass other vehicles. There is also a suspicion that some motorists may not understand the significance of the green arrow/yellow X/red X displayed on top of each lane, resulting in some motorists not realizing that the shoulder lane may be closed at some times.

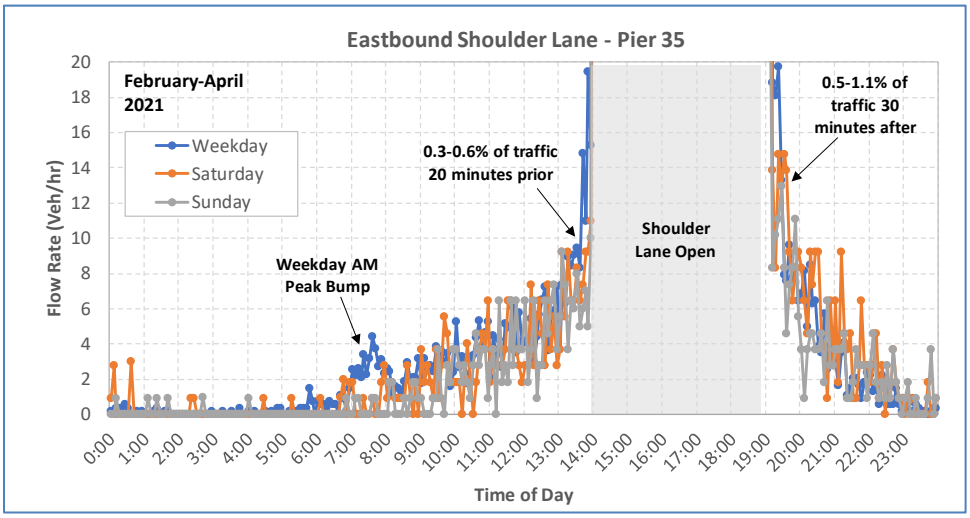

Figure 8-18: Lower Deck Shoulder Lane – Flow Rate When Closed

Figure 8-18 indicates that the periods of highest non-compliance are usually right before the shoulder lane opens and after it closes, typically 20 minutes before its opening and up to 30 minutes following its closure. A short peak in shoulder lane usage is also observed during the weekday morning AM peak period. On weekdays, shoulder traffic in the 20 minutes before its opening typically represents 0.6% of the total observed traffic. On Saturdays and Sundays, non-compliant traffic represents 0.4% and 0.3% of

the 20-minute traffic respectively. For the 30 minutes following the closing of the shoulder, non-compliant traffic typically represents 1.1% of weekday traffic and 0.5% of Saturday and Sunday traffic.

Non-compliance use of the shoulder outside its opening period is believed to have a minimal impact on traffic operations, largely due to its relatively small share of the overall traffic and because some of the observed traffic might be legitimate use by maintenance, police, or other vehicles. However, the use of the lane by non-authorized users may carry increased safety risks, as motorists traveling on the right lane may be surprised by vehicles traveling on the shoulder.

8.2.4. IMPACT ON LOWER DECK CAPACITY

Figure 8-19 illustrates peak eastbound hourly flows on the bridge near its entrance on weekdays, Saturdays, and Sundays between February 2018, when the bridge sensors were activated, and mid-June 2022. As expected, the data appears to indicate that the opening of the shoulder lane has increased peak flows across the bridge. From February to mid-April 2018, between 3,300 and 3,570 vehicles/hour were observed crossing the bridge during the afternoon peak. Since the opening of the shoulder lane, peak flows have mainly ranged between 3,750 and 4,500 vehicles/hour, depending on the observation day, representing a 13-26% capacity increase.

Figure 8-20 presents an additional look at the capacity increase discussed above by comparing eastbound flows measured in May 2016 at the toll plaza to flows captured at the same location in March 2022. Similar to the previous figure, an increase in peak afternoon flow rate from 3,500-3,600 vehicles/hour to around 4,500 vehicles/hour can be observed. The figure also indicates a potential reduction in the duration of the afternoon peak period associated with the elimination of congestion on the Marin side of the bridge. This is illustrated by the earlier drop in traffic after 6 PM. While some of this drop may be due to lower traffic demand due to the Covid-19 pandemic, a portion may be due to fewer vehicles being held back on the Marin side of the bridge. Similar to other analyses, morning and evening flow reductions are primarily due to Covid-related effects.

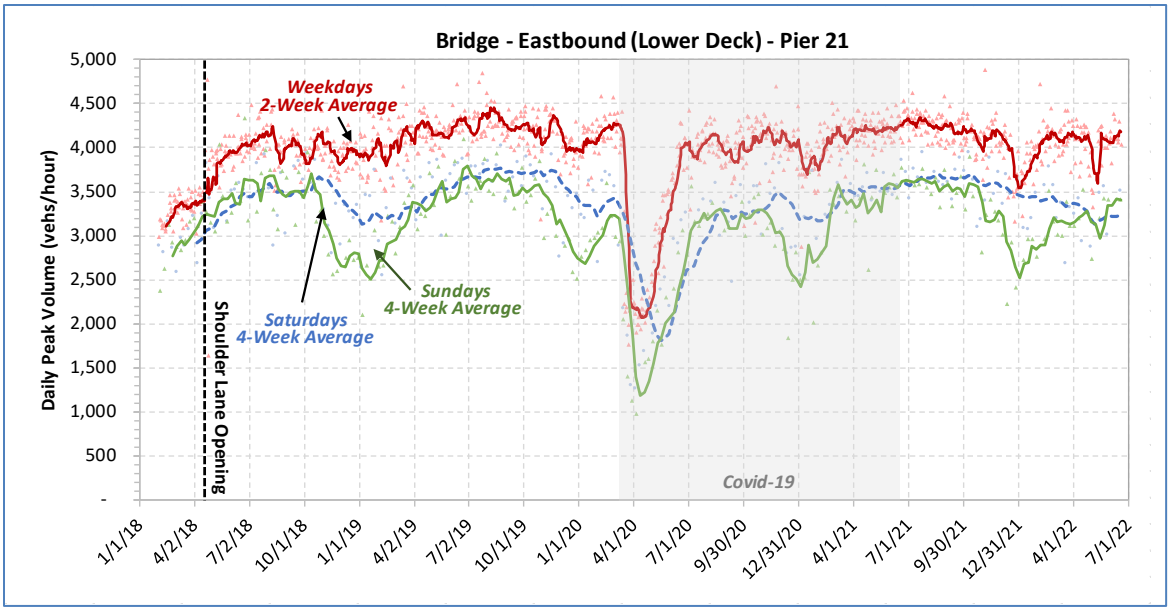

Figure 8-19: Average Peak Traffic Flow at Entrance of Bridge – Eastbound, 2018-2022

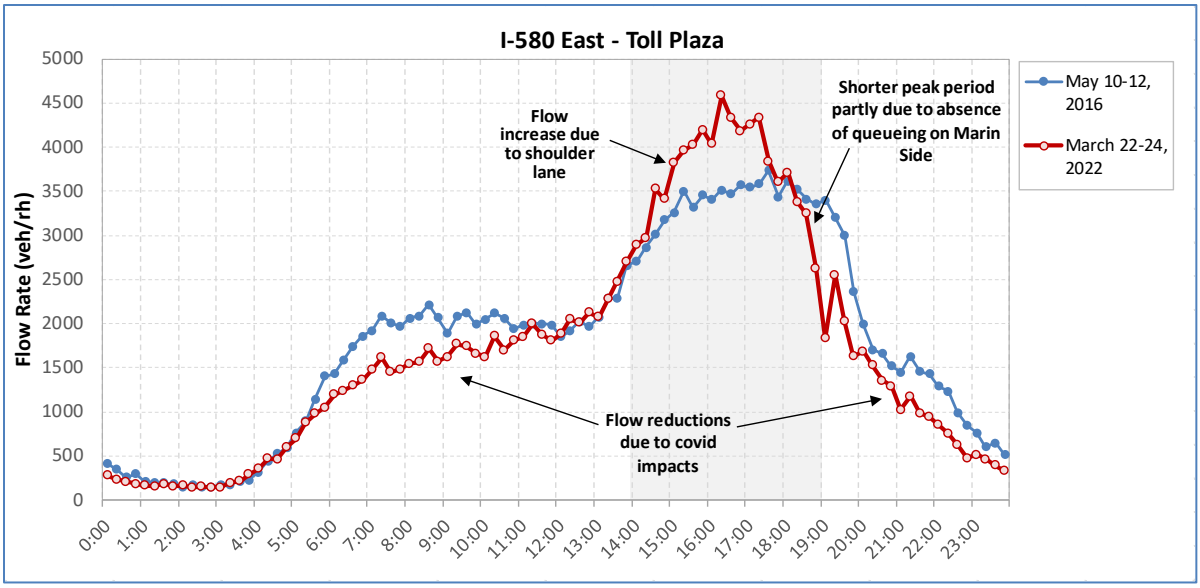

Figure 8-20: Observed Peak Traffic Flow at Toll Plaza – Eastbound, 2016 and 2022

An additional assessment can be made using data from freeway sensors just downstream of the Canal Boulevard off-ramp (PeMS station #400639) that has been continuously recorded since February 2015. While these sensors do not capture traffic that would have exited at the Castro Street and Richmond Parkway off-ramps, any significant increase in traffic crossing the bridge would normally translate into higher flows at this location. The peak flows measured there are shown in Figure 8-21. Before the opening, average peak weekday flows hovered around 2,425 vehicles/hour. After the opening, peak flows of around 2,825 vehicles/hour have been observed. This is a 16% increase that is in line with the data in Figure 8-19. While higher flows in the 3,250 vehicle/hour range appeared to have occurred immediately following the opening, motorists adjusting their travel time in response to the absence of congestion on the bridge approach may have resulted in the current lower peak flows.

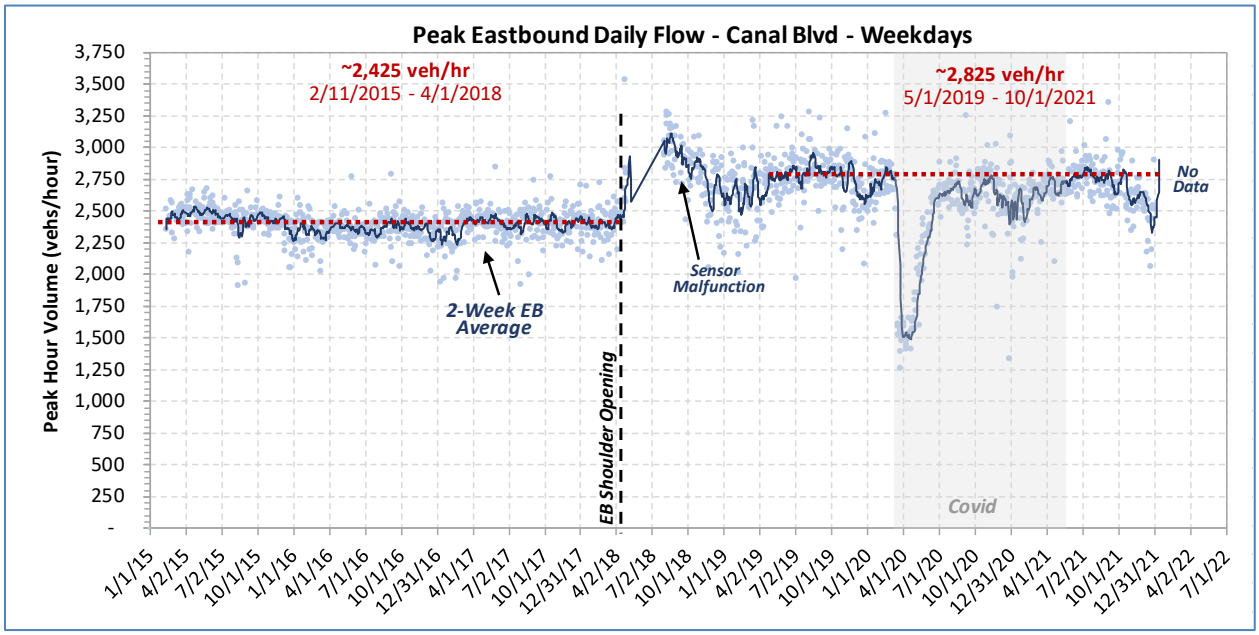

Figure 8-21: Average Peak Traffic Flow on I-580 East near Canal Boulevard, 2015-2021

Data collected from PeMS further suggests that peak hour flows on Saturdays and Sundays near Canal Boulevard have similarly increased by 15-16% following the shoulder lane opening. Prior average daily peak flows ranged from 2,250 and 2,750 vehicles/hour, while peak flows now range between 2,750 and 3,200 vehicles/hour.

The observed increases are a direct result of the added capacity provided by the third traffic lane. Before the modifications, the two existing lanes did not provide sufficient capacity to accommodate peak eastbound traffic on weekdays and weekends. This caused traffic to back up along I-580 East up to the US-101 interchange, as was illustrated earlier in Figure 8-13 to Figure 8-15. With the added capacity, the bridge is now able to better handle the peak traffic, thus explaining the current absence of congestion on the I-580 East bridge approach.

Another key observation is that the increase in maximum flow does not correspond to the full capacity of a new traffic lane. In the initial two-lane setup, an average peak flow of 3,500 vehicles/hour would translate into 1,750 vehicles/hour/lane. With three lanes of traffic, a peak flow of 4,500 vehicles/hour translates instead into an average flow of 1,500 vehicles/hour/lane. This apparent reduction in lane capacity is explained by vehicles not fully utilizing all the available lanes. As was shown in Figure 8-17, less than 25% of the weekday traffic and 20% of the weekend traffic uses the shoulder lane. If traffic were equally distributed along all lanes, each lane would instead carry 33% of the total traffic. A typical distribution is 40% on the left lane, 36-40% on the middle lane, and 20-25% on the shoulder lane. Since the shoulder lane is not fully utilized, this translates into some unused capacity.

8.2.5. TRAVEL CONDITIONS ON EASTBOUND APPROACH AND BRIDGE

The opening of the eastbound shoulder lane to traffic during the afternoon peak has significantly reduced congestion on the Marin County approach to the bridge. This change can be observed in Figure 8-22 to Figure 8-24, which illustrates the average observed speeds on I-580 East from the US-101 interchange to the toll plaza on weekdays, Saturdays, and Sundays from mid-September to mid-November for each year between 2015 and 2021. Before the April 2018 modification, speeds typically dropped below 15 mph from approximately 3:00 to 7:30 PM from the US-101 to about 0.5 miles onto the bridge. After the opening, speeds have remained at or above 50 mph in the absence of disturbances from incidents or bridge/roadway maintenance activities.

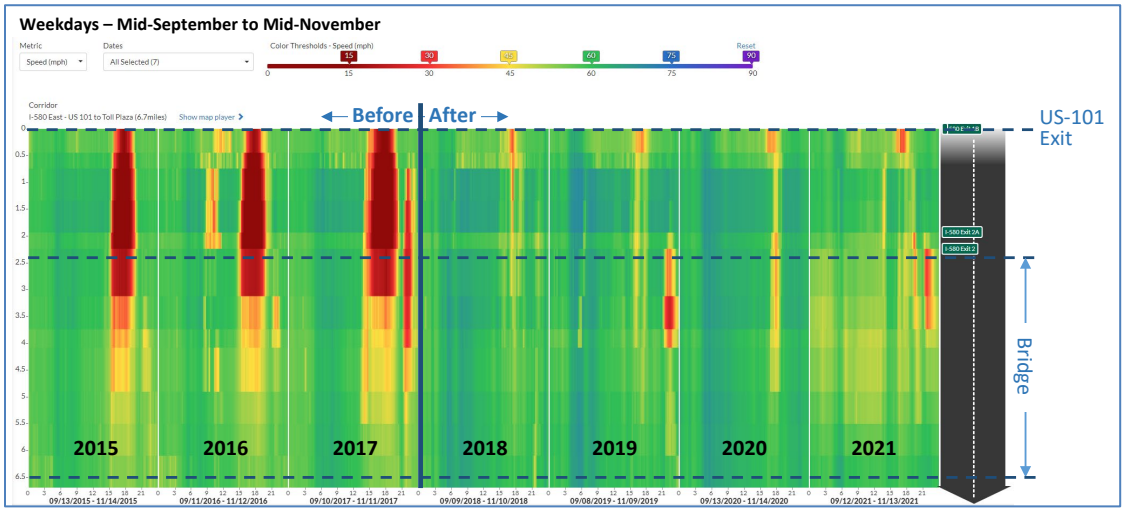

Figure 8-22: Speed Maps – I-580 East – US-101 to Toll Plaza – Weekdays, Fall 2015-2021

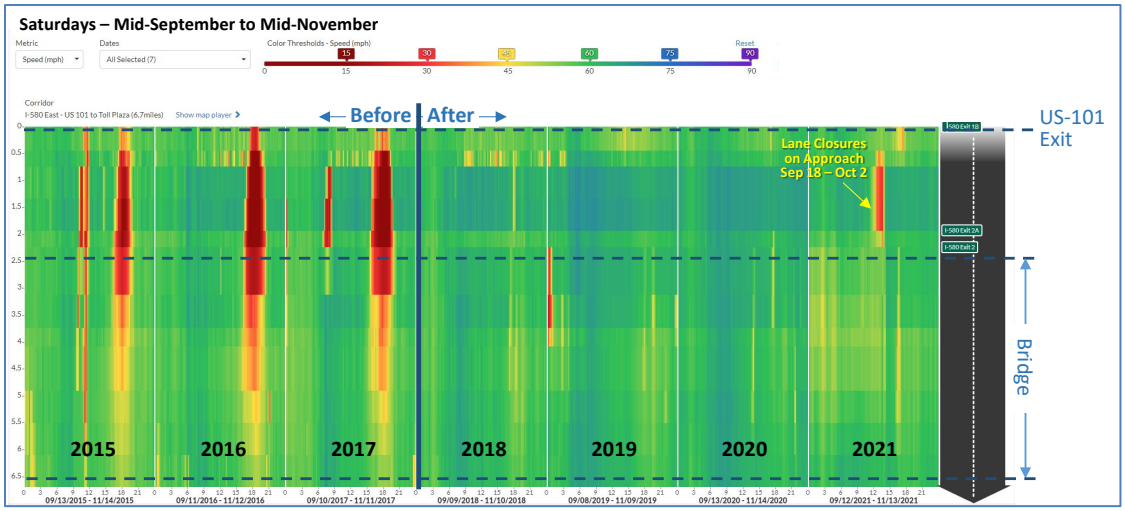

Figure 8-23: Speed Maps – I-580 East – US-101 to Toll Plaza – Saturdays, Fall 2015-2021

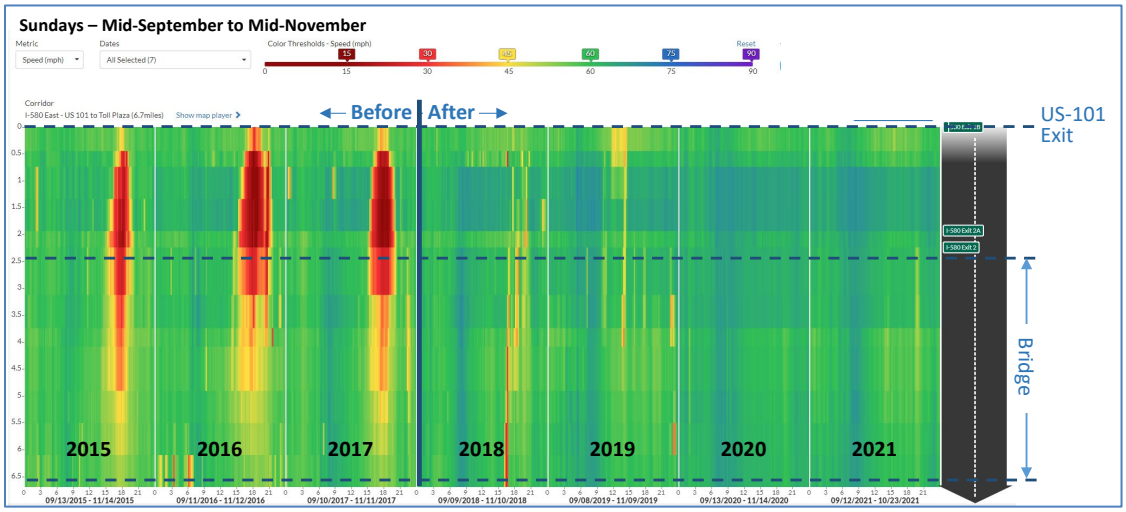

Figure 8-24: Speed Maps – I-580 East – US-101 to Toll Plaza – Sundays, Fall 2015-2021

While the 2020 data may be tainted with Covid-19 effects, this is not the case for the 2018 and 2019 data. The fact that the congestion on the approach disappears before the onset of the pandemic is proof that the improved conditions are a direct result of the bridge modifications. Figure 8-25 further enforces this point by illustrating observed speeds from four months before the modification to four months after. As can be observed, the change in traffic conditions unmistakably corresponds to the shoulder lane opening.

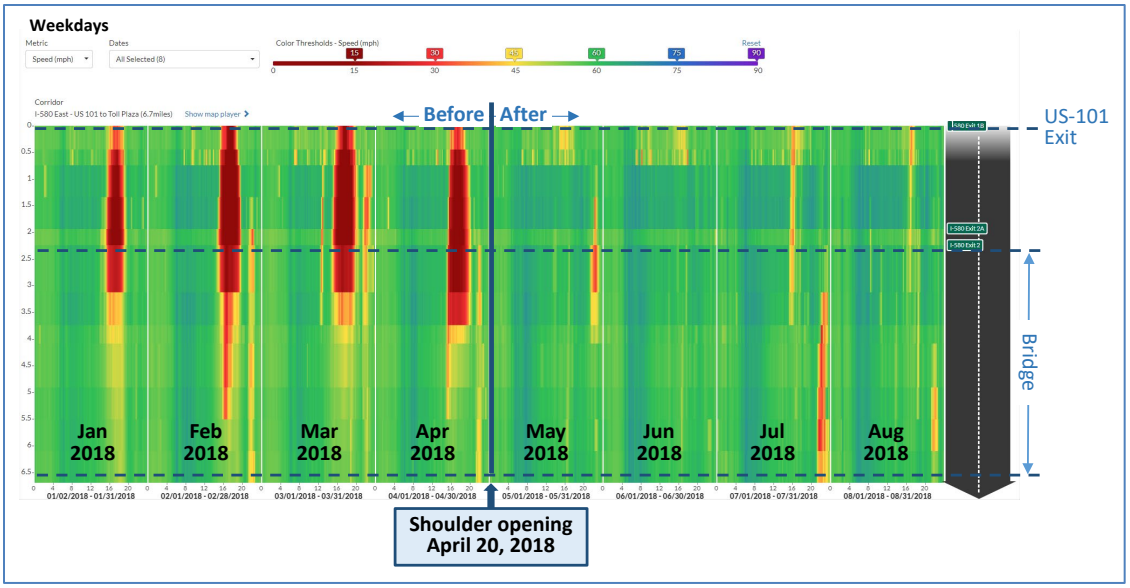

Figure 8-25: Speed Maps – I-580 East – US-101 to Toll Plaza – Weekdays, January-August 2018

Figure 8-26 to Figure 8-28 further illustrate the impacts on travel times from the US-101 interchange to the toll plaza. The travel times before the modification are shown with a dotted line and those for the after period with a solid line. Before the modification, peak weekday travel times reached 21-23 minutes. Since then, peak travel times have remained around 8-9 minutes, yielding a reduction of 13-14 minutes. On Saturdays, peak travel times have similarly reduced from 17-21 to about 7 minutes, for a reduction of 10-14 minutes. On Sundays, peak travel times have been further reduced from 13-15 to 7 minutes, for a reduction of 6-8 minutes.

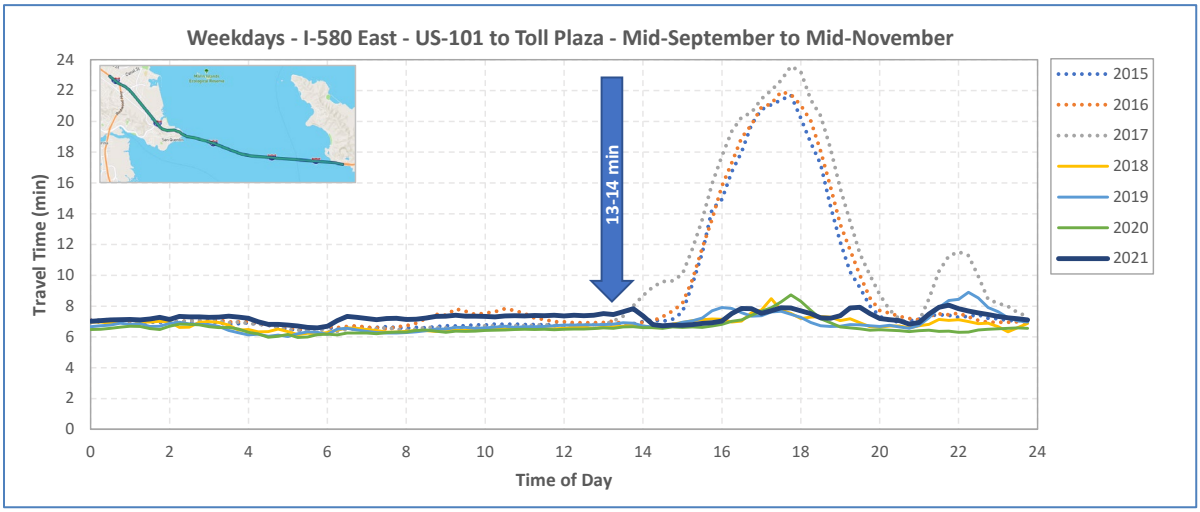

Figure 8-26: Travel Times – I-580 East – US-101 to Toll Plaza – Weekdays, Fall 2015-2021

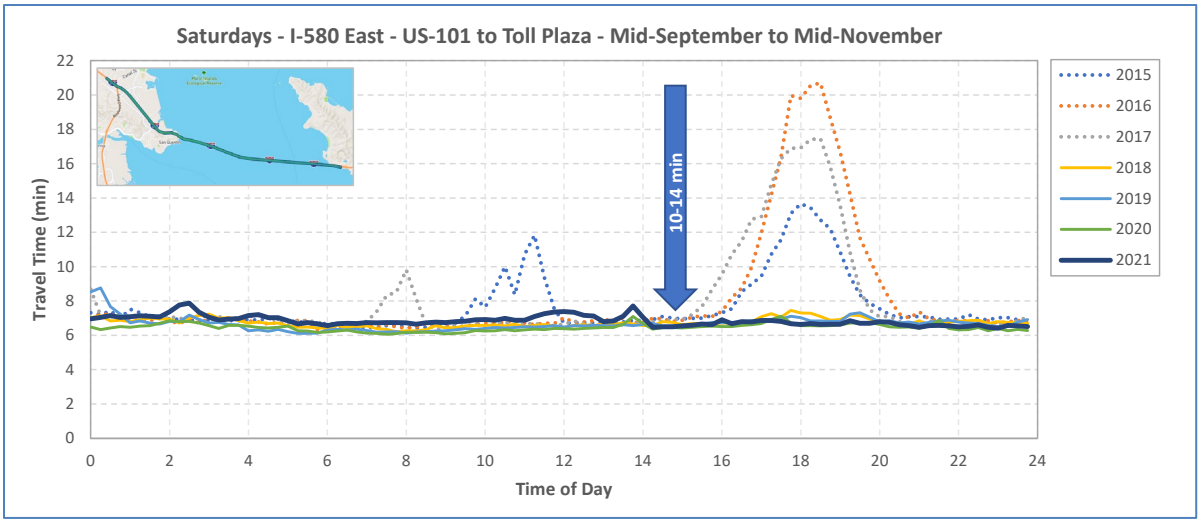

Figure 8-27: Travel Times – I-580 East – US-101 to Toll Plaza – Saturdays, Fall 2015-2021

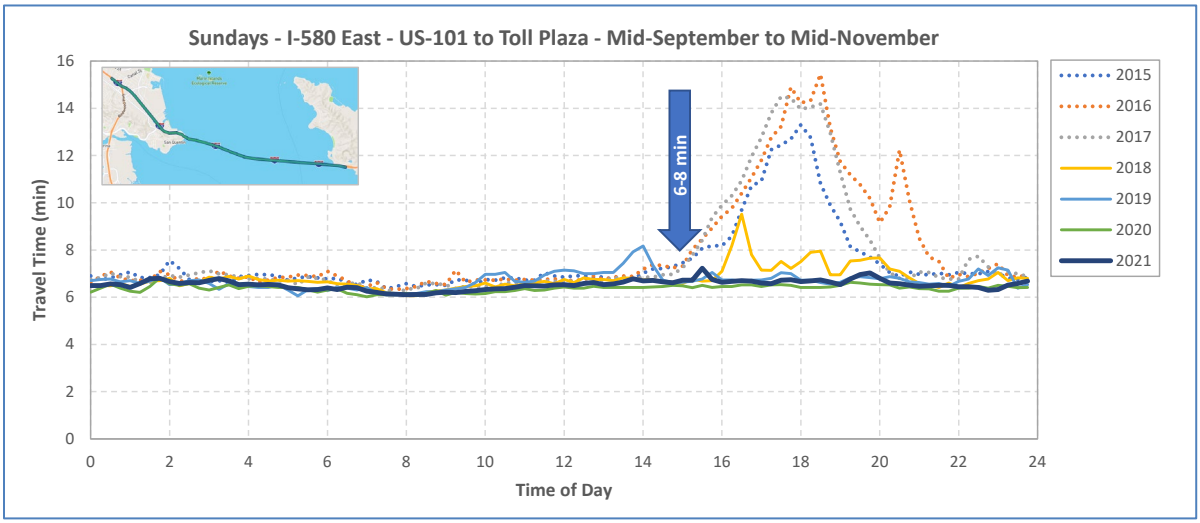

Figure 8-28: Travel Times – I-580 East – US-101 to Toll Plaza – Sundays, Fall 2015-2021

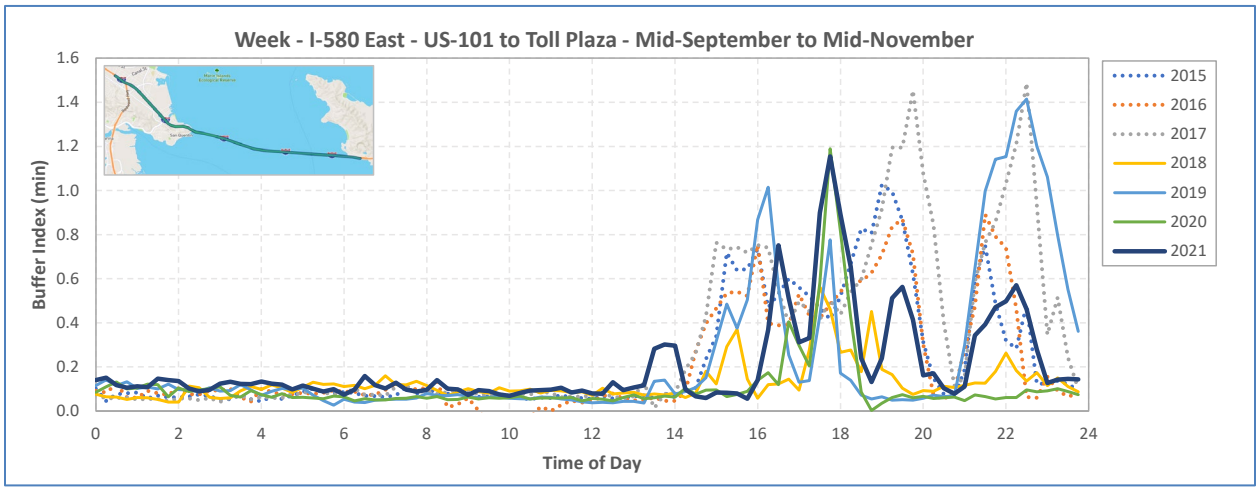

Figure 8-29: Travel Time Reliability I-580 East – US-101 to Toll Plaza – Weekdays, Fall 2015-2021

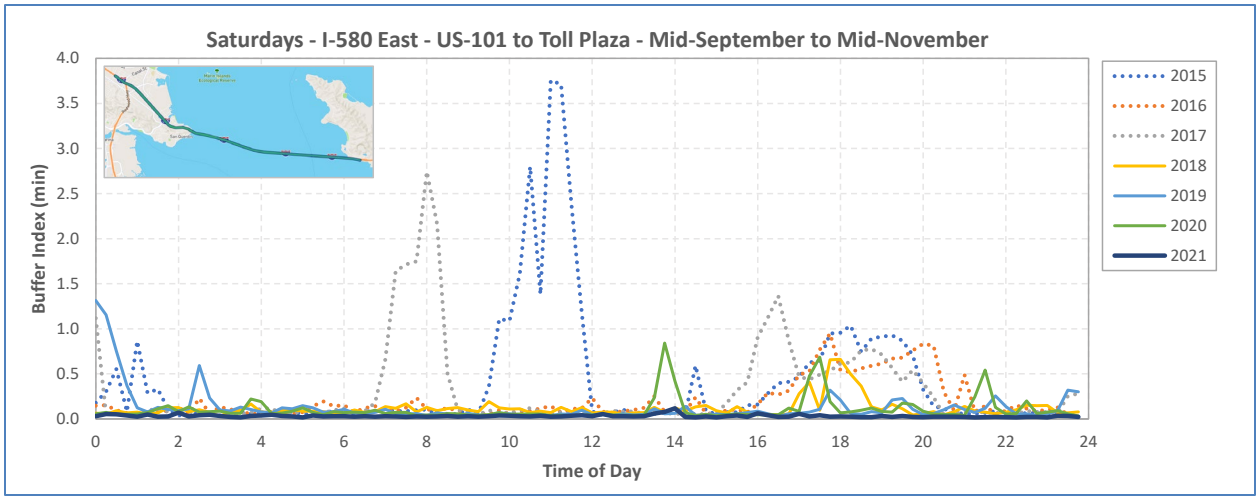

Figure 8-30: Travel Time Reliability I-580 East – US-101 to Toll Plaza – Saturdays, Fall 2015-2021

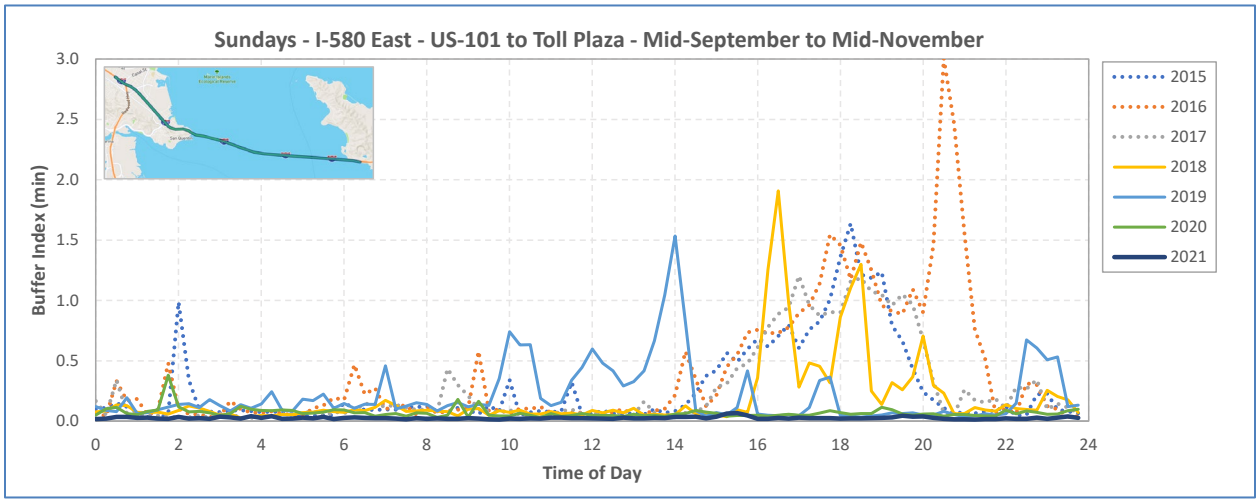

Figure 8-31: Travel Time Reliability I-580 East – US-101 to Toll Plaza – Sundays, Fall 2015-2021

Figure 8-29 to Figure 8-31 finally present the buffer time index for the weekday, Saturday, and Sunday conditions illustrated in the previous graphs. This is a measure of reliability. The index represents the additional time that travelers must add to their planned trip to arrive on time 95 percent of the time, expressed as a percentage of the average travel time. For the eastbound bridge approach, the figures indicate that the bridge modifications have significantly reduced the variability of travel times from the US-101 to the toll plaza, particularly on Saturdays and Sundays. This is mainly due to the elimination of congestion on the bridge approach during peak travel periods.

