



Memorandum

AGENDA ITEM 6

DATE: March 18, 2024
TO: Transportation Authority Board
FROM: Carl Holmes - Deputy Director for Capital Projects
SUBJECT: 3/27/24 Committee Meeting: Adopt I-280 Northbound Geneva Avenue Off-Ramp Study

<p>RECOMMENDATION <input type="checkbox"/> Information <input checked="" type="checkbox"/> Action</p> <p>Adopt I-280 Northbound Geneva Avenue Off-Ramp Study</p> <p>SUMMARY</p> <p>The I-280 Northbound Geneva Avenue Off-Ramp Study (Study) explores potential safety improvements at the freeway ramps intersection with Geneva Avenue next to the Balboa Park Bay Area Rapid Transit (BART) station. The station also serves multiple Muni light rail and bus lines. As a result, the Geneva Avenue off-ramps experience high traffic volume at rush hours which can lead to vehicle queues extending to the mainline freeway that causes collisions. This safety improvement study analyzed the on- and off- ramp intersections to improve multimodal safety for pedestrians and vehicles, and address vehicle queuing, without negatively impacting BART and Muni facilities. The Transportation Authority-led project team developed the study in coordination with key stakeholders including Caltrans and the San Francisco Municipal Transportation Agency (SFMTA).</p> <p>The project team has already implemented near-term signal phasing and timing change recommendations from the report. The team later collected traffic counts which showed improvements at the northbound Geneva Ave off-ramp.</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Fund Allocation <input type="checkbox"/> Fund Programming <input type="checkbox"/> Policy/Legislation <input checked="" type="checkbox"/> Plan/Study <input type="checkbox"/> Capital Project Oversight/Delivery <input type="checkbox"/> Budget/Finance <input type="checkbox"/> Contract/Agreement <input type="checkbox"/> Other:
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BACKGROUND

The I-280 Northbound Geneva Avenue off-ramp is located next to the Balboa Park BART/Muni Station, the busiest station in San Francisco outside of the downtown area with morning and afternoon commuters. The multimodal facility is a major transfer point between BART, Muni light rail train (LRT) lines J, K, and M, and Muni bus lines 8,



29,43, 49 and 54. The station area also experiences a high number of passenger drop-offs and pick-ups because of proximity to the I-280 freeway. The City College of San Francisco, Ocean Avenue business corridor, Lick Wilmerding High School, and Balboa High School are major trip attractors nearby, creating an environment with significant vehicle traffic and overall transportation demand (bus/rail transit, pedestrian, bicycle) at peak hours at the northbound Geneva Avenue off-ramp. This high travel demand often leads to traffic queues backing up to the mainline I-280 freeway causing rear-end collisions, traffic blocking ramp intersections, vehicle-pedestrian crossing conflicts, and other safety issues. Balboa Park Station's current drop off and pick up area also lacks the capacity to handle the current traffic volume during rush hour periods which exacerbates the queue for freeway vehicular traffic exiting northbound Geneva Ave off-ramp.

DISCUSSION

Off-ramp Constraints and Safety Issues: The existing I-280 Geneva Avenue ramp intersection is a tight diamond interchange with the Geneva Avenue bridge at only 150 feet long. This interchange is bordered by BART train tracks and Balboa Park Station on the east side and Lick Wilmerding High School on the west side with no room to expand the interchange. The short overpass bridge and nearby light-rail K line at San Jose Avenue limits capacity along eastbound Geneva Avenue which results in vehicle queues spilling back onto the mainline I-280 freeway. However, the short off-ramp has physical constraints which limit storage capacity and causes non-standard design features including no auxiliary lane and a shorter paved gore section. The San Jose Avenue bridge just south of the off-ramp also acts as a bottleneck, and a freeway horizontal curve prior to the bridge limits sight distance for vehicles exiting at high speed.

Between 2016 and 2021, there were 89 total crashes on northbound I-280 freeway within a quarter mile south of the Geneva Avenue overcrossing and 31 crashes associated with the northbound off-ramp. The collisions include 54 injury crashes and one fatal crash. Unsafe speed (58%) and unsafe lane changes (29%) were the main primary collision factors. Rear-end crashes (66%) and sideswipes (21%) comprised most types of collisions.

Geneva Avenue also experienced a high collision rate. Between 2016 and 2021, there were 44 crashes in total between the I-280 ramp intersections and San Jose Avenue. There were 26 crashes associated with the I-280 ramp intersections. These crashes include 11 pedestrian-involved collisions including one severe injury, seven visible



injury, and 27 complaints of pain crashes. The main collision factors involve drivers failing to observe traffic signals (34%), driving at an unsafe speed (16%), and failing to observe pedestrian right of way (14%).

The project team also observed various multimodal conflicts while developing this safety study. This congested condition often results in aggressive driver behavior. Balboa Park Station passengers at times use the off-ramp as a drop-off and pick-up area. The northbound off-ramp right-turn lane queues tended to form after light rail train preemption events at the Geneva Avenue / San Jose Avenue intersection or people crossing at the off-ramp intersection crosswalk. The northbound off-ramp left-turning vehicles were occasionally blocked by vehicles queued at the westbound left turn lane to I-280 southbound on-ramp. This left turn queue also includes vehicles using the diamond interchange as a U-turn from northbound I-280 freeway to southbound I-280 freeway. There have also been community complaints and concerns about the safety of the southern crosswalk across the southbound I-280 on-ramp for pedestrians contending with traffic from a permissive left turn from westbound Geneva Avenue and right turns from eastbound Geneva Avenue.

The project team also conducted a traffic count at this intersection and observed that the northbound off-ramp at PM peak hour averages 11.5 vehicles per cycle making a right turn when there are no pedestrians crossing Geneva and no congestion along Geneva. This number drops to about 8 vehicles per cycle when there is a pedestrian crossing in one direction and about 5 vehicles per cycle when there are pedestrians crossing both directions. The northbound left turn lane averages about 9.2 vehicles per cycle. Geneva Avenue averages about 16.3 vehicles per cycle in the westbound direction and 17.7 vehicles per cycle in the eastbound direction.

Improvement Measures: After analyzing the traffic circulation, the project team developed potential improvement measures that can be considered in the near-term to mid-term to address the operational and physical deficiencies of the project study area. These measures also vary in terms of implementation cost, approval time, right-of-way issues, and possible construction impacts. Caltrans operates the traffic signals at the ramp intersections while SFMTA operates traffic signals at the San Jose Avenue intersection to the east and the Howth Street intersection to the west. Any improvement implementation would need to be closely coordinated with both Caltrans and SFMTA.

A near-term improvement measure is modifying the signal phasing and timing at both Geneva ramp intersections. Programming a longer cycle time will increase the share



of effective green-light time and enable more throughput to clear the northbound off-ramp and reduce queue lengths backing up to the mainline. However, this also needs to be balanced with Geneva Avenue traffic flow and Muni bus performance as well as pedestrian safety. Modifying the traffic configuration to clear the Geneva Avenue overcrossing traffic and then simultaneously enacting a green-light phase for both northbound and southbound off-ramps traffic may be more promising in terms of efficiency, while accommodating pedestrian movements. Modifying the left-turn signal to I-280 southbound on-ramp from a permissive leading left to a lagging left can also correct a pedestrian crossing conflict at that location. Near-term implementation measures will require modifying nearby traffic signal controllers by both Caltrans and SFMTA. They can be implemented faster, improve traffic circulation, but will not resolve all traffic issues.

A mid-term implementation recommended measure is upgrading the existing ramp intersections traffic signal system to add longer mast arms on existing mast arm poles for improved visibility, improve lighting levels for drivers particularly at night, and installing vehicle detection equipment to adjust traffic signals to vehicle demand. New traffic signals may include elements of Intelligent Transportation Systems (ITS) that allow the signal controller to adjust the phase times to respond to traffic demand. These mid-term recommended measures will also require the project team to initiate a Caltrans project study report to environmentally clear the measures to get Caltrans approval. A detailed design process that produces plans, specifications, and cost estimates (PS&E) and construction would follow.

Another mid-term recommended measure is to conduct a new study on the possibility of lengthening of the I-280 northbound off-ramp to improve storage capacity to reduce collisions. This study will explore the feasibility of lengthening and other design changes to improve safety and scope any potential solution with Caltrans, followed by preliminary engineering and environmental document approval process if warranted. Caltrans project approval may lead to design and construction phases.

Recommendations: The study has 3 main recommendations. A near-term recommendation to modify the traffic signal phasing and timing to improve traffic circulation and safety has been piloted and is undergoing refinement. In the mid-term, the study recommends modernizing the traffic signal system to replace the existing aging system as it reaches the end of its life cycle and to upgrade lighting and potentially add adaptive signaling capabilities to optimize signal timings. A final mid-term recommendation is to initiate a study of lengthening the off-ramp to accommodate the traffic queue spillback onto the I-280 mainline. These mid-term



measures will also include close cooperation with City departments, including SFMTA and San Francisco Public Works, as well as Caltrans on program funding and project approvals.

Near-term Implementation: The project team, with the assistance of Caltrans and SFMTA, was able to implement near-term signal phasing and timing changes along Geneva Avenue in August 2023. These changes focused on improving signal progression through the ramps intersection to clear more vehicles through both ramps intersections in a single cycle, clearing the queue on the Geneva Avenue bridge to free up capacity for turn movements from the off-ramps, increasing total cycle time during peak period to 95 seconds to reduce queue on the northbound off-ramp, and correcting a pedestrian conflict from vehicles running the red light at a permissive left turn from Geneva Avenue to the southbound on-ramp.

The project team followed-up on the implementation with a new round of traffic counts in November 2023. Based on the results, it appears that the traffic signal and phasing changes implemented were successful in improving the capacity of the I-280 northbound off-ramp. Traffic flow rates in terms of vehicles per second (veh/s) improved during peak periods. For the PM peak period, the northbound left lane improved from .23 veh/s to .28 veh/s, an improvement of 22%. The northbound right lane improved from .29 veh/s to .35 veh/s, an improvement of 21%. In terms of vehicles flowing through the intersection per traffic cycle, the right lane improved from 11.5 vehicles per cycle to 13.5 vehicles per cycle, and the left lane improved from 9.2 vehicles per cycle to 10.8 vehicles per cycle. The off-ramp AM peak period also showed improvements, 36% for the northbound left lane and 11% for the northbound right lane.

The overall traffic circulation and safety appear to improve with smoother traffic flows, shorter ramp queues and the pedestrian crossing conflict at the southbound on-ramp addressed.

COST AND FUNDING

The table below shows the estimated cost and potential funding sources for the recommended improvement measures. The Board approved programming of \$500,000 in Prop L funds to implement recommendations to this study as part of the Vision Zero Ramps 5-Year Prioritization Program.



Improvement Measures	Estimated Cost	Potential Funding Sources
Near-term signal timing and phase changes	\$300,000	Completed as part of feasibility study
Mid-term signal upgrades and lighting improvement	\$4 -\$5.5 million	- Caltrans State Highway Operation and Protection Program (SHOPP) - SB 1 Local Partnership Program formula
Mid-term lane lengthening study and PSR/PDS	\$425,000	- California Highway Safety Improvement Program (HSIP) - California Office of Traffic Safety (OTS) - Prop L, Prop AA - SFPUC

FINANCIAL IMPACT

There is no impact on the adopted FY 2023/24 budget associated with the recommended action.

CAC POSITION

The CAC will consider this item at its March 27, 2024, meeting.