8.2.6. TRAVEL CONDITIONS ON US-101 NORTH

In addition to reducing travel times along I-580 East, the opening of the eastbound shoulder lane on the bridge may have contributed to a slight reduction in travel time along US-101 North during weekday afternoon peaks. As previously shown in Figure 8-15, the congestion generated by the lane drop at the foot of the bridge typically reached the I-580/US-101 interchange. On weekdays, this congestion then appeared to spread onto the portion of US-101 North between Sir Francis Drake Boulevard and the Francisco Boulevard/I-580 exit. However, it did not appear to significantly impact US-101 traffic on

Saturdays and Sundays. Without current congestion on I-580 East, the signals at the end of the ramp are now the only element constraining flow on the Francisco Boulevard/I-580 exit. While these signals still cause some vehicle queues to back up onto US-101 during weekdays, they do so to a much lower extent than before.

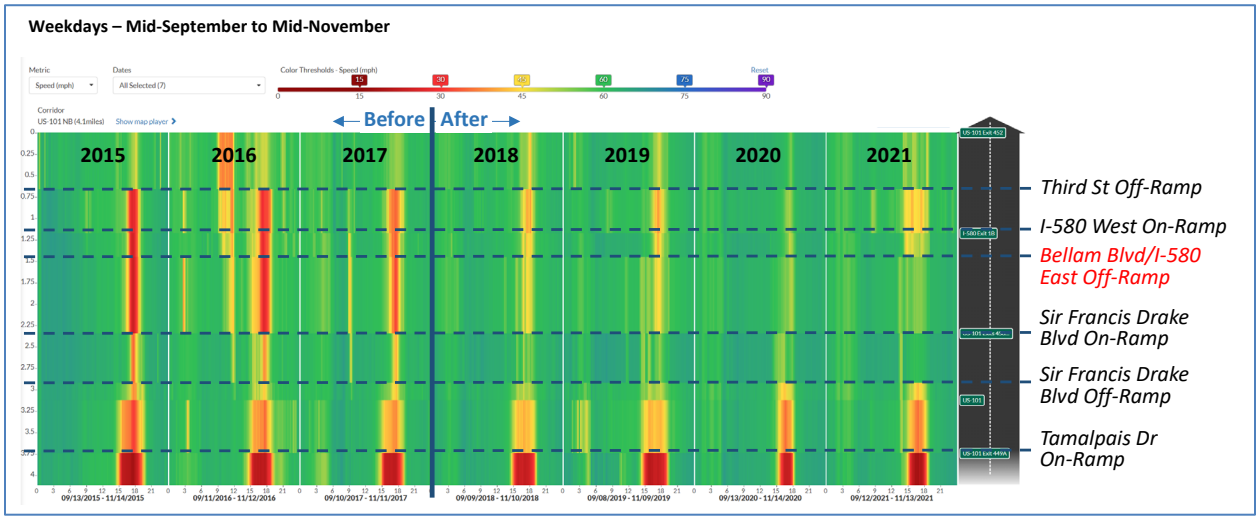

Figure 8-32: Speed Maps – US-101 North – Weekdays, Fall 2015-2021

Figure 8-32 compares the 2015 to 2021 mid-September to mid-November average speed profiles along the section of US-101 North extending from the Tamalpais interchange to the Third St interchange past the I-580 interchange. The thick vertical blue line indicates the boundary between observations made before the bridge modifications and observations made after. As can be observed, significant congestion existed on the US-101 North section between Sir Francis Drake Boulevard and I-580 before the modifications. As was noted in Section 8.2.1, this congestion could be attributed to both the I-580 East congestion and traffic frictions north of the interchange resulting from the merging of the US-101 North and I-580 West traffic streams. Following the bridge modifications, reduced congestion is observed on this section of US-101 in 2018 and 2019, before the Covid-19 pandemic, suggesting a direct potential impact from the bridge modifications. However, it can also be observed that congestion on US-101 North downstream of the off-ramp has also reduced.

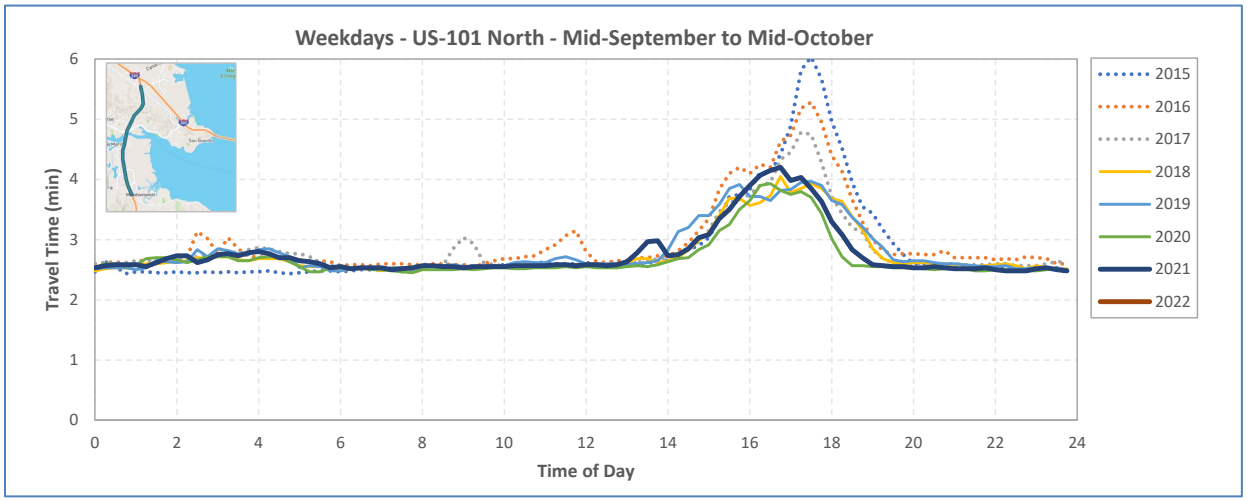

Figure 8-33: Travel Times – US-101 North – Weekdays, Fall 2015-2021

Figure 8-33 further illustrates the average travel times from mid-September to mid-November between 2015 and 2021 along the US-101 section extending from the Tamalpais Drive interchange to the Francisco Boulevard/I-580 exit, as shown in the embedded map. Before the shoulder lane opening, peak travel times on this section of US-101 ranged from 4.75 to 6 minutes. Since then, average travel times have not exceeded 4.2 minutes. This translates into an average reduction of 0.5 to 1.8 minutes. This is for all vehicles traveling on the section. Unfortunately, a more detailed characterization distinguishing travel time reductions for US-101 and I-580 bound traffic is not possible due to sensor data quality issues near the interchange with I-580, as was highlighted in Section 5.2.1.

No significant changes in travel time were observed for Saturday and Sunday over the same segment and evaluation period. This is explained by the fact that the bridge congestion did not affect the US-101 North traffic as much during the weekend before the modifications, as illustrated in the congestion maps of Figure 8-14 and Figure 8-15.

8.2.7. TRAVEL CONDITIONS ON EASTBOUND SIR FRANCIS DRAKE BOULEVARD

Figure 8-34 to Figure 8-36 illustrate eastbound speeds along Sir Francis Drake Boulevard, from the US-101 to the I-580 interchanges, over the 2015-2021 period. Similar to I-580 East, the opening of the eastbound shoulder lane has positively impacted traffic along the arterial. Before the opening, speeds below 20 mph were observed across the entire length of the arterial. While speeds below 20 mph are still currently observed on weekdays, their spatial and temporal extent is significantly reduced and primarily centered on the section west of the San Quentin Prison entrance.

Figure 8-37 to Figure 8-39 further illustrate changes in travel times along the arterial, from the US-101 to the I-580 interchanges, over the evaluation period. Travel times during the weekday afternoon peak have dropped from 11-12 minutes to around 5 minutes between fall 2017 and fall 2018. This is a 6–7-minute reduction that can be directly attributed to the improved traffic conditions that resulted from the bridge modifications. Saturday peak travel times similarly dropped from 8-10 minutes to about 3 minutes, while Sunday peak travel times dropped from 6-7 minutes to 3 minutes. These correspond to travel time reductions of 5-7 and 3-4 minutes, respectively.

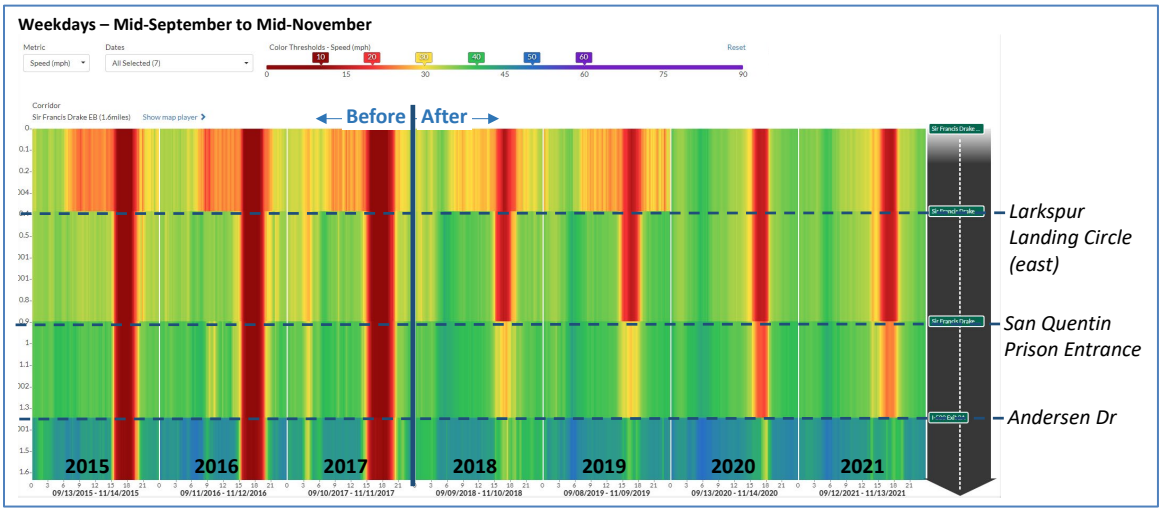

Figure 8-34: Speed Maps – Sir Francis Drake Boulevard EB – Weekdays, Fall 2015-2021

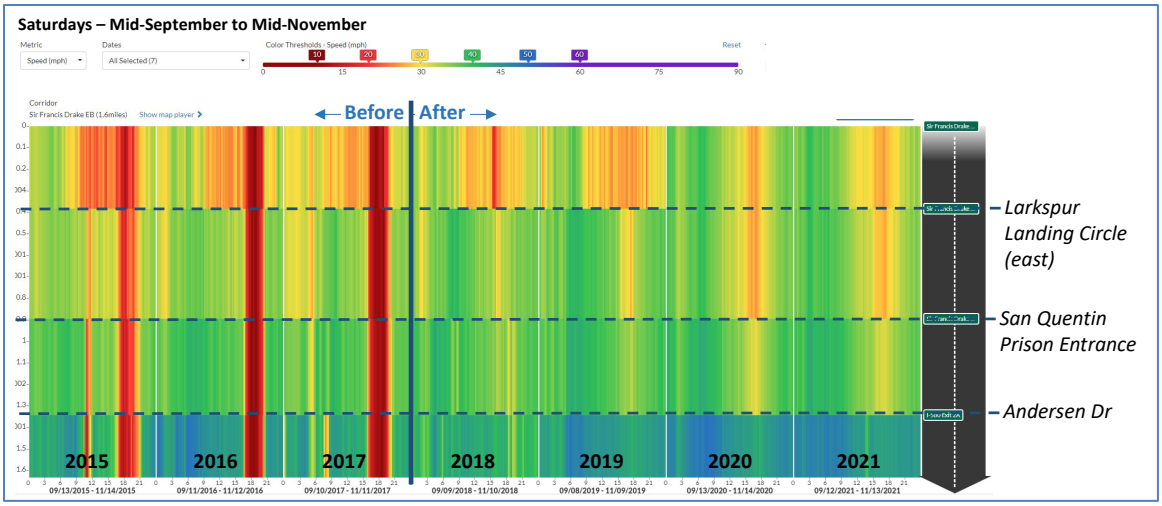

Figure 8-35: Speed Maps – Sir Francis Drake Boulevard EB – Saturdays, Fall 2015-2021

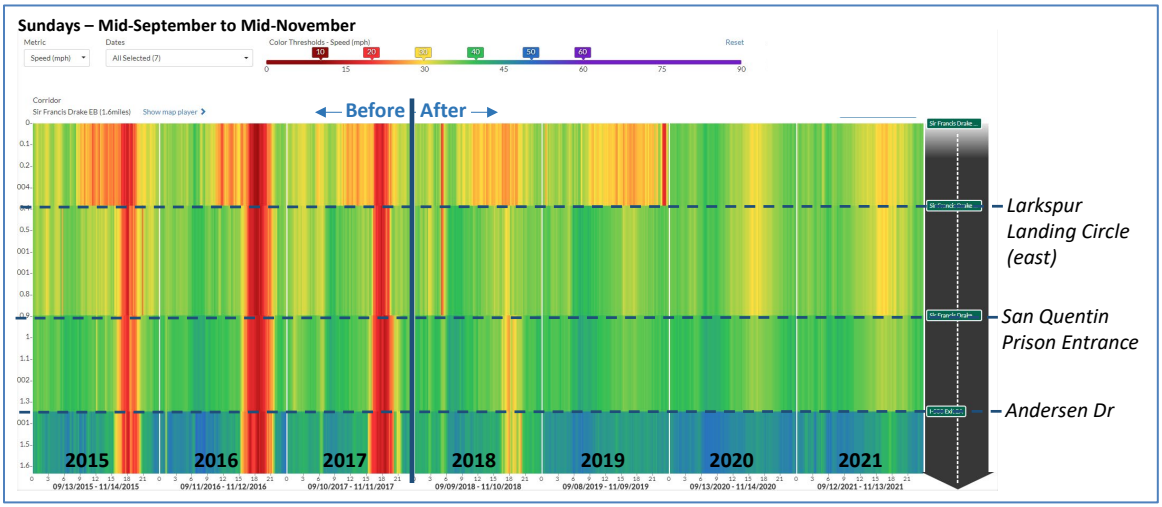

Figure 8-36: Speed Maps – Sir Francis Drake Boulevard EB – Sundays, Fall 2015-2021

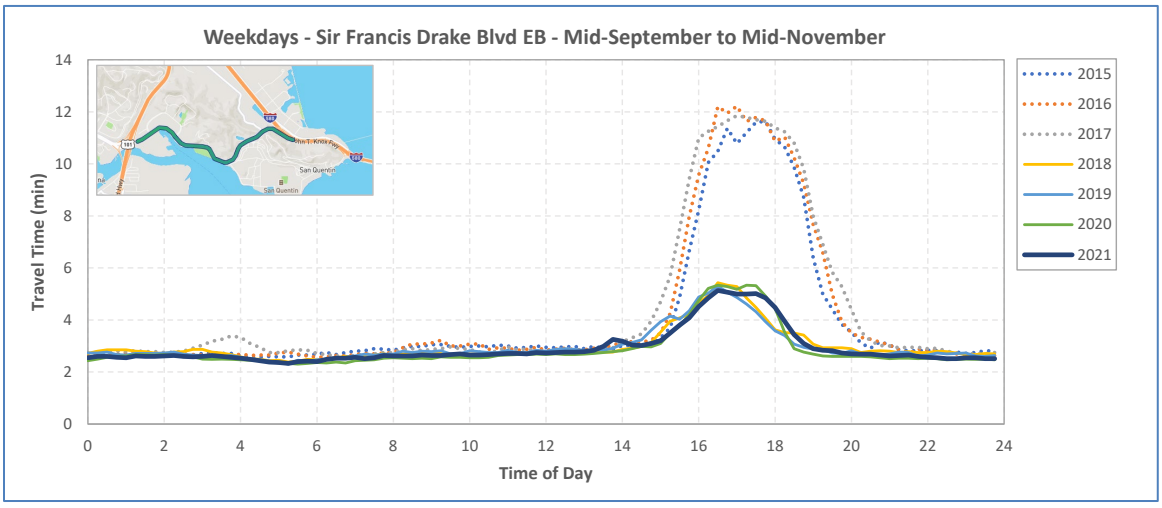

Figure 8-37: Travel Times – Sir Francis Drake Boulevard EB – Weekdays, Fall 2015-2021

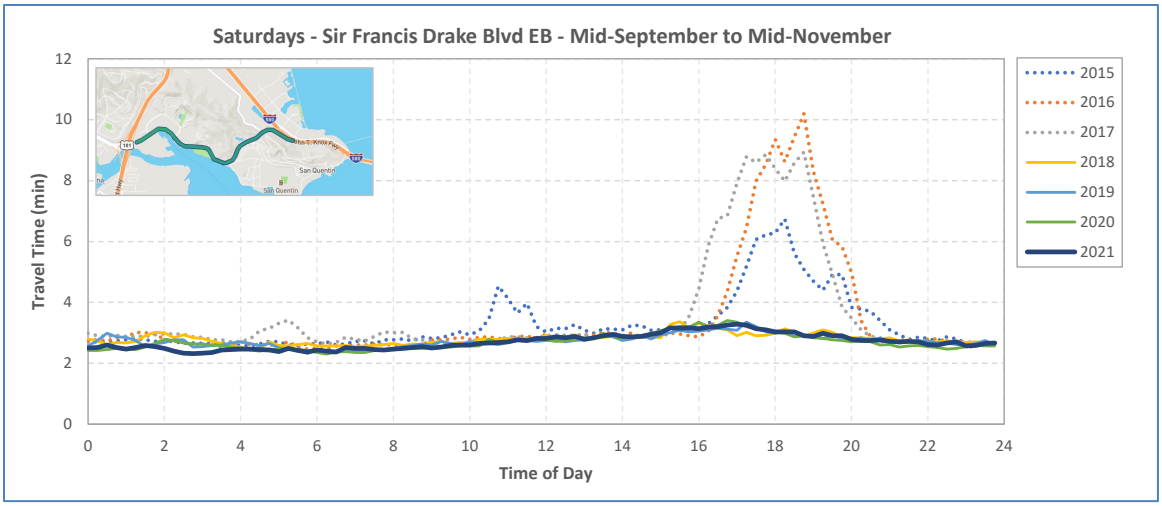

Figure 8-38: Travel Times – Sir Francis Drake Boulevard EB – Saturdays, Fall 2015-2021

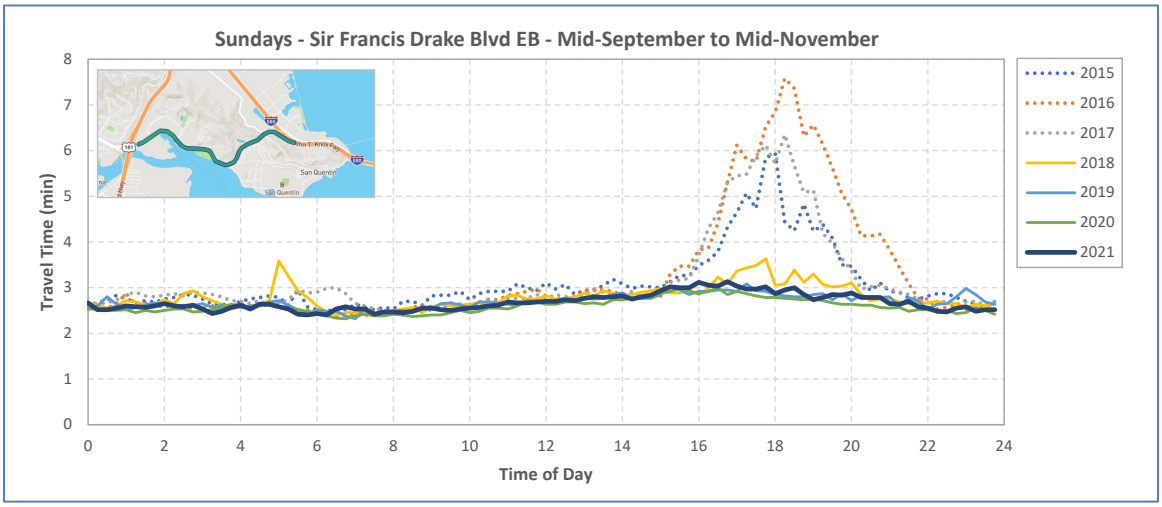

Figure 8-39: Travel Times – Sir Francis Drake Boulevard EB – Sundays, Fall 2015-2021

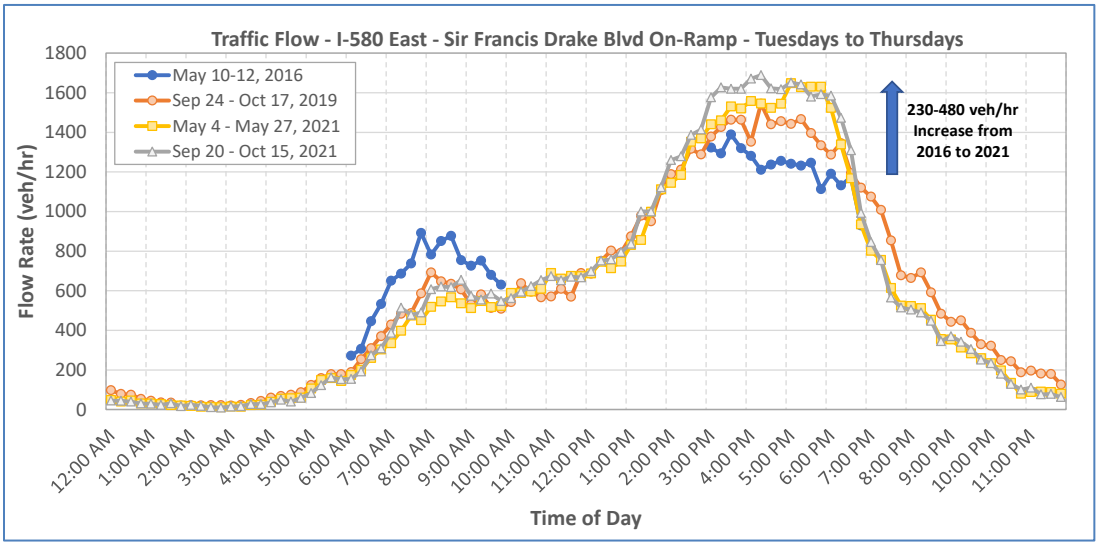

Figure 8-40: Flow on I-580 Sir Francis Drake Boulevard On-Ramp, 2016-2021

Figure 8-40 concludes by comparing weekday flow on the I-580 East on-ramp at the end of the arterial from mid-May 2016 to flows from September 2019, May 2021, and September 2021. Data from spring 2020 are not considered due to the impacts of the Covid-19 pandemic on traffic demand. Data between Spring 2016 and fall 2019 are also not presented as count data is not available.

Based on the illustrated data, the following two observations can be made regarding traffic using the arterial to access I-580 East and the Richmond-San Rafael bridge:

- Weekday afternoon peak traffic has significantly increased following the April 2020 modifications. Increases between 230 and 480 vehicles/hour in flow rate are observed between 2016 and 2021, for an average increase of 364 vehicles/hour. While this could partly be due to an increase in traffic demand, the elimination of congestion on I-580 East that used to cause backups onto Sir Francis Drake Boulevard is seen as a major contributing factor. Travel times have decreased despite the increase in traffic. Easier travel conditions along the arterial may have enticed more motorists to use it to reach I-580 East. This is supported by the data of Figure 8-41, which show a nearly 300 vehicle/hour increase in flow from the US-101 North off-ramp to the I-580 on-ramp between May 2016 and March 2022 despite reductions in flows originating from other sources.
- While AM peak on-ramp traffic has reduced since 2016, this is estimated to be likely due to changes in travel demand as there was, or is, generally no congestion affecting eastbound traffic along the arterial during the morning.

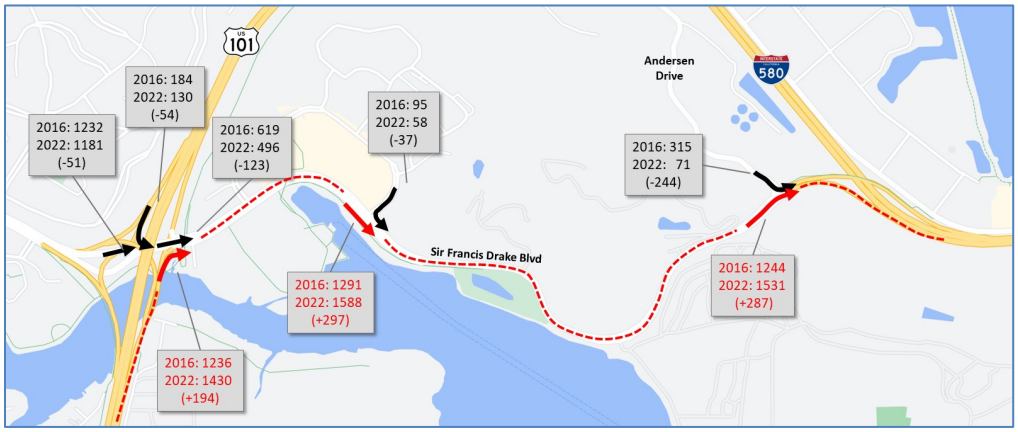

Figure 8-41: Changes in Traffic Flows along Sir Francis Drake Boulevard between 2016 and 2022

8.2.8. TRAVEL CONDITIONS ON EASTBOUND FRANCISCO BOULEVARD

Before the bridge modifications, it was hypothesized that some traffic would use Francisco Boulevard to bypass congestion along I-580 East. As shown on the left side of Figure 8-42, which illustrates counts around the Main Street interchange from May 2016, this was supported by a high volume of vehicles turning right on Main Street from Francisco Boulevard and then left onto the I-580 East on-ramp during an average weekday afternoon peak hour. Recent counts from March 2022, shown on the right side, show a significant reduction in traffic accessing I-580 East at Main Street from Francisco Boulevard. Additional evidence is provided in Figure 8-43, which shows a large drop in traffic on the Main Street on-ramp from May 2016 to fall 2019. Data between May 2016 and fall 2019 are not due to lack of availability.

While there is no direct evidence that the flow reductions described above occurred immediately after the opening of the shoulder lane in April 2018, logic suggests that this is the likely contributing factor. As the modification has eliminated congestion along I-580, motorists have had since then fewer incentives to use local arterials to shave some travel time on their eastbound trips.

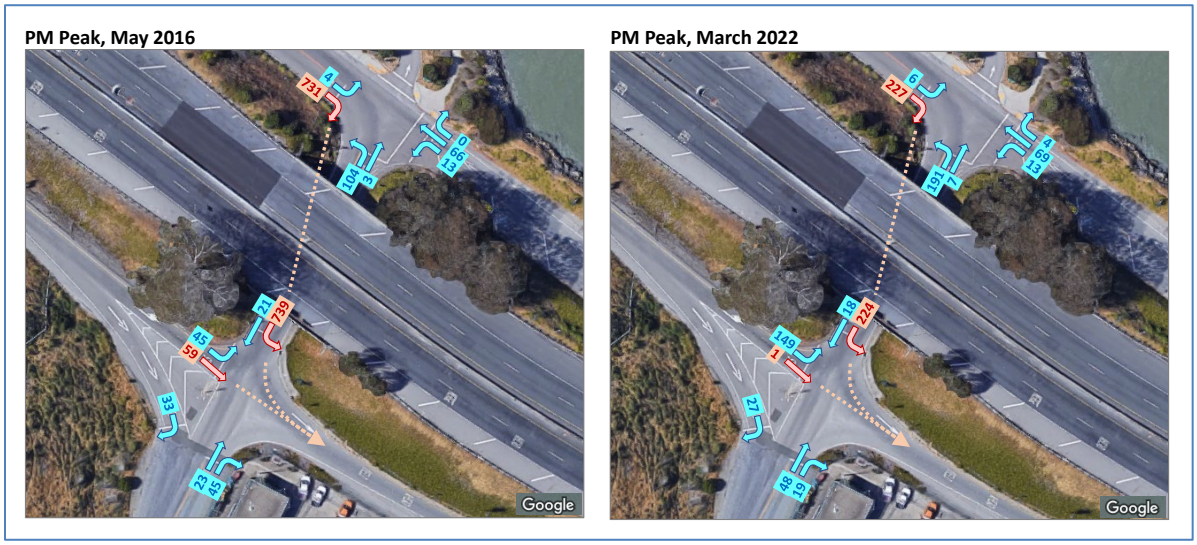

Figure 8-42: Traffic Flows at Main Street Interchange, 2016

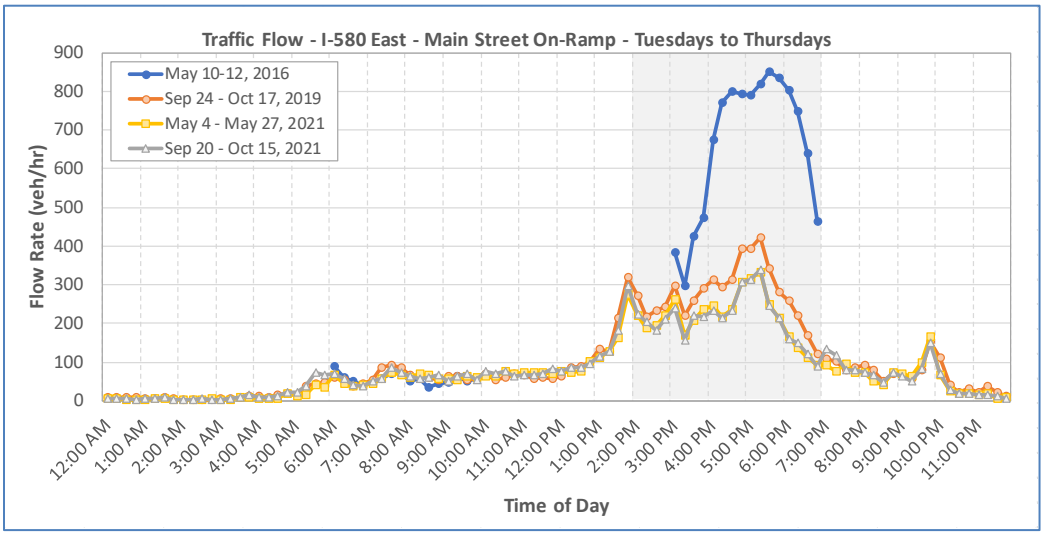

Figure 8-43: Flow on I-580 East Main Street On-Ramp, 2016-2021

Additional evidence that fewer vehicles are utilizing Francisco Boulevard to access I-580 East is obtained by comparing counts taken at various locations along the arterial, as illustrated in Figure 8-44. As can be observed, most of the reduction in traffic along Francisco Boulevard appears to originate from the intersection with Bellam Boulevard. The reduction can more particularly be traced to fewer vehicles traveling north on Bellam Boulevard and turning right onto Francisco Boulevard after having bypassed the local I-580 East on-ramp.

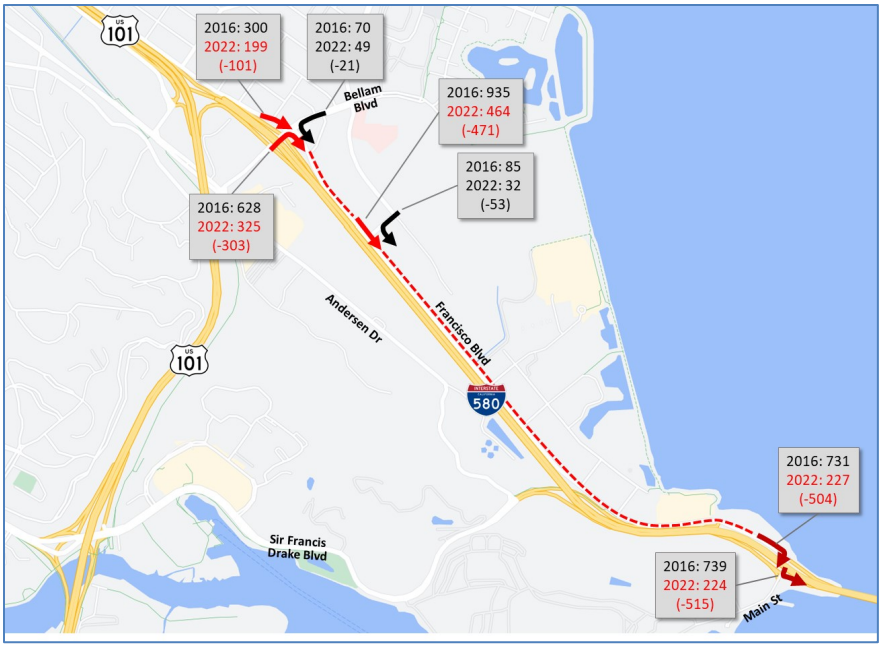

Figure 8-44: Changes in Traffic Flows along Francisco Blvd between 2016 and 2022

While an analysis of travel times along Francisco Boulevard would help confirm the above observation, such analysis could not be made as INRIX only started collecting travel times along Francisco Boulevard in 2019, after the shoulder lane opening.

8.2.9. TRAVEL CONDITIONS ON ANDERSEN DRIVE

A comparison of traffic counts from May 2016 and March 2022 indicates that a significant reduction in traffic has occurred on Andersen Drive since the shoulder lane opening. As shown in Figure 8-45, the 2016 data show an average of 315 vehicles per hour turning onto the I-580 East on-ramp from Andersen Drive, while the 2022 data only shows a flow of 71 vehicles/hour. This represents a 77% drop.

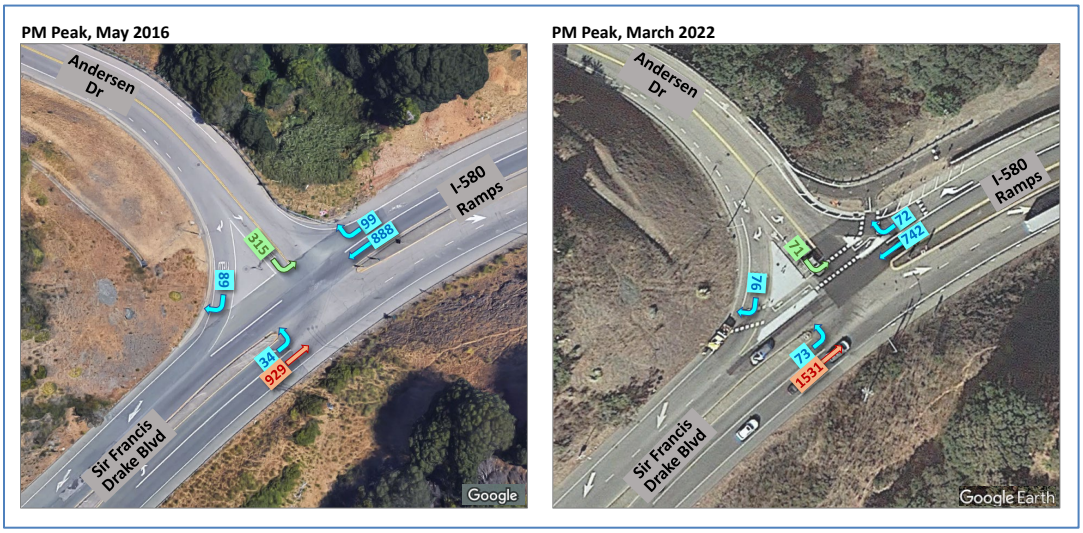

Figure 8-45: Traffic Flows at Sir Francis Drake and Andersen, 2016 and 2022

Similar to what was observed on Francisco Boulevard, it could be hypothesized that the drop results from fewer vehicles using Andersen Drive as a bypass to I-580 East. However, a review of congestion hotspots using INRIX average speed data indicates that the drop in volume may have occurred one to two years after the modifications. As shown in Figure 8-46, changes in traffic conditions along the arterial appeared to have occurred between the fall of 2019 and the fall of 2020, likely because of the Covid-19 pandemic.

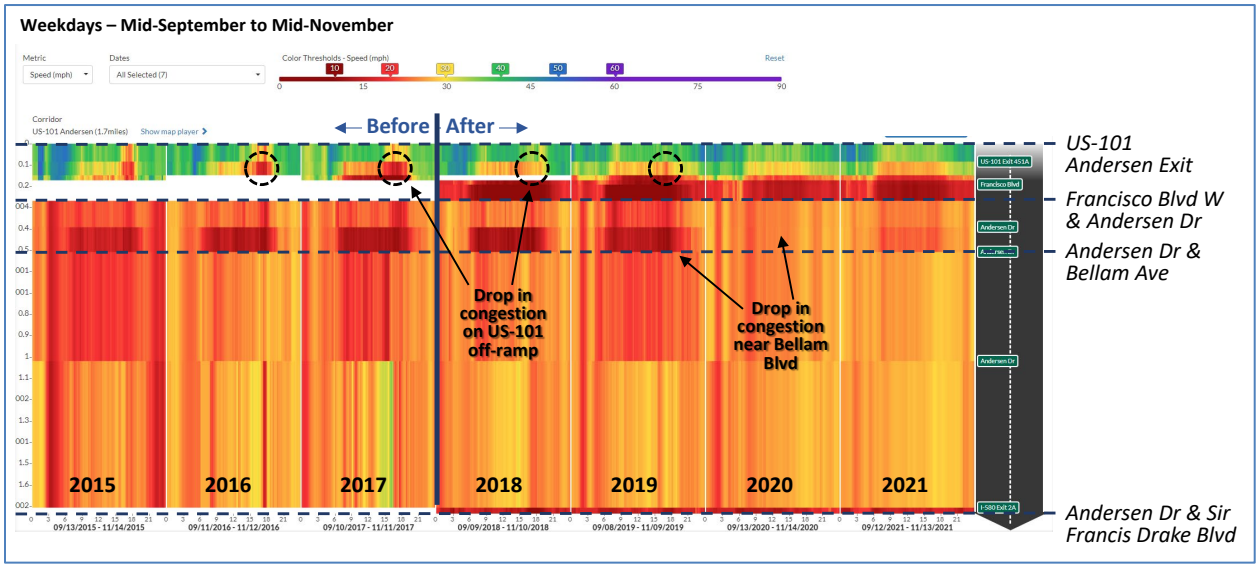

Figure 8-46: Speed Maps – Andersen Drive – Weekdays, Fall 2015-2021

However, a slight reduction in congestion could be observed on the US-101 off-ramp before and after the April 2018 bridge modifications. This change, highlighted by the black circles, could be the result of fewer vehicles taking the off-ramp due to less congestion on I-580 East. Unfortunately, there is no data to definitively prove this assertion since the traffic sensors on the Andersen Dr/Francisco Boulevard West off-ramp (PeMS 418213) did not produce reliable data before April 2020.

8.2.10. TRAVEL CONDITIONS ON I-580 EAST MAIN STREET RAMPS

As was shown in Figure 8-42, 59 vehicles/hour were observed in the May 2016 counts going straight from the Main Street off-ramp to the Main Street on-ramp during the afternoon peak. This is despite lane marking indicating the left lane as a left-turn only lane. This behavior was likely done as a way to save some travel time by bypassing a portion of the congestion along I-580 East. In the March 2022 counts, an average of only 1 vehicle/hour was observed making the same move during the afternoon peak, indicating the existence of significantly fewer travel constraints along I-580 East.

8.2.11. TRAVEL CONDITIONS ON I-580 EAST BELLAM BOULEVARD ON-RAMP

Counts data show an increase in traffic on the I-580 East Bellam Boulevard on-ramp between May 2016 and March 2022. As shown in Figure 8-47, weekday afternoon peak ramp traffic went from 282 to 464 vehicles/hour. This represents a 64% increase that occurred at the same that traffic across the intersection decreased by around 10%. This increase can be attributed to both a change in traffic demand and fewer vehicles opting to use Francisco Boulevard as a bypass to I-580, as noted in Section 8.2.8.

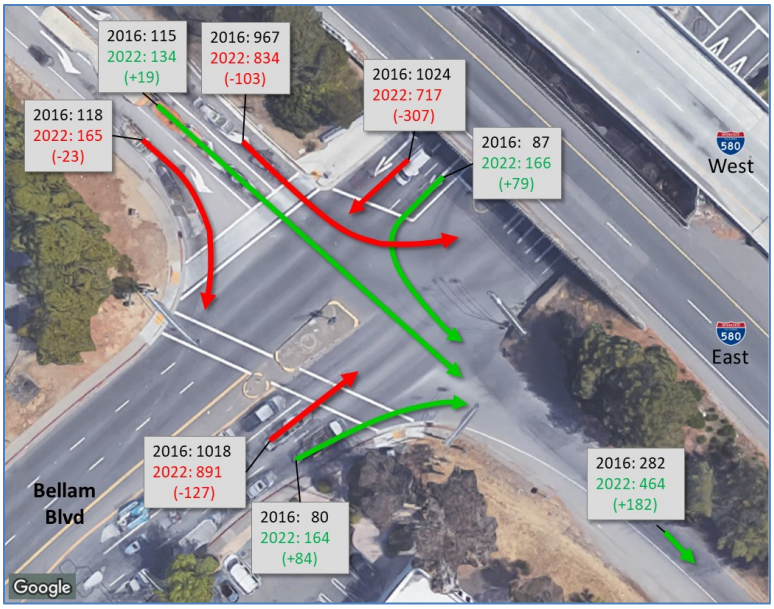

Figure 8-47: Traffic Flows at I-580 East Bellam Blvd Ramps, 2016 and 2022

8.2.12. SUMMARY OBSERVATIONS

The following are key observations from the analysis of impacts on eastbound traffic associated with the opening to traffic of the bridge lower deck shoulder lane between 2 PM and 7 PM daily:

- The availability of an extra traffic lane has increased eastbound peak hourly flow across the bridge by 13-26%, from 3,300-3,570 to 3,750-4500 vehicles/hour.
- The shoulder lane typically only carries less than 25% of the eastbound bridge traffic during weekday peak periods, and less than 20% on weekends.
- The added peak-hour capacity has eliminated congestion on the eastbound approach to the bridge. This has caused peak travel times from the US-101 interchange to the toll plaza to drop by 13-14 minutes on weekdays, 10-14 minutes on Saturdays, and 6-8 minutes on Sundays.
- Peak-hour travel times to reach the toll plaza are significantly less variable than before.
- The absence of congestion on I-580 East has likely contributed to a 1- to 2-minute reduction in average travel times on US-101 between the Sir Francis Drake and I-580 interchanges
- Weekday afternoon peak travel times along Sir Francis Drake Boulevard have dropped by up to 4 minutes, while traffic volumes have increased by over 300 vehicles/hour.
- Less traffic is using Francisco Boulevard to bypass congestion on I-580 East. While less traffic is also using Andersen Drive, it is unclear to which extent this is due to the bridge modifications.
- Fewer vehicles are using the Main Street off-ramp and on-ramp as a congestion bypass.
- Increased traffic is observed entering I-580 East at the Bellam Boulevard on-ramp, likely partly due to fewer vehicles attempting to use local arterials as bypasses to the freeway.

The following are additional observations regarding the compliance of motorists with the period during which the shoulder lane is opened to traffic:

- Motorists are generally compliant with the shoulder opening period, as relatively few vehicles are observed using the lane before 2 PM and after 7 PM.
- Non-compliant use of the shoulder lane is highest 20 minutes before its opening and up to 25 minutes following its closure.
- CHP officers have indicated observing some vehicles using the shoulder as a passing or traveling lane when a red or yellow X is shown above it. This suggests that some motorists may not fully understand the meaning of the current lane control signs.

8.3. IMPACTS ON WESTBOUND BRIDGE TRAFFIC

This section evaluates the impacts on traffic of the conversion of the westbound upper deck shoulder lane into a barrier-delimited bike/pedestrian path. The primary goals of this evaluation are to assess:

- Whether the provision of a travel path visually constrained by the path barrier is causing a capacity reduction on the bridge and/or traffic to slow down.
- whether the provision of a shorter merge area at the exit of the toll plaza is causing an increase in congestion on the westbound approach to the bridge.

Based on the above goals, the following section successively presents the following elements:

- Typical congestion profile on the bridge approach
- Impacts on upper deck capacity
- Impacts on traffic conditions on the approach to the bridge
- Impacts on traffic conditions across the bridge
- Impacts on traffic distribution across lanes on the bridge
- Impacts on local arterials on the Richmond side of the bridge
- Summary of observations

8.3.1. TYPICAL APPROACH CONGESTION PROFILES

To help with the analysis of traffic impacts associated with the bridge modifications, Figure 8-48 presents speed maps illustrating general traffic conditions on the westbound approach to the bridge in the fall of 2021. The heat map on the left illustrates average conditions on weekdays, the one in the middle on Saturdays, and the one on the left on Sundays.

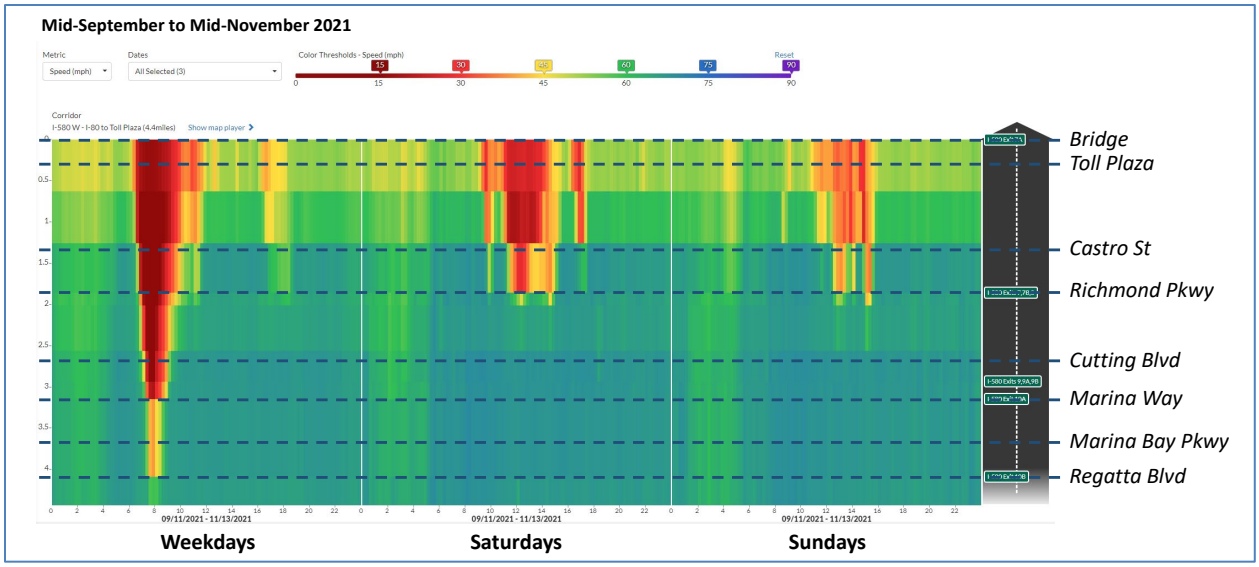

Figure 8-48: Typical Congestion Profiles on Westbound Bridge Approach, Fall 2021

Based on the illustrated data, the following observations can be made:

- During weekdays, congested conditions typically exist between 6 AM and 10 AM. Traffic speeds during this period drop to 10 mph, with peak queues occurring around 8 AM and extending 2.75 to 3.25 miles upstream of the toll plaza, to somewhere between the Marina Way and Regatta Boulevard interchanges.
- On Saturdays, congestion conditions exist between 11 AM and 2 PM. Traffic speeds during this period drop to about 20 mph, with peak queues occurring around Noon and extending 1.25 miles from the toll plaza, to around the Richmond Parkway interchange.
- On Sundays, less intense congestion occurs between 12 Noon and 3 PM. Traffic speeds during this period only drop to around 30-35 mph, with peak queues occurring around 1 PM and extending 1.00 to 1.25 miles from the toll plaza, to somewhere between the Castro Street and Richmond Parkway interchanges.

8.3.2. IMPACTS ON UPPER DECK CAPACITY

Figure 8-49 and Figure 8-50 illustrate the peak weekday and weekend hourly flows observed at the Richmond toll plaza between January 2015 and mid-June 2022. Within the figure, the dots illustrate the maximum observed flow on a given day, excluding holidays and days with abnormally low volume. Since day-to-day maximum flows are subject to significant fluctuations due to weather, incidents, variations in the proportion of trucks, and other factors, a 2-week rolling average is superimposed on the daily data to facilitate the identification of trends.

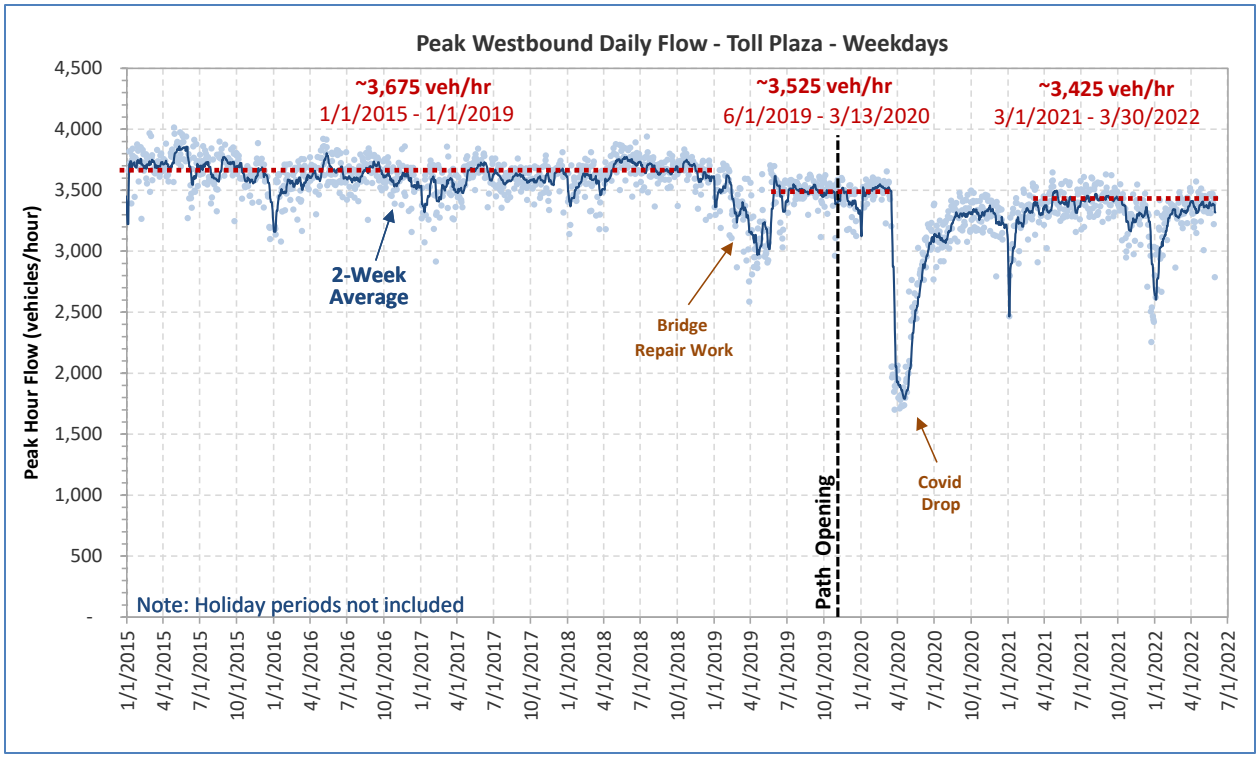

Figure 8-49: Peak Hourly Flows – I-580 West – Toll Plaza, Weekdays, 2015-2022

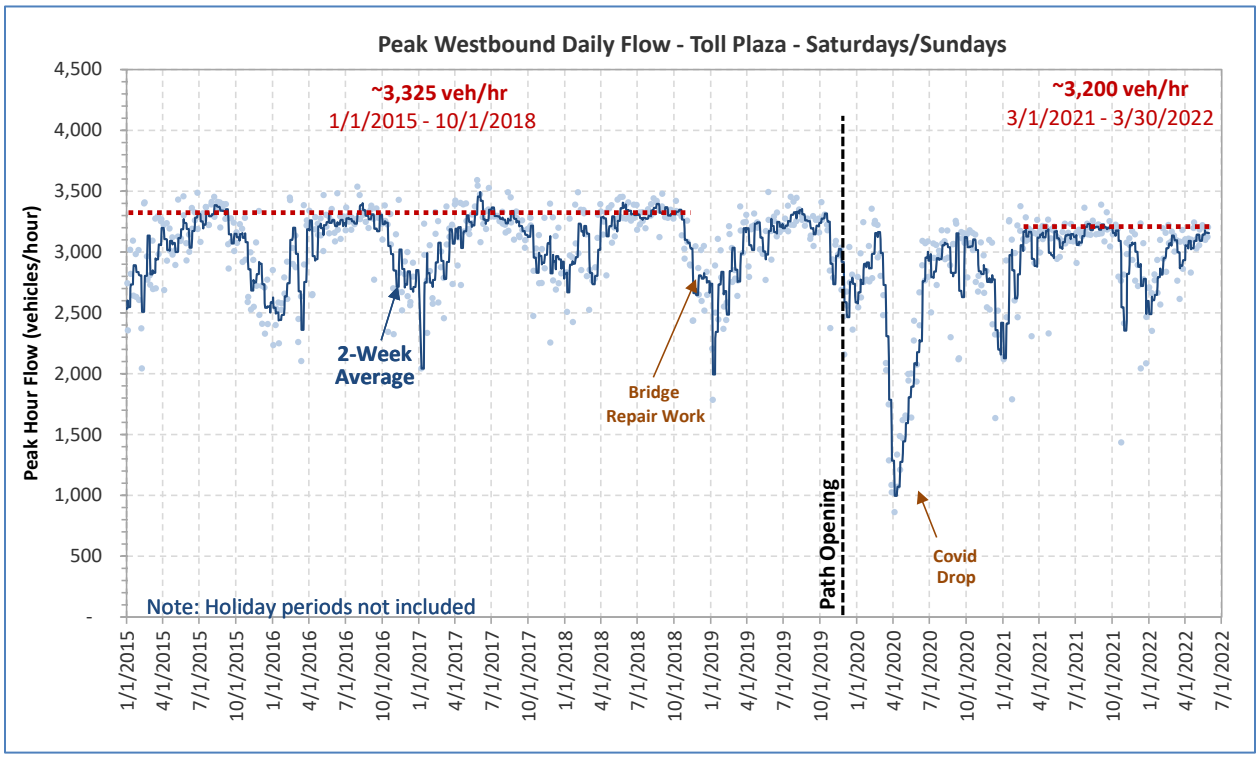

Figure 8-50: Peak Hourly Flows – I-580 West – Toll Plaza, Weekends, 2015-2022

The following observations can be made from the illustrated data:

- A weekday peak traffic capacity of approximately 3,675 vehicles/hour existed before January 2019. Average peak flows on Saturdays and Sundays were slightly lower, at 3,325 vehicles/hour, likely due to the presence of drivers with less aggressive behavior.
- Following the failure of a bridge joint on February 7, 2019, and the subsequent decision to perform emergency maintenance on the bridge, significantly lower maximum flows were observed from February to July 2019 on both weekdays and weekends. These are the results of occasional lane closures and reduced traffic speeds caused by steel plates covering joints.
- After the installation of the barrier delimiting the bike/pedestrian path, peak flows averaged 3,525 vehicles/hour on weekdays between November 2019 and February 2020. This represents a 150 vehicles/hour, or 4%, average drop over the before conditions. Weekend peak traffic flows remained too variable to provide a representative average.
- Since June 2021, following the termination of workplace Covid-19 restrictions, average peak flows across the bridge have remained around 3,425 vehicles/hour. This represents a 250 vehicles/hour, or roughly 7%, drop from the pre-modifications historical average. On Saturdays and Sundays, a similar reduction is observed, with average peak flows dropping from 3,325 to 3,200 vehicles/hours, corresponding to a roughly 4% drop.
- Over a four-hour peak period, the observed weekday decrease in capacity could translate into 1,100 vehicles that could potentially not be served by the bridge if traffic demand remains at or above capacity over the entire period. On weekends, the data further suggest that 600 vehicles may potentially not be served by the bridge if demand similarly exceeds the capacity for four hours.

While daily traffic remains lower than pre-Covid-19 levels, as shown earlier in Figure 8-1 to Figure 8-6, congestion is again observed on the approach to the toll plaza on Weekdays, Saturdays, and Sundays. This is an indication that traffic is again reaching bridge capacity during peak periods. However, since daily maximum flows have not returned to pre-Covid-19 levels, it can be inferred that the observed drops in capacity are the results of the bridge modifications, as outlined below:

- The capacity chokepoint appears to be the section downstream of the toll plaza where the number of traffic lanes reduces from seven to two. Implementation of the bikeway has reduced the length of the merge area from 900 ft to 325 ft. Forcing vehicles to merge over a shorter distance cause more friction between traffic streams and reduce the maximum number of vehicles that can go through the section in an interval.
- The barrier also creates a more visually constrained environment on the bridge, enticing vehicles to slow down. This is particularly true near the entrance of the bridge, where vehicles often change lanes. While lower speeds have historically been observed on the first half-mile of the bridge due to lane changing activities, as evidenced later in Figure 8-60, Figure 8-61, and Figure 8-62, slight additional speed reductions could further lower the maximum number of vehicles that can enter the bridge in periods of heavy traffic.

The impacts of the above factors are further compounded by the elimination of cash toll payments at the toll plaza in March 2020. This change allows more vehicles to cross the plaza on lanes that were previously not equipped with an electronic toll payment system, increasing traffic attempting to go through the merge area at the same time.

8.3.3. TRAVEL CONDITIONS ON WESTBOUND APPROACH

The following sets of figures are presented to illustrate traffic conditions on the westbound approach to the bridge:

- Figure 8-51 to Figure 8-53 present average speed contour maps along I-580 West from the I-80 interchange to the Richmond toll plaza, for weekdays, Saturdays, and Sundays, between 2015 and 2021. For each year, the speeds and travel times are the averages from mid-September to mid-November. To facilitate data analyses, the thick vertical blue line in each figure indicates which portion of the data falls before and after the path opening.
- Figure 8-54 to Figure 8-56 further present travel times over the same period and section of freeway. In this case, data from the before period are indicated by a dotted line, while the after are shown by solid lines.
- Figure 8-57 to Figure 8-59 finally present the buffer time index for the weekday, Saturday, and Sunday conditions illustrated in the previous graphs. The buffer time index is a measure of reliability. It represents the additional time that travelers must add to their planned trip to arrive on time 95 percent of the time, expressed as a percentage of the average travel time.

The following observations can be made from the illustrated data regarding the weekday traffic conditions:

- Current weekday congestion on the approach to the bridge is similar to before the modifications. In the speed maps of Figure 8-51, the congested area upstream of the toll plaza in the fall of 2021 is observed to extend between Cutting Boulevard and Marina Bay Parkway. This is like what was observed before 2019 and in prior years.
- Average peak weekday travel times from I-80 to the entrance of the bridge reached 21 minutes in the fall of 2021. As shown in Figure 8-54, this is similar to the peak of fall 2019, but still below the 23-27 travel times observed between 2015 and 2018.
- Weekday morning travel time reliability is worse in the fall of 2021 than in any previous years. This is likely due to the lack of a shoulder on the bridge's upper deck. Before the modification, some incidents could be moved out of the way onto the shoulder lane. This is no longer possible, resulting in every incident having a more significant negative impact on travel times.
- Weekday data from fall 2020 must be disregarded as the observed reductions in congestion and travel times are largely due to the drop in traffic caused by the Covid-19 pandemic. While traffic had partly rebounded by then, daily peak traffic remained below pre-Covid levels, as illustrated earlier in the daily flow profiles of Figure 8-10. This caused the congestion on the bridge approach to artificially remain subdued.

The following observations can further be made for the Saturday and Sunday conditions:

- Peak Saturday congestion appears to match what was observed before the modifications. In Figure 8-52, midday Saturday congestion in the fall of 2021 extends midpoint between Castro Street and Cutting Boulevard, like what was observed between 2015 and 2019. The similarity of traffic conditions is further highlighted by the travel time data of Figure 8-53, which show a peak average time to cross the bridge in the fall of 2021 of 9 minutes that is generally matching what was observed in previous years.

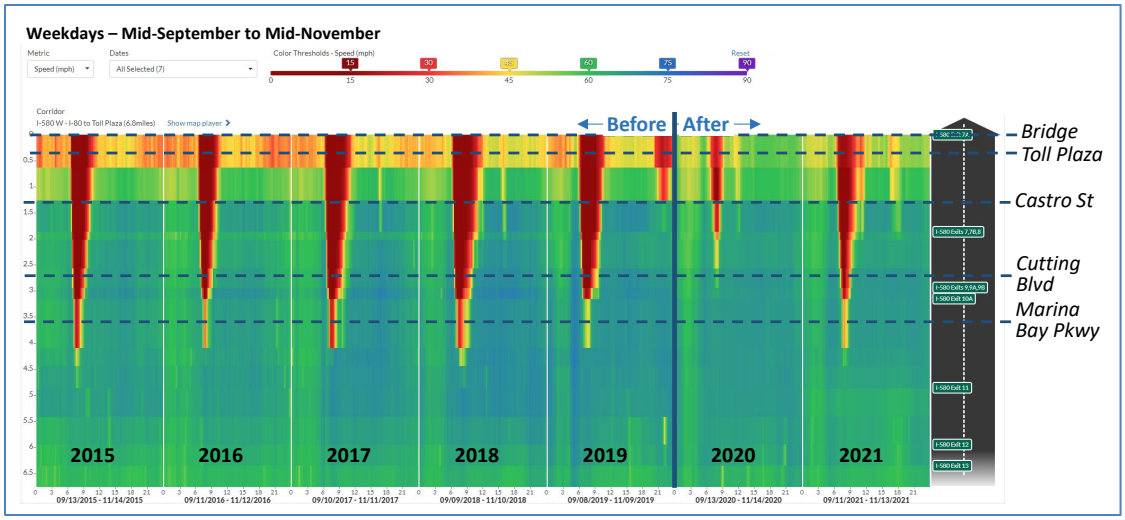

Figure 8-51: Speed Maps – I-580 West – Richmond Approach – Weekdays, Fall 2015-2021

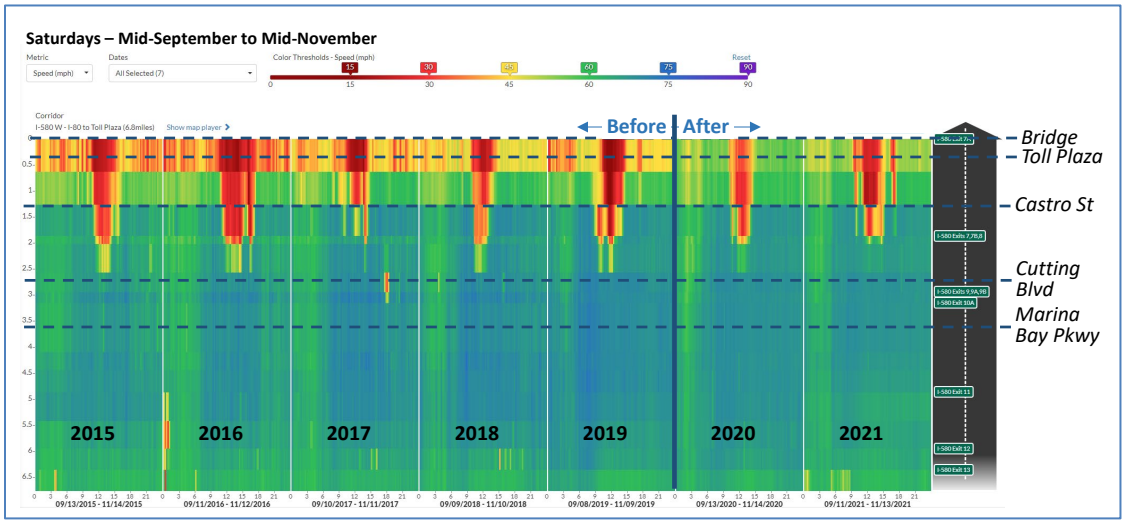

Figure 8-52: Speed Maps – I-580 West – Richmond Approach – Saturdays, Fall 2015-2021

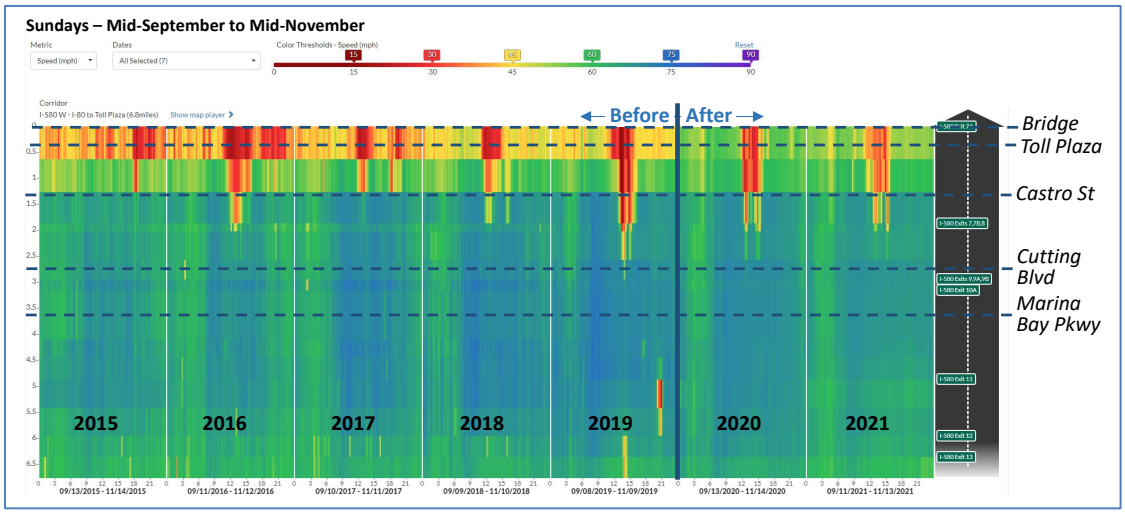

Figure 8-53: Speed Maps – I-580 West – Richmond Approach – Sundays, Fall 2015-2021

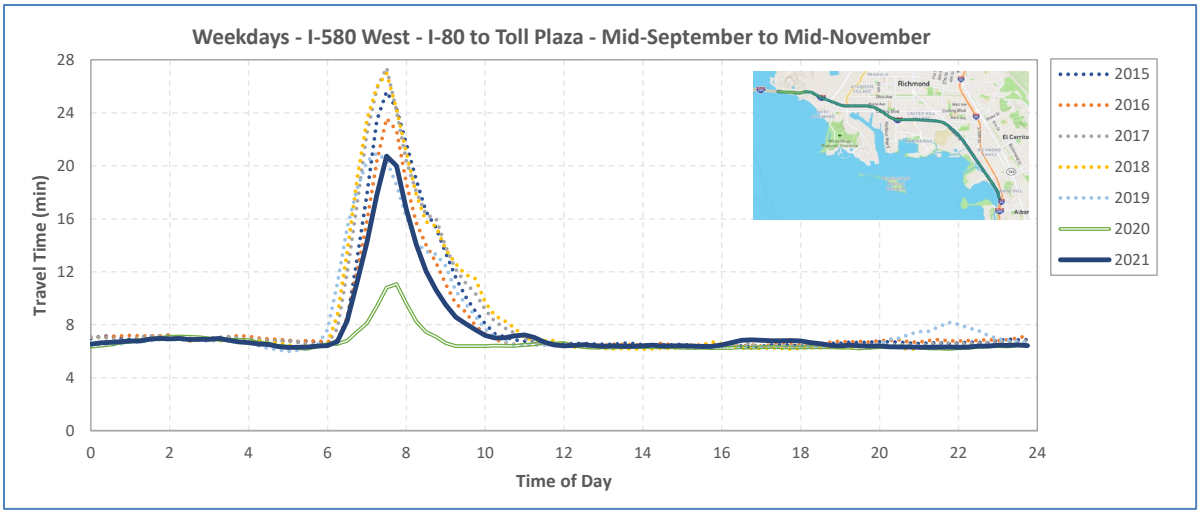

Figure 8-54: Travel Times – I-580 West – Richmond Approach – Weekdays, Fall 2015-2021

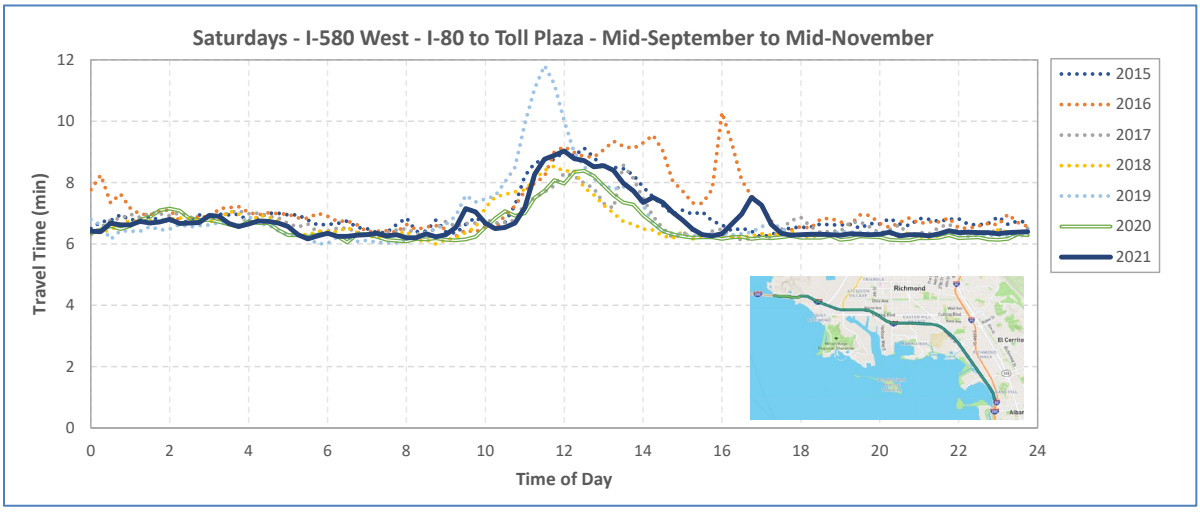

Figure 8-55: Travel Times – I-580 West – Richmond Approach – Saturdays, Fall 2015-2021