SUPPLEMENTAL MATERIALS

- Attachment 1 - I-280 Northbound Geneva Avenue Off-Ramp Study

I-280 Northbound Geneva Avenue Off-Ramp Study



Acknowledgments

PROJECT TEAM

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Table of Contents

1. INTRODUCTION

2. BACKGROUND

- 2.1 Prior Studies
- 2.2 Concurrent Projects

3. EXISTING CONDITIONS & ISSUES

- 3.1 Multimodal Traffic Demand
- 3.2 Existing Vehicle Queuing Observations
- 3.3 Observed Multimodal Conflicts
- 3.4 Crash Records

4. PROJECT AREA DEFICIENCIES

- 4.1 Northbound I-280 Ramp-Intersection Layout & Cross-Section
- 4.2 Northbound I-280 Mainline-Ramp Layout
- 4.3 Ramp Intersection Layout
- 4.4 Traffic Signal Systems
- 4.5 Traffic Signal Operations

5. POTENTIAL IMPROVEMENT MEASURES

- 5.1 Near-Term Actions / Areas for Further Study
- 5.2 Mid-Term Project Concept – Signal System Upgrade
- 5.3 Mid-Term Lane Lengthening Study
- 5.4 Concepts Not Recommended for Further Consideration
- 5.5 Travel Demand Management Strategies

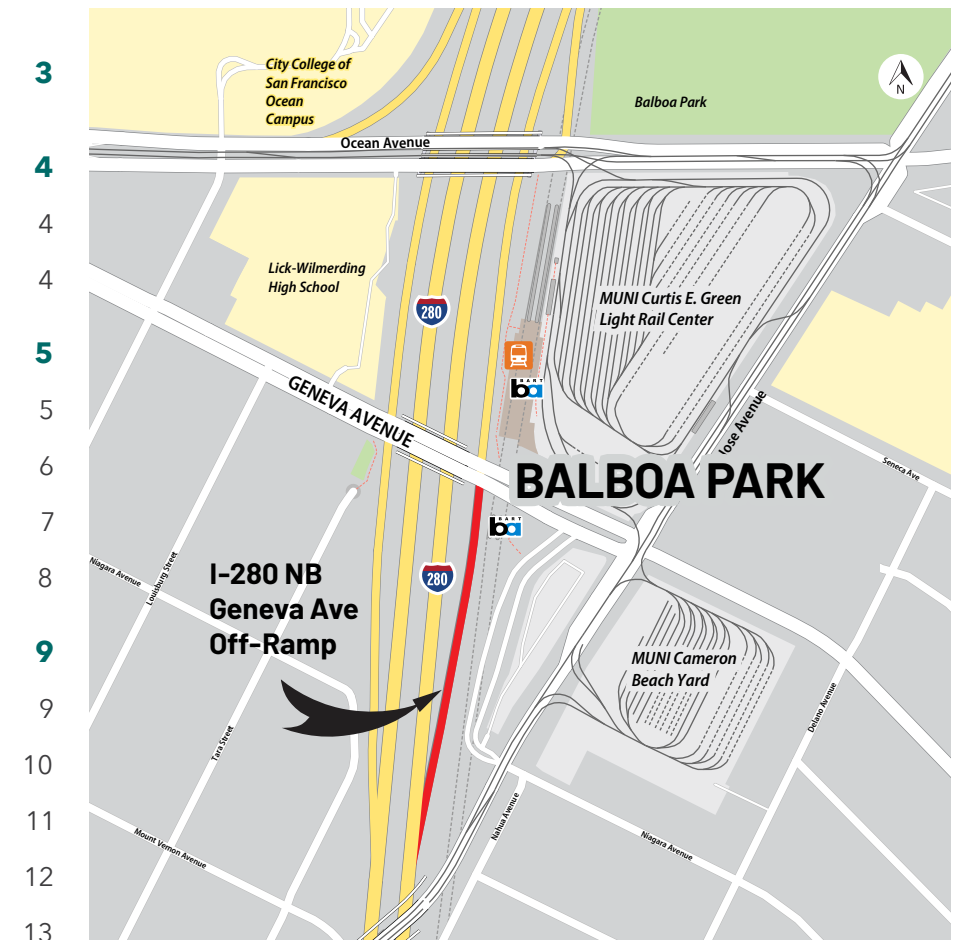
6. PRELIMINARY ENVIRONMENTAL CLEARANCE ASSESSMENT

7. RECOMMENDATIONS & NEXT STEPS

APPENDIX A: POST IMPLEMENTATION ANALYSIS

Project Location Map

Map data from OpenStreetMap.



Project Vicinity Map



1. Introduction

Geneva Avenue is one of the Balboa Park neighborhood’s principal east-west transportation corridors and the Balboa Park Station area is a major transportation hub for the City and County of San Francisco. The objective of this study was to find opportunities to improve multimodal safety and address vehicle queuing at the I-280 northbound off-ramp at Geneva Avenue, inclusive of the ramp intersections and freeway mainline, while maintaining essential transit and pedestrian movements in the area. This study was requested by District 11 Board member Ahsha Safai.

The combined BART/Muni Balboa Park Station is one of the busiest transit facilities in San Francisco and region. Intermodal facilities in this area include the Balboa Park BART station, the Muni Curtis E. Green light rail station (Green Yard), the Muni Cameron Beach Yard, several Muni bus lines, and the I-280 interchange. The station area experiences a high number of passenger drop-offs and pick-ups because of close proximity to the I-280 freeway. City College of San Francisco and Lick Wilmerding High School are two major trip attractors in the area and the Kapuso housing project just opened at the Balboa Park Station Upper Yard site.

Issues that should be addressed, as expressed by the community and discovered during this study, include:

- 1 I-280 northbound ramp queuing extending back onto mainline I-280 and related collisions.
- 2 Congested conditions and aggressive driver behavior at ramp intersections and their adverse effect on pedestrian safety.
- 3 Passenger drop-off and pick-up in prohibited locations, e.g., the freeway ramp shoulder and at bus stop areas.
- 4 Limited sight distance for motorists
- 5 Limited vehicle storage capacity as a result of terrain and high density location
- 6 Need for better coordination between Caltrans and local traffic signals

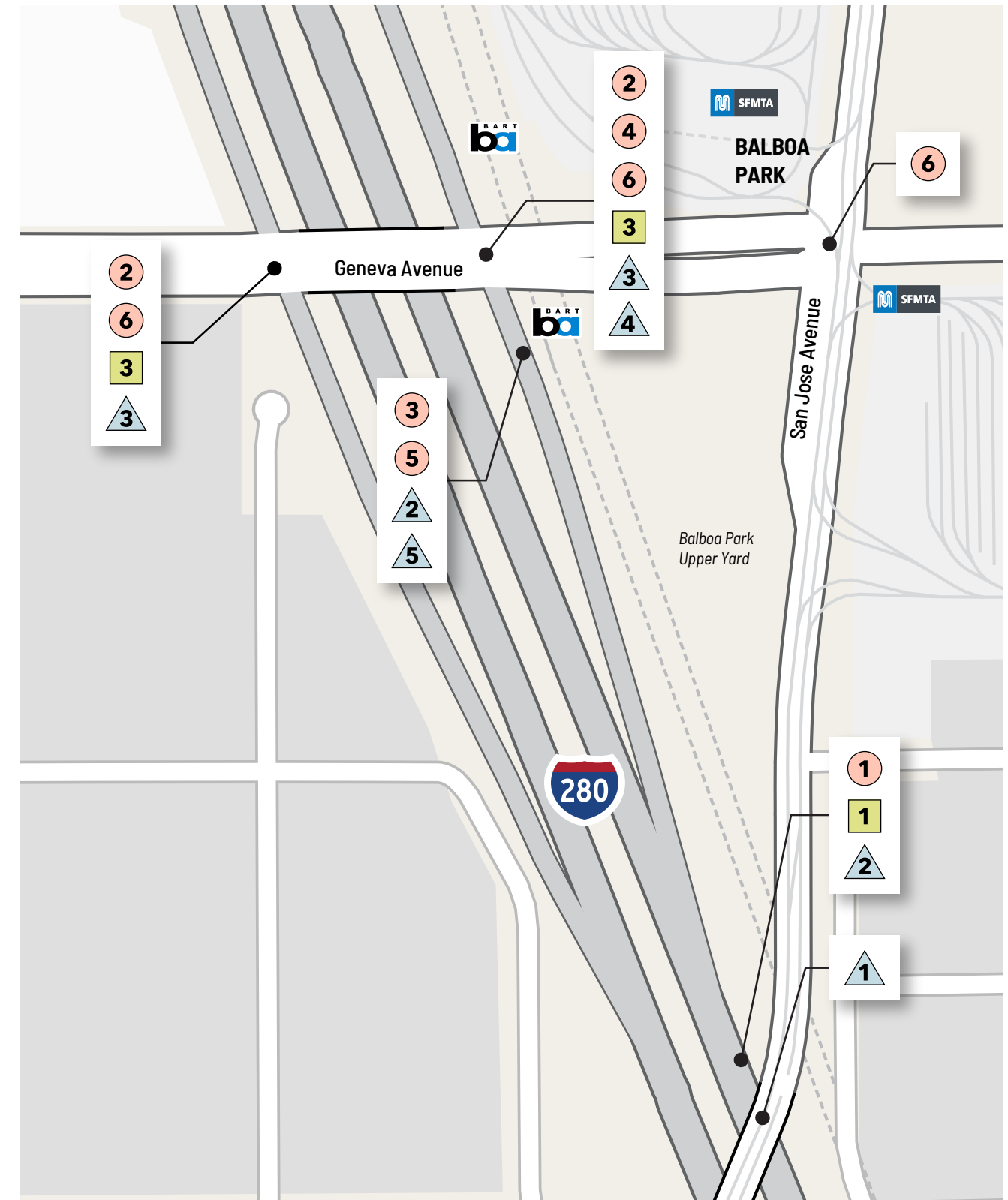
The desired outcomes of this study include:

- 1 Traffic operations and efficiency, including reducing ramp queuing and queue spillback on to US101 mainline.
- 2 Traffic safety, including reducing collisions at I-280 mainline.
- 3 Enhance pedestrian safety.

The primary physical and capital constraints in this area are:

- 1 The I-280 northbound mainline is width constrained by the San Jose Avenue overcrossing.
- 2 The northbound off-ramp to Geneva Avenue is constrained to the east by the BART station.
- 3 Existing traffic signal operations are limited by the existing equipment and need to coordinate with light rail vehicle movements at the Geneva Avenue - San Jose Avenue intersection.
- 4 The current design provides a single lane allowed to right turn to east-bound (EB) Geneva. SFMTA indicates that dual right turns lanes are discouraged at crosswalks. The non-perpendicular intersection alignment also makes potential dual right turns challenging.
- 5 The area does not have pick up/drop off areas for BART/Muni station near the freeway ramps.

Figure 1. Project Study Area Issues, Objectives and Constraints.



Map data from OpenStreetMap.

2. Background

2.1 PRIOR STUDIES

The following reports concerning the project study area have been completed in the last 10 years.