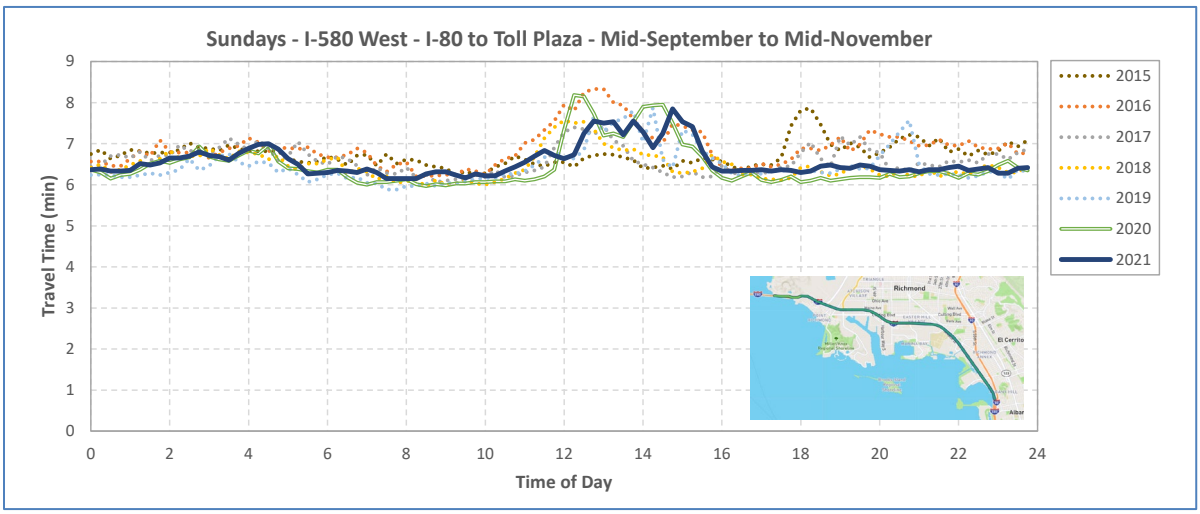

Figure 8-56: Travel Times – I-580 West – Richmond Approach – Sundays, Fall 2015-2021

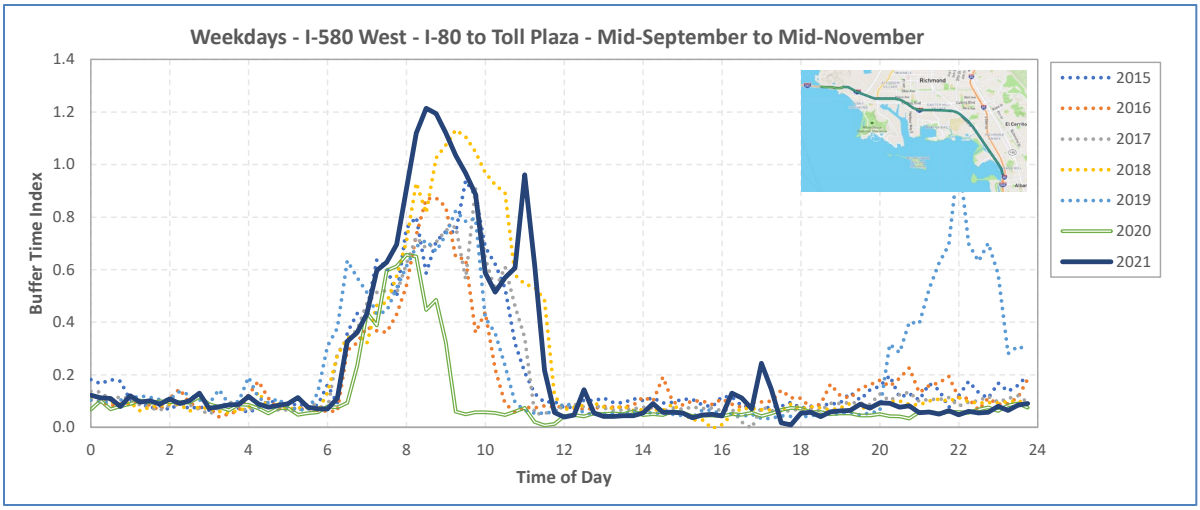

Figure 8-57: Travel Time Reliability – I-580 West – Richmond Approach – Weekdays, Fall 2015-2021

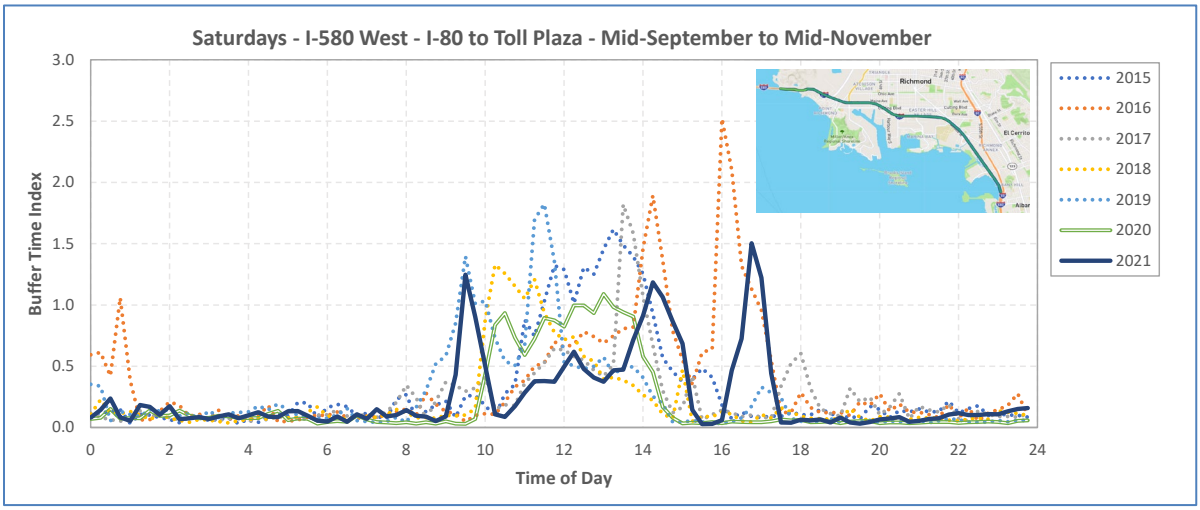

Figure 8-58: Travel Time Reliability – I-580 West – Richmond Approach – Saturdays, Fall 2015-2021

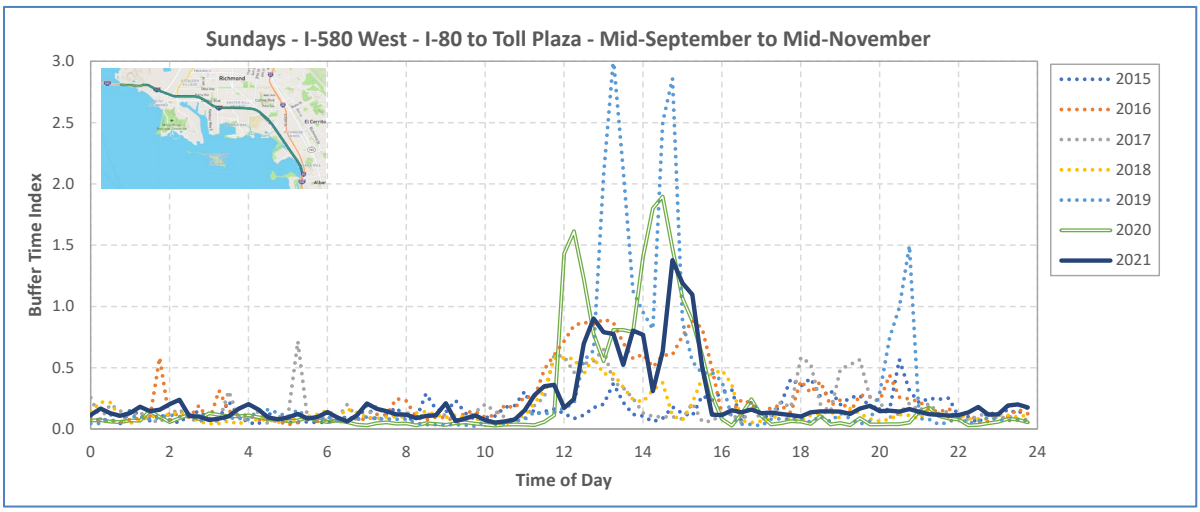

Figure 8-59: Travel Time Reliability – I-580 West – Richmond Approach – Sundays, Fall 2015-2021

- Peak Sunday congestion appears to match was what observed before the modifications. As shown in Figure 8-54, peak Sunday congestion typically extends to Castro Street before and after the modifications. As further shown in Figure 8-60, travel times to cross the bridge in the fall of 2021 generally correspond to travel times observed earlier.
- Peak travel time reliability on Saturdays and Sundays appears to be similar to what was observed before the modifications.
- A similar explanation can be provided for reductions in congestion on Saturday and Sunday in the fall of 2020. Here, while the Covid-related drop in traffic also translated into a slight reduction in travel times on Saturdays, there were no apparent impacts on Sunday. This is likely because the initial Saturday and Sunday demand did not significantly exceed the capacity of the toll plaza, resulting in the observed delays being mainly attributed to normal frictions associated with more vehicles changing lanes and merging around the toll plaza.

Based on the assessed reduction in bridge capacity outlined in Section 8.3.2, a reasonable expectation was that both the extent of congestion and travel times on the westbound approach to the bridge would have slightly increased following the upper deck modifications if traffic demand had remained the same. Based on the data in Figure 8-51 through Figure 8-56, this is not the case. Despite lower peak flows going through the toll plaza, the congestion and travel times on the approach remain similar to prior years. This can be explained by a peak traffic demand that remains slightly below the demand of prior years, particularly at the start and end of the traditional peak periods. Lower traffic demand at the beginning of the peak period may delay or constrain the growth of congestion, while lower demand at the end of the peak may facilitate a quicker return to normality.

The elimination of cash collection activities at the toll plaza may have also contributed to reducing congestion at the start and end of the peak travel periods. However, it is unlikely to have played an effect in the middle of the period. While this change allows more vehicles to go through the toll plaza in an interval, it only provides an advantage when there is no traffic backing up from the downstream merge area. As shown in Figure 8-60, Figure 8-61, and Figure 8-62 presented in the next section, congestion often exists at the entrance of the bridge during the morning peak period. This means that traffic conditions downstream of the plaza likely affect conditions at the plaza and upstream of it. Any reduction in congestion upstream of the toll plaza, while there is congestion at the foot of the bridge, is thus likely to be due to a reduction in traffic demand.

8.3.4. TRAVEL TIMES ACROSS BRIDGE

Figure 8-60 to Figure 8-62 map the average mid-September to mid-November speeds on the bridge upper deck between 2016 and 2021 for weekdays, Saturdays, and Sundays. Figure 8-63 to Figure 8-65 further present travel times across the bridge for the same period, from the toll plaza to just before the Main Street exit in Marin County. Only fall speeds are analyzed, as this is typically the period of the year with the highest traffic.

Based on the illustrated data, the following observations can be made regarding traffic conditions on the upper deck of the bridge:

- The addition of the barrier-separated path appears to have caused slight speed reductions on the bridge under heavy traffic demands. Before the modifications, reduced speeds on weekday mornings were primarily contained to the first third of the bridge, and more particularly to the

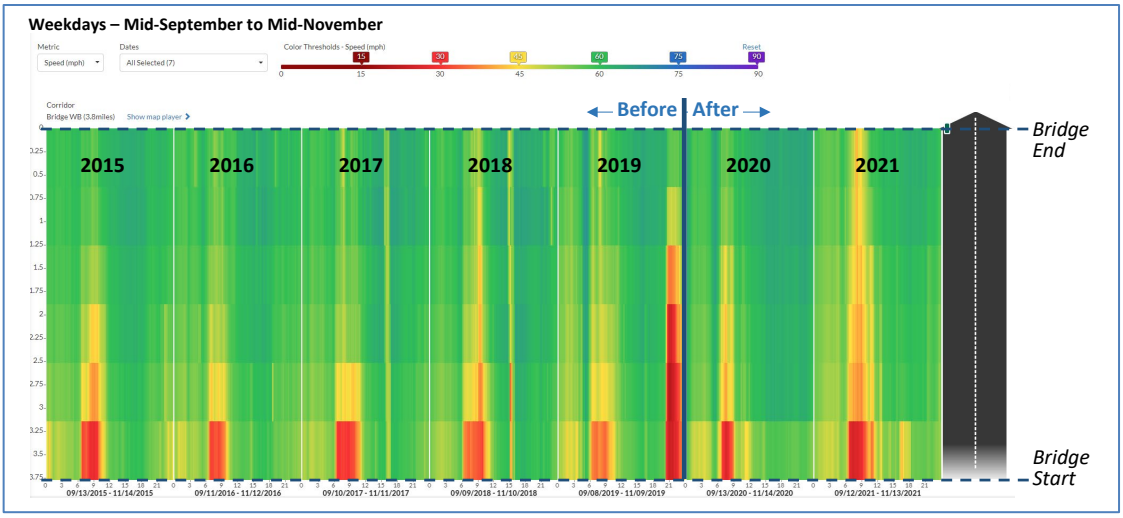

Figure 8-60: Speed Maps – I-580 West – Bridge – Weekdays, Fall 2015-2021

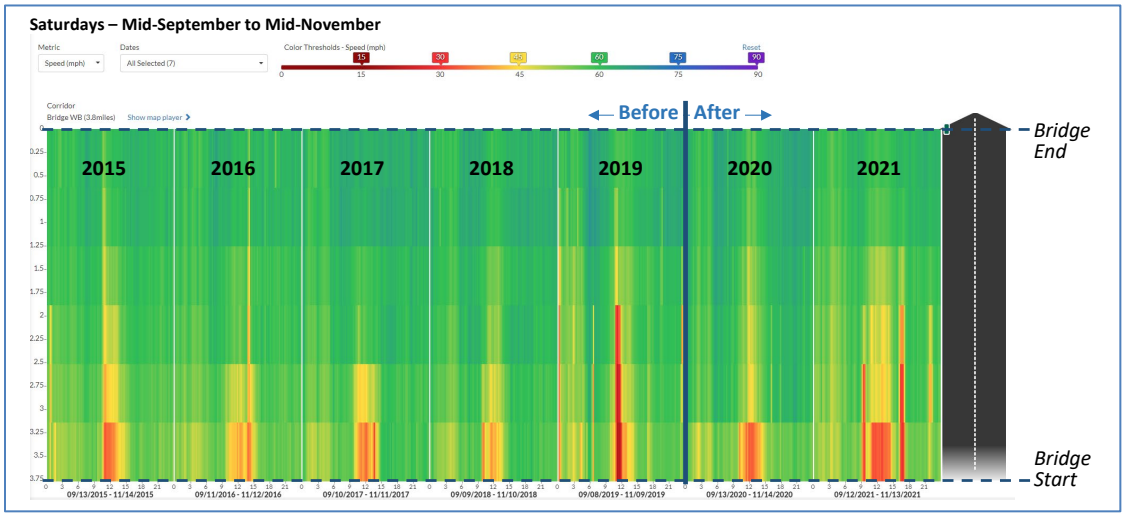

Figure 8-61: Speed Maps – I-580 West – Bridge – Saturdays, Fall 2015-2021

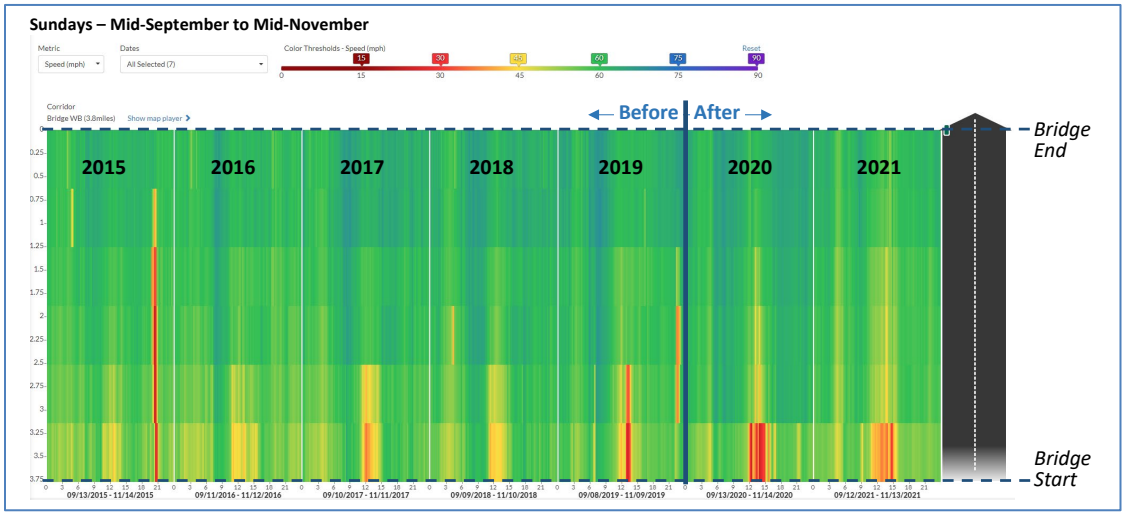

Figure 8-62: Speed Maps – I-580 West – Bridge – Sundays, Fall 2015-2021

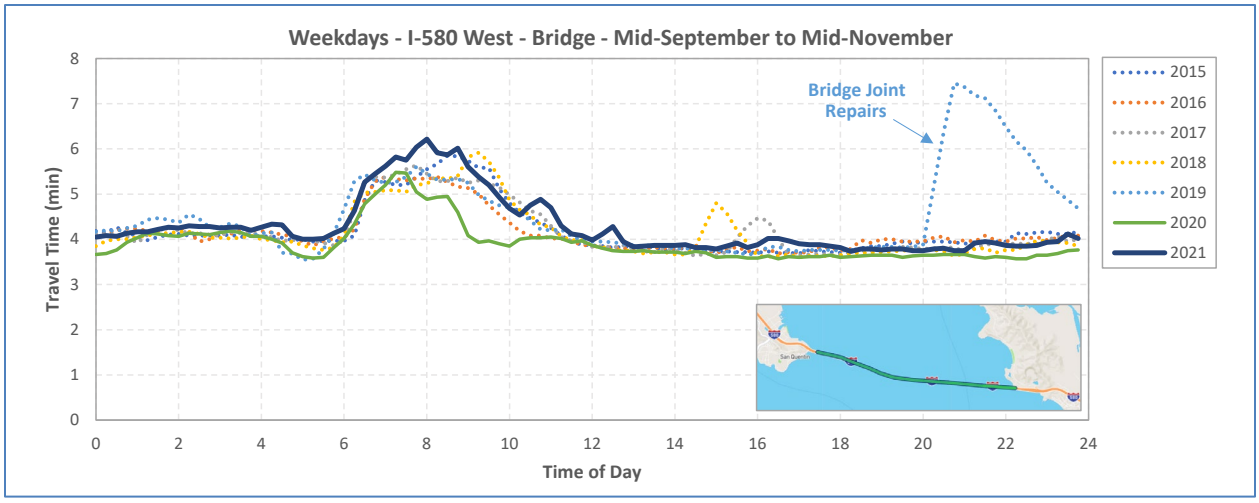

Figure 8-63: Travel Times –Bridge WB – Weekdays, Fall 2015-2021

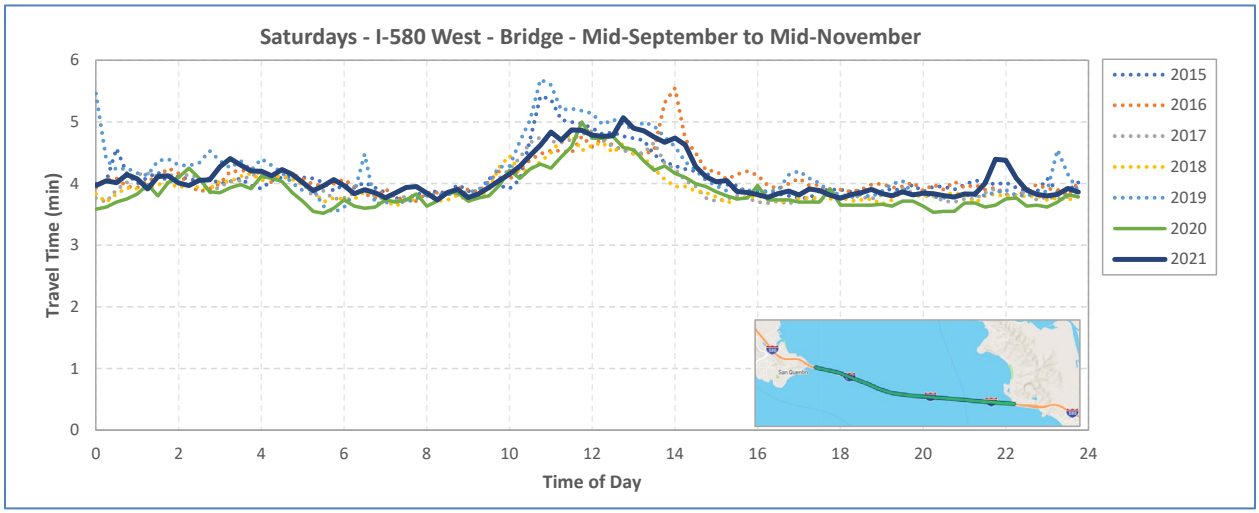

Figure 8-64: Travel Times –Bridge WB – Saturdays, Fall 2015-2021

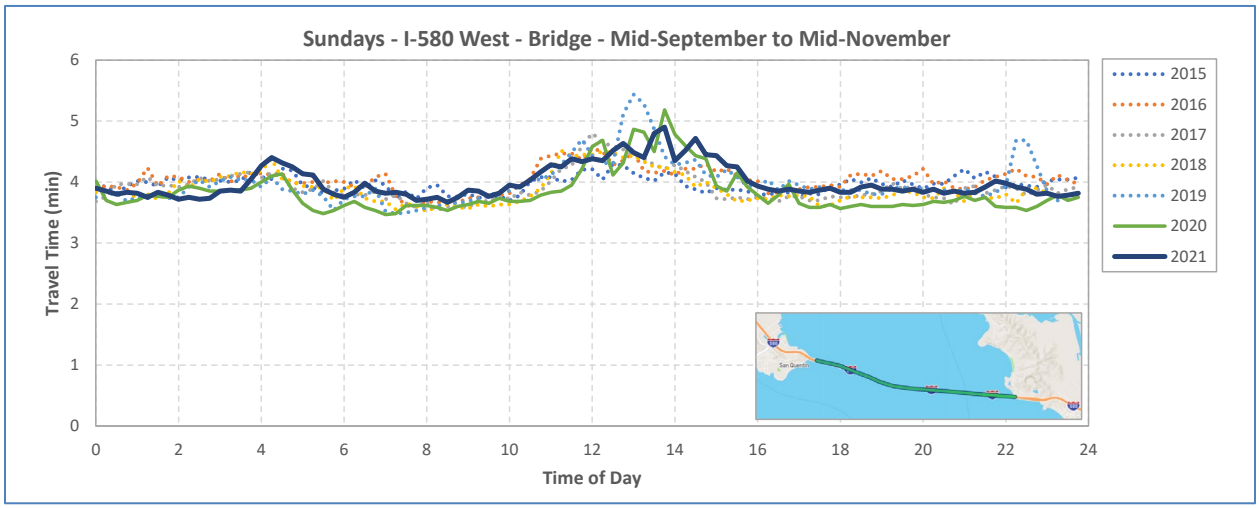

Figure 8-65: Travel Times –Bridge WB – Sundays, Fall 2015-2021

first half mile. Traffic then flowed at or above 50 mph on the remainder of the bridge. In the fall of 2021, average speeds between 40 and 50 mph (yellow and orange areas) were observed across most of the length of the bridge during weekday mornings, indicating a slight deterioration of traffic conditions under heavy traffic demand.

- Similar speed deteriorations are observed for the Saturday and Sunday afternoon peak periods, but to a lower extent due to lower traffic demands.
- The expansion of reduced speed areas did not translate into significant increases in travel times across the bridge. As shown in Figure 8-63, average peak travel times for the weekday morning peak in the fall of 2021 are less than one minute higher than the travel times that were observed before the modifications.
- As shown in Figure 8-64 and Figure 8-65, peak travel times on Saturdays and Sundays remain similar to those observed with the prior bridge configuration.

8.3.5. TRAFFIC DISTRIBUTION ACROSS LANES ON THE BRIDGE

Figure 8-66 compares the proportion of traffic using the left traffic lane on weekdays, Saturdays, and Sundays in the middle of the bridge between September/October 2018, before the modifications, and September/October 2021, after the modifications. The following observations can be made from the illustrated data:

- The changes made to the bridge have not significantly altered the distribution of traffic across the two traffic lanes between 7 AM and 7 PM on weekdays, Saturdays, or Sundays. Before the modifications, between 52% and 56% of daytime traffic used the left lane, with higher proportions observed in periods with the highest traffic. Similar proportions are observed in the fall of 2021, but 1-2% higher, suggesting a slight shift in preference towards using the left lane.
- Higher increases in left lane usage are observed before 7 AM and after 7 PM across all days. Shifts of up to 20% are observed in these cases. These shifts cannot be attributed to increases in traffic as evening, night, and morning traffic flows in the fall of 2021 were generally similar to or below those for fall 2018. The most probable cause is motorists being uncomfortable with the barrier being at the edge of the right traffic lane. Before the modifications, physical barriers were 12 feet away from the right traffic lane, at the edge of the shoulder lane, and at the edge of the left lane. After the modifications, drivers feeling uncomfortable by the closeness of the path barrier on the right might prefer to be on the left lane, where the recess in the bridge guardrail at eye level makes it visually less intimidating.

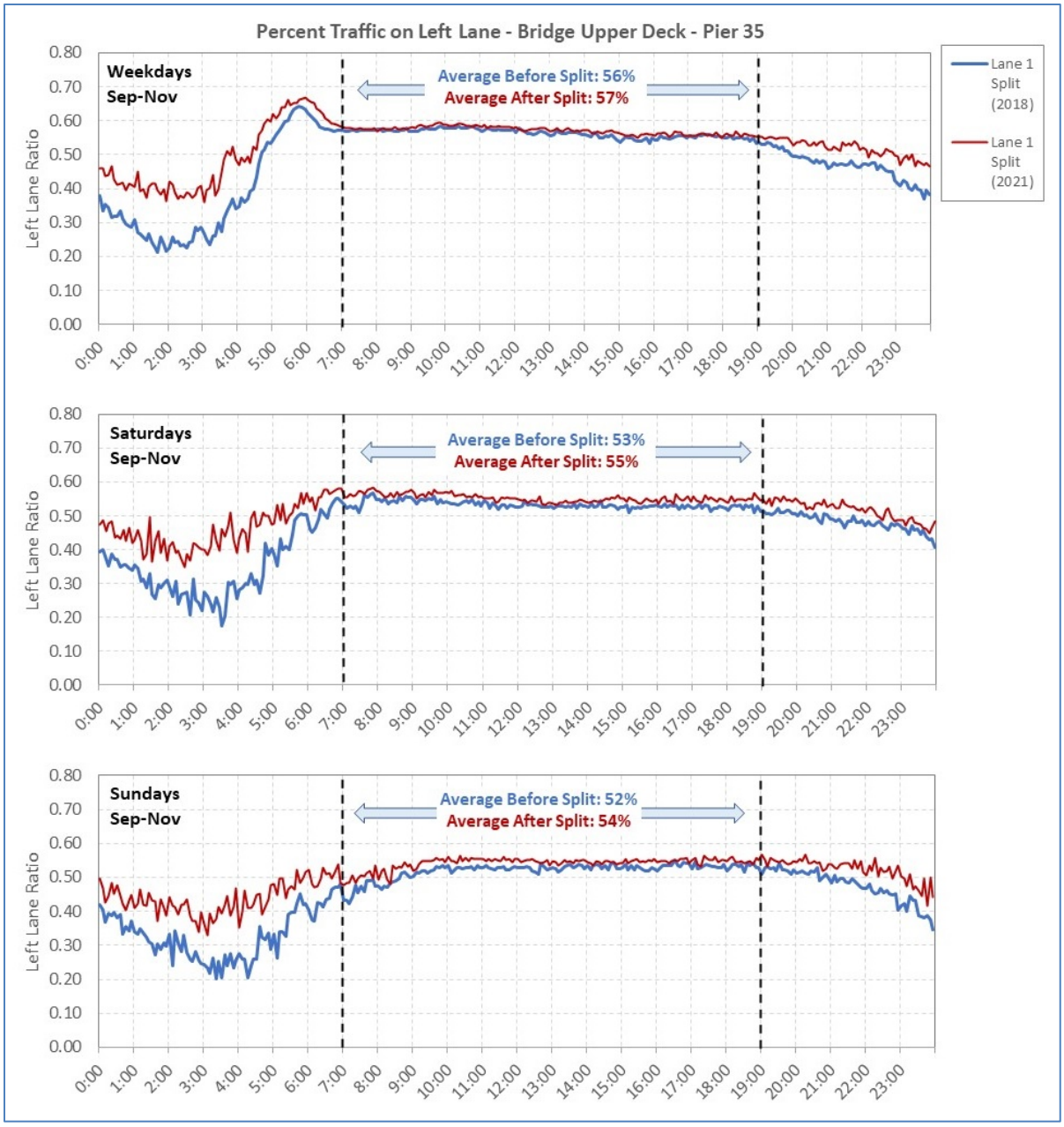

Figure 8-66: Percent of Traffic in Left Lane – Upper Deck, 2018 & 2021

8.3.6. IMPACTS ON LOCAL ARTERIALS IN RICHMOND

Figure 8-67 to Figure 8-69 illustrates observed average speeds along southbound Castro Street and Richmond Parkway/Canal Boulevard, as well as westbound Cutting Boulevard, in February/March between 2015 and 2022. As can be noted, this analysis does not reveal any negative impacts associated with the conversion of the upper deck shoulder into a barrier-delimited bike/pedestrian path during the AM peak period. Along Castro Street and Richmond Parkway/Canal Boulevard, the highest level of congestion near I-580 in the morning peak period, when traffic on I-580 is mainly traveling west, is observed in the spring of 2019, before the conversion. No significant changes are observed along Cutting Boulevard in traffic conditions between 2020 and 2017-2019.

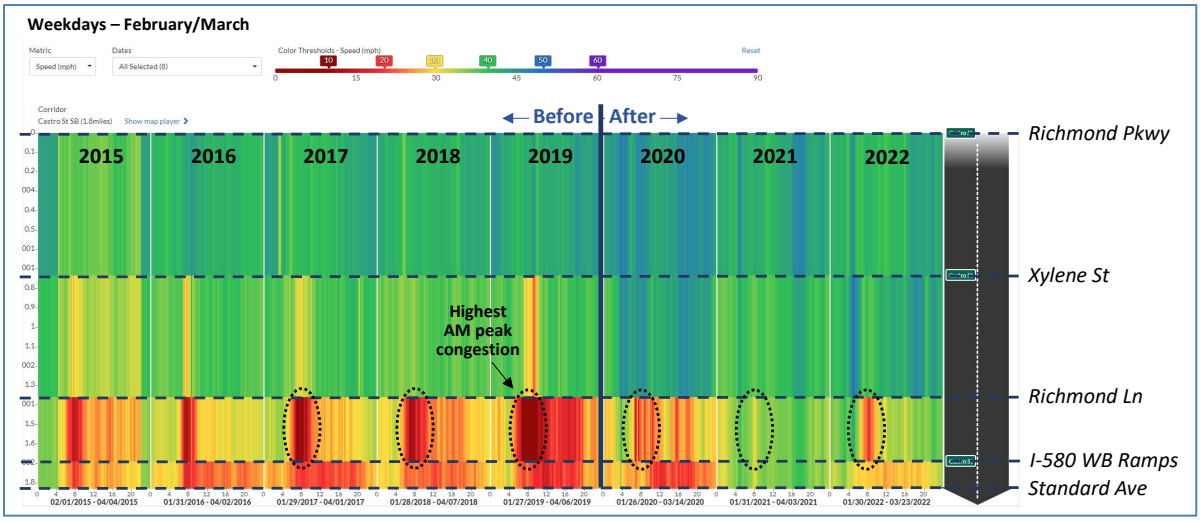

Figure 8-67: Speed Maps – Castro Street SB – Weekdays, Spring 2015-2022

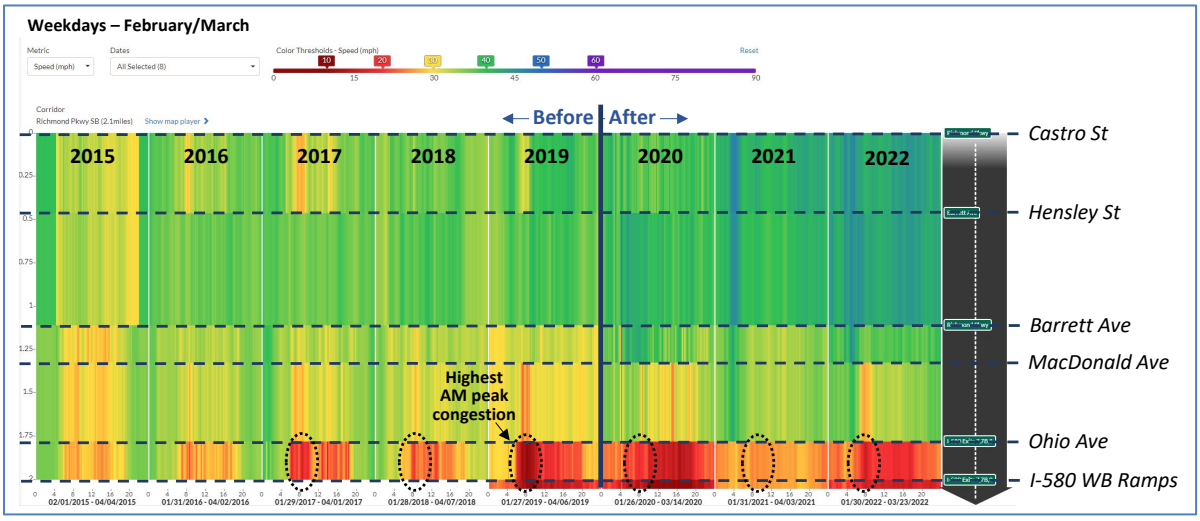

Figure 8-68: Speed Maps – Richmond Parkway SB – Weekdays, Spring 2015-2022

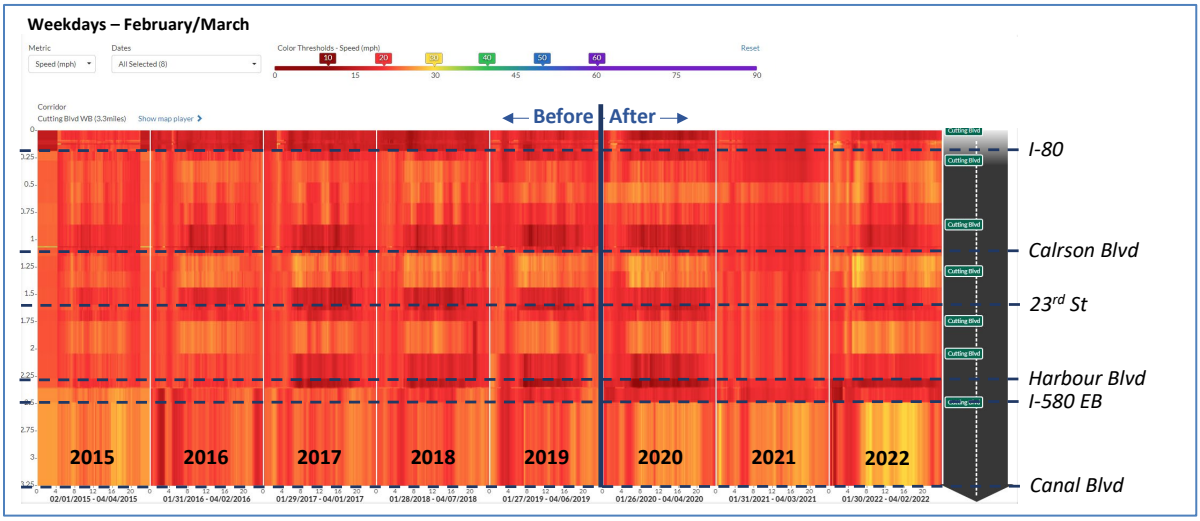

Figure 8-69: Speed Maps – Cutting Blvd WB – Weekdays, Spring 2015-2022

Along the three arterials, traffic conditions for 2021, in the after period, are heavily affected by the drop in traffic that has accompanied the Covid-19 pandemic. The observed improved conditions observed for that year should therefore be discounted. While arterial traffic has rebounded since then, observed flows remain below pre-pandemic levels. A comparison of traffic counts taken along the three arterials and I-580 West on-ramps in May 2016 and March 2022 (see section 5.2.4) indicates that AM peak arterial traffic flows in March 2022 are typically 15-20% below the May 2016 counts. This indicates that the illustrated 2022 traffic conditions are still likely affected by the Covid-19 pandemic and that definitive conclusions on arterial impacts may not be made until traffic fully recovers from the pandemic.

8.3.7. SUMMARY OBSERVATIONS

The following are the key summary observations from the analysis of the traffic impacts of the conversion of the westbound shoulder into a barrier-separated bike/pedestrian path:

- Following the modifications, average weekday peak hourly flows have dropped by 7%, and peak weekend flows by 4%. This may be due to the shorter merge area downstream of the toll plaza, as well as a roadway that appears narrower due to the barrier.
- Despite the apparent slight drop in capacity, the extent of the congestion upstream of the toll plaza during the weekday, Saturday, and Sunday peak periods remain similar to before the modifications.
- Travel times to access the bridge from I-80 remain close to historical averages on weekdays, Saturdays, and Sundays.
- Peak weekday travel times are more variable than before the modifications, likely due to the increased impacts of incidents due to the lack of a shoulder to move vehicles out of the way. Travel time reliability on weekends is like before the modifications.
- While reduced speeds are observed on more bridge sections during weekday peak periods, these reductions have only increased travel times across the bridge by less than one minute. Speed reductions observed during Saturday and Sunday midday peaks have also not caused significant changes in average travel times across the bridge.
- The installation of the path barrier appears to have caused some shift in traffic towards the left lane, particularly under low traffic volumes. Only 1-2% of traffic is observed to have shifted towards the left during high traffic periods, but up to 15% during low traffic periods.
- Available data do not indicate that the bridge modifications have had significant impacts on local arterials on the Richmond side of the bridge.

8.4. SUMMARY OBSERVATIONS

The following is a summary of key observations from the analysis of traffic impacts associated with the various bridge modifications:

- **Compliance with lower deck shoulder lane open/close periods:**
    - Motorists are generally compliant with the shoulder opening period, as relatively few vehicles are observed using the lane before 2 PM and after 7 PM.

- Non-compliant use of the shoulder lane is highest 20 minutes before its opening and up to 25 minutes following its closure.
- CHP officers have indicated observing some vehicles using the shoulder as a passing or traveling lane when a red or yellow X is shown above it. This suggests that some motorists may not fully understand the meaning of the current lane control signs.

- **Traffic impacts – Lower deck modifications:**
  - The availability of an extra traffic lane has increased the eastbound peak hourly flow across the bridge by 13-26%, from 3,300-3,570 to 3,750-4500 vehicles/hour.
  - Traffic is generally not split event across lanes. Less than 25% of traffic is observed at any given time using the shoulder lane during weekday peak periods, and less than 20% on weekends.
  - The added peak-hour capacity has eliminated congestion on the I-580 East approach to the bridge. This has caused peak travel times from the US-101 interchange to the toll plaza to drop by 13-14 minutes on weekdays, 10-14 minutes on Saturdays, and 6-8 minutes on Sundays.
  - Travel times to reach the toll plaza from the US-101 during peak periods are significantly less variable than before.
  - The absence of congestion on I-580 East has contributed to a 1- to 2-minute reduction in average travel times on US-101 North between the Sir Francis Drake Boulevard and I-580 exits.
  - Afternoon peak travel times along Sir Francis Drake Boulevard have dropped by up to 4 minutes while traffic volumes have increased by nearly 475 vehicles/hour.
  - Fewer vehicles are using local arterials as bypasses to I-580 East. The modifications have contributed to reducing traffic along Francisco Boulevard, and possibly Andersen Drive. More vehicles are also observed entering I-580 east at Bellam Boulevard, while fewer vehicles are using the Main Street ramps as a bypass.

- **Traffic Impacts – Upper deck modifications:**
  - Following the modifications, average weekday peak hourly flows have dropped by 7%, and peak weekend flows by 4%. This may be due to the shorter merge area downstream of the toll plaza, as well as a roadway that appears narrower on the bridge due to the barrier.
  - Despite the slight apparent drop in capacity, the extent of the congestion upstream of the toll plaza during the weekday, Saturday, and Sunday peak periods remain similar to before the modifications. Travel times to cross the bridge from I-80 also remain close to historical averages. This can be explained by overall traffic demands remaining slightly below before conditions, particularly at the start and end of the traditional peak periods, due to lingering Covid-related factors.
  - While reduced speeds are observed on more bridge sections during weekday peak periods, these reductions have only increased average travel times across the bridge by less than one minute. Speed reductions observed during Saturday and Sunday midday peaks have also not caused significant changes in average travel times across the bridge.

- Peak weekday travel times are more variable than before the modifications, likely due to the increased impacts of incidents due to the lack of a shoulder to move vehicles out of the way. Travel time reliability on weekends is like before the modifications.
- The path barrier appears to have caused a shift in traffic towards the left lane, particularly during low traffic periods. Only 1-2% of traffic is observed to have shifted left during high traffic periods, but up to 15% during low traffic periods.
- Available data do not indicate that the bridge modifications have had significant impacts on local arterials on the Richmond side of the bridge.

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9. BIKE/PEDESTRIAN PATH SAFETY

This section reviews reports of incidents that have occurred on the new bike/pedestrian bridge path to determine its safety for cyclists and pedestrians. The following specific elements are discussed:

- Incidents logged into the SWITRS database.
- Incidents reported on the Street Story online platform.
- Comments from a user survey
- Summary of observations.

9.1. SWITRS BICYCLE/PEDESTRIAN INCIDENT DATA

A review of bicycle and pedestrian incidents contained in the SWITRS database indicates that no incident involving cyclists or pedestrians has been logged into the database related to the new bridge path between November 2019 and December 2021.

9.2. STREET STORY REPORTS

Figure 9-1 shows a compilation of crash/near-miss incidents and safe/unsafe reports logged by travelers on the Street Story online platform between October 2018 and December 2021. The two maps indicate the following:

- No incidents or near misses were reported on the bridge.
- One hazard report was logged for the bridge path in November 2019, shortly after its opening, highlighting the need to improve access to the bridge from Marin County.

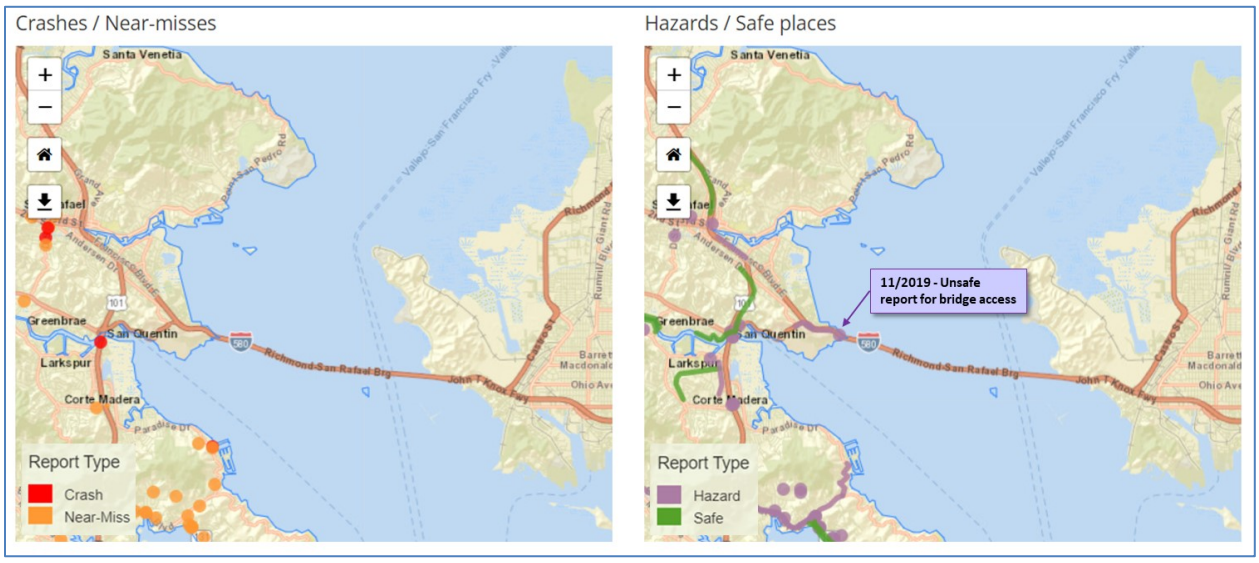

Figure 9-1: Street Story Reports for Area Surrounding Bridge

9.3. COMMENTS FROM USER SURVEY

Several respondents made safety-related comments on the bridge path during the user survey that was conducted in the summer of 2021.

Below is a summary of the key comments made regarding the bridge path:

- The bridge path needs to be swept regularly to remove glass fragments and other debris that tend to accumulate on it.
- Many were concerned about being hit by objects or incommoded by sand flung from the adjacent traffic lane and suggested that a higher barrier could help prevent such occurrences.
- A few path users commented on being blinded by lights from cars when traveling eastbound due to the low height of the barrier.
- The lane separating the two travel directions is not placed in the center of the path, resulting in a narrower eastbound lane than the westbound lane.
- Some accidents could result from cyclists traveling at high-speed sharing a narrow path with slow-moving cyclists and pedestrians.
- Noise from traffic on the adjacent lanes makes it difficult to hear other cyclists or what might be happening around.

Comments made regarding paths leading to the bridge:

- Several respondents indicated the need for improving access to the bridge, particularly on the Marin County side. Many expressed the need for fully separated bikeways going from the bridge to downtown San Rafael, as well as to Larkspur along Sir Francis Drake Boulevard.
- One rider indicated that the line of sight at the Stenmark Drive crossing might be inadequate for a safe crossing by cyclists.
- Some respondents indicated concerns that the I-580 shoulder path is only delimited by a painted line and soft bollards, as this would not stop vehicles traveling at relatively high speed to hit cyclists using the shoulder path.
- Several individuals also felt that allowing cyclists to travel along the freeway without a barrier presents a safety risk.

9.4. SUMMARY OBSERVATIONS

The following is a summary of key observations from the safety analysis of the new bridge path:

- No path-related incidents were recorded by the CHP or reported on the Street Story platform.
- While no bridge path incidents have been recorded in databases, anecdotal evidence suggests that some incidents have on rare occasions happened, such as cyclists injuring themselves after falling.
- The low height of the barrier on the bridge put riders at risk of being hit by debris flung from the adjacent traffic lanes. The low height also may cause eastbound travelers to be blinded by the

lights of passing cars and trucks in the adjacent traffic lane. While a desire has been expressed by many for a higher barrier, this may not be compatible with the barrier-moving system.

- There is a need to improve paths leading to the bridge, particularly on the Marin County side.

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10. TRAFFIC SAFETY IMPACTS

This section assesses the impacts of the bridge modifications on traffic safety along the I-580. This is accomplished by comparing the number, type, and severity of incidents before and after the bridge modifications. The following subsections respectively present:

- Identification of I-580 sections used for the safety analysis.
- Impacts of the lower deck shoulder opening on traffic safety on eastbound traffic.
- Impacts of the upper deck bicycle/pedestrian path installation on westbound traffic.
- Summary of observations.

10.1. SAFETY ANALYSIS SECTIONS

Figure 10-1 illustrates the various sections used for evaluating the safety impacts of the bridge modifications. These sections include:

- **Bridge, eastbound and westbound directions**: Sections of I-580 East and West extending from the toll plaza in Richmond to the foot of the bridge in Marin County (Contra Costa County Postmile 6.15 to Marin County Postmile 2.50).
- **Bridge westbound approach**: Section of I-580 West in Contra Costa County extending from the Harbour Way interchange to the toll plaza (Contra Costa County Postmiles 3.50 to 6.05).
- **Toll Plaza area**: Section of I-580 West around the Richmond toll plaza (Contra Costa County Postmiles 6.05 to 6.25).
- **Toll Plaza merge area**: Section of I-580 West downstream of the toll plaza where the number of traffic lanes drops from 7 to 2 (Contra Costa County Postmiles 6.25 to 6.55).
- **Bridge eastbound approach**: Section of I-580 East in Marin County from the US-101 interchange to the foot of the bridge (Marin County Postmiles 4.80 to 2.50).

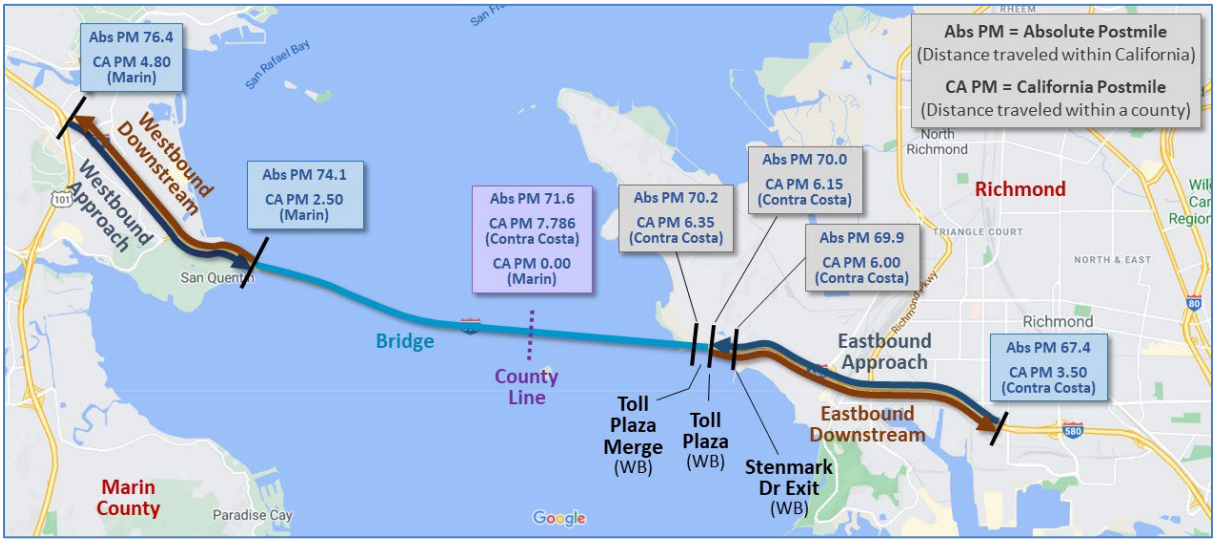

Figure 10-1: Safety Analysis Sections

- **Bridge westbound downstream section**: Section of I-580 West in Marin County from the Main Street off-ramp to the US-101 interchange (Marin County Postmiles 2.50 to 4.80).
- **Bridge eastbound downstream section**: Section of I-580 East in Contra Costa County from the toll plaza to the Harbour Way interchange in Richmond (Contra Costa County Postmiles 6.15 to 3.50).

Section limits are provided using California Postmile (also known as Relative postmiles) since incidents reported by the California Highway Patrol are typically positioned along freeways using the California Postmile system.

10.2. ESTIMATED VEHICLE MILES TRAVELED

Figure 10-2 and Figure 10-3 present the estimated vehicle miles of travel (VMT) statistics for the eastbound and westbound sections considered for the safety analysis. East figure presents the estimated VMT for the approach to the bridge, the bridge itself, and the section downstream of the bridge as defined in Figure 10-1. Within each figure, grey areas further identify the quarter during which the bridge modifications were made and the period affected by Covid-19 stay-at-home orders.

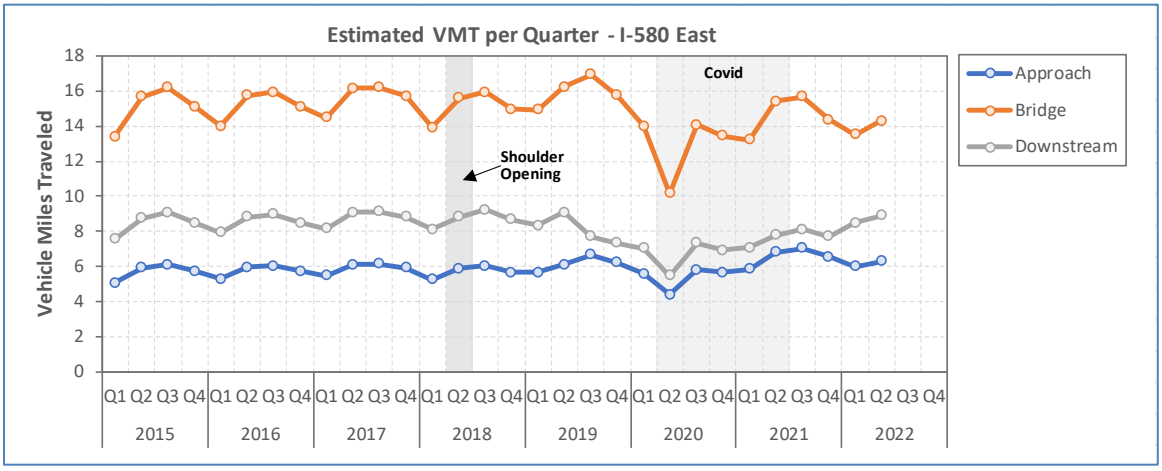

Figure 10-2: Estimated Vehicle Miles of Travel for Analysis Sections – I-580 East

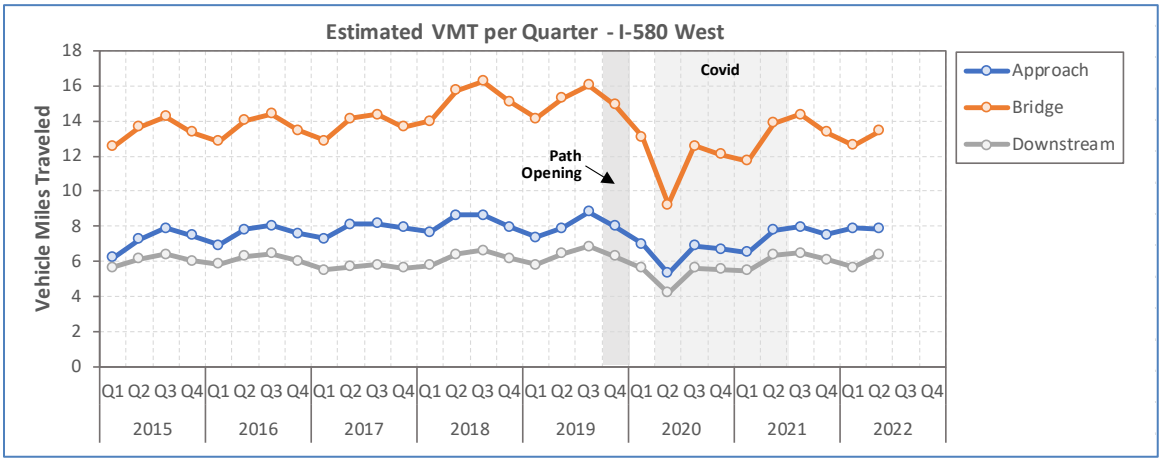

Figure 10-3: Estimated Vehicle Miles of Travel for Analysis Sections – I-580 West

For both directions, estimation of the VMT is based on data provided by PeMS. For the period between June 25, 2019, and June 2022, the statistics are mainly data directly provided by PeMS as there was adequate coverage along the corridor. Between February 2018 and June 25, 2019, data from several traffic monitoring stations on I-580 East in Marin County and Richmond had to be estimated. Statistics from the bridge were still available. Before February 2018, statistics from the bridge had to be estimated in addition to several stations on each side of the bridge as only a few stations produced count data for this period. As indicated earlier in Figure 5-1 to Figure 5-4, only the Canal Blvd stations on I-580 East and West and one station on I-580 West in Marin County were producing data, in addition to the toll plaza counts on I-580 West.

10.3. IMPACTS ON I-580 EAST SAFETY

This section presents incident statistics related to the conversion of the eastbound shoulder lane on the bridge's lower deck into a part-time traffic lane. The following analyses are presented based on data from the TASAS database from January 2016 to December 2021:

- Total number of incidents
- Categorization by incident types
- Categorization by incident severity
- Duration of incidents on the bridge
- Motorist recognition of overhead signs

10.3.1. OVERALL INCIDENT RATES ON BRIDGE AND APPROACH

Figure 10-4 illustrates the frequency of accidents, per million miles traveled, on I-580 East around the bridge for each quarter between January 2016 and December 2021 based on information contained in the TASAS database. The graph distinguishes incidents occurring on the approach to the bridge, the bridge itself, and downstream, based on the section boundaries shown earlier in Figure 10-1. The light gray area further marks the period during which the eastbound shoulder lane has been opened, while the dark gray area marks the period affected by Covid-19 stay-at-home orders.

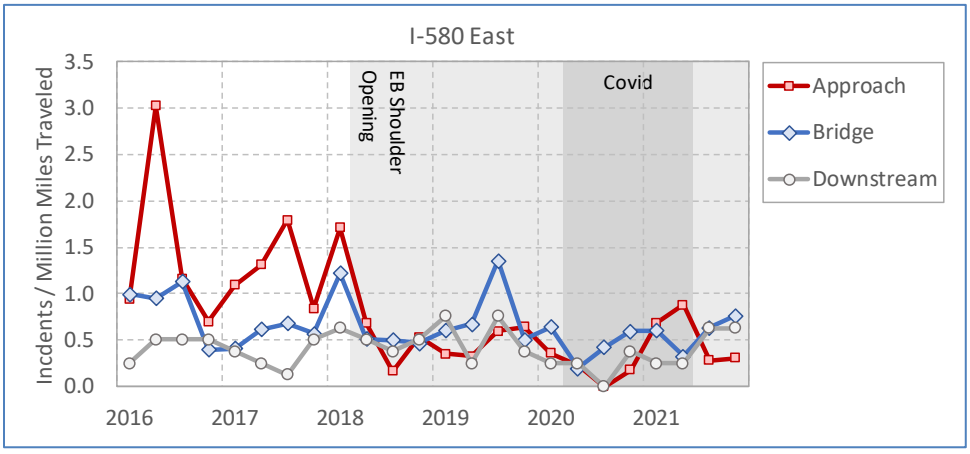

Figure 10-4: Number of Accidents by Quarter – I-580 East, 2016-2021

Ignoring any Covid-impacted data from the second quarter of 2021 to the second quarter of 2022, inclusively, the following observations can be made based on the illustrated data:

- Following the shoulder lane opening, the frequency of incidents occurring on the bridge approach has dropped from 1.40 to 0.40 per million miles traveled. This is a 72% reduction that is statistically significant at the 95% confidence level. Most of this drop coincides with the lane opening, suggesting that the modification is the primary contributing factor. The drop can largely be explained by the elimination of the congestion that used to affect traffic on the bridge approach during the weekday and weekend afternoon peak periods.
- The frequency of incidents occurring on the bridge also appears to have dropped by 10%, from 0.78 to 0.68 incidents per million miles traveled. However, this reduction is not statistically significant at the 95% confidence level based on the observed quarter-to-quarter variations in incident rates and could therefore simply be the result of stochastic variability.
- Incidents occurring downstream appears to have increased by 24%, from 0.41 to 0.51 incidents per million miles traveled. However, this change is not statistically significant at the 95% confidence level on the observed quarter-to-quarter variations in incident rates. Significant changes were not expected in this section as the only modification has been an increase in the number of lanes around the toll plaza from two to three to provide continuity in the number of lanes with downstream sections of I-580.

10.3.2. INCIDENT TYPES ON BRIDGE AND APPROACH

Figure 10-5 illustrates the frequencies at which various types of incidents have occurred on the eastbound approach to the bridge and the bridge's lower deck for each quarter between January 2016 and December 2021. Table 10-1 further presents the total numbers of documented incidents for both sections for the before and after periods, while Table 10-2 presents the average rates, on a per million miles traveled basis, at which each type of incident occurred before and after the modifications. In both tables, data from the second quarter of 2018 are ignored as some incidents within this period fall before the change and others after. Data between April 2020 and June 2021 are also ignored due to a bias towards fewer incidents associated with the drop in traffic caused by the Covid-19 stay-at-home orders.

The following specific observations can be made regarding changes in the types of incidents occurring in the eastbound traffic direction:

- For both before and after the modifications the primary types of incidents around the bridge are rear-ends, sideswipes, and vehicles hitting objects. On the approach, these three categories represent 99% of the before cases and 96% of the after cases. On the bridge, they represent 95% and 89% of the before and after incidents respectively.
- Following the shoulder opening, the rate of **rear-end collisions** per million miles traveled occurring on the approach dropped from 0.79 to 0.14 (-82%), and on the bridge from 0.50 to 0.34 (-33%). These changes reduced the overall incident rate from 0.58 to 0.28 (-51%).
- The rate of **sideswipes** occurring on the approach dropped from 0.41 to 0.16 (-60%) but increased from 0.12 to 0.15 (+22%) on the bridge, resulting in an overall drop from 0.20 to 0.15 (-23%). The increase on the bridge is likely the result of more vehicles changing lanes as a result of the availability of an additional traffic lane during peak hours.

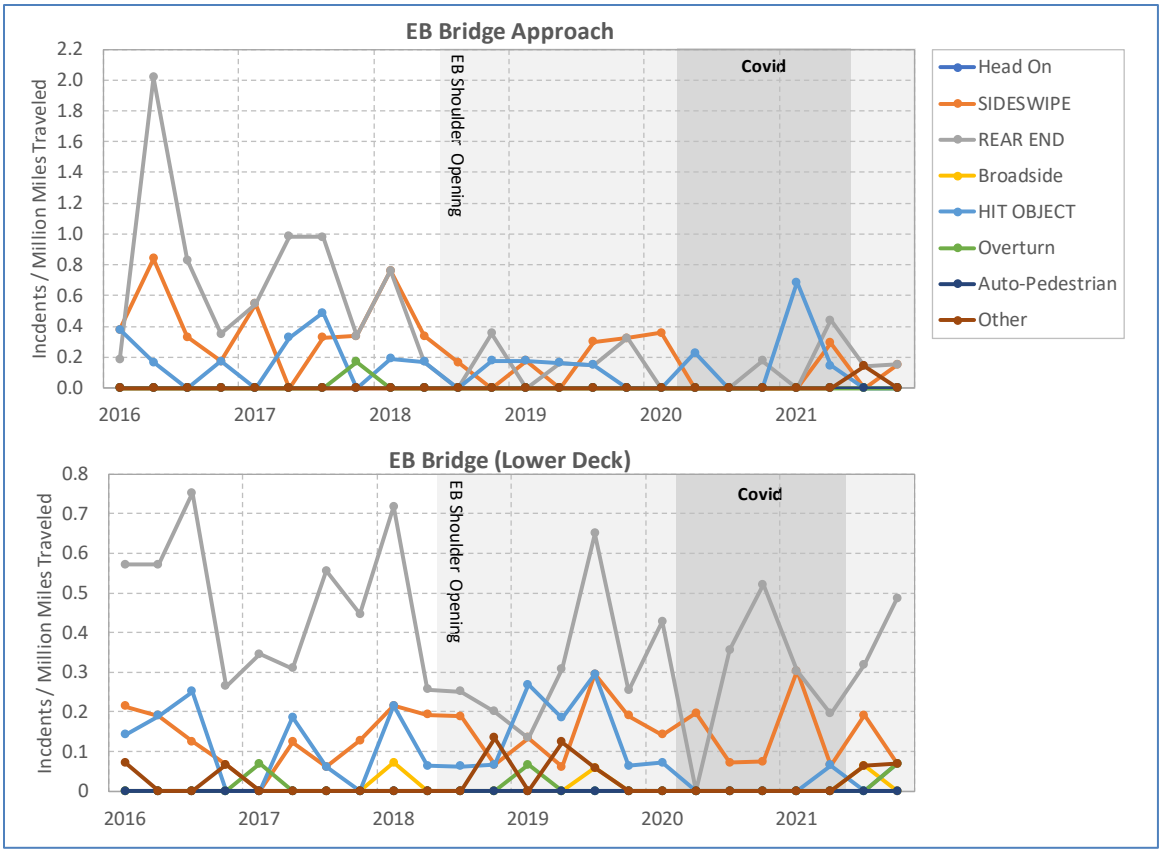

Figure 10-5: Quarter Accidents Rates by Type – I-580 East, 2016-2021

Table 10-1: Before/After Incident Types on Bridge Approach and Lower Deck – I-580 East

Incident Type	Approach		Bridge Lower Deck		Overall	
	Before	After	Before	After	Before	After
Rear-End	41 (56.2%)	8 (36.4%)	69 (65.1%)	47 (49.0%)	110 (61.5%)	55 (46.6%)
Sideswipe	21 (28.8%)	9 (40.9%)	17 (16.0%)	21 (21.9%)	38 (21.2%)	30 (25.4%)
Hit Object	10 (13.7%)	4 (18.2%)	16 (15.1%)	17 (17.7%)	26 (14.5%)	21 (17.8%)
Broadside	0 (0.0%)	0 (0.0%)	1 (0.9%)	2 (2.1%)	1 (0.6%)	2 (1.7%)
Overturn	1 (1.4%)	0 (0.0%)	1 (0.9%)	2 (2.1%)	2 (1.1%)	2 (1.7%)
Other	0 (0.0%)	1 (4.5%)	2 (1.9%)	7 (7.3%)	2 (1.1%)	8 (6.8%)
Overall	**73**	**22**	**106**	**96**	**179**	**118**

Note: Before Period: 01/2016 to 03/2018 (9 quarters)
After Period: 07/2018 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (9 quarters)

Table 10-2: Before/After Incident Rates per Million Miles Traveled by Type – I-580 East

Incident Type	Approach		Bridge		Overall	
	Before	After	Before	After	Before	After
Rear End	0.791	0.144	0.503	0.339	0.582	0.283
Sideswipe	0.405	0.162	0.124	0.151	0.201	0.154
Hit Object	0.193	0.071	0.117	0.123	0.137	0.108
Broadside	0.000	0.00	0.007	0.014	0.005	0.010
Overturn	0.019	0.00	0.007	0.014	0.011	0.010
Other	0.000	0.018	0.015	0.050	0.011	0.041
Overall	**1.408**	**0.397**	**0.772**	**0.692**	**0.946**	**0.608**

Note: Before Period: 01/2016 to 03/2018 (9 quarters)
After Period: 07/2018 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (9 quarters)

- The rate of **vehicles hitting objects** dropped from 0.19 to 0.11 (-63%) on the approach, but slightly increased from 0.117 to 0.124 (+4%) on the bridge, resulting in an overall drop from 0.14 to 0.11 (-21%) when combining both sections.
- No definitive observations can be made on the rates of other types of incidents due to their relatively low incidence. In these cases, the observed changes could simply be the results of stochastic variations.

The above results are a direct consequence of eliminating congestion on the bridge approach and increasing the number of traffic lanes on the bridge. The reduced congestion on the approach to the bridge has led to fewer stop-and-go situations and fewer lane changes. This has translated into fewer rear-end and sideswipe collisions. On the bridge, the addition of a traffic lane has led to lower traffic densities during peak traffic periods, and thus fewer risks for rear-end collisions. However, this change is also providing more opportunities for lane changes and leading to more frequent sideswipe collisions.