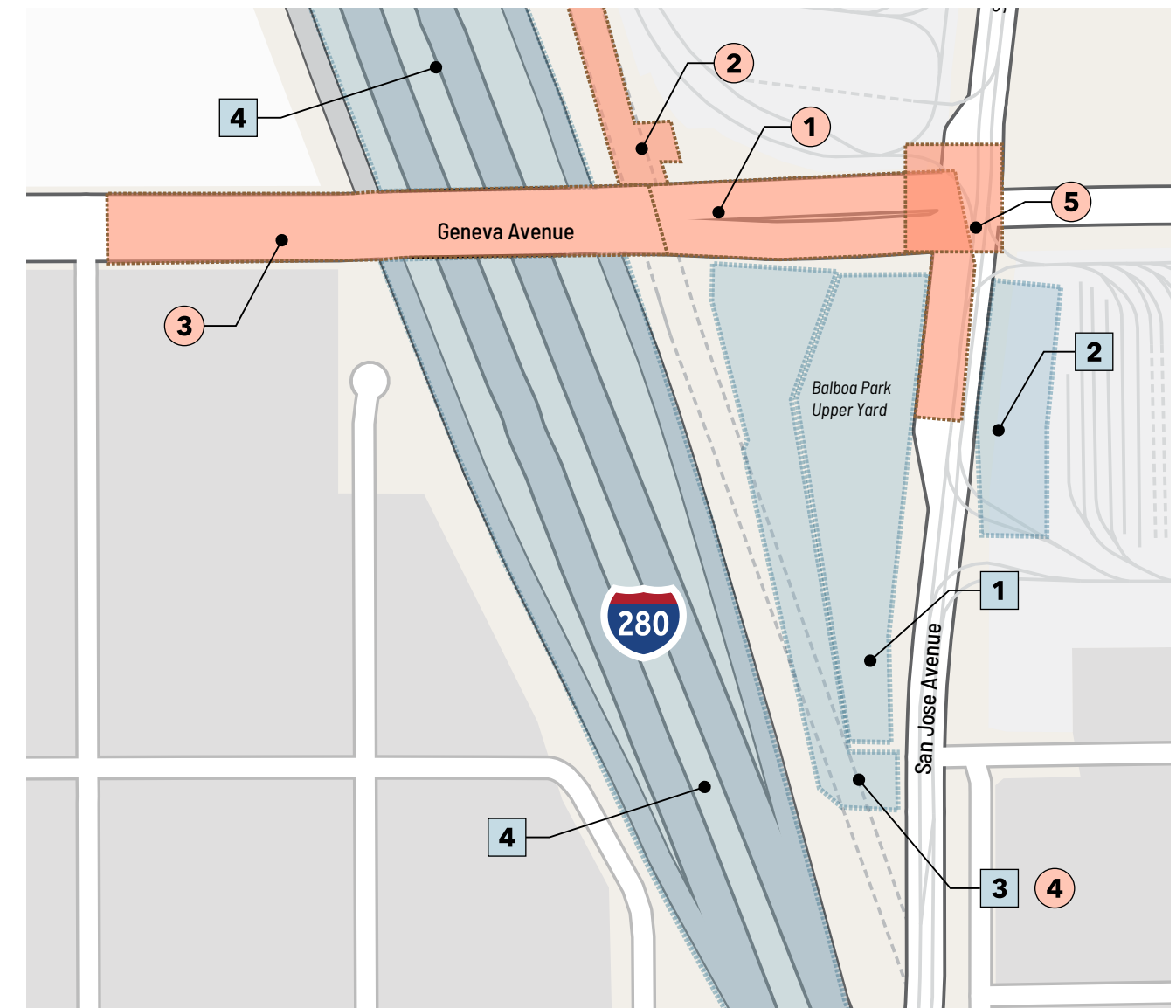
- 1 **The Balboa Park Station Capacity and Conceptual Engineering Study (October 2012)** developed designs for M Line boarding improvements and the reconfiguration of Geneva Avenue, in front of Balboa Park Station. These improvements included new directional curb ramps at all four corners and a realigned east crosswalk and pedestrian refuge, which were completed in 2016.
- 2 **The Balboa Park Circulation Study (April 2014)** evaluated multimodal transportation circulation in the Muni and BART Station Area and explored ways to improve freeway access, passenger loading areas and transit access. The study developed a concept that would close the northbound on-ramp from Geneva Avenue and replace it with a new northbound frontage road and BART kiss and ride area on the east side of I-280 between Geneva Avenue to Ocean Avenue. This concept is not currently an active project.
- 3 **The Ocean and Geneva Corridor Design Plan (March 2015)** developed a framework for public realm improvements along the Ocean Avenue corridor and a portion of Geneva Avenue.
- 4 **The Balboa Park Station Modernization Kiss-and-Ride Study (March 2017)** was developed by BART in parallel with the adjacent Kapuso housing project and BART Station Modernization projects. This concept developed in this study constructs a plaza fronting Geneva Avenue and moves the BART Patron/Passenger loading area to a cul de sac loop accessed from San Jose Avenue and Niagara Avenue; the project is currently under construction.
- 5 **The Geneva Avenue - San Jose Avenue Intersection Study (2020)** prepared conceptual designs for transit stop improvements at the San Jose Avenue - Niagara Avenue intersection to improve Muni M Line access. The study noted that the Geneva Avenue/San Jose Avenue intersection traffic signal is one of the more complicated signals in the City, serving multiple light rail vehicle (LRV) train movements and heavy pedestrian, bus and private vehicle traffic. SFMTA staff noted that many possible enhancements have been completed; further enhancements would require major equipment reconfiguration that would impact transit facilities. Staff noted that the Geneva Avenue/San Jose Avenue intersection does not fit the criteria for a pedestrian scramble phase due to the LRV movements through the intersection.

2.2 CONCURRENT PROJECTS

The Balboa Park station area has several projects in various stages of development.

- 1 **The Mayor's Office of Housing and Community Development's (MOHCD) Kapuso housing project** completed construction and resulted in 131 units.
- 2 **The San Francisco Recreation and Parks Department** completed Geneva Car Barn & Powerhouse Phase I Improvements.
- 3 **BART** completed patron drop-off loop to create a new plaza (see Balboa Park Station Modernization Kiss-and-Ride Study). Subject to available funding, BART has plans to modernize and renovate the existing elevator at the station.
- 4 **Caltrans's State Highway Operation and Protection Program (SHOPP)** has programmed \$105M for pavement repair and roadside safety projects on I-280 (EA #oQ120). The project initiated in March 2020, is scheduled for design through late 2023, and would initiate construction in mid-2024.
- 5 **The San Francisco Municipal Transportation Agency's Muni Forward** will improve M-line transit and safety between Junipero Serra Blvd and Balboa Park Station.

Figure 2. Project Study Area Issues, Objectives and Constraints. Map data from OpenStreetMap.



3. Existing Conditions & Issues

Geneva Avenue experiences heavy traffic congestion, and the congestion negatively impacts automobile movements, Muni bus operations, bicycle travel, and pedestrian activity. Occasionally congestion on Geneva Avenue results in backups on the NB off-ramp that extend back onto the freeway mainline. Due to the hilly topography adjacent to Geneva Avenue, it is the only primary east-west corridor in the region with few alternatives for parallel travel.

3.1 MULTIMODAL TRAFFIC DEMAND

Weekday AM and PM peak hour traffic counts were taken on December 1st and 2nd of 2021. The volumes shown in Figure 3 and Table 1 are the two-day averages. On average, approximately 13 cars arrive at the northbound off-ramp every minute or 20 vehicles arrive every 90-second signal cycle. Vehicle traffic tends to be heavier approaching the ramp intersections from the east, along westbound Geneva Avenue. The crosswalks are busier along the south side of Geneva in the morning and busier crossing Geneva at the Balboa Park station area in the afternoon.

Traffic volumes and traffic patterns appear to show lingering effects from the COVID-19 pandemic, particularly revolving around commute traffic and school trips, which may not be consistent over the long term. In comparison to 2017 counts at the San Jose Ave intersection, the 2021 traffic volumes recorded a higher amount of traffic westbound on Geneva, slightly less eastbound traffic, and slightly less northbound off-ramp traffic. There are also several Muni routes that are not active due to the pandemic.

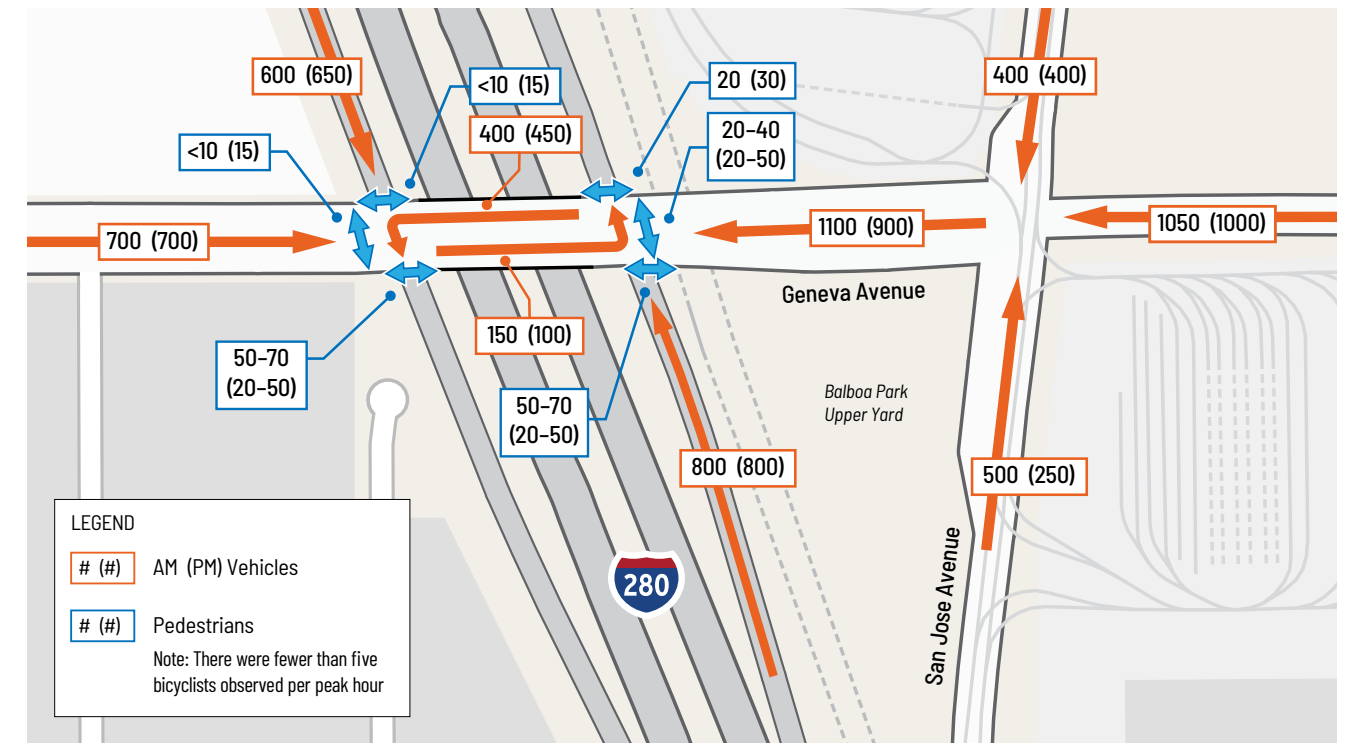
Based on the combined Muni bus frequency, (Table 2 and Figure 4) there is currently one bus every two to four minutes in each direction on average. The M Line Light Rail Transit (LRT) route passes through the Geneva Avenue / San Jose Avenue while the J and KT lines serve stops within the Green Yard. Trains serving other routes also move between yards for maintenance and storage purposes and enter/exit the yard at the beginning/end of service.

Table 1. Nov/Dec. 2021 Two-Day Average Peak Hour Counts

I-280 SB RAMPS / GENEVA AVENUE			I-280 NB RAMPS / GENEVA AVENUE		
MOVEMENT	VEHICLES	AVG VEH / CYCLE	MOVEMENT	VEHICLES	AVG VEH / CYCLE
AM Peak Hour					
EBT	339	8.5	EBL	168	4.2
EBR	395	9.9	EBT	515	12.9
WBL	421	10.5	WBT	694	17.4
WBT	662	16.6	WBR	363	9.1
SBL	345	8.6	NBL	394	9.9
SBR	283	7.1	NBR	429	10.7
PM Peak Hour					
EBT	380	9.5	EBL	84	2.1
EBR	330	8.3	EBT	707	17.7
WBL	438	11.0	WBT	650	16.3
WBT	575	14.4	WBR	283	7.1
SBL	435	10.9	NBL	367	9.2
SBR	224	5.6	NBR	459	11.5

Note: Volumes do not balance between ramp intersections due to residual queues. | 2021 Signal Cycles = 90s

Figure 3. Project Study Area Multimodal Traffic Counts: Geneva & I-280 Ramps, 2-day peak hour counts in Nov./Dec. 2021.



Map data from OpenStreetMap.

Table 2. Weekday Muni Service Frequencies

ROUTE	SERVICE FREQUENCIES (MINS)		
	MORNING	MIDDAY	EVENING
Geneva Avenue Routes			
8 Bayshore	8	8	12
8BX Bayshore Exp.	8	--	8
43 Masonic	12	12	15
54 Felton	20	20	30
LRT Routes			
J*	15	15	17
KT*	10	10	15
M**	10	10	15

Figure 4. Muni Service Map, Balboa Park Station Area



* J and KT routes do not require LRT preemption through the Geneva / San Jose intersection but do travel along San Jose Avenue into and out of the Green Yard.

** M Line Vehicles require signal preemption at the Geneva / San Jose intersection.

3.2 EXISTING VEHICLE QUEUING OBSERVATIONS

The presence and magnitude of vehicle queuing in the Geneva Avenue / I-280 interchange area reflects the asymmetrical design of the roadway network and the operations of signals and LRT stations.