10.3.3. INCIDENT SEVERITY ON BRIDGE AND APPROACH

Figure 10-6 presents the rates, on a per million miles traveled basis, at which incidents of various severity have occurred on the bridge's eastbound approach and lower deck for every quarter between January 2016 and December 2021. Table 10-3 further presents the number of incidents of each type that have been documented for the before and after periods, while Table 10-4 presents the average rates at which

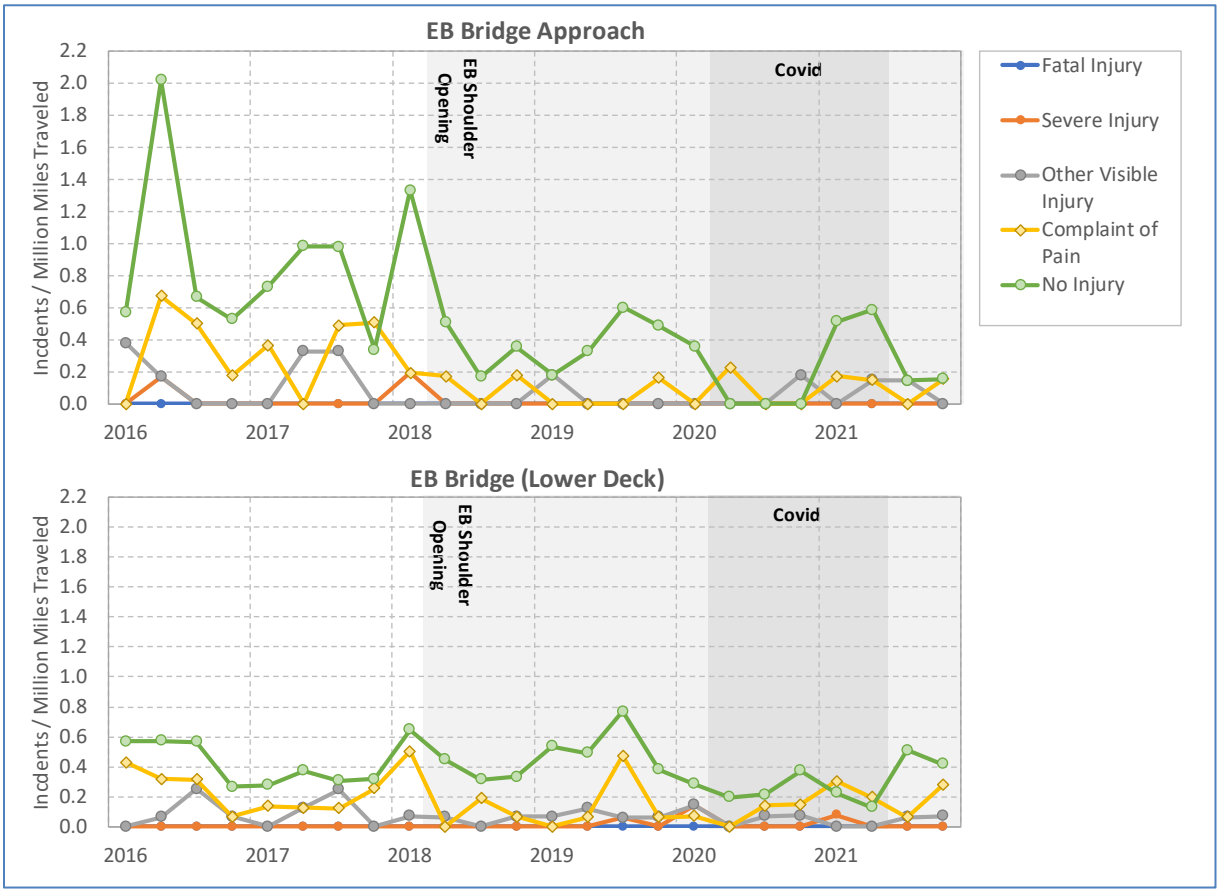

Figure 10-6: Accidents by Severity – I-580 East, 2016-2021

Table 10-3: Before/After Incidents by Severity on Bridge Approach and Lower Deck – I-580 East

Incident Type	Approach		Bridge Lower Deck		Overall	
	Before	After	Before	After	Before	After
No Injury	47 (64%)	17 (77%)	59 (56%)	63 (66%)	106 (59%)	60 (68%)
Complaint of Pain	17 (23%)	3 (14%)	34 (32%)	20 (21%)	51 (28%)	23 (19%)
Other Visible Injury	7 (10%)	2 (9%)	13 (12%)	10 (10%)	20 (11%)	12 (10%)
Severe Injury	2 (3%)	0 (0%)	0 (0%)	3 (3%)	2 (1%)	3 (3%)
Fatal Accident	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Overall	**73**	**22**	**106**	**96**	**179**	**118**

Note: Before Period: 01/2016 to 03/2018 (9 quarters)
After Period: 07/2018 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (9 quarters)

Table 10-4: Before/After Incident Rates per Million Miles Traveled by Severity – I-580 East

Incident Severity	Approach		Bridge		Overall	
	Before	After	Before	After	Before	After
No Injury	0.906	0.307	0.430	0.454	0.560	0.412
Complaint of Pain	0.328	0.054	0.248	0.144	0.270	0.118
Other Visible Injury	0.135	0.036	0.095	0.072	0.106	0.062
Severe Injury	0.039	0.000	0.000	0.022	0.011	0.015
Fatal Accident	0.000	0.000	0.000	0.000	0.000	0.000
Overall	**1.408**	**0.397**	**0.772**	**0.692**	**0.946**	**0.608**

Note: Before Period: 01/2016 to 03/2018 (9 quarters)
After Period: 07/2018 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (9 quarters)

each type of incident occurred. In both tables, data from the second quarter of 2018 are ignored as some incidents within this period fall before the change and others after. Data from April 2020 to June 2021 are also ignored due to a bias towards fewer incidents associated with the significant drop in traffic caused by the Covid-19 stay-at-home orders.

As illustrated, the dominant types of incidents occurring around the bridge both before and after the modifications are incidents without injuries and incidents with only a complaint of pain. These represent 88% of the before incidents and 89% of the after incidents. Of the 297 documented incidents, only 32 (11%) were incidents with other visible injuries and 5 (2%) incidents with severe injuries. No fatal accidents were reported during the analysis period (but one did occur in 2022).

Reflecting the overall reduction in incident rate illustrated in Figure 10-4, Table 10-4 indicates that the rates of incidence of the various types of incidents dropped on the approach to the bridge following the opening of the eastbound shoulder lane in April 2018. This is again linked to the elimination of the congestion on the approach. The data in Table 10-4 confirms the rate reductions, with a 66% reduction in the rate of incidents without injury, an 83% reduction in incidents with complaints of pain, and a 73% reduction in incidents with other visible injuries.

Matching the 10% overall reduction in incident rate mentioned earlier, small reductions in accident rates are also observed on the bridge's lower deck. The data indicate a 42% drop in the rate of incidents with a complaint of pain and a 24% drop in incidents with other visible injuries. However, the rate of incidents without injury, the dominant type, is shown to have increased by 6%, from 0.43 to 0.45. This change is at the border of statistical rejection, meaning that it may or may not be significant. While the rate of incidents with severe injury has also increased, from 0.00 to 0.02 per million miles traveled, the frequency of this type of incident remains extremely low.

Overall, the data indicate a general drop in the severity of incidents occurring on the bridge. Incidents without injury, the type with the lowest severity, represented 59% of all incidents before the modifications. Since the modifications, this incident type has represented 68% of all incidents.

10.3.4. INCIDENT DURATIONS ON BRIDGE

Figure 10-7 plots the estimated duration of crashes that have occurred on the lower deck of the bridge between 2 PM and 7 PM, from July 2016 to November 2021, based on incident logs from the CHP CAD data feed that have been processed by the Bay Area Traffic Incident Management Dashboard. This is the only dataset from which incident duration can be estimated. This is also the source of most statistics on incident durations reported by Bay Area transportation agencies.

For the analysis, only incidents that have occurred between 2 PM and 7 PM are considered since the lower deck modifications are only in effect during this period. In addition, only incidents lasting 5 minutes or more are considered as shorter incidents often have incomplete logs in the CHP CAD database.

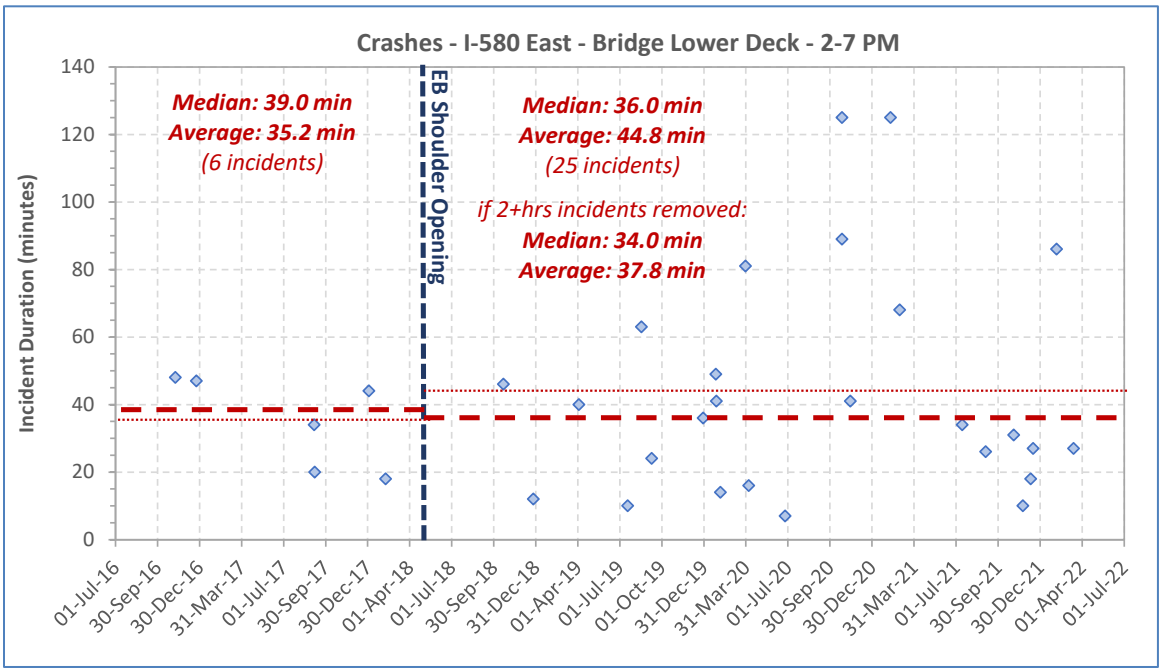

Figure 10-7: Incident Durations – Bridge Lower Deck, 2 PM to 7 PM, 2016-2022

As was indicated in Sections 5.5.4 and 5.5.5, incident durations estimated from CHP CAD logs are subject to some errors as these are simply based on when the first and last event-related messages were logged and as these messages do not always correspond to the actual start and end of an incident. While errors may exist in the reported durations, the purpose of the analysis presented here is to determine whether the bridge modifications may have had significant negative impacts on incidents. Since a single data source is used, the following analysis is thus made under the assumption that potential errors in how incident durations are estimated are consistent before and after the bridge modifications, thus allowing a rough comparative evaluation to be made of conditions before and after the changes.

The data of Figure 10-7 suggests that the average duration of incidents occurring on the bridge lower deck between 2 PM and 7 PM may have increased following the opening of the eastbound shoulder lane as the

average duration is estimated to have increased from 35.2 to 44.8 minutes. However, this is contradicted by a reduction in the median duration from 39.0 to 36.0 minutes. In addition, if the two incidents lasting more than two hours are removed, there is then slightly less than a 3-minute increase in average duration.

Given the relatively wide variability of incident durations and the relatively limited number of observations, particularly before the modifications, there is a high likelihood that the observed changes might simply be due to randomness in the characteristics of incidents included in the before and after datasets. This is supported by statistical tests indicating that the before and after average durations are not statistically different at a 95% confidence level based on the low sample sizes and observed variability. As a result, no definite conclusions can be drawn from the analysis regarding the impacts of the shoulder lane opening on incident duration.

10.3.5. UNDERSTANDING OF OVERHEAD LANE SIGNS

A key concern from CHP officers regarding the overhead signage on the lower deck is that some motorists do not appear to fully understand the significance of the green arrow/yellow X/red X displayed above the lanes. This is based on the fact that officers have repeatedly seen vehicles traveling on the shoulder when a yellow or red X is displayed above, treating it as a passing lane or regular traffic lane. Such behavior may in part be promoted by the fact that motorists now generally know that the shoulder lane is used at times as a traffic lane that extends across the entire bridge. As a result, there may be a reduced perceived risk of using it when it is closed.

Unauthorized use of the shoulder creates a significant safety hazard, has unauthorized users run the risk of encountering stopped vehicles on the shoulder. This is particularly problematic for maintenance, tow trucks, and other emergency vehicles that may be stopped on the shoulder. Additional risks may also come from motorists in the adjacent regular traffic lane not expecting to be passed by a vehicle on the right.

10.4. IMPACTS ON I-580 WEST SAFETY

This section presents incident statistics related to the conversion of the westbound shoulder lane on the bridge's upper deck into a barrier-separated bike/pedestrian path. The following analyses are presented based on data from the TASAS databased between January 2016 to December 2020:

- Total number of incidents
- Categorization by incident types
- Categorization by incident severity
- Duration of incidents occurring on the bridge

10.4.1. OVERALL INCIDENT RATES ON BRIDGE AND APPROACH

Figure 10-8 illustrates the frequency of accidents, per million miles traveled, on I-580 West around the bridge for each quarter between January 2016 and December 2021 based on information contained in the TASAS database. The graph distinguishes incidents occurring on the approach to the bridge, the bridge itself, and downstream, based on the section boundaries shown earlier in Figure 10-1. The light gray area further marks the period during which the eastbound shoulder lane has been opened, while the dark gray area marks the period that has been affected by Covid-19 stay-at-home orders.

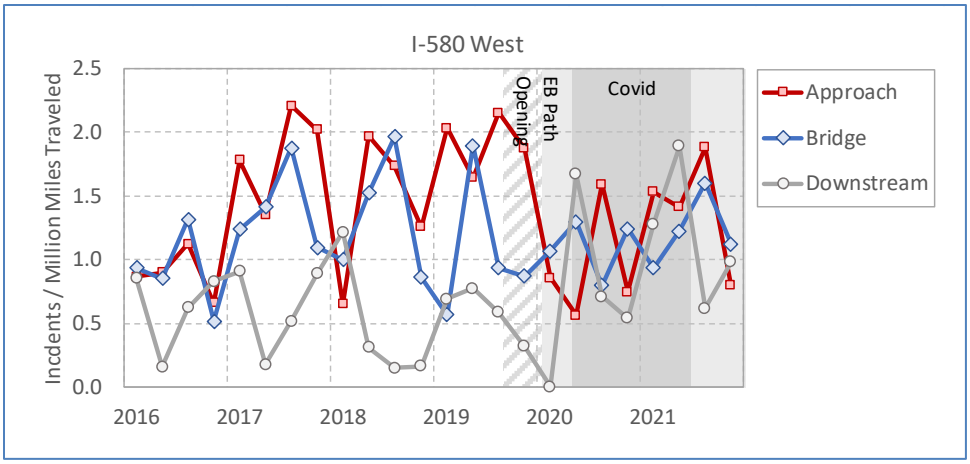

Figure 10-8: Number of Accidents by Quarter – I-580 West, 2016-2021

The following observations can be made regarding the overall rates of incidents on the approach to the bridge, the bridge itself, and the section of I-580 downstream of the bridge based on the illustrated data:

- While a large drop in the approach and downstream incident rates is observed in the first quarter of 2020, the first full quarter after the modifications, the drop falls within the past observed variability of incident rates on a quarterly basis.
- Ignoring the Covid-impacted period of April 2020 to June 2021, the overall rate of incidents on the bridge approach, expressed on a per million miles traveled basis, is observed to drop slightly from 1.51 to 1.20 (-20%) following the bridge modifications. However, the rate of incidents on the bridge increased slightly from 1.22 to 1.27 (+5%) while the rate of incidents downstream of the bridge decreased slightly from 0.58 to 0.55 (-5%).
- If the Covid-impacted period is included, the rate of incidents on the approach is calculated to have decreased further, from 1.51 to 1.18 (-21%), the rate of incidents on the bridge to have decreased from 1.22 to 1.17 (-4%) instead of increased, and the rate of incidents downstream of the bridge to have significantly increased, from 0.58 to 0.95 (+63%) instead of a slight decrease.

Based on the above elements, there is no straightforward evidence that the implementation of the bike/pedestrian path on the upper deck of the bridge has negatively impacted traffic safety on the approach of the bridge or the bridge itself. Both data analysis scenarios point to a reduction in accident rates on the approach to the bridge but provide opposite conclusions regarding what might have happened on the bridge and downstream of it. More data points would be needed to make stronger assessments.

10.4.2. INCIDENT TYPES ON BRIDGE AND APPROACH

Table 10-7 further presents the total numbers of documented incidents for both sections for the before and after periods, while Table 10-8 presents the average rates, on a per million miles traveled basis, at which each type of incident occurred before and after the modifications. In both tables, data from the last quarter of 2019 are ignored as some incidents within this period fall before the change and others after. Data from April 2020 to June 2021 are also ignored in the first set of after statistics (After A) due to the potential effects of the Covid-19 pandemic but are included for reference in the second set of after data (After B).

The following specific observations can be made regarding changes in the types of incidents occurring in the westbound traffic direction:

- For both before and after the modifications the primary types of incidents around the bridge are rear-ends, sideswipes and vehicles hitting objects. On the approach, these three categories represent 95% of the before cases and 96-97% of the after cases depending on the after period considered. On the bridge, they represent 97% of the before cases and 97-100% of the after cases.

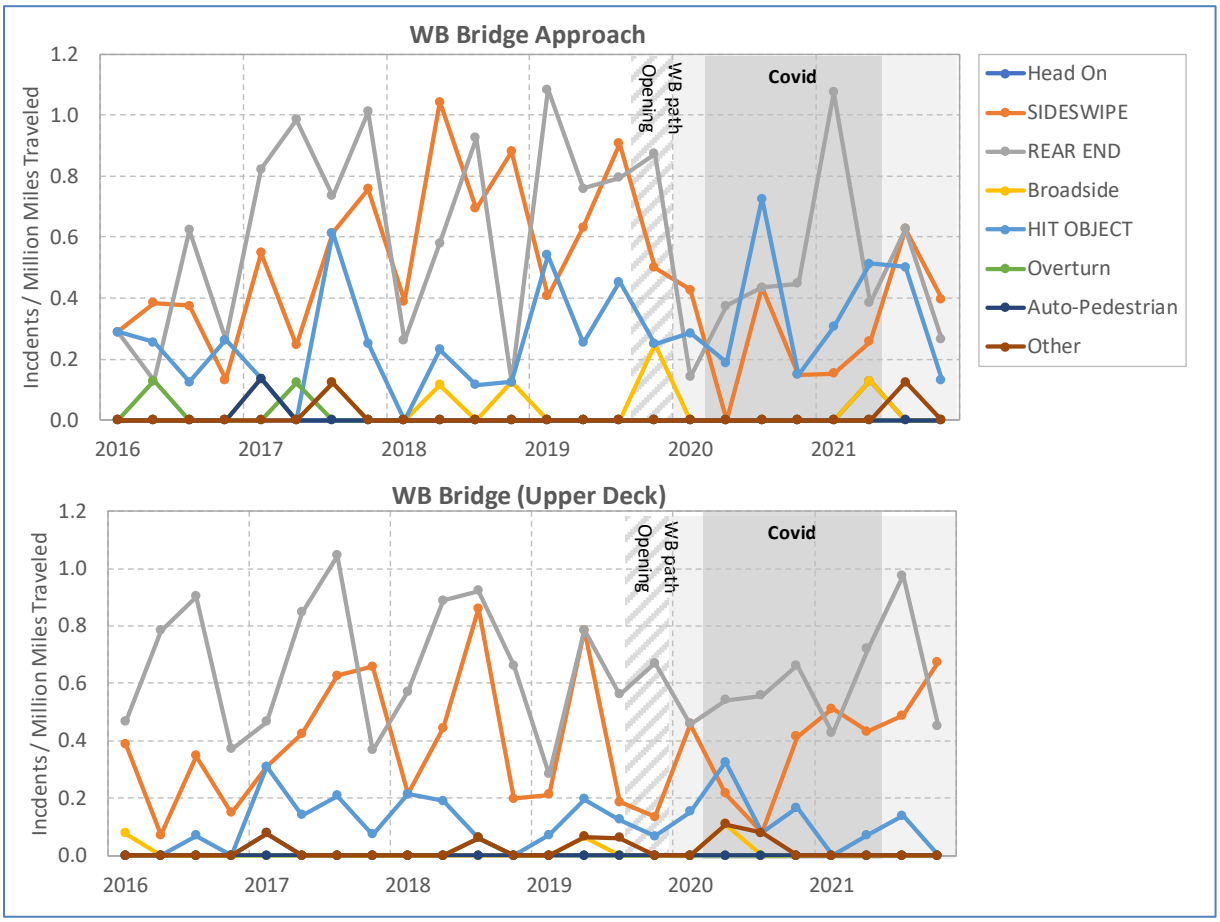

Figure 10-9: Accidents by Type – I-580 West, 2016-2021

Table 10-5: Before/After Incident Types on Bridge Approach and Upper Deck – I-580 West

Incident Type	Approach			Bridge Upper Deck			Overall		
	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]
Rear End	75 (41.9%)	8 (29.6%)	*26 (39.4%)*	145 (55.1%)	26 (50.0%)	*61 (52.1%)*	220 (49.8%)	34 (43.0%)	*87 (47.5%)*
Sideswipe	67 (37.4%)	11 (40.7%)	*18 (27.3%)*	86 (32.7%)	22 (42.3%)	*42 (35.9%)*	153 (34.6%)	33 (41.8%)	*60 (32.8%)*
Hit Object	29 (16.2%)	7 (25.9%)	*7 (30.3%)*	24 (9.1%)	4 (7.7%)	*11 (9.4%)*	53 (12.0%)	11 (13.9%)	*31 (16.9%)*
Broadside	4 (2.2%)	0 (0.0%)	*1 (1.5%)*	2 (0.8%)	0 (0.0%)	*1 (0.9%)*	6 (1.4%)	0 (0.0%)	*2 (1.1%)*
Overturn	2 (1.1%)	0 (0.0%)	*0 (0.0%)*	1 (0.4%)	0 (0.0%)	*0 (0.0%)*	3 (0.7%)	0 (0.0%)	*0 (0.0%)*
Other	2 (1.1%)	1 (3.7%)	*1 (1.5%)*	5 (1.9%)	0 (0.0%)	*2 (1.7%)*	7 (1.6%)	1 (1.3%)	*3 (1.6%)*
Overall	**179**	**27**	***66***	**263**	**52**	***117***	**442**	**79**	***183***

Note: Before Period: 01/2016 to 09/2019 (15 quarters)
After Period A: 01/2020 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (3 quarters)
After Period B: 01/2020 to 12/2021 (8 quarters)

Table 10-6: Before/After Incident Rates per Million Miles Traveled by Type – I-580 West

Incident Type	Approach			Bridge			Overall		
	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]
Rear End	0.631	0.355	*0.466*	0.670	0.637	*0.608*	0.656	0.537	*0.557*
Sideswipe	0.564	0.489	*0.323*	0.397	0.539	*0.419*	0.456	0.521	*0.384*
Hit Object	0.244	0.311	*0.359*	0.111	0.098	*0.110*	0.158	0.174	*0.199*
Broadside	0.034	0.000	*0.018*	0.009	0.000	*0.010*	0.018	0.000	*0.013*
Overturn	0.017	0.000	*0.000*	0.005	0.000	*0.000*	0.009	0.000	*0.000*
Auto-Pedestrian	0.008	0.000	*0.000*	0.00	0.000	*0.000*	0.003	0.000	*0.000*
Other	0.008	0.044	*0.018*	0.023	0.000	*0.020*	0.018	0.016	*0.019*
Overall	**1.506**	**1.199**	***1.184***	**1.215**	**1.274**	***1.166***	**1.318**	**1.247**	***1.172***

Note: Before Period: 01/2016 to 09/2019 (15 quarters)
After Period A: 01/2020 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (3 quarters)
After Period B: 01/2020 to 12/2021 (8 quarters)

- When ignoring the Covid-influenced interval in the after period (*After A*), the rate of **rear-end collisions** per million miles traveled occurring on the approach dropped from 0.63 to 0.36 (-44%), and on the bridge from 0.67 to 0.64 (-5%), following the installation of the path. These changes reduced the overall incident rate from 0.66 to 0.54 (-18%). When including the Covid-affected interval (*After B*), a 26% rate reduction is calculated for the approach and a 5% increase for the bridge, yielding a 15% overall reduction.
- When ignoring the Covid-influenced interval in the after period (*After A*), the rate of **sideswipes** dropped from 0.56 to 0.49 (-13%) on the approach but increased from 0.40 to 0.54 (+36%) on the bridge, yielding an overall increase from 0.52 to 0.38 (+14%). When including the Covid-affected interval (*After B*), the rate of sideswipes dropped to 0.32 (-43%) on the approach and 0.42 (+5%) on the bridge, producing instead an overall rate of 0.38 (-16%). The increase in sideswipe rates on the bridge calculated with the Covid-exempt period might be due to more vehicles switching lanes to the left to move away from the path barrier, as documented in Section 8.3.5. However, as suggested by the negative rates obtained by including the Covid-impacted interval, the observed increase can also be due to the relatively low number of incidents considered relative to the observed quarter-to-quarter variability of the rate.
- When ignoring the Covid-influenced interval in the after period (*After A*), the rate of **vehicles hitting objects** increased from 0.24 to 0.31 (+27%) on the approach but decreased from 0.11 to 0.10 (-12%) on the bridge, resulting in an overall increase from 0.16 to 0.17 (+10%). When including the Covid-affected interval (*After B*), the rate of vehicles hitting objects on the approach increases instead to 0.36 (+47%) and remains at 0.11 (no change) on the bridge, producing an overall rate increase to 0.20 (+26%).
- No definitive observations can be made on the rates of other types of incidents due to their relatively low incidence. In these cases, the observed increases and decreases could simply be the results of stochastic variations.

A key takeaway from the above analysis is that the installation of the bike/pedestrian path on the upper deck of the bridge does not appear to have caused vehicles to hit the new barrier as the rate of vehicles hitting objects has slightly decreased, whether the Covid-impacted interval is considered or not. The rate of rear-ends has also decreased. However, the rate of sideswipes has increased. This can be explained by the shorter merge at the entrance of the bridge causing more aggressive lane changes and a slightly higher proportion of traffic opting to travel on the left lane, resulting in more lane changes at the entrance of the bridge. Another contributing factor suggested by the slight increase in sideswipes and the very

small increase in vehicles hitting fixed object might be the current inability of vehicles on the right lane to move away from vehicles encroaching on the lane. Before the path installation, this could be done by moving into the shoulder lane. Following the path installation, encroachments may then results in more frequent sideswipes if motorists try to avoid hitting the barrier. Upstream of the toll plaza, incident rates have for their part generally reduced, except for vehicles hitting objects.

However, caution in reaching definitive conclusions must still be exercised until data from more quarters are gathered to allow a before/after comparison with minimal Covid-19-related impacts. The inclusion of data for at least another year, or four quarters, should be sufficient in this case.

10.4.3. INCIDENT SEVERITY ON BRIDGE AND APPROACH

Table 10-8 presents the rates, on a per million miles traveled basis, at which incidents of various severity have occurred before on the bridge's westbound approach and upper deck for every quarter between January 2016 and December 2021. Table 10-7 further presents the number of incidents of each type that have been documented for the before and after periods, while Table 10-8 presents the average rates at which each type of incident occurred. In both tables, data from the last quarter of 2019 are ignored as some incidents within this period fall before the change and others after. Data from April 2020 to June 2021 are also ignored in the first set of after statistics (After A) due to the potential effects of the Covid-19 pandemic but are included for reference in the second set of after data (After B).

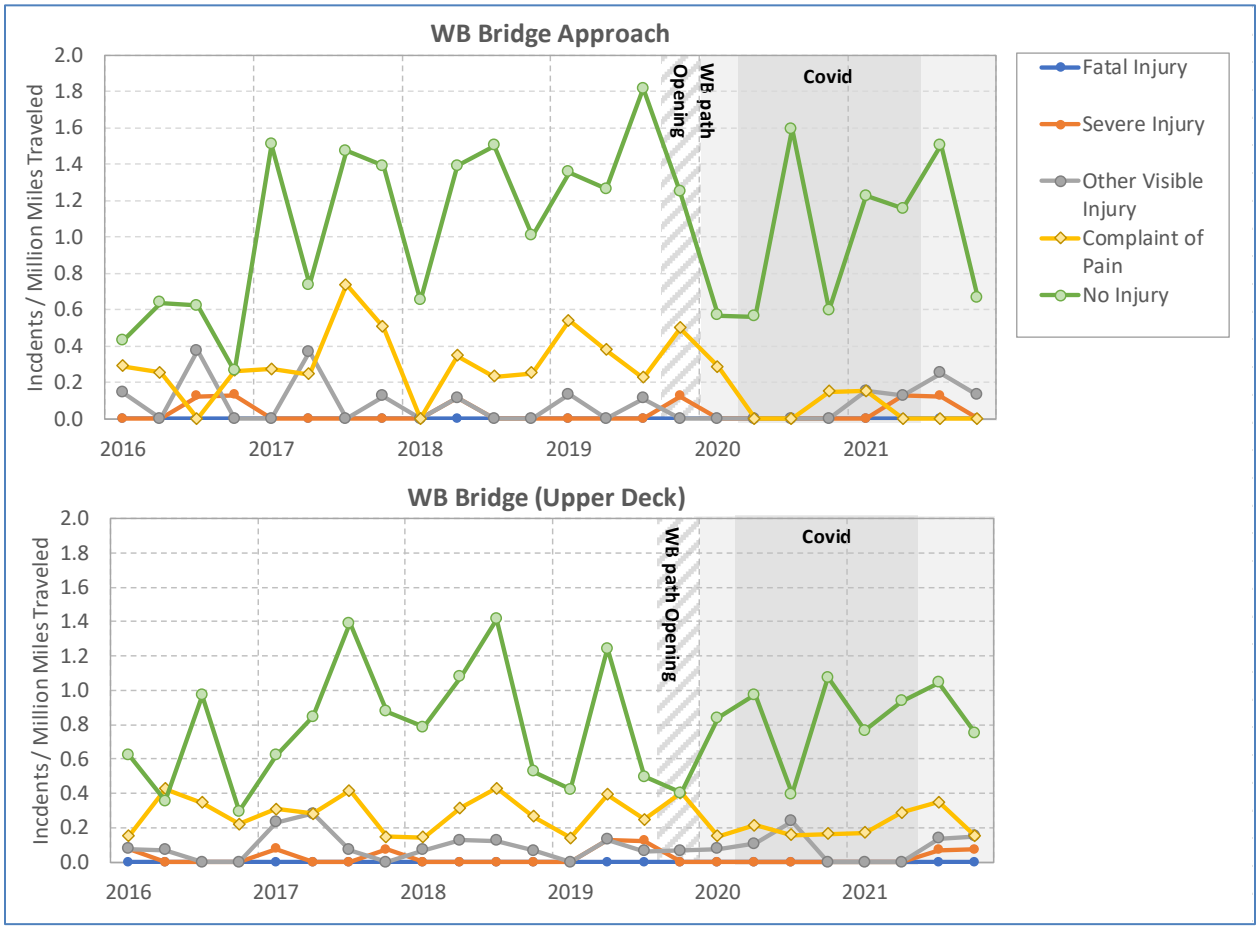

Figure 10-10: Accidents by Severity – I-580 West, 2016-2021

Table 10-7: Before/After Incidents by Severity on Bridge Approach and Upper Deck – I-580 West

Incident Type	Approach			Bridge Upper Deck			Overall		
	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]
No Injury	129 (72%)	21 (78%)	*56 (84%)*	175 (67%)	36 (69%)	*85 (73%)*	304 (69%)	57 (72%)	*141 (77%)*
Complaint of Pain	36 (20%)	2 (7%)	*4 (6%)*	62 (24%)	9 (17%)	*21 (18%)*	98 (22%)	11 (14%)	*25 (14%)*
Other Visible Injury	11 (6%)	3 (11%)	*5 (7%)*	19 (7%)	5 (10%)	*9 (8%)*	30 (7%)	8 (10%)	*14 (8%)*
Severe Injury	3 (2%)	1 (4%)	*2 (3%)*	7 (3%)	2 (4%)	*2 (2%)*	10 (2%)	3 (4%)	*4 (2%)*
Fatal	0 (0%)	0 (0%)	*0 (0%)*	*0 (0%)*	*0 (0%)*	*0 (0%)*	*0 (0%)*	*0 (0%)*	*0 (0%)*
Overall	**179**	**27**	***66***	**263**	**52**	***117***	**442**	**79**	***184***

Note: Before Period: 01/2016 to 09/2019 (15 quarters)
After Period A: 01/2020 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (3 quarters)
After Period B: 01/2020 to 12/2021 (8 quarters)

Table 10-8: Before/After Incident Rates per Million Miles Traveled by Severity – I-580 West

Incident Severity	Approach			Bridge			Overall		
	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]	Before	After A[1]	After B[2]
No Injury	1.085	0.933	*1.004*	0.808	0.882	0.847	0.907	0.900	0.903
Complaint of Pain	0.303	0.089	*0.072*	0.286	0.221	0.209	0.292	0.174	0.160
Other Visible Injury	0.093	0.133	*0.090*	0.088	0.123	0.090	0.089	0.126	0.090
Severe Injury	0.025	0.044	*0.036*	0.032	0.049	0.020	0.030	0.047	0.026
Fatal	0.000	0.000	*0.000*	0.000	0.000	0.000	0.000	0.000	0.000
Overall	**1.506**	**1.199**	***1.202***	**1.215**	**1.274**	**1.166**	**1.318**	**1.247**	**1.179**

Note: Before Period: 01/2016 to 09/2019 (15 quarters)
After Period A: 01/2020 to 12/2021, excluding 03/2020 to 06/2021 due to Covid-19 effects (3 quarters)
After Period B: 01/2020 to 12/2021 (8 quarters)

As illustrated, the dominant types of incidents occurring on the approach of the bridge or the bridge itself both before and after the modifications are incidents without injuries and incidents with a complaint of pain. These represent 91% of the before incidents and 86-90% of the after incidents depending on whether the identified Covid-impacted interval is considered or not. 10% or less of the documented collisions were incidents with other visible injuries and 4% or less were incidents with severe injuries. No fatal accidents were reported during the analysis period.

Based on the three quarters of data considered post modifications when excluding the identified Covid-impacted interval (first quarter of 2020 and third and fourth quarter of 2021), the following observations can be made from the data of Table 10-8:

- The rate of **incidents with no injury,** on a per million miles traveled basis, occurring on the approach of the bridge dropped from 1.09 to 0.93 (-14%), while the rate of incidents on the bridge increased from 0.81 to 0.89 (+9%), for an overall marginal decrease of 1%.
- The rate of **incidents with a complaint of pain** decreased from 0.30 to 0.09 (-71%) on the approach and from 0.29 to 0.22 (-23%) on the bridge, yielding an overall reduction from 0.29 to 0.17 (-41%).
- The rate of **incidents with other visible injuries** is estimated to have increased on the approach from 0.093 to 0.133 (+44%) and the bridge from 0.088 to 0.123 (+40%), for an overall increase from 0.089 to 0.126 (+41%).

The following observations can further be made if data from the Covid-impacted interval are added to the analysis:

- The rate of **incidents with no injury** occurring on the approach of the bridge only drops from 1.09 to 1.00 (-7%), while the rate of incidents on the bridge only increases from 0.81 to 0.85 (+5%), for an overall marginal decrease of less than 1%.
- The rate of **incidents with a complaint of pain** decreases further on both the approach and the bridge, from 0.30 to 0.07 (-76%) and from 0.29 to 0.21 (-27%) respectively, yielding an overall reduction from 0.29 to 0.16 (-45%).
- The rate of **incidents with other visible injuries** remains relatively unchanged with respect to the before period instead of exhibiting an increase.

The key takeaway from the above analysis is that the upper deck bridge modifications seem to have caused a significant reduction in the frequency of incidents with a complaint of pain, and have slightly increased the rate of incidents with no injury on the bridge but reduced them on the approach, and have produced no conclusive trend regarding the incidents with other visible injuries.

Similar to the analysis regarding incident types, caution must be exercised here in reaching definitive conclusions until data from more quarters are gathered to allow a before/after comparison based on a higher number of quarters with minimal Covid-19-related impacts. In this case, the consideration of only three quarters after the modification likely does not provide sufficient data to establish clear trends. The inclusion of data for at least another year, or four quarters, should be sufficient in this case.

10.4.4. INCIDENT DURATIONS ON BRIDGE

Figure 10-11 plots the estimated duration of crashes that have occurred at any time of the day on the upper deck of the bridge between July 2016 and December 2021 based on incident logs from the CHP CAD data feed that has been processed by the Bay Area Traffic Incident Management Dashboard. This is the only dataset from which incident duration can be estimated. This is also the source of most statistics on incident durations reported by Bay Area transportation agencies.