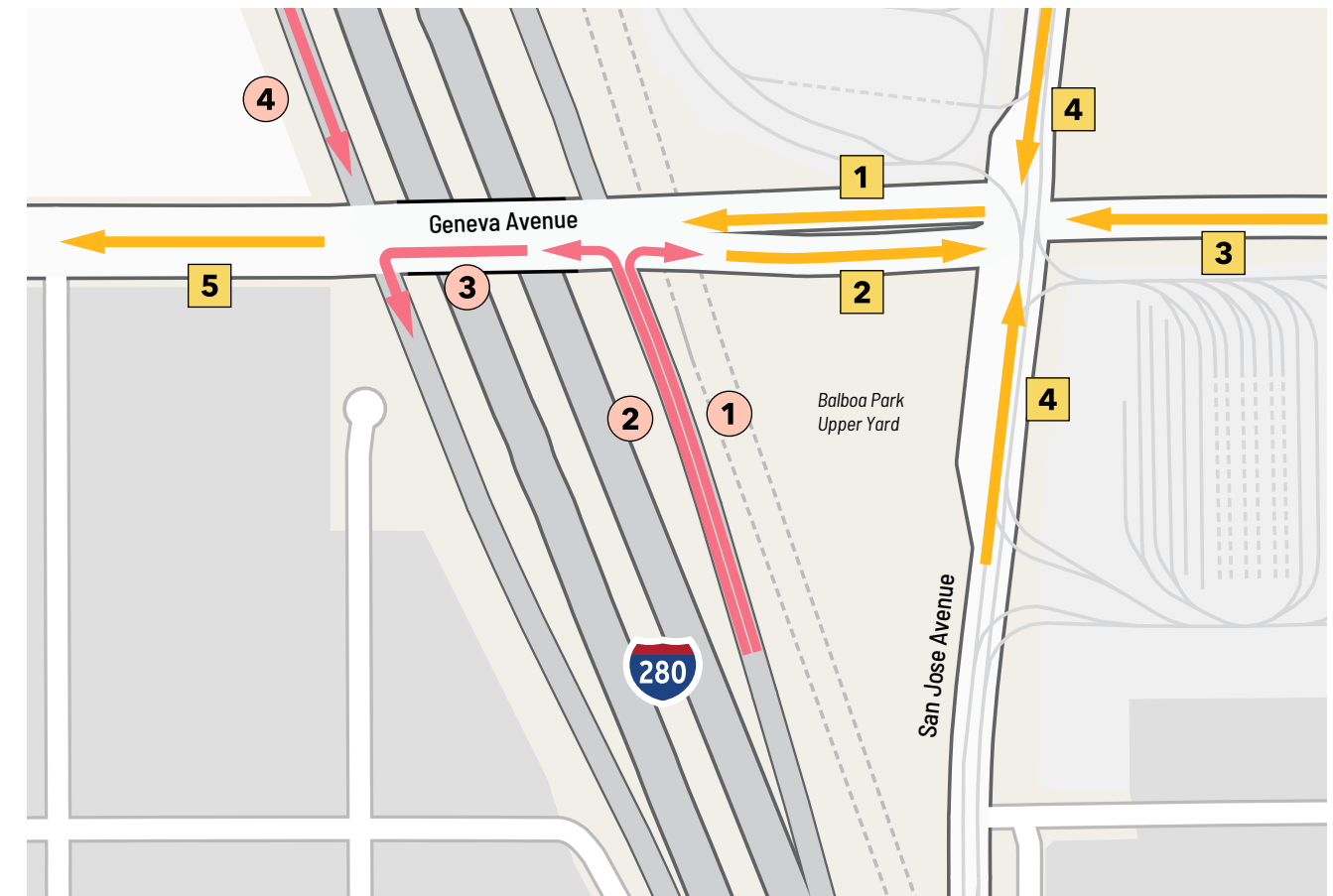
Freeway Queues

- 1 Queues were observed on the northbound off ramp right lane. This queue would reach the mainline I-280 during rush hours and block the rightmost lane, causing slow-downs in adjacent northbound freeway lanes. These queues tended to form after LRT preemption events at the Geneva Avenue / San Jose Avenue intersection and people crossing at the Geneva Avenue / northbound 280 ramp crosswalk (Section 3.3, Geneva Ave / I-280 Northbound Ramps).
- 2 Northbound left-turning vehicles were occasionally blocked by vehicles queued at the westbound left turn lane.
- 3 Queues at the westbound Geneva Ave left turn lane onto the southbound ramp intersection occasionally spill back to the northbound ramp intersection, which delays northbound off ramp left turn traffic. These queues were more frequent with a leading westbound left turn phase at the Geneva Avenue / southbound 280 ramp intersection (Section 3.3, Geneva Ave / I-280 Southbound Ramps).
- 4 Southbound off-ramp queues at Geneva Avenue rarely exceeded the storage capacity because of the longer ramp storage and second exit to Ocean Avenue.

Local Street Queues

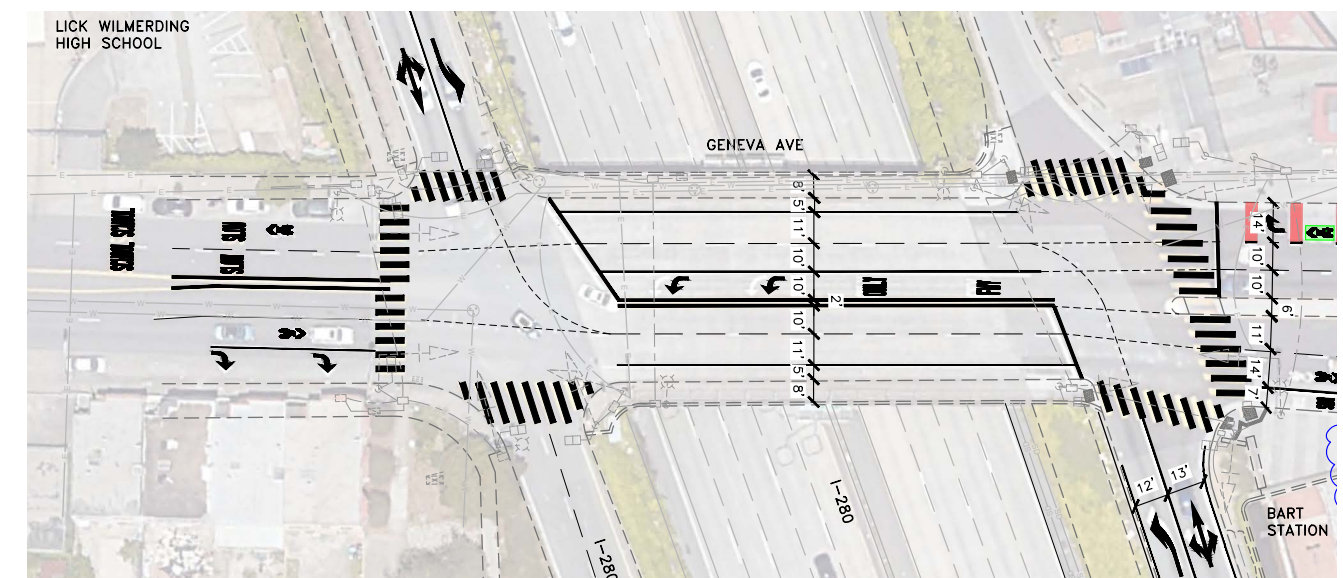
- 1 Queues on Geneva Avenue were more frequent approaching from the east. Westbound queues to enter southbound I-280 frequently extended back to San Jose Avenue. Passenger vehicles queued to enter northbound I-280 frequently conflicted with Muni buses at the right bus-only lane at the northbound ramp intersection.
- 2 Eastbound queues tended to occur following an LRT preemption event at the Geneva Avenue / San Jose Avenue intersection. During peak commute hours, LRT preemption events occurred between four to six times per hour.
- 3 Queues extending back from the Geneva Avenue / San Jose Avenue intersection are primarily a product of spillback queues from the I-280 northbound ramp intersection and, to a lesser extent, LRT preemption events.
- 4 Muni buses are able to bypass some queues on westbound Geneva Avenue using the bus-taxi-only lane. Queues on San Jose Avenue negatively affect Muni LRTs.
- 5 Westbound queues to the west of the I-280 ramps were occasionally observed at the Geneva Avenue / Howth Street intersection and may have been due to pick-up at Lick Wilmerding High School. These queues rarely extended back into the ramp intersections.

Figure 5. Vehicle Queuing Observations.



Map data from OpenStreetMap.

Figure 6. Traffic Striping



Source: Parisi, 2021

3.3 OBSERVED MULTIMODAL CONFLICTS

There are several locations and movements that represent the bulk of the intermodal conflict and safety issues in the Geneva Avenue interchange area.

Geneva Avenue / Southbound I-280 On-Ramp (Figure 7)

There have been community complaints and concerns about the safety of the southern crosswalk across the southbound I-280 on-ramp for pedestrians contending with permissive left and right turns. The safety issues concern the traffic signal operations that are in effect outside of the afternoon commute peak (See Section 4.5).

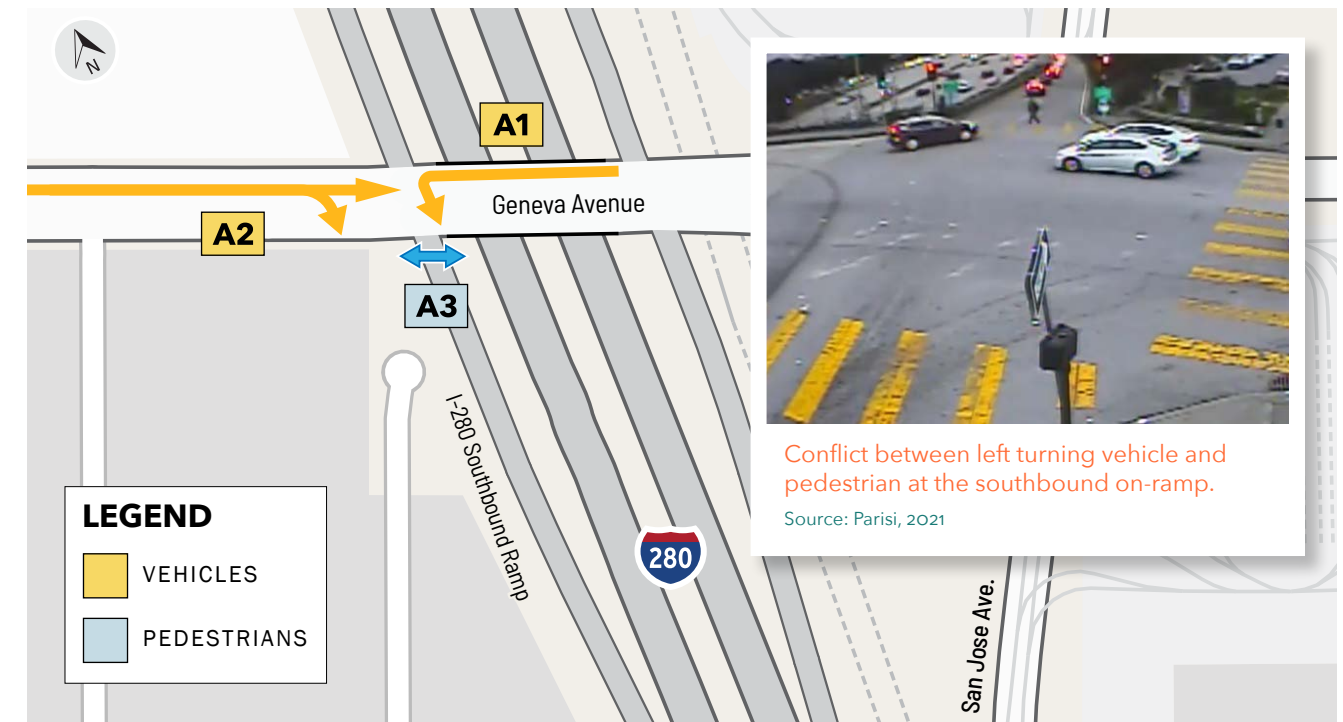
- Westbound left turning drivers [A1] receive a protected left turn (green arrow) phase simultaneous with westbound through traffic. When left turns receive priority before the through movements, this is referred to as a “leading” left turn. When the protected phase terminates, many left turning drivers continue to enter the intersection on the red light, tailgating the left-turning vehicle ahead to prevent eastbound drivers [A2] from initiating their movement.
- Left turning drivers [A1] entering the intersection on red also violate the right of way of pedestrians in the south crosswalk [A3] that have the Walk signal phase that is typically concurrent with eastbound through traffic [A2].
- After the protected left turn (green arrow) ends, westbound left turning drivers [A1] are allowed to make the turn on the permissive (green ball) phase; they are required to yield to eastbound vehicle traffic [A2] and people in the crosswalk [A3]. However, left-turning drivers were observed turning against oncoming traffic and not being aware of pedestrians when initiating the turn.
- Eastbound right turning drivers [A2] were observed failing to yield to pedestrians crossing in the south crosswalk [A3].

Geneva Avenue / Northbound I-280 Ramps & San Jose Avenue (Figure 8)

The right turn queues at the northbound I-280 off-ramp reflect downstream congestion that are associated with or that manifest as several issues:

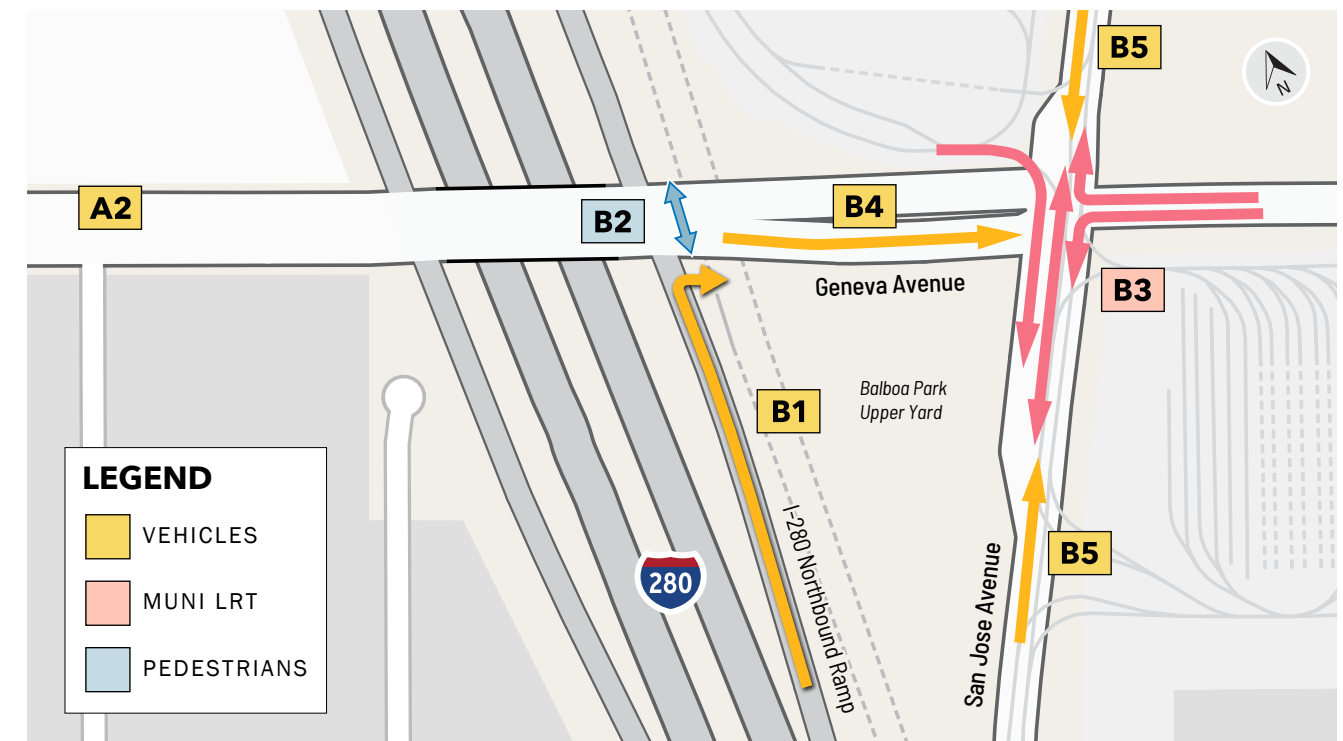
- Approximately 12 drivers can make the right turn [B1] every northbound green phase when there are no people crossing Geneva Avenue [B2] and no downstream congestion; this drops to 8 to 10 cars, and fewer trucks, every phase when there is a person crossing in one direction and even fewer when there are people crossing in both directions. There is usually at least one person on foot crossing Geneva Avenue every other cycle during the commute peak hours.
- Muni LRT preemption events [B3], where all vehicle traffic is stopped, occur 4 to 6 times during the commute peak hour. The LRT preemption typically follows the end of eastbound Geneva Avenue vehicle phase [B4] and lasts around 30 seconds each. LRT preemption is followed by the San Jose Avenue phase [B5], which services several Muni bus and LRT lines.
- Some drivers drop off passengers on the off-ramp [B1] when queued at a red light and then drive back onto northbound I-280 to avoid exiting onto Geneva Avenue. Some drivers drop off passengers on Geneva Avenue at the BART station [B4].

Figure 7. Westbound Left Turns.



Map data from OpenStreetMap.

Figure 8. Northbound Right Turns.



Map data from OpenStreetMap.

3.4 CRASH RECORDS

There were a total of 164 crashes in the project study that were recorded between 2016 and 2021.

Northbound I-280 Crashes

Between 2016 and 2021, there were 120 total northbound I-280 crashes near the Geneva Avenue interchange. Specifically, there were 89 total crashes on northbound I-280 within a quarter mile south of the Geneva Avenue overcrossing (PM R1.4 - R1.65) and 31 crashes associated with the northbound off-ramp.

Among the significant crash factors, there were:

- One fatal crash and 54 injury crashes
- Unsafe speed (58%) and unsafe lane changes (29%) were the main primary collision factors (PCFs).
- Rear-end crashes (66%) and sideswipes (21%) comprised most types of collisions.

The table below summarizes the calculated collisions rates against the statewide average for similar facilities. For both the mainline and ramp, the project study area has a fatal / injury collision rate higher than the statewide average but a total collision rate approximately 10% lower than the statewide average.

Table 3. TASAS Table B Crash Rates (January 1, 2016 – December 31, 2021)

LOCATION	TOTAL NO. OF CRASHES	ACTUAL I-280 RATES (PER MVM)			AVERAGE CALIFORNIA RATES (PER MVM)		
		FATAL	FAT. + INJURY	TOTAL	FATAL	FAT. + INJURY	TOTAL
SF-280-PM R1.4/R1.65 Northbound Mainline	89	0.01	0.46	1.0	0.004	0.35	1.09
Northbound Off-ramp to Geneva Avenue. PM R1.556	31	0.0	0.43	0.96	0.003	0.38	1.04

Source: Caltrans Traffic Accident Surveillance and Analysis System (TASAS), report generated 10/3/2022.

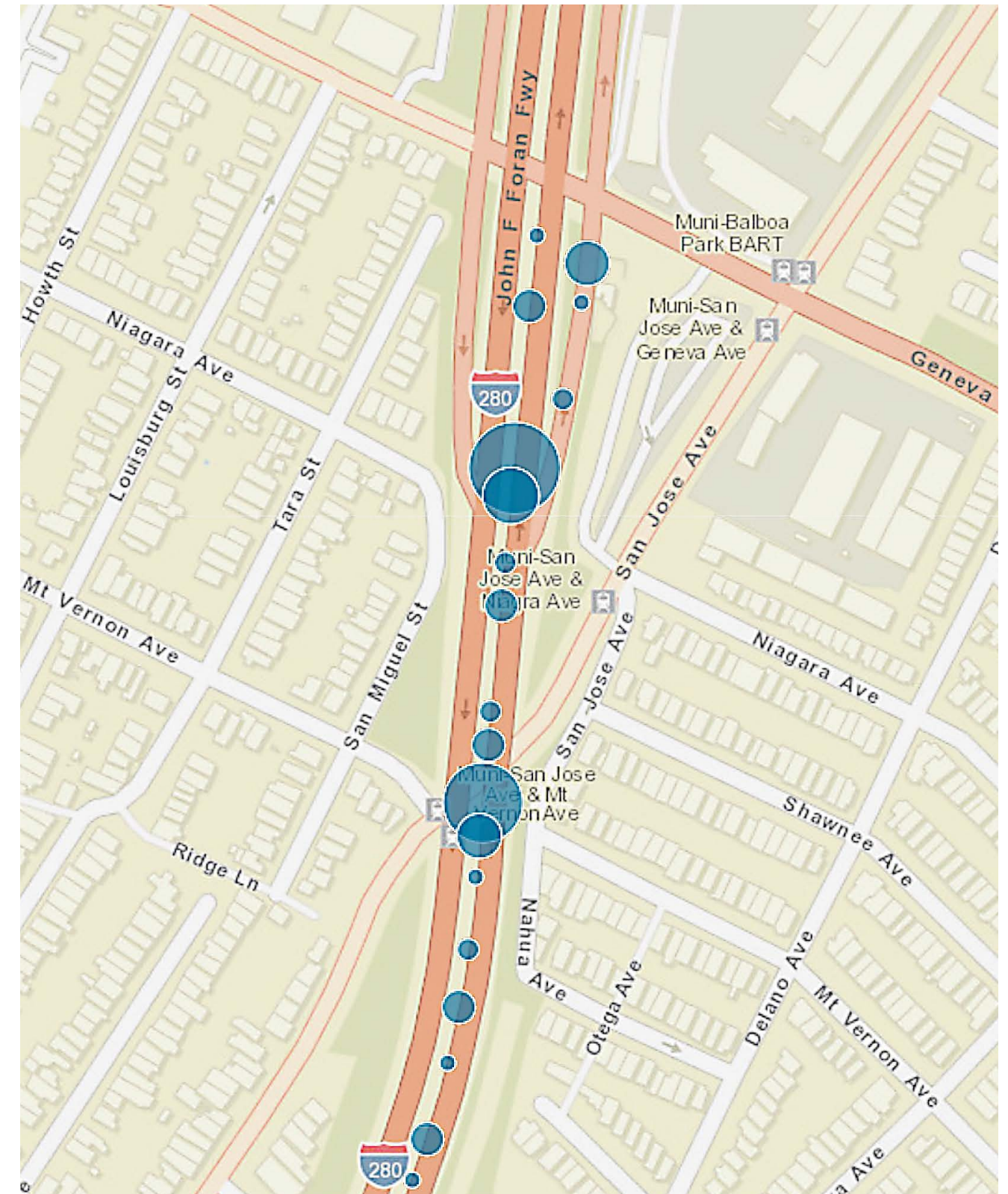
Geneva Avenue Crashes

Between 2016 and 2021, there were 44 crashes in total Geneva Avenue between the I-280 ramp intersections and San Jose Avenue. There were 26 crashes associated with the I-280 ramp intersections and 18 crashes west of or within the San Jose Avenue intersection.

Among the significant crash factors, there were:

- Eleven (11) pedestrian-involved collisions. Nine out of 11 crashes occurred when the pedestrian was in the crosswalk.
- One severe injury, seven visible injury, and 27 complaint of pain crashes.
- Drivers failing to observe traffic signals (34%), driving at an unsafe speed (16%), and failing to observe pedestrian right of way (14%) were the main PCFs.
- Broadside (41%), vehicle-pedestrian (20%), sideswipe (16%) and rear-end (14%) crashes were the most common collision types.

Figure 9. I-280 Northbound Collision Map, 2016 - 2021



Source: UC Berkeley SafeTREC Transportation Injury Mapping System (TIMS)

4. Project Area Deficiencies

This section summarizes some of the existing physical deficiencies leading to the operational and safety issues discussed in the prior section and references to current design standards in the current California Highway Design Manual (CA HDM 2020).

4.1 NORTHBOUND I-280 RAMP-INTERSECTION LAYOUT & CROSS-SECTION

The northbound off-ramp has northbound two lanes, a left turn lane and a shared left-through-right lane. To the right of the off-ramp, a BART station wall is between 5 feet and 7.5 feet away from the curb. To the left of the off-ramp, there is a 5-foot level embankment that transitions into a steep slope down to meet the mainline freeway.

BART tunnels are assumed to run under the off ramp, with BART having a sub-surface easement reaching the middle of the off ramp. Height of cover between the ramp and the tunnels is assumed at minimum 20 feet according to BART standards, with variance along the length of the ramp.