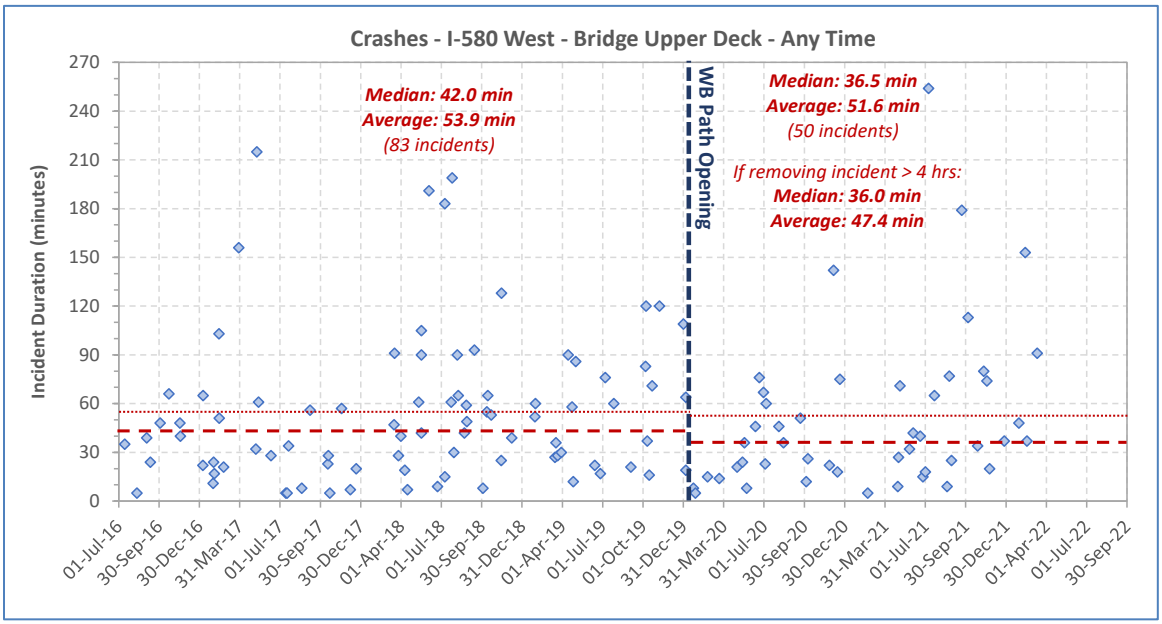

Figure 10-11: Incident Durations – Bridge Upper Deck, All Day, 2016-2022

Contrary to the lower deck analysis, all incidents that have occurred on the upper deck are considered here as the upper deck modifications affect traffic throughout the day. Like the previous analysis, only incidents lasting 5 minutes or more are considered as shorter incidents often have incomplete logs in the CHP CAD database.

As was indicated in Sections 5.5.4 and 5.5.5, incident durations estimated from CHP CAD logs are subject to some errors as these are simply based on when the first and last event-related messages were logged and as these messages do not always correspond to the actual start and end of an incident. While errors may exist in the reported durations, the purpose of the analysis presented here is to determine whether the bridge modifications may have had significant negative impacts on incidents. Since a single data source is used, the following analysis is thus made under the assumption that potential biases in how incident durations are estimated are consistent before and after the bridge modifications, thus allowing a rough comparative evaluation to be made.

The data in Figure 10-11 suggests that the average duration of incidents on the bridge's upper deck might have slightly decreased following the conversion of the westbound shoulder into a barrier-separated bike/pedestrian path, with an increase from 53.9 to 51.6 minutes. This is supported by a reduction in the median duration, from 42.0 to 36.5 minutes. In addition, if the two incidents lasting more than four hours (240 minutes) are removed, the average duration is then shown to decrease even further, from 53.9 to 47.4 minutes.

Statistical tests conducted to assess the significance of the observed changes indicate that no definitive conclusions can be made. Tests conducted at a 95% confidence level indicate that a similar variance is observed in the before and after samples and that the estimated average durations for both samples are not statistically different. This analysis thus indicates that converting the westbound shoulder lane into a barrier-delimited bike/pedestrian path does not appear to have had significant negative impacts on the duration of incidents.

10.5. SUMMARY OBSERVATIONS

Key observations from the traffic safety impacts associated with the upper and lower deck bridge modifications are as follows:

- **Lower deck modifications:**
    - The conversion of the eastbound shoulder lane into a part-time traffic lane has reduced by 72% the frequency of incidents occurring on the eastbound bridge approach. This is mainly due to the elimination of the congestion that affected traffic along I-580 East from the US-101 interchange to the entrance of the bridge. While the data also show a 10% rate reduction on the bridge, this change could simply be the result of stochastic variability.
    - On the approach, the absence of congestion on the approach to the bridge has resulted in an 82% reduction in the rate of rear-end collisions, a 60% drop in the rate of sideswipes, and a 63% reduction in the rate of vehicles hitting fixed objects.
    - On the bridge, the addition of a traffic lane has led to lower peak traffic densities and a 33% reduction in the rate of rear-end collisions. However, this change is also providing

more opportunities for lane changes, which has translated into a 22% increase in the rate of sideswipes and a slight increase (+4%) in vehicles hitting objects.

- In terms of severity, the modifications have resulted in a reduction from 41% to 32% of the proportion of incidents on the bridge or its approach with severe injury, a complaint of pain, or other visible injuries.
- Based on an analysis of CHP CAD logs, there is no evidence that the bridge modifications are producing longer crash-related incidents or changing the location where crashes tend to occur on the bridge.
- Based on estimated incident duration data derived from the CHP CAD logs, there is no statistical evidence that the bridge modifications are increasing the time needed to clear crash events. In this case, data measuring more precisely the period during which an incident affects traffic would be required to provide a more definitive answer.
- Motorists traveling on the lower deck may not fully understand the meaning of the green arrow/yellow X/red X signage above the lower deck traffic lanes, resulting in some opting to use the shoulder as a traffic or passing lane when it is formally closed.

- **Upper deck modifications:**
  - There is no straightforward evidence that the modifications have negatively impacted traffic safety on the approach of the bridge or the bridge. Scenarios including or excluding the April 2020 to June 2021 interval both point to a 20% reduction in accident rates upstream of the toll plaza but provide opposite conclusions regarding incidents on the bridge and downstream of it.
  - No clear impacts are observed on the types of incidents occurring around the bridge. Rear-end incidents remain dominant on the bridge before and after the modifications, at around 50-55% of all incidents. These are followed by sideswipes (33-42%) and vehicles hitting objects (8-9%). In particular, no increase is observed in the proportion of vehicles hitting a fixed object on the bridge, such as the path's barrier.
  - In terms of incident severity, the upper deck modifications seem to have caused a 23% reduction in the frequency of incidents with a complaint of pain on the bridge and a 71% on the approach. The rate of incidents without injury has further slightly increased on the bridge (+9%) but reduced on the approach (-14%), while no conclusive trend could be identified for incidents with other visible injuries.
  - Based on an analysis of CHP CAD logs, there is no evidence that the bridge modifications are producing longer crash-related incidents or changing the location where crashes tend to occur on the bridge.
  - Based on estimated incident durations derived from the CHP CAD logs, there is no statistical evidence that the bridge modifications are increasing the time needed to clear crash events. In this case, data measuring more precisely the period during which an incident affects traffic would be required to provide a more definitive answer.
  - The analysis of additional data is recommended to more clearly established impacts associated with the modification, the current data only include three quarters with minimal Covid-19 impact. A recommendation is to include at least one additional year of data (January to December 2022).

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11. IMPACTS ON INCIDENT RESPONSES

This section assesses whether significant inconveniences to incident response crews have been introduced by the conversion of the lower deck shoulder lane into a part-time traffic lane and the conversion of the upper deck shoulder lane into a barrier-separated multi-use path. This is done by:

- Reviewing current incident response practice by CHP officers
- Assessing whether there have been significant changes in the location of bridge incidents
- Analyzing tow truck response logs
- Comparing available data on approximating incident response times before and after the modifications
- Summarizing key observed impacts

A key initial assumption was that the changes made to the bridge could increase response times due to the constraints they may impose on the movements of vehicles responding to incidents. A lack of noticeable change would therefore be viewed as a lack of significant negative impact.

11.1. LOCATION OF INCIDENTS ON BRIDGE

Figure 11-1 maps the locations of all reported upper and lower deck incidents on the bridge since January 2016. This includes 89 incidents on the upper deck, 56 before modifications and 33 after, and 41 incidents on the lower deck, 8 before modifications and 33 after.

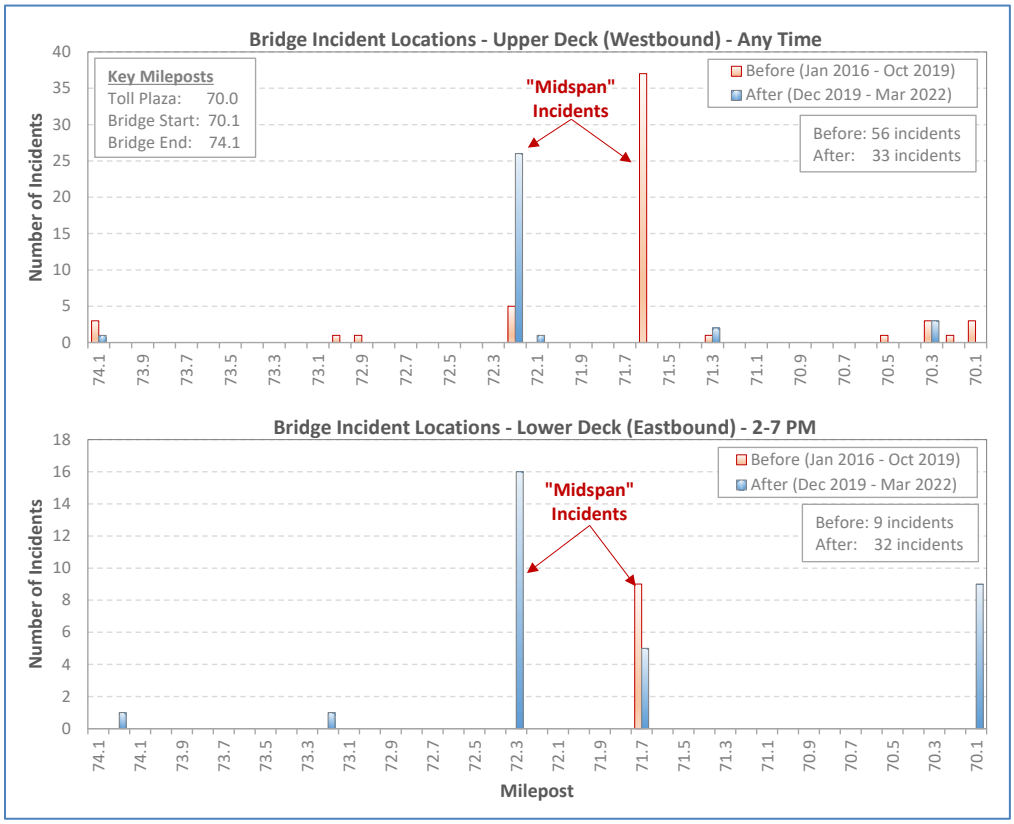

Figure 11-1: Location of Bridge Incidents – Before/After

As can be seen, most incidents are reported as having either occurred near the midspan of the bridge or the toll plaza. While there appears to be a shift in midspan location between the before and after conditions on each deck, this shift is likely the result of changes in how incident locations are reported as it would be unlikely that a similar shift happens to both decks. Milepost 71.7 appears to have generically been used to report midspan incidents up to about mid-2019, and milepost 72.3 after that.

Based on the illustrated data and the above assessment, a notable change in incident locations cannot be assumed to have occurred. This means that it can be assumed that response vehicles are roughly responding to similar incidents similarly located before and after the modifications on each deck.

11.2. CHP INCIDENT RESPONSE PRACTICE

The following summarizes current incident response practice by CHP officers for incidents occurring in traffic lanes on the Richmond-San Rafael bridge or the multi-use path.

- Response to incidents on bridge traffic lanes
    - Most incidents on the bridge are responded to by the Marin Division of the California Highway Patrol as it is often easier for them to access the bridge.
    - For incidents blocking all lanes on the upper or lower deck, CHP vehicles generally reach the incident by driving counterflow on the bridge. Vehicles to do attempt to reach a site by traveling in the normal traffic direction as it could result in units being stuck in traffic. The CHP officers that were interviewed reported that some vehicles have been stuck in the past for nearly an hour. Vehicles generally wait for all the traffic downstream of an incident to have exited the bridge before attempting to travel in a counterflow direction. Some vehicles may also travel around the bay to access the bridge from its other end. This practice is similar to what was done before the modifications.
    - For incidents that do not block all lanes, responding units generally access the location of an incident by traveling within the traffic stream. This is again similar to what was done before the modifications.
- Response to incidents on the upper deck bike/pedestrian path:
    - Responding units usually travel toward the site of an incident using the lane next to the barrier. Once the incident location is reached, officers then stopped their vehicle in the lane and jump over the barrier to assist.
    - While CHP officers could try to reach incidents using alternate transportation modes, this is not privileged as it would cause officers to lose access to the computer/communication terminals in their vehicle.
    - The need to stop vehicles on the right traffic lane is a constraint imposed by the new path.

11.3. TOW TRUCK RESPONSE TIMES

Data about tow truck response times obtained from Caltrans for incidents occurring on the bridge provided a limited view of the potential impacts of the bridge modifications on incident response times.

As shown in Table 2, analysis of the collected tow truck logs yielded an exceedingly small amount of data for both the before and after periods. The first row in the table lists the sample sizes for all incidents that have occurred around the bridge after excluding all logs for which the reported dispatch time corresponds to the scene arrival time (0-minute response time). The second row indicates the remaining sample sizes after excluding all incidents that have occurred around the toll plaza, on the eastbound or westbound approach to the bridge, and downstream of the bridge. For the eastbound direction (lower deck), only 4 incidents could be retrieved for the before period, and 7 for the after period. In this case, only incidents having occurred between 2 PM and 7 PM were considered as changes made to the shoulder lane only affect incident response during this interval. For the westbound travel direction (upper deck), only 7 before and 26 after incidents could be retrieved.

Table 11-1: Bridge Tow Truck Response Time Sample Sizes

Data Type	Eastbound Incidents 2 PM – 7 PM		Westbound Incidents Any Time	
	Before	After	Before	After
Incidents on and around the bridge with a dispatch time	15	19	39	50
Bridge incidents with dispatch time	2	9	9	26

Notes: Data coverage: January-June 2016; March 21-31, 2019; February-March 2022
Only incidents occurring on the bridge, no incident with dispatch time corresponding to arrival time

For both travel directions, the small sizes of the before and after data samples do not allow to perform robust analyses of the impacts of bridge modifications on tow truck response times. Figure X illustrates the distribution of response times for the lower and upper deck of the bridge, respectively. As can be observed, no clear trend can be established as response times for both the before and after incidents cover the same range. Due to the limited number of data points, statistical tests also indicate that there are no significant differences at the 95 percent confidence level between the before and after sampled average response times for either the lower deck or upper deck incidents. This means that any observed differences could be due to randomness.

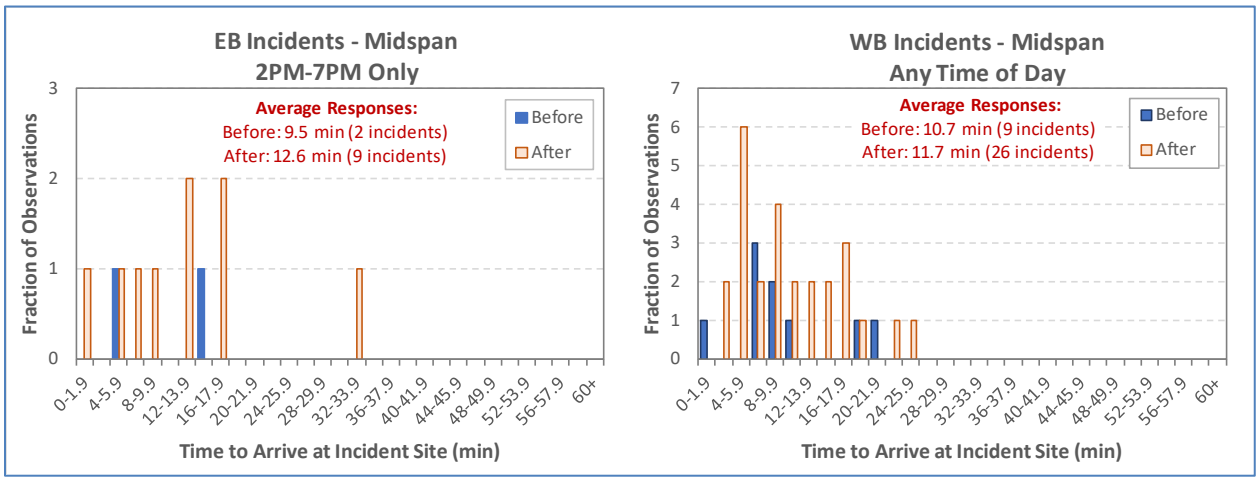

Figure 11-2: Before/After Tow Truck Response Times

The following are elements that potentially make it difficult to ensure that the evaluated before and after conditions are for responding to similar incidents, particularly with limited samples:

- Incident locations are not usually referenced precisely. While some logs mention a specific pier or call box, most logs simply indicate that a response is to a midspan incident, an incident just

east of just west of the midspan, or an incident on the bridge incline. These loose references make it difficult to ensure that the before and after samples only include responses to similar incident locations.

- Response times are subject to whether a tow truck is departing from its normal waiting location or another location. Caltrans usually has tow trucks waiting for potential responses on each side of the bridge. In some cases, a service dispatch may have been issued when a truck is already on the bridge, such as while performing a routine patrol across the bridge, resulting in shorter response times. An extreme opposite example might be for a dispatch to be issued when both trucks happen to be on the same side of the bridge, thus forcing one vehicle to first go back across the bridge before being able to access the deck on which a response is needed.
- For incidents blocking all traffic lanes, a response time may be for a tow truck traveling in a counterflow on the bridge. Unfortunately, the logs do not provide information if this may have been the case.

11.4. INCIDENT RESPONSE TIMES ON LOWER DECK BASED ON CHP-CAD LOGS

Figure 11-3 illustrates estimated response times for crashes that have occurred on the lower deck of the bridge between 2 PM and 7 PM, from July 2016 to March 2021, based on CHP dispatch messages captured by PeMS and later processed by the Bay Area Traffic Incident Management Dashboard web application. Only incidents that occurred between 2 PM and 7 PM are considered as this is the only period when bridge operations have changed for this direction of travel. In addition, only incidents for which an estimated response time could be calculated are considered.

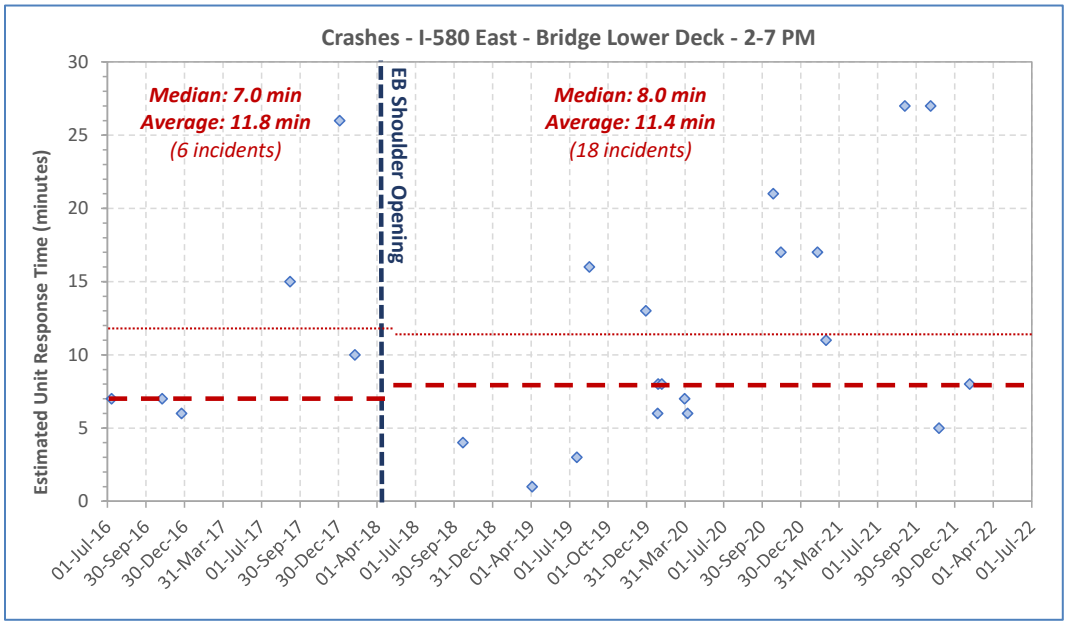

Figure 11-3: Estimated Incident Response Time – Bridge Lower Deck – 2016-2021

The reported response times are the time that elapsed between when a response vehicle has been reported in the CHP CAD system as being assigned or en route and the moment the vehicle has been logged as having arrived at the scene of an incident. These are estimates, as the dispatch logs do not always clearly indicate when a vehicle has been assigned, has departed, or has arrived. For instance,

dispatch logs often record multiple vehicle assignments in succession but only specify one incident scene arrival. Many logs do not even indicate when, or whether, am assigned vehicle has arrived at an incident scene following an initial dispatch. Based on the above situations, some of the data is thus subject to interpretation.

The collected data do not indicate a notable change in response times following the conversion of the eastbound shoulder lane into a part-time traffic lane. For the six afternoon peak incidents logged before April 2018, the median response time was 8.5 minutes, while the 18 similar incidents logged after the bridge modifications have an 8.0-minute median response time. The average response time has similarly decreased from 11.8 to 11.4 minutes.

While there are slight decreases in response times, the changes are not statistically significant based on the observed variability of estimated response times across incidents. This assessment is based on standard statistical tests at the 95% confidence level. This means that the observed changes could simply be due to randomness in the characteristics of the incidents considered in the before and after conditions.

11.5. INCIDENT RESPONSE TIMES ON UPPER DECK BASED ON CHP-CAD LOGS

Figure 11-4 illustrates the estimated incident response time for crashes that have occurred on the upper deck of the bridge between July 2016 and March 2022 based on information contained in the CHP dispatch logs captured by PeMS and later processed by the Bay Area Traffic Incident Management Dashboard web application. In this case, all incidents that have occurred on a given day are included in the analysis as the shoulder lane is no longer available. Like Figure 11-3, the reported response times are only estimates based on information captured in the CHP CAD logs and may not necessarily reflect actual response times.

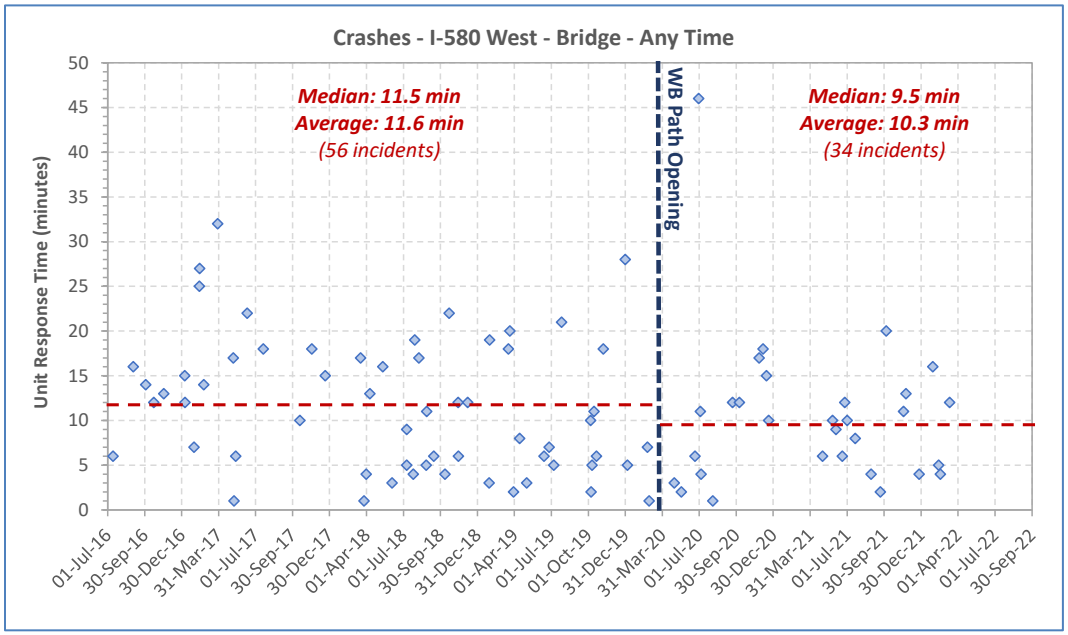

Figure 11-4: Estimated Incident Response Time – Bridge Upper Deck – 2016-2021

The starting hypothesis was that the introduction of a barrier to delimitate the bike/pedestrian path would create a significant constraint for response vehicles attempting to reach incident locations. With the elimination of the shoulder, it was thought that response vehicles might have to navigate more frequently through heavy congestion to reach an incident, thus leading to an increase in response times.

The estimated incident response times from the CHP dispatch logs suggest instead that an increase in response times has not occurred. The 56 incidents logged before the modifications have a median response time of 11.5 minutes while the 34 incidents post modifications have a median response time of 9.5 minutes. The average response time similarly drops from 11.6 to 10.3 minutes. However, similar to the lower deck analysis, statistical tests indicate that the changes are not statistically significant at the 95% confidence level. The observed differences may therefore simply be the result of randomness in the characteristics of the incidents affecting response times, such as starting location of dispatched response vehicle (Richmond or Marin side, close or far from the bridge) and ease of travel towards incident (through traffic still flowing at decent speed or low speed).

Considering all the potential influencing factors, the relatively small number of incidents that have occurred on the bridge since 2016 makes it difficult to provide any clear conclusion on whether the modifications have significantly affected incident response times. Current data suggests no significant impacts.

11.6. SUMMARY OBSERVATIONS

Key observations from the analysis of impacts on incident responses are as follows:

- There is no evidence that bridge modifications changed where incidents occur on the upper deck or lower deck.
- Retrieved tow truck dispatch logs do not provide enough observations to determine whether the bridge modifications have resulted in longer response times.
- Estimated incident response times from CHP-CAD logs also do not provide evidence that bridge modifications have caused an increase in incident response times.

12. IMPACTS ON MAINTENANCE ACTIVITIES

This section assesses whether significant inconveniences to maintenance activities have been introduced by the conversion of the lower deck shoulder lane into a part-time traffic lane and the installation of the upper deck barrier-separated multi-use path. The assessment was primarily conducted through conversations with Caltrans maintenance staff.

Summaries of key maintenance-related elements that were brought to attention by Caltrans staff are presented below for the bridge upper deck and lower deck. An overall summary concludes this section.

12.1. LOWER DECK ACTIVITIES

Key impacts on lower deck maintenance activities include the following:

- Since the lower deck shoulder lane is only open to traffic during the afternoon and maintenance activities tend to occur in the evening and at night, there has been a relatively minimal impact on operations.
- Because vehicles might be traveling on the shoulder lane when it is closed, maintenance crews must now generally always treat the lane as if it were an active lane. This means taking additional precautions to ensure that motorists are aware that stopped vehicles may be on the shoulder lane.

12.2. UPPER DECK ACTIVITIES

Key impacts on upper deck maintenance activities include the following:

- The installation of the multi-use path has eliminated the ability of maintenance crews to park vehicles on the upper without impeding traffic. Vehicles must now block a traffic lane when conducting routine or emergency maintenance work on the upper deck traffic lanes, which carries additional safety setup implications, in addition to potentially resulting in some traffic disturbances if conducted during periods of significant traffic.
- Closing of a traffic lane for path maintenance mainly occurs for routine monthly cleanings when the barrier must be moved. To minimize traffic impacts, this is typically done, with bulletins published by MTC/511 well ahead of time.
- Daytime path closures are periodically needed to conduct structure inspections as this requires moving a bucket truck along the bike path. These closures typically have no effects on vehicular traffic.
- Caltrans maintenance has a motorized cart to use on the bike path for routine maintenance. For major maintenance of the bike path, the bike path would be closed to traffic.
- The path barrier is typically realigned once a month as part of normal bridge operations. The scheduling of these activities can be observed in activity logs from the Caltrans Lane Closure System.
- Vehicles hitting the barrier can result in the barrier being moved inwards on the path. When this occurs, emergency repairs are only made if an incident causes the width of the path to be

reduced to less than 10 feet. If more than 10 feet remain available, the bridge maintenance crew generally either uses tools to manually realign the barrier or waits for the monthly machine re-alignment of the barrier to fix the issue.

- Damages to the toppers sitting on top of the barrier elements, illustrated in Figure 12-1, are usually repaired as soon as possible as this is a crucial safety element of the barrier. The toppers are added to allow the barrier to reach a legal height of 42 inches and to minimize the risk of cyclists falling over the barrier into the adjacent traffic lane. Bridge maintenance indicated that 75 toppers had to be replaced between November 2019 and March 2022, representing an average replacement rate of 2.6 toppers per month.

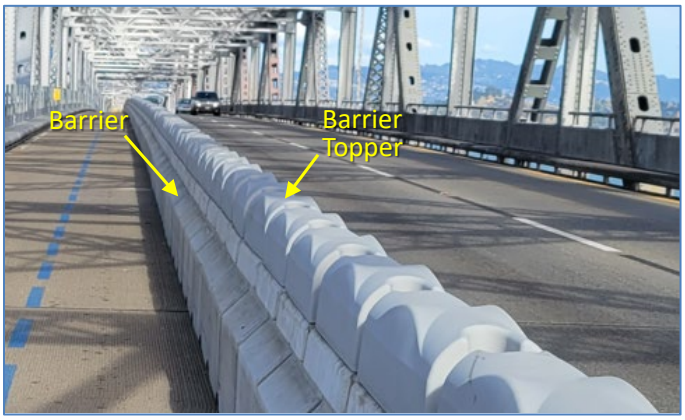

Figure 12-1: Bridge Path Barrier Toppers

12.3. SUMMARY OBSERVATIONS

The following is a summary of key observations from the analysis of impacts on maintenance activities:

- Upper deck:
    - The path barrier now forces the maintenance crew to close the right traffic lane when they need to do maintenance work on the bridge as they have no other place to park their vehicles.
    - Emergency realignment to the barrier is only conducted if an accident causes the barrier to leave less than 10 feet of width on the path. This has only occurred twice between November 2019 and April 2022. In other cases, the barrier is realigned during the monthly alignment check.
- Lower deck:
    - The primary impact of opening the eastbound shoulder to traffic during the afternoon peak is the need to always treat the shoulder as an active lane as vehicles are now more likely to be seen traveling on the shoulder when it is formally closed.

13. QUALITY OF LIFE ASSESSMENT

This section presents the results of the following two surveys that were conducted to assess impacts on quality of life:

- Before/After interviews with managers from 8 businesses located on local Marin County streets potentially used as alternate routes to the bridge, first visited in 2016 and revisited in May 2022, to obtain information about how traffic conditions around the bridge might affect their operations (see details in Section 5.9).
- An online survey of bridge path users that was conducted in the summer of 2021 to collect information on how individuals are using the path and perceiving its safety and benefits (see details in Section 5.8).

13.1. MARIN COUNTY BUSINESS SURVEY RESULTS

Results of the business survey that was conducted between April and December 2016, before the bridge modifications, were as expected. The sentiments collected primarily reflected inconveniences associated with the congestion on the eastbound bridge approach. It should however be noted that the comments collected only represent the views of managers from a relatively small number of businesses and may not, therefore, represent the sentiments of all businesses.

A summary of the key sentiments expressed by the few managers interviewed is provided below:

- Most of the interviewees indicated that congestion during the afternoon commute period typically spilled over to the local streets as commuters attempt to use alternative routes to reach the bridge. All the major alternate routes appeared to be affected, including Bellam, Francisco, Andersen, and Sir Francis Drake. The time intervals most cited for which this problem was observed were 3:00 PM to 7:00 PM or 4:00 PM to 7:00 PM, i.e., during the afternoon peak.
- Interviewees expressed that they believe that their businesses were adversely affected by the daily afternoon traffic congestion spillover.
- Due to high housing costs in Marin County, which were approaching or exceeding one million dollars in 2015, many employees of the surveyed businesses live in Richmond or on the Richmond side of the bridge and as far away as Vallejo or San Leandro. The decreasing reliability of the morning travel time, primarily due to congestion at the toll plaza merge, had resulted in an increasing proportion of employees arriving at work late.
- In certain circumstances, it could be hard to exit the businesses themselves due to traffic congestion on local streets, particularly on Francisco Boulevard or Andersen Avenue.
- Businesses that rely on trucks or delivery services (e.g., UPS) padded their schedules to accommodate the anticipated delays.
- Commute travel times in the afternoon/evening could be double those observed in the morning. Traffic has affected employee commute times.
- Only one business commented that their employees might use the new bicycle lane. Otherwise, the consensus was that their employees wouldn't use it.

Below are the results of a similar business survey that was conducted in May 2022 to assess the potential impacts of the bridge modifications on business activities:

- Many interviewees indicated that congestion on the Richmond approach to the bridge during the morning peak period or midday Saturdays and Sundays remains a significant inconvenience. Many indicated perceiving that the congestion has never been worse, even though traffic data suggests this is not the case. A few further indicated that the lack of shoulder now amplifies the impacts of simple incidents, causing significant swings in travel times.
- For some businesses, the morning congestion on the Richmond side translates into a difficulty to hire or retain employees living on the Richmond side of the bridge. While some businesses would like to hire individuals from Marin County, it was pointed out that the high cost of housing in the counter often forces them to try to look for employees living across the bridge.
- One business indicated that while there appear to be more delays to access the bridge from Richmond in the morning this is partly compensated by shorter travel times back to Richmond in the afternoon.
- No business indicated that the congestion caused employees to frequently arrive late. Most employees appear to have built some buffer time in their morning commute to ensure arrival on time.
- No interviewee was aware of any significant impact of the Richmond approach congestion on their business activities.
- Most of the interviewees indicated that they currently do not see any issues with traveling toward Richmond at any time of the day. Afternoon traffic conditions are much better than they were. The only few negative comments were about temporary inconveniences caused by lane closures on the lower deck for bridge repairs.
- No interviewee was aware of any significant traffic currently using local arterials as a bypass to I-580.
- Several businesses along Francisco Boulevard acknowledged that fewer vehicles now use the arterial as a bypass to I-580 East.
- One business that indicated the difficulty for corporate vehicles to reach the company office from Larkspur using Sir Francis Drake Boulevard and/or Andersen Drive that existed in 2016 has completely disappeared following the lower deck modifications and the elimination of traffic backup onto Sir Francis Drake Boulevard and Andersen Drive.
- Employees from two businesses indicated that the remaining key eastbound bottleneck is the US-101 North exit to Bellam/I-580 East. Because of the traffic light at the end of the ramp, ramp queues often back up onto US-101 North, causing occasional slowdown on the right mainline lane upstream of the exit. A second bottleneck is the signals metering traffic at the Sir Francis Drake Boulevard exit.
- No one indicated being aware of employees using the bike path to commute to work. Some have indicated using it on occasion for recreational purposes.

13.2. USER SURVEY RESPONSES

This section provides a summary of responses to the user survey that was conducted in the summer of 2021. Specific elements discussed below include:

- Characterization of survey respondents
- Starting and ending points of trips made on the bridge path
- Typical use of bridge path
- Perceived safety of bridge path
- Perceived benefit of the bridge path

13.2.1. CHARACTERIZATION OF SURVEY RESPONDENTS

2,166 individuals responded to the online survey between June 16 and August 13, 2021. As indicated in Table 13-1, 1,543 of these respondents, or 73.9%, are cyclists or pedestrians who reported having used the bridge path. 623 individuals, or 28.8% of respondents, further reported having never used the bridge path. Based on the comments provided by these individuals, this group is assumed to be primarily comprised of motorists traveling across the bridge.