Among the issues identified during this analysis, the existing design is inconsistent with current CA HDM standards for:

Lane & Shoulder Widths

- A** The existing ramp lanes meet the CA HDM boldface standard of 12 feet width (504.3(1)(b)). However, the right and left ramp shoulders are not marked and when accounting for a 12-foot-wide lane, the resulting differences in some sections fall below the typical ramp shoulder width of 4 feet on the left and 8 feet on the right (CA HDM 504.3(1)(c)).

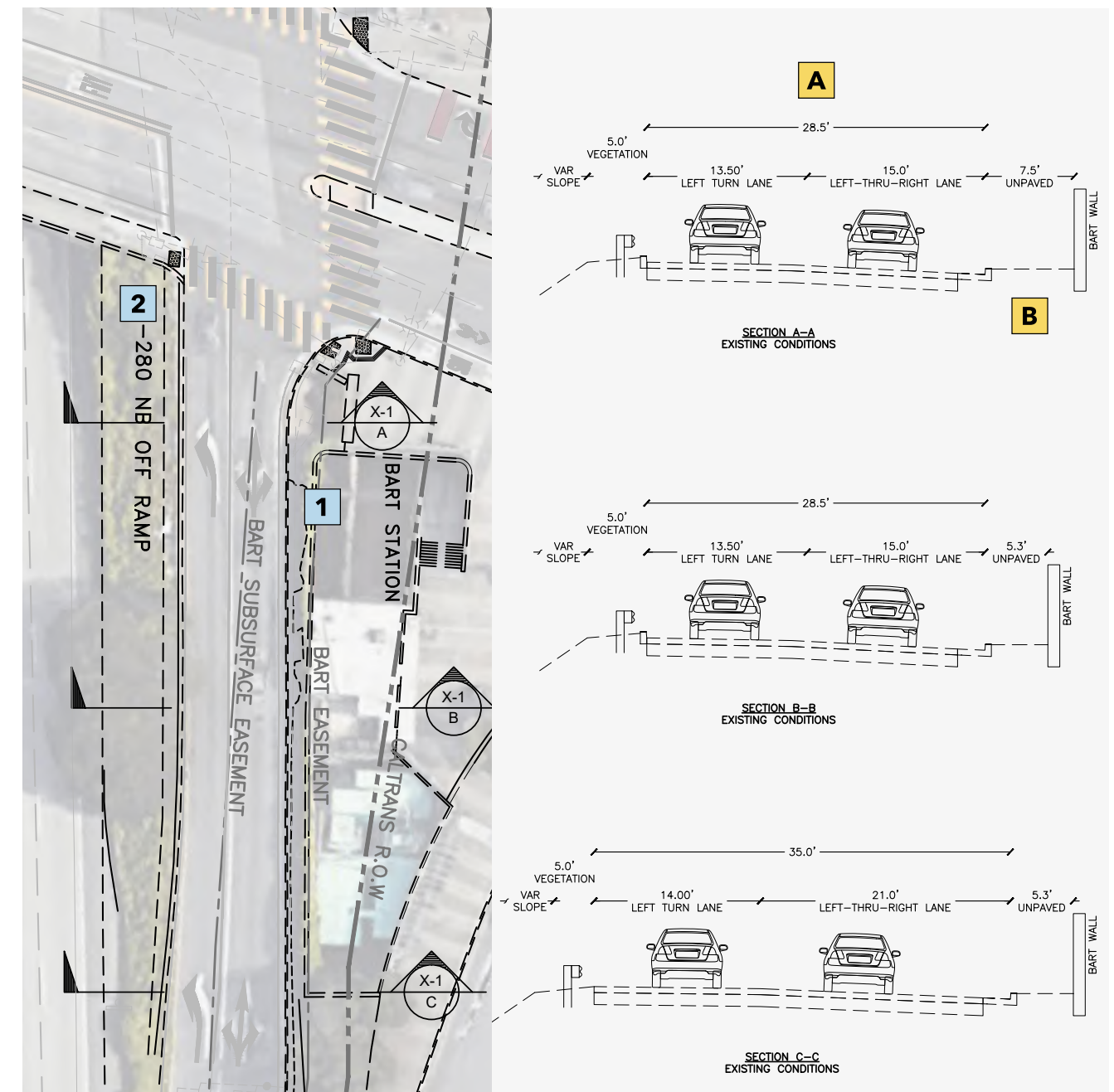
Curbs

- B** Curbs are generally discouraged at freeway ramps, with exceptions granted to provide separations from parallel local roads and to control drainage (504.3.(11)). The existing ramp curbs provide some protection from the crash barrier on the left and the BART station wall on the right.

Operational and behavioral issues associated with the existing design include:

- 1** The unpaved area between the curb and wall is regularly used by motorists dropping passengers off on the ramp.
- 2** The setback of the right lane at the Geneva Avenue approach combined with the bridge railing and overgrown ivy obstructs the visibility between eastbound vehicles and northbound right turning drivers, which reduces the efficiency of NB right turns on red. The SFCTA and SFMTA have reached out to Caltrans for landscape maintenance.

Figure 10. Existing Northbound I-280 Off-Ramp to Geneva Avenue Layout and Cross-Sections



Source: Parisi Transportation Consulting, 2022

4.2 NORTHBOUND I-280 MAINLINE-RAMP LAYOUT

The CA HDM recommends providing two-lane off-ramps when the estimated vehicle demand exceeds 1500 vehicles per hour (Section 504.3(6)). The existing northbound ramp vol is between 800 and 900 vehicles per hour (Figure 3), which suggests that there are design deficiencies and/or downstream impedances (e.g., congestion) that are resulting in the poor performance of the freeway ramp.

Among the issues identified during this analysis, the existing design does not meet the current CA HDM standards. Other ramps in San Francisco on I-280 similarly do not meet the current HDM standard due to the hilly terrain that results in compact designs like at Geneva Avenue.

Ramp Auxiliary Lanes

A According to CA HDM Section 504.3(6), two lane exits should be provided with an auxiliary lane approximately 1,300 feet long. The existing northbound I-280 / Geneva Avenue has no auxiliary lane (Figure 11). Instead, the ramp lanes transition directly into the I-280 northbound mainline lanes beneath the San Jose Avenue overcrossing where there are width and visibility constraints adjacent to the existing bridge abutment/wall.

As shown in Figure 12, CA HDM Figure 504.3K, the auxiliary lane allows for off-ramp queueing on a section parallel to the mainline highway. Drivers are afforded a distance to transition into the auxiliary lane if they wish to exit and traffic on the mainline lanes are able to recognize the queue and slow down to accommodate drivers making lane changes.

Under existing conditions without the auxiliary lane (Figure 11), the queue would extend directly into the mainline lanes and the likelihood of vehicle crashes would increase due to the abrupt change in vehicle speed and drivers needing to maneuver onto the ramp or away from the queue. The high share of rear-end crashes and sideswipe crashes in the ramp area appears to confirm this hypothesis (Section 3).

Ramp Diverge Length

B According to the CA HDM two-lane off-ramps should provide a paved gore section that is 270' long (Figure 12). The existing I-280 northbound off-ramp's paved gore section is shorter at approximately 180 feet long (Figure 11). Combined with the lack of an auxiliary lane, the short, paved gore section may also increase the likelihood of rear-end crashes and sideswipe crashes.



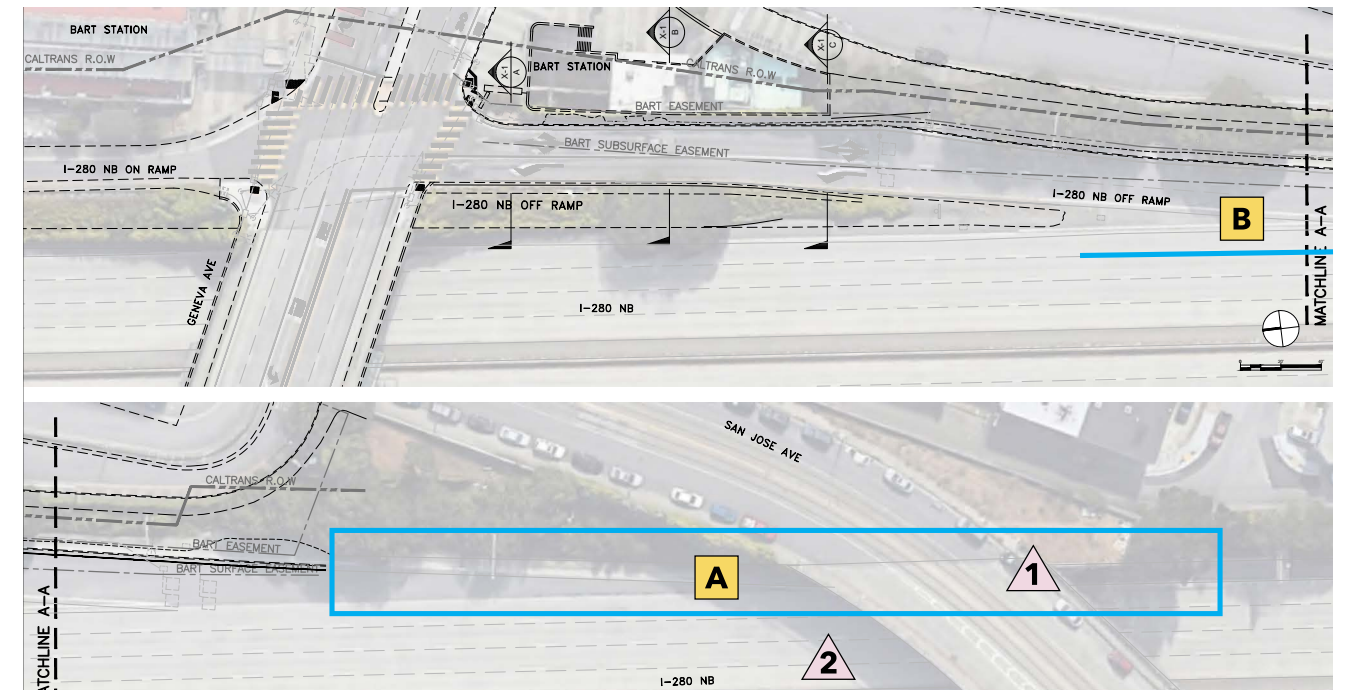
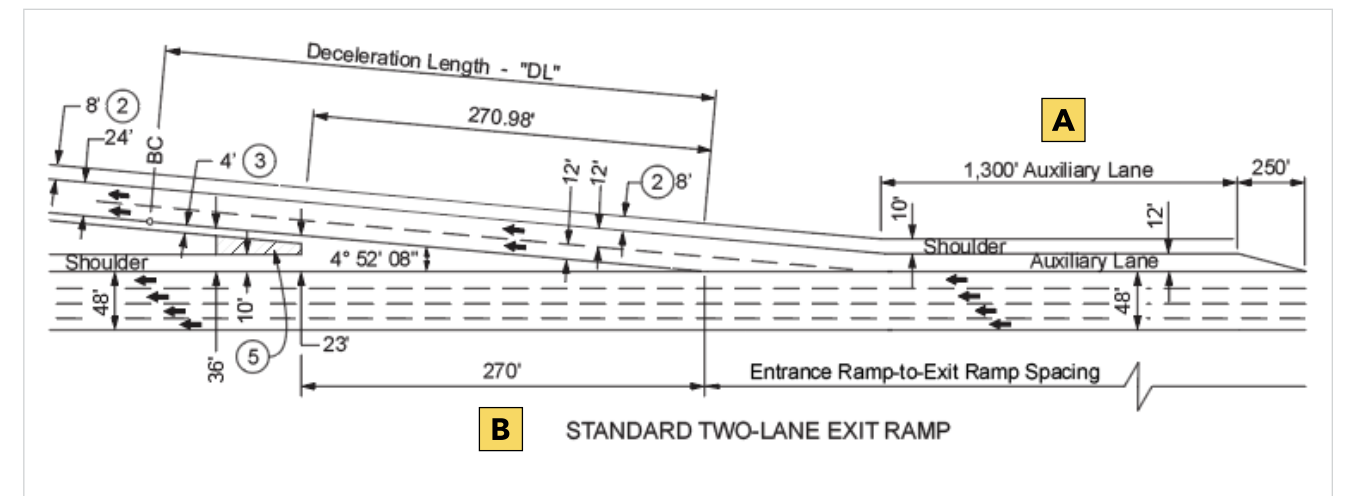
The existing physical constraints to adding an auxiliary lane and / or lengthening or widening the off-ramp are the retaining wall to the east (Figure 11, ) which contains the BART tunnel, and the highway barrier to the west (). Narrowing the freeway lanes and shoulders to below the CA HDM standard of 12 feet and 8 feet wide, respectively, would be subject to Caltrans approval of a design exception but may increase the likelihood of sideswipe crashes and crashes into the freeway barrier.

Figure 11. Existing I-280 Northbound / Geneva Avenue Off-Ramp Layout



Source: Parisi Transportation Consulting, 2022

Figure 12. Standard Two-Lane Exit Ramp



Source: California Highway Design Manual (2020) Figure 504.3K.

4.3 RAMP INTERSECTION LAYOUT

The Geneva Avenue bridge was constructed in 1964 alongside the Ocean Avenue and San Jose Avenue bridges. The deck measures 150 feet long and 82 feet wide. Bridge as-built plans indicate existing electrical and water utility lines running along the north side of the bridge and electrical service running across the west side of the bridge (Figure 13).

The intersection striping plan (Figure 14) reflects changes to the intersection geometry made in the last several years.

- A** Prior to 2016, Geneva Avenue was configured with two lanes in each direction. A fifth lane was added in 2016 by restriping narrower lanes to create a dedicated westbound left turn lane onto the southbound I-280 on-ramp. The eastbound Geneva Avenue approach retained the shared through-left lane.
- B** The leftmost westbound Geneva Avenue west of San Jose Avenue leads directly into the left turn lane and tends to experience high traffic demand during commute peak hours.
- C** Striping updates on Geneva Avenue in 2016 included a shared bus-taxi only and vehicle right turn lane for westbound Geneva traffic onto the northbound on-ramp. Drivers making the westbound right turn frequently maneuver around Muni buses stopped at the curbside bus stop.
- D** A pedestrian median refuge across Geneva Avenue and upgraded curb ramps were constructed on all four corners of the northbound ramp intersection in 2016.
- E** Upgraded curb ramps at the southbound ramp intersection have not yet been constructed.
- F** There are marked shoulders but no dedicated bicycle facilities on the Geneva Avenue bridge. There are shared lane markings approaching the Geneva Avenue bridge but very few people were observed riding bicycles in the area.

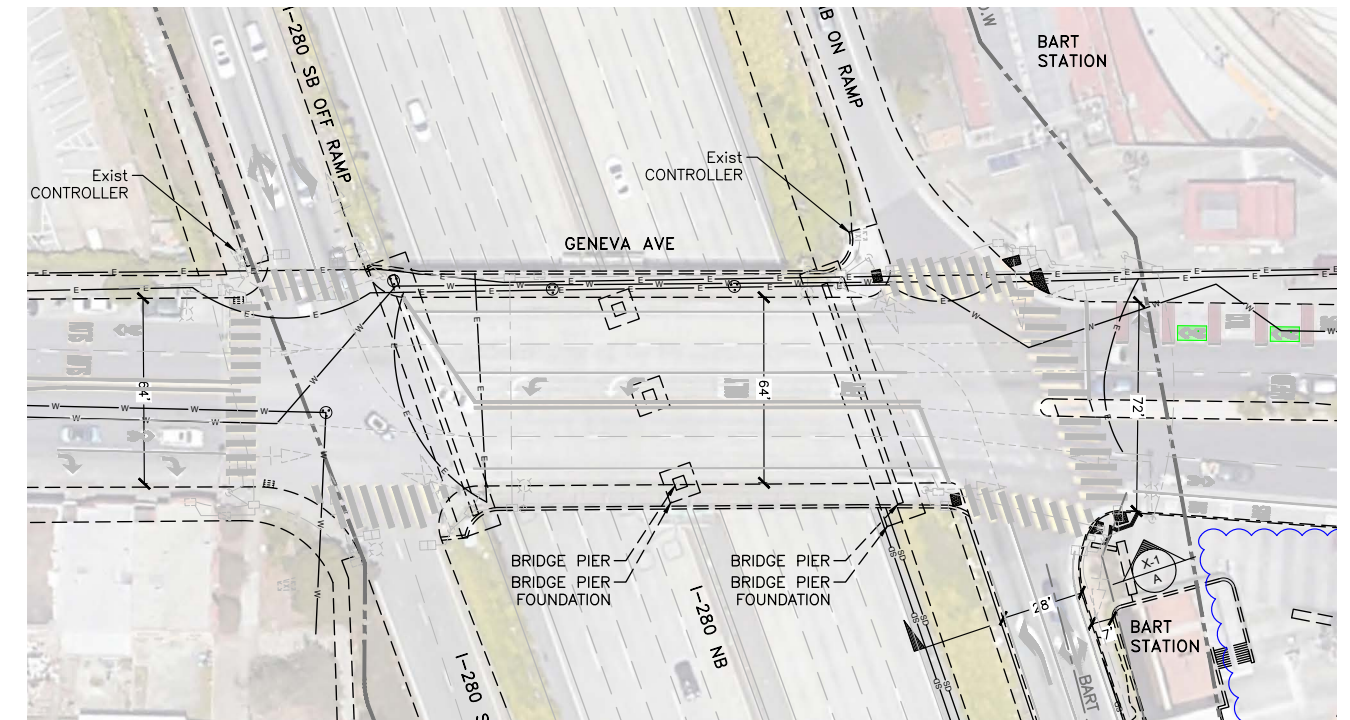
The distance between ramp intersections provides queuing space for between six and eight vehicles per lane. Queues on the bridge most typically occur for the westbound and eastbound left turn movements. When these queues extend back into the ramp intersection, they tend to obstruct left turns from the freeway ramp approaches; this situation can be mitigated by changes to the traffic signal phasing order (see next section 4.4).



Westbound queued vehicles block northbound off-ramp left turns.

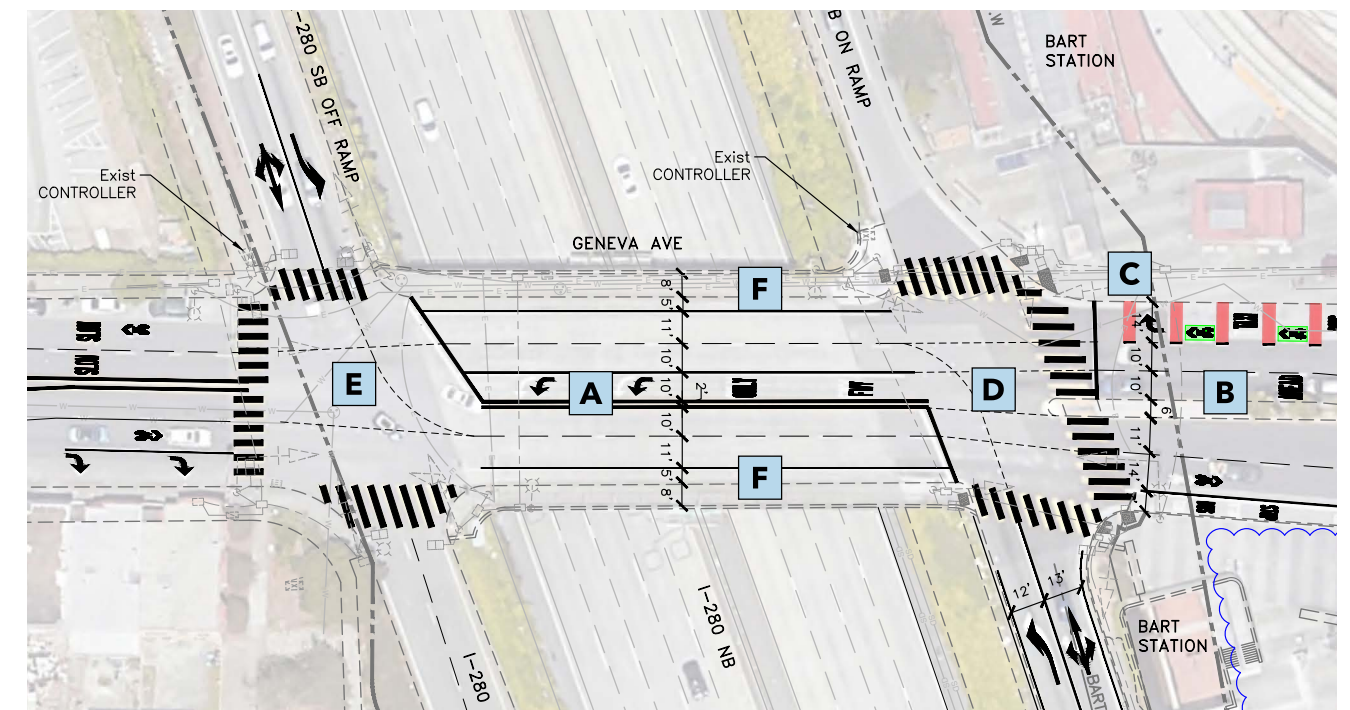
Source: SFCTA: 2021

Figure 13. Existing I-280 / Geneva Avenue Utility Plan



Source: Parisi Transportation Consulting, 2022; Caltrans as-built drawings

Figure 14. Existing I-280 / Geneva Avenue Pavement Delineation Plan



Source: Parisi Transportation Consulting, 2022

4.4 TRAFFIC SIGNAL SYSTEMS

Caltrans operates the existing traffic signal systems at the Geneva Avenue / northbound and southbound ramp intersections. Although they have two separate controllers, the signals are programmed to act as a cohesive system (i.e., the signals are coordinated). The nearby Geneva Avenue / San Jose Avenue intersection is operated by the SFMTA and uses a clock-based time offset to coordinate movements along Geneva Avenue.

The pedestrian signal equipment at the ramp intersections generally meets current design standards. Accessible pedestrian signals (APS) that include audible indicators and tactile push buttons were installed in 2022 at both intersections. The pedestrian signal heads are the standard countdown type.

However, there are several deficiencies at the ramp intersection signals that reduce the system efficiency. Areas where the signal systems fail to meet current design standards include:

A. Poor Signal Visibility

- A1** The left turn signals for westbound Geneva at the southbound ramp intersection and eastbound Geneva at the northbound ramp intersection should be upgraded to new, longer mast arm poles that would position one signal heads over the left turn lane.
- A2** The signals for eastbound Geneva at the southbound ramp intersection and westbound Geneva at the northbound ramp intersection should be upgraded from post-mounted poles to mast arm poles that would position at least one signal head in line with the approach lanes.
- A3** The signals for the I-280 off-ramp approaches should be upgraded to mast arm poles to provide better signal visibility due to the crest vertical curve at the intersection and obstructions by large vehicles.

B. Inadequate Lighting Coverage

Lighting coverage is a function of several factors that include luminaire position, mast arm length, height, and brightness.

- B1** The southbound ramp intersection appears to have adequate lighting coverage with luminaires on each of the four corners and across all three crosswalks.
- B2** The northbound ramp intersection appears to have inadequate lighting coverage with luminaires on only two of the corners and across one crosswalk.