Table 13-1: Survey Respondents – Bridge Path Users

Bridge Path User Type	Number of Respondents	Percent
Cyclist	1,402	64.7%
Cyclist/Pedestrian	78	3.6%
Pedestrian	63	2.9%
Non-User	623	28.8%
TOTAL	2,166	100.0%

13.2.2. STARTING AND END POINTS OF TRIPS MADE ON THE BRIDGE PATH

As part of the survey, respondents were asked to indicate what were their trip starting and ending points. In this case, ending destinations were defined as locations individuals were heading to before returning home, such as a place of work, a local restaurant, or a recreational location.

Table 13-2 compiles the reported trip starting and ending points from individuals who reported using the bridge path as a cyclist or a pedestrian. These respondents were primarily individuals traveling from Richmond to Marin County. These trips represented 787, or 51.7%, of the 1522 reported trips. Only 16.8% of trips were from Marin County to the Richmond side of the bridge. 22% of trips were further reported as starting and ending on the Richmond side, while 9.5% were reported as starting and ending on the Marin side.

Table 13-2: Origin/Destination of Trips by Bridge Path Users

Trip Origin	Trip Destination		Total Origin Trips
	Richmond Side	Marin Side	
Richmond Side	335 (22.0%)	787 (51.7%)	1,122 (73.7%)
Marin County Side	255 (16.8%)	145 (9.5%)	400 (26.3%)
Total Destination Trips	590 (38.8%)	932 (61.2%)	1,522 (100.0%)

Table 13-3 further compiles the reported trips starting and ending points from individuals who did not use the bridge path. Like the path users, most of the respondents in this category were individuals traveling westward, with 361 of the 603 reported trips (59.9%) starting on the Richmond side and ending in Marin County. Only 26% of the reported trips were in the opposite direction. Only 5.8% further started and ended on the Richmond side, while 8.3% of trips started and ended in Marin County.

Table 13-3: Origin/Destination of Trips by Respondents Who Did Not Use Bridge Path

Trip Origin	Trip Destination		Total Origin Trips
	Richmond Side	Marin Side	
Richmond Side	35 (5.8%)	361 (59.9%)	396 (65.7%)
Marin County Side	157 (26.0%)	50 (8.3%)	207 (34.3%)
Total Destination Trips	192 (31.8%)	411 (68.2%)	603 (100.0%)

13.2.3. USE OF BRIDGE PATH

The following characterizes the use of the bridge path by individuals, either as a cyclist or a pedestrian:

- 1.9% of survey responses indicated using the path more than four times per week, 10.7% up to four times per week, 29.8% up to four times a month, 31.8% less than once a month, and 25.8% less than four times since its opening.
- 68.3% of respondents indicated using the path on Saturdays, 55.4% on Sundays, and 50.7% on weekdays. This is consistent with bicycle and pedestrian count data, which show significantly higher traffic on the path on weekends than on weekdays.
- 85.1% have indicated using the path for recreation (63.1%) or exercise (22.0%). Only 14.0% have used it for commuting, either to work (4.9%) or other locations (9.1%). The remaining 0.9% used it for other, non-specified, reasons.
- 83.9% indicated having completed one or more round trips on the path while cycling or walking. Of these, 90.6% reported fully crossing the bridge both ways, 6.9% turning back mid-way, and 2.5% having both fully crossed the bridge or turned back mid-way depending on the occasion.
- 3.7% reported having used a car or a bus to come back across the bridge.
- 19.2% reported having used a different route to come back to their origin point.
- Of the 63 individuals who reported having solely used the path as a pedestrian, only 23.8% completed a full round trip on the bridge. 57.1% turned around midway, 7.9% used a vehicle to cross the bridge back, and 11.1% returned to their origin using a different route.

13.2.4. SAFETY OF BRIDGE PATH

Bridge path users generally view it as safe. As shown in Table 13-4, the path received an average safety rating of 8.19 for its cyclists and pedestrians who used it, with 75.1% of them providing a rating of 8 or above. Only 4.9% of respondents gave the path a safety rating of less than 5.

Table 13-4: Bridge Path Safety Rating by User Type

User Type	Count	Rating Distribution										Average Rating
		1	2	3	4	5	6	7	8	9	10	
Cyclists	1,399	10	6	18	20	42	63	173	353	351	363	8.27
Cyclists/Pedestrians	78	4	1	1	4	1	4	10	19	14	20	7.72
Pedestrians	61	2	4	2	3	7	3	4	14	11	11	7.05
All Users	1,538	16	11	21	27	50	70	187	386	376	394	8.19

Survey respondents generally considered the ability to separate cyclists and pedestrians from the adjacent fast-moving traffic as the primary safety benefit of the path. However, the following concerns were cited more than once by various respondents:

- 46 respondents, or 3%, noted the narrow width of the path, particularly the fact that this creates problems when encountering cyclists traveling in the opposing direction or slow-moving pedestrians or cyclists. Some individuals also cited the problem caused for tricycle riders.
- While the barrier helps separate the path from the nearby fast-moving traffic, some concerns remain about the ability of the barrier to prevent trucks and cars to breach the path during an accident.
- Debris on the path flying from passing cars and trucks creates riding hazards.
- Debris flying from passing cars/trucks also creates some safety hazards

13.2.5. BENEFITS OF BRIDGE PATH

Most path users have a positive view of the new bridge path. Path users collectively assigned a rating of 8.35 to the path, with 81.5% of users giving the path a benefit rating of 8 or above. The lower ratings primarily stem from environmental factors associated with the path, such as wind, noise, and pollution from traffic, interactions with cyclists, etc.

Table 13-5: Bridge Path Benefit Rating by User Type

User Type	Count	Rating Distribution										Average Rating
		1	2	3	4	5	6	7	8	9	10	
Cyclists	1,393	40	15	20	15	39	22	83	208	193	758	8.67
Cyclists/Pedestrians	78	7	3	0	0	2	0	5	7	11	43	8.24
Pedestrians	60	14	3	6	1	3	2	4	5	4	18	5.88
Non-Users	616	392	47	25	19	20	9	13	18	8	65	2.84

Most non-path users view the new path negatively. The 616 non-users who provided a benefit rating collectively assigned a rating of 2.84 to the path, with 63.6% of them assigning a rating of 1 to it, the lowest possible. Based on the written comments provided, 156 (25%) of these respondents appear to be motorists who explicitly state that they would like the path removed for one or more of the following reasons:

- The removal of the westbound shoulder now prevents vehicles to pull out of traffic in an emergency. This results in more severe congestion when incidents occur on the bridge.
- The shoulder lane should better be used to relieve traffic congestion, as is done in the eastbound direction.
- The bike lane appears to be significantly underused.

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14. SUMMARY

This section presents a summary of the key findings from the study related to the modifications performed on the lower and upper decks of the bridge.

14.1. IMPACTS OF SHOULDER LANE MODIFICATIONS ON BRIDGE LOWER DECK

- **Compliance of traffic with lower bridge shoulder lane open/close periods**
    - On average, 99.6% of traffic observed on the bridge before 2 PM and after 7 PM is compliant with the shoulder closure.
    - Non-compliant use of the shoulder lane is highest 20 minutes before its opening and up to 30 minutes following its closure. Non-compliant use in the 20 minutes to opening varies between 0.3% and 0.6% of traffic, depending on the day of the week, while non-compliance 30 minutes after closing varies between 0.5% and 1.1%.
    - Motorists traveling on the lower deck may not fully understand the meaning of the green arrow/yellow X/red X signage above the lower deck traffic lanes, resulting in some opting to use the shoulder as a traffic or passing lane when it is formally closed.

- **Traffic impacts on I-580 East and US-101 North**
    - The availability of an extra traffic lane during peak hours has increased the hourly flow across the bridge by 13-25%, from a range of 3,300-3,600 vehicles/hour before the modification to a range of 3,750-4,500 vehicles/hour after.
    - Less than 25% of traffic is observed at any given time using the shoulder lane during weekday peak periods, and less than 20% on weekends.
    - The added peak-hour capacity has eliminated congestion on the I-580 East approach to the bridge in Marin County. This has caused peak travel times from the US-101 to the toll plaza to drop by 13-14 minutes on weekdays, 10-14 minutes on Saturdays, and 6-8 minutes on Sundays.
    - Peak-hour travel times from the US-101 to the toll plaza are significantly less variables.
    - Traffic improvements along I-580 East may have partly contributed to the observed 1-2 minutes reduction in average peak weekday travel times on US-101 North between the Sir Francis Drake Boulevard and I-580 interchanges since 2017.
    - Fewer vehicles are using the Main Street off-ramp and on-ramp as a congestion bypass. Illegal use of the ramps during the afternoon peak has dropped from an average of 56 vehicles/hour in May 2016 to 1 vehicle/hour in March 2022.

- **Traffic impacts on local arterials in Marin County**
    - Compared to 2016, weekday afternoon peak travel times along Sir Francis Drake Boulevard have dropped by up to 4 minutes, while traffic volumes have increased by over 300 vehicles/hour.

  - Fewer vehicles are using local arterials as a bypass to I-580 to save time while traveling towards the bridge in the afternoon. Peak traffic on Francisco Boulevard has for instance dropped from 730 to 227 vehicles/hour between May 2016 and March 2022.

- **Impacts on traffic safety along I-580 East:**
  - The opening of the eastbound shoulder lane has reduced by 72% the frequency of incidents occurring on the eastbound approach to the bridge. This includes significant reductions in rear-end collisions, sideswipes, and vehicle hitting objects. This is due to the elimination of the heavy congestion that used to affect traffic along I-580 East from the US-101 interchange to the entrance of the bridge.
  - On the approach, the absence of congestion on the approach to the bridge has resulted in an 82% reduction in the rate of rear-end collisions, a 60% drop in the rate of sideswipes, and a 63% reduction in the rate of vehicles hitting fixed objects.
  - On the bridge, the addition of a traffic lane has led to lower peak traffic densities and a 33% reduction in the rate of rear-end collisions. However, this change is also providing more opportunities for lane changes, which has translated into a 22% increase in the rate of sideswipes and a slight increase (+4%) in vehicles hitting objects.
  - In terms of severity, the modifications have resulted in a reduction from 41% to 32% of the proportion of incidents on the bridge or its approach with severe injury, a complaint of pain, or other visible injuries.
  - Based on an analysis of CHP CAD logs, there is no evidence that the bridge modifications are producing longer crash-related incidents or changing the location where crashes tend to occur on the bridge.
  - Based on estimated incident duration data derived from the CHP CAD logs, there is no statistical evidence that the bridge modifications are increasing the time needed to clear crash events. In this case, data measuring more precisely the period during which an incident affects traffic would be required to provide a more definitive answer.

- **Key impacts on incident response times:**
  - Retrieved tow truck dispatch logs do not provide enough observations to determine whether the bridge modifications have resulted in longer response times.
  - Estimated incident response times from CHP-CAD logs also do not provide evidence that bridge modifications have caused an increase in incident response times.

- **Key impacts on maintenance activities:**
  - Because vehicles are occasionally seen using the lower deck shoulder when closed, maintenance crews must always treat it as an active lane to ensure their safety.

14.2. IMPACTS OF NEW PATH ON BRIDGE UPPER DECK

- **Utilization of new bridge path by cyclists:**
    - Since January 2021, between 100 and 300 cyclists have been traveling in each direction on the upper deck path on Saturdays or Sundays, with an average of 190 cyclists/direction/day. Saturday traffic is usually the highest.
    - On weekdays, bicycle traffic has ranged between 50 and 75 cyclists in each direction, with an average of 68 cyclists/direction/day.
    - Weekend bicycle traffic follows an annual cycle, with the lowest demand during winter and the highest during summer months. Weekday traffic is relatively constant, with only minor seasonal variations.
    - Path users mainly travel westbound in the morning and eastbound in the afternoon. On weekends, peak westbound traffic is between 10 AM and 11 AM, and eastbound traffic is between 1 PM and 2 PM. On weekdays, peak westbound traffic is also between 10 AM and 11 AM, but peak eastbound traffic is later, between 3 PM and 4 PM, with notable traffic between 12 Noon and 3 PM.
    - 1.9% of surveyed path users in 2021 indicated using the path more than four times per week, 10.7% up to four times per week, 29.8% up to four times a month, 31.8% less than once a month, and 25.8% less than four times since its opening.
    - 85.1% of path users have indicated using the path for recreation (63.1%) or exercise (22.0%). Only 14.0% have used it for commuting, either to work (4.9%) or other locations (9.1%). The remaining 0.9% used it for other, non-specified, reasons.
    - 83.9% of path users indicated having completed one or more round trips on the path while cycling or walking. Of these, 90.6% reported fully crossing the bridge both ways, 6.9% turning back mid-way, and 2.5% having both fully crossed the bridge or turned back mid-way depending on the occasion.
    - Between 2015 and 2019, Golden Gate Transit buses typically carried between 465 and 829 bicycles per month across the bridge, depending on the season. Between April 2020 and December 2021, the number of bicycles carried over dropped 40-50% to a 227-466 range. However, between January and May 2022, monthly counts have increased significantly, to a 337-533 range, or 11-17 bicycles per day.
    - It is still unclear what part of the drop in bicycles carried over by Golden Gate Transit can be linked to the opening of the path and what part might be a byproduct of the pandemic.

- **Utilization of new bridge path by pedestrians:**
    - Pedestrian traffic on the bridge is relatively low. Average weekday eastbound traffic is only 11 pedestrians/day while westbound traffic is around 8 pedestrians/day. Weekend eastbound and westbound traffic reach 24 and 14 pedestrians/day respectively.
    - The estimated pedestrian use is likely underestimated as the counts are based on a single sensor located on the Richmond side of the bridge. This sensor would not have captured individuals accessing the path from the vista point in Marin County and turning back before having fully crossed the bridge.

  - The 4-mile length of the bridge likely explains the low pedestrian demand, and why less than 24% of pedestrians indicated completing a full round trip on the bridge and 57% turned around midway.
  - Fishermen have been observed using the path to access locations from where to cast fishing lines, either on the shore or the path itself. Such individuals are more often seen on the Marin County side, where they use the vista parking lot as a staging area.

- **Impacts onI-580 West traffic:**
  - Average weekday peak-hour flows across the bridge have dropped by 7% following the addition of the path, from a range of 3,500-3,850 vehicles/hour to a range of 3,250-3,600 vehicles/hour depending on the day considered. Weekend peak-hour flows have similarly dropped by 4%, from a range of 3,200-3,500 vehicles/hour to a range of 3,100-3,300 vehicles per hour.
  - The significantly shorter merge downstream of the toll plaza (325 ft instead of 850 ft) and the perceived narrowness of the roadway on the bridge causing some vehicles to slow down and others to move to the left lane may explain the maximum flow reductions across the bridge. These negative impacts may have partly been compensated by the elimination of the toll cash collection.
  - Despite the slight capacity reduction, the extent of the congestion upstream of the toll plaza and average peak travel times from I-80 to the end of the bridge on weekdays, Saturdays, and Sundays have remained similar to the before conditions. This can be explained by traffic demands remaining slightly below before conditions, particularly at the start and end of the peak periods, due to lingering Covid-related factors.
  - Before the modifications, upper deck traffic generally flowed on weekday mornings at or above 50 mph following the first mile of the bridge. In the fall of 2021, speeds between 40 and 50 mph were typically observed across the bridge, resulting in a slight increase in travel time of less than one minute. Some slight speed reductions were also observed on Saturdays and Sundays, but with negligible impacts on travel times.
  - Peak weekday travel times on the bridge's approach are now more variable, i.e., less reliable, than before the path installation, mainly due to the barrier now preventing disabled vehicles to pull out of a traffic lane. The reliability of peak weekend travel times remains similar to before.
  - The closeness of the path's barrier to the right traffic lane appears to have caused 1-2% of peak-hour traffic to shift to the left lane, and up to 20% of the evening and night traffic to do the same. This has resulted in an average 57%/43% split across the left and right lanes during weekday peaks, and a 55%/45% split during weekend peaks.
  - Many of the traffic impacts described above may still be affected by lingering reductions in traffic caused by an increase in the proportion of individuals working from home following the Covid-19 pandemic.

- **Impacts on local arterials in Richmond**
  - Available data do not indicate that the bridge modifications have had significant impacts on local arterials on the Richmond side of the bridge.

- **Safety of new bridge paths for cyclists and pedestrians:**
    - No incidents involving bicyclists or pedestrians were recorded by the CHP or reported on the Street Story platform during the evaluation period. However, anecdotal evidence suggests that some incidents have occurred.
    - Users generally have a positive view of the safety offered by the paths. The 1538 individuals who assessed the bridge path during the survey of summer 2021 gave an overall rating of 8.19 out of 10.
    - Several path users indicated that the low height of the barrier put them at risk of being hit by debris flung from the adjacent traffic lanes. Several also indicated that they could be blinded at night by vehicle lights when traveling toward Richmond. However, while a desire may exist to have a higher barrier, fulfilling such a request would be incompatible with the current barrier moving system.
    - A need exists to improve paths leading to the bridge, particularly in Marin County, notably the crossings at the intersection between Sir Francis Drake Boulevard and Andersen Drive, providing better separation for the I-580 shoulder path, and providing additional separated paths along Sir Francis Drake Boulevard and Francisco Boulevard.
    - Only 3.0% of bridge path users commented on its narrowness in the user survey.
- **Impacts on traffic safety on I-580 West:**
    - There is no straightforward evidence that the modifications have negatively impacted traffic safety on the approach of the bridge or the bridge itself despite the creation of a constrained roadway and a shorter merge downstream of the toll plaza. Scenarios including or excluding the April 2020 to June 2021 interval both point to a 20% reduction in accident rates upstream of the toll plaza but provide opposite conclusions regarding incidents on the bridge and downstream of it.
    - No clear impacts are observed on the types of incidents occurring around the bridge. Rear-end incidents remain dominant on the bridge before and after the modifications, at around 50-55% of all incidents. These are followed by sideswipes (33-42%) and vehicles hitting objects (8-9%). In particular, no increase is observed in the proportion of vehicles hitting a fixed object on the bridge, such as the path's barrier.
    - In terms of incident severity, the upper deck modifications seem to have caused a 23% reduction in the frequency of incidents with a complaint of pain on the bridge and a 71% on the approach. The rate of incidents without injury has further slightly increased on the bridge (+9%) but reduced on the approach (-14%), while no conclusive trend could be identified for incidents with other visible injuries.
    - Based on an analysis of CHP CAD logs, there is no evidence that the bridge modifications are producing longer crash-related incidents or changing the location where crashes tend to occur on the bridge.
    - The analysis of additional data is recommended to more clearly established impacts associated with the modification, the current data only include three quarters with minimal Covid-19 impact. A recommendation is to include at least one additional year of data (January to December 2022).

- **Key impacts on upper deck incident response times:**
    - Retrieved tow truck dispatch logs do not provide enough observations to determine whether the bridge modifications have resulted in longer response times.
    - Estimated incident response times from CHP-CAD logs also do not provide evidence that bridge modifications have caused an increase in incident response times.

- **Key impacts on upper deck maintenance activities:**
    - On the upper deck, the barrier now forces the maintenance crew to close the right traffic lanes when they need to do maintenance on the bridge.
    - Emergency realignment to the barrier is only conducted if an accident causes the barrier to leave less than 10 feet of width on the path. This has only occurred twice between November 2019 and April 2022. In other cases, the maintenance crew either try use tools to manually realign the barrier or wait for the monthly machine re-alignment of the barrier to fix the issue.

14.3. OTHER IMPACT ASSESSMENTS

- **Anecdotal impacts on businesses in Marin County**
    - According to 8 surveyed businesses in March 2022, morning congestion on the Richmond side of the bridge continues to affect the ability of businesses in Marin County to hire and retain staff from the East Bay. This is a problem that pre-existed the upper bridge modifications. However, travel time reductions to access Richmond from the Marin side during the afternoon peak following the lower deck improvements may have helped reduce the impacts of the morning commute.
    - For one business, less traffic using local streets to bypass I-580 East in the afternoon is significantly easing fleet movements around San Rafael and Larkspur.
    - None of the few surveyed business managers were aware of employees using the new bridge bike path for commute purposes.

APPENDIX A. USER SURVEY RESPONSES

Below is a summary of the responses that were provided to the online user survey that ran over 8 weeks from June 16 to August 13 in 2021. Summaries are provided for the four following categories of questions:

- Richmond-San Rafael bridge path
- Trip origin and destination
- Source of survey awareness

A.1 – RICHMOND-SAN RAFAEL BRIDGE PATH QUESTIONS

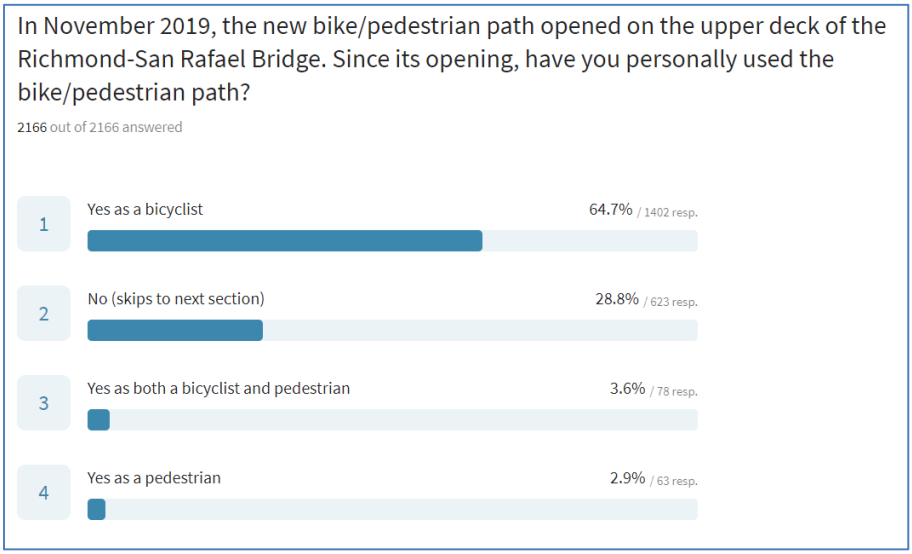

Figure A-1: User Survey – User Type

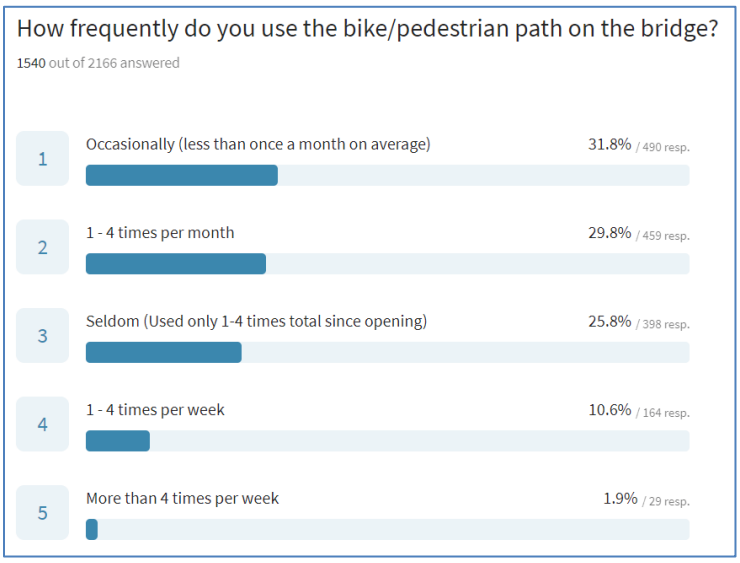

Figure A-2: User Survey – Frequency of Use

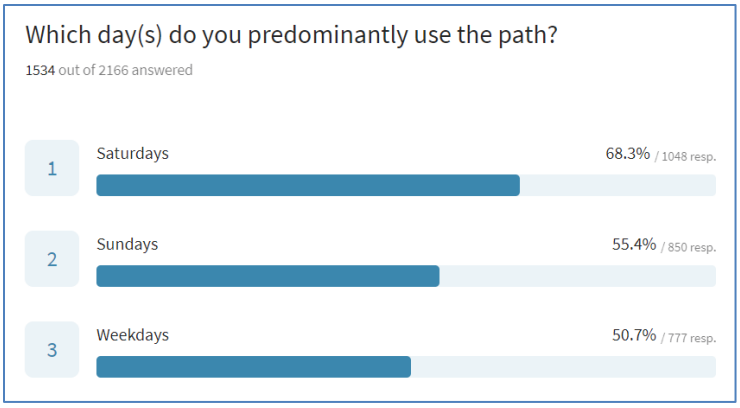

Figure A-3: User Survey – Day of Use

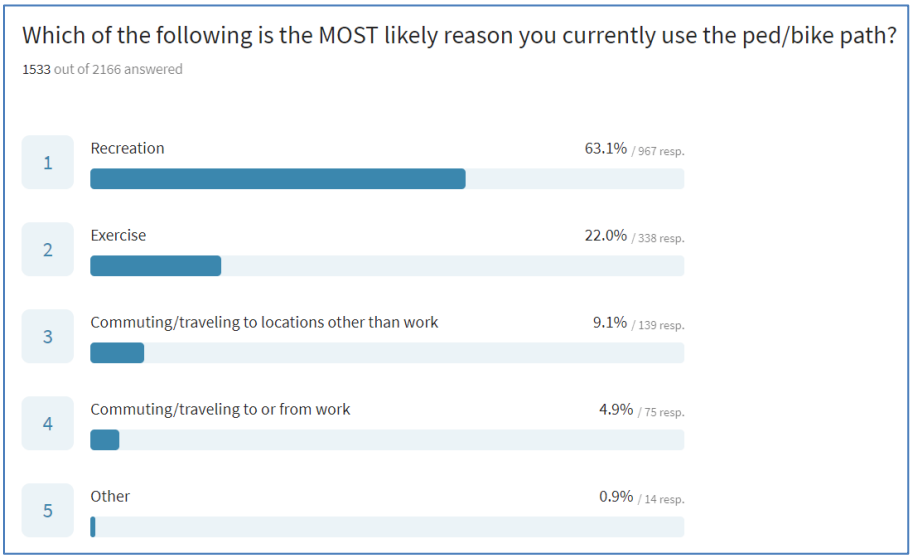

Figure A-4: User Survey – Reason of Use

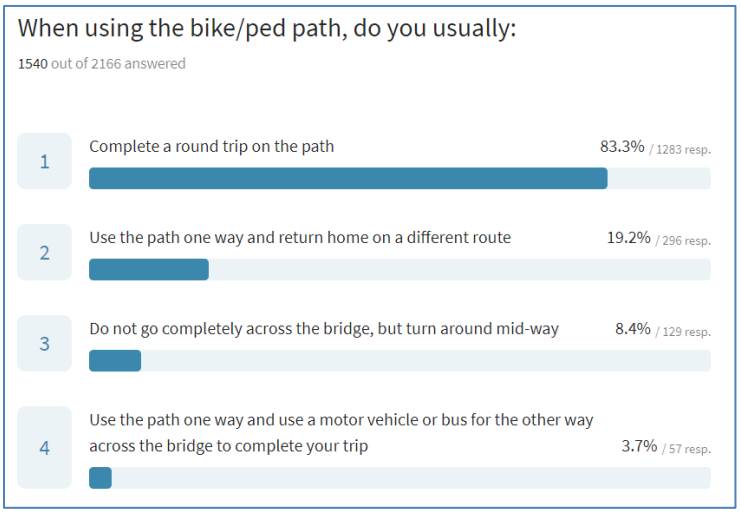

Figure A-5: User Survey – One Way or Round Trips

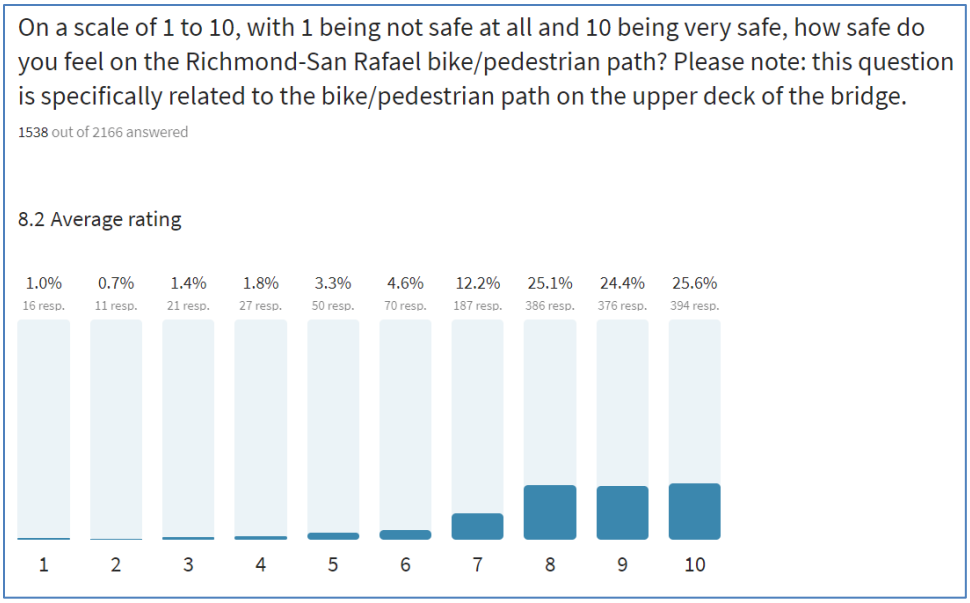

Figure A-6: User Survey – Perceived Safety

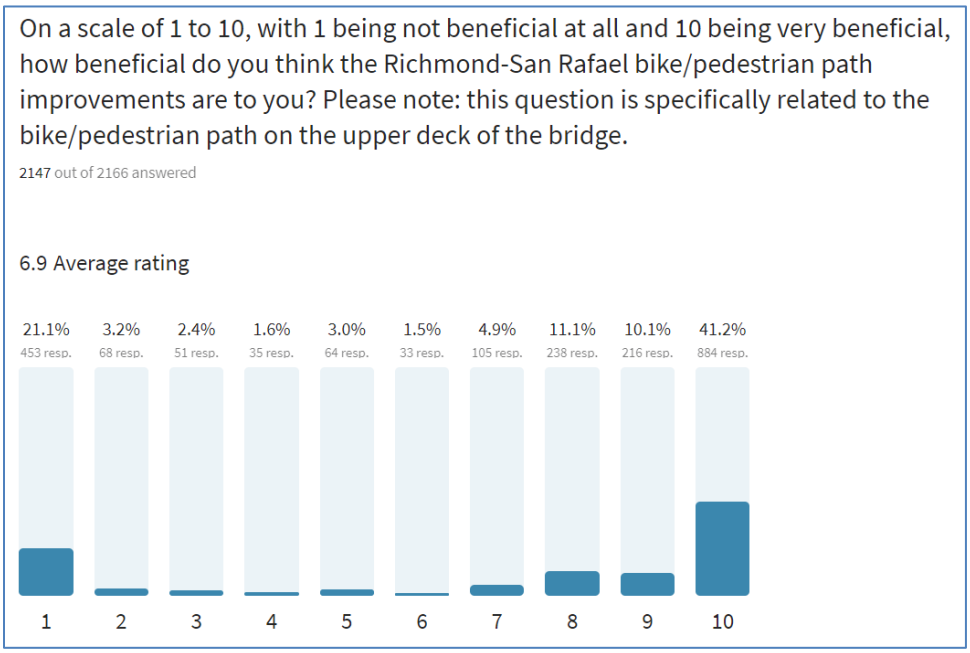

Figure A-7: User Survey – Perceived Benefits

A.2 – TRIP ORIGIN-DESTINATION QUESTIONS

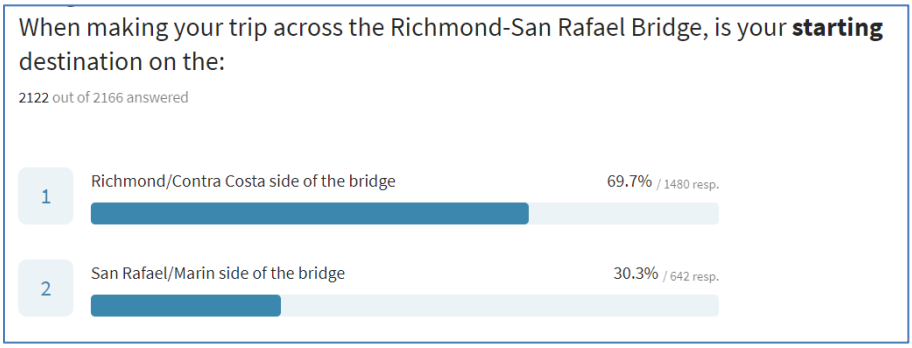

Figure A-8: User Survey – Trip Origin

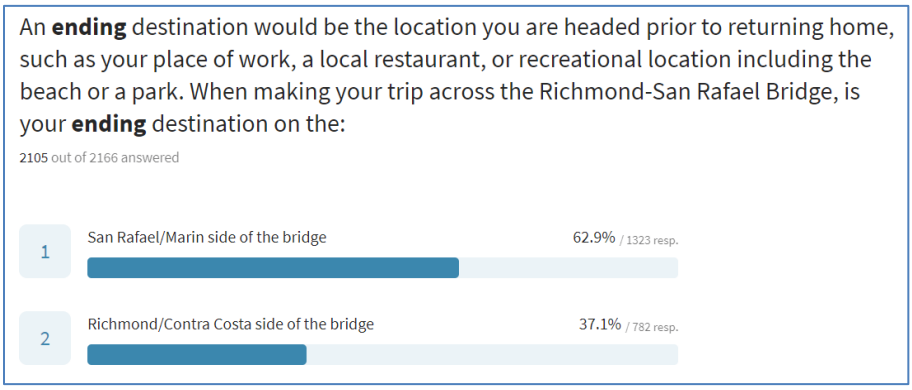

Figure A-9: User Survey – Trip Destination

A.3 – SOURCE OF SURVEY AWARENESS

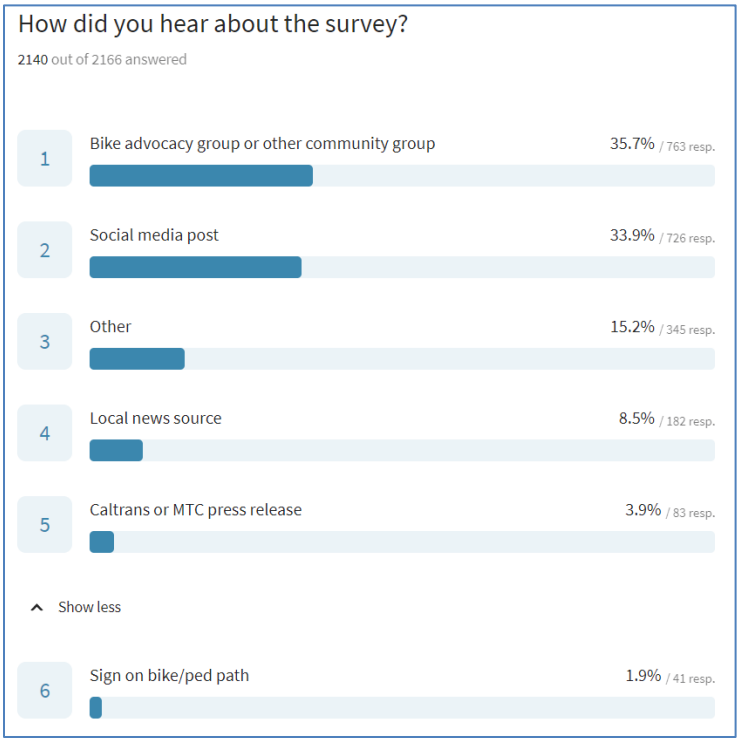

Figure A-10: User Survey – Survey Awareness