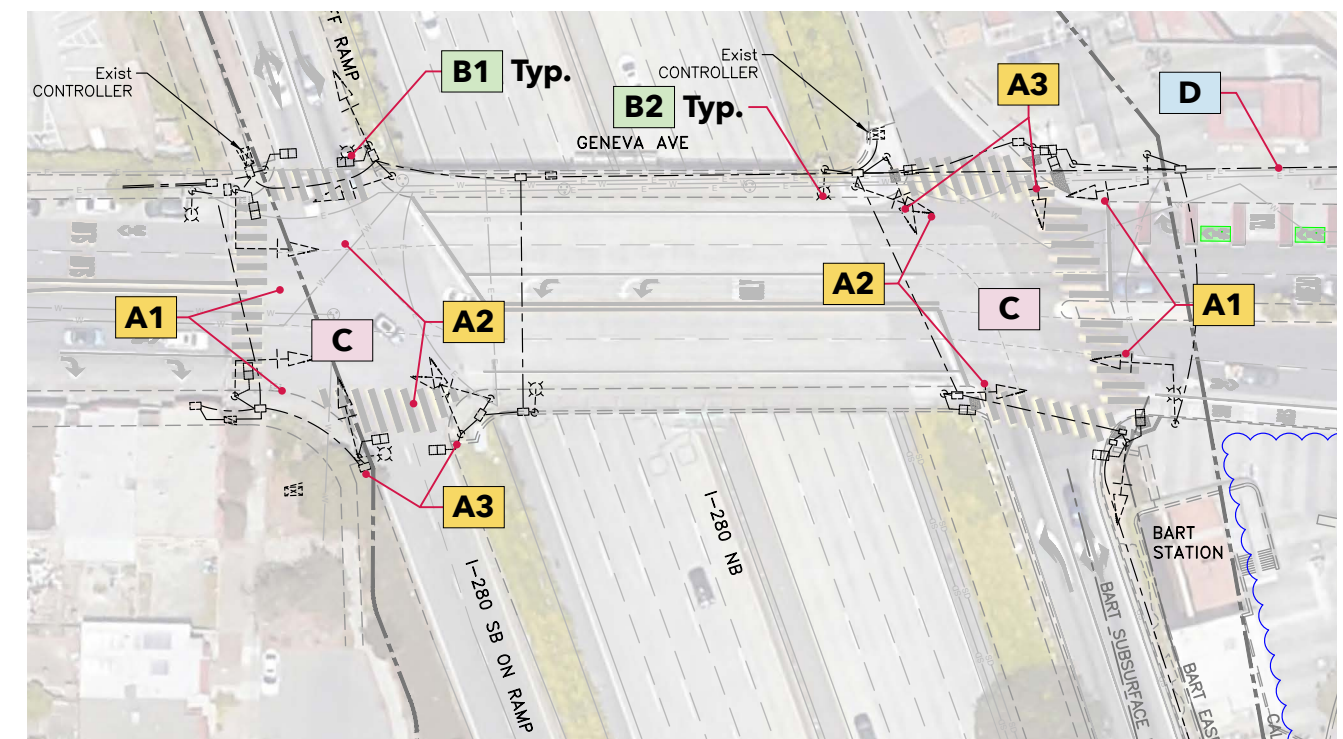
C. Lack of Vehicle Detection Equipment

- C** Both ramp intersection signals operate with pretimed signal timings (i.e., each approach receives a consistent length of green light every cycle), and the pedestrian signal phases are active every signal cycle (i.e., recall). The ramp intersection signal systems do not have active vehicle detection equipment, which are typically video cameras or inductive loops. Inductive loops in the northbound off-ramp lanes do not appear to be active. As such, the traffic signal is unable to reallocate signal time from low-demand movements to higher demand movements, resulting in some instances when there is no traffic passing through the intersection. The traffic demand on Geneva Avenue varies throughout the day and pretimed operations may result in system inefficiency.

D. Lack of Signal Controller Interconnect Equipment

- D** Modern signal controllers have the ability to modify their timings to account for traffic movements between multiple intersections and potential disruptions, e.g., LRT preemptions. A data connection, typically a wired or fiber-optic cable connection, allows for reliable communication. and will help coordinate signals, especially in instances of LRT preemption events. Maintenance responsibility for the interconnect equipment would be subject to a maintenance agreement between the SFMTA and Caltrans.

Figure 15. Existing I-280 / Geneva Avenue Traffic Signal System Plan



Source: Parisi Transportation Consulting, 2022

4.5 TRAFFIC SIGNAL OPERATIONS

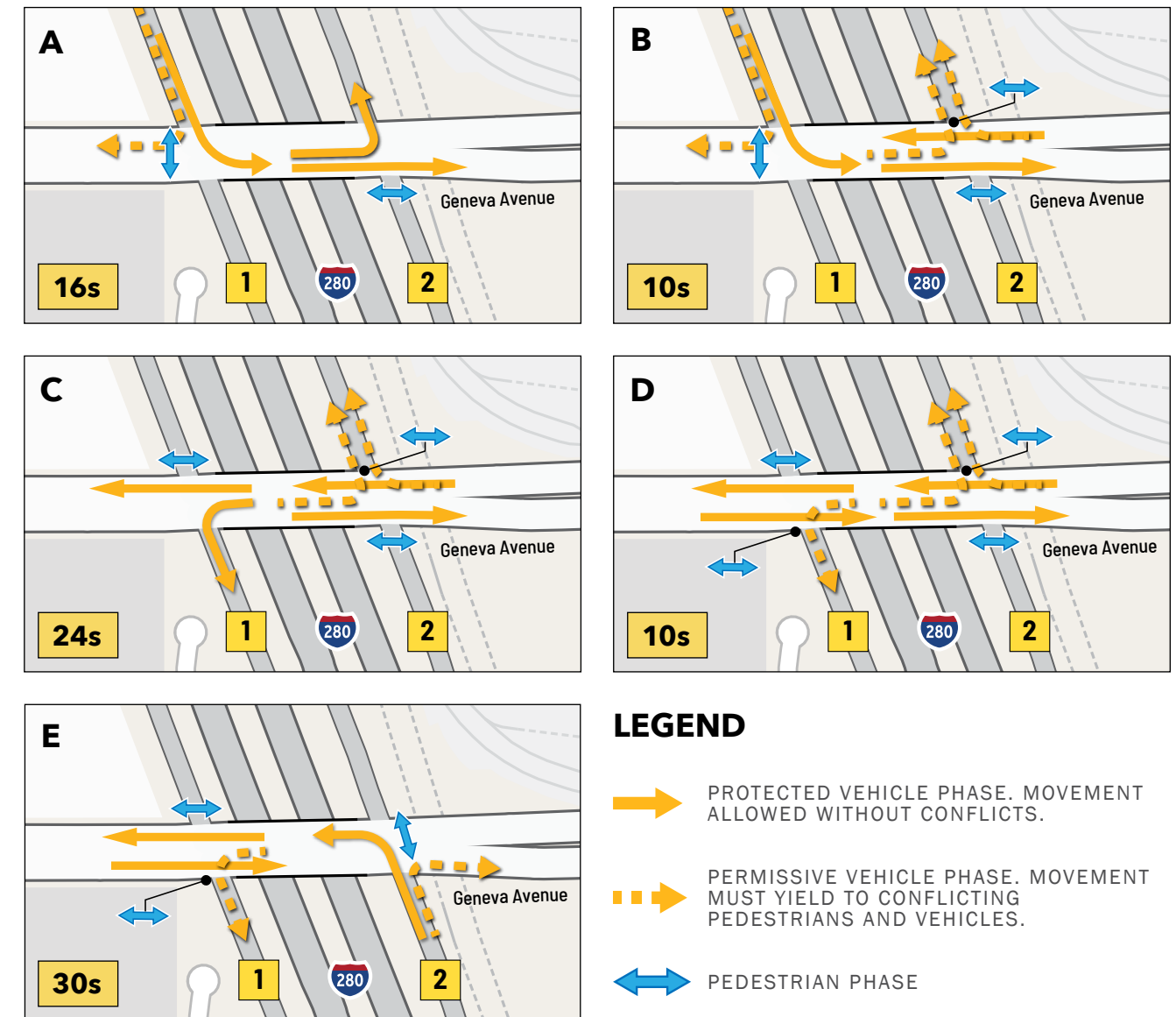
Prior to this study initiating in late 2021, the ramp intersection signals operated with one timing and phasing plan throughout the day. Caltrans has since implemented a modified signal phasing plan for the afternoon commute peak hour to address issues raised by this study. The following section contains a description of each plan and a discussion of the potential deficiencies and opportunities for improvement.

4.5.1 Existing AM, Midday and Off-Peak Signal Phasing Plan

This traffic signal phasing plan is currently in effect outside of the afternoon commute peak. Operational issues associated with this phasing and timing plan are noted in underline.

PH. 1 SOUTHBOUND RAMP INTERSECTION	2 NORTHBOUND RAMP INTERSECTION
A Off-ramp traffic gets the green phase	Eastbound left turn and through traffic gets the green phase.
B Off-ramp traffic continues	Eastbound left turn arrow terminates but is allowed as a permissive turn (green ball). Eastbound through traffic continues. Westbound through traffic gets the green phase.
C Westbound left turn and through traffic gets the green phase.	Eastbound and westbound through traffic continue.
D Westbound left turn arrow terminates but is allowed as a permissive turn (green ball). Westbound through traffic continues. Eastbound through traffic gets the green phase. <u>Westbound left turning traffic often enters on red and violate the pedestrian right of way.</u>	Eastbound and westbound through traffic continue. <u>This phase is too short to offer adequate progression for eastbound traffic to clear both intersections.</u>
E Eastbound and westbound through traffic continue. <u>Residual westbound left turn queues block traffic from the northbound ramp intersection.</u>	Off-ramp traffic gets the green phase. <u>Residual queues at the southbound ramp intersection block northbound left turns.</u>

Figure 16. Non-PM Peak Phasing Plan



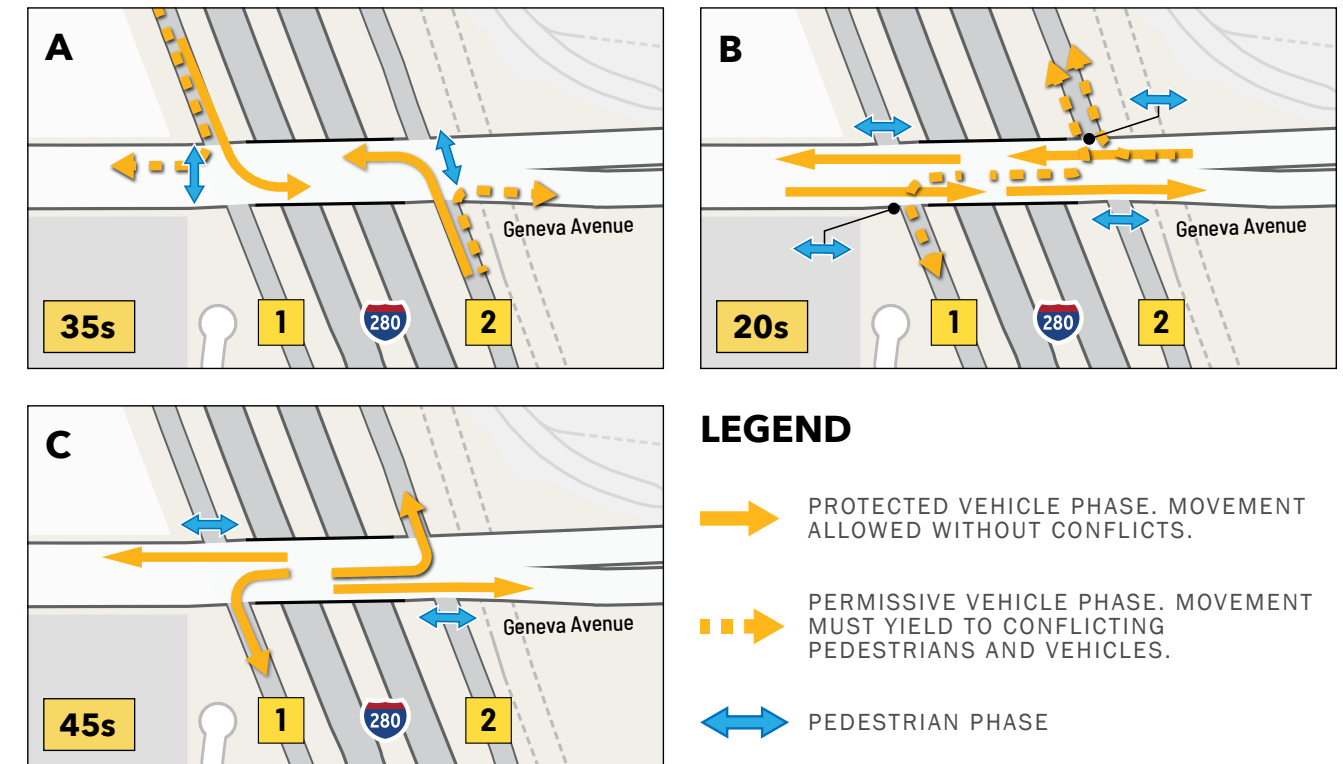
Map data from OpenStreetMap.

4.5.2 Existing PM Commute Peak Hour Signal Phasing Plan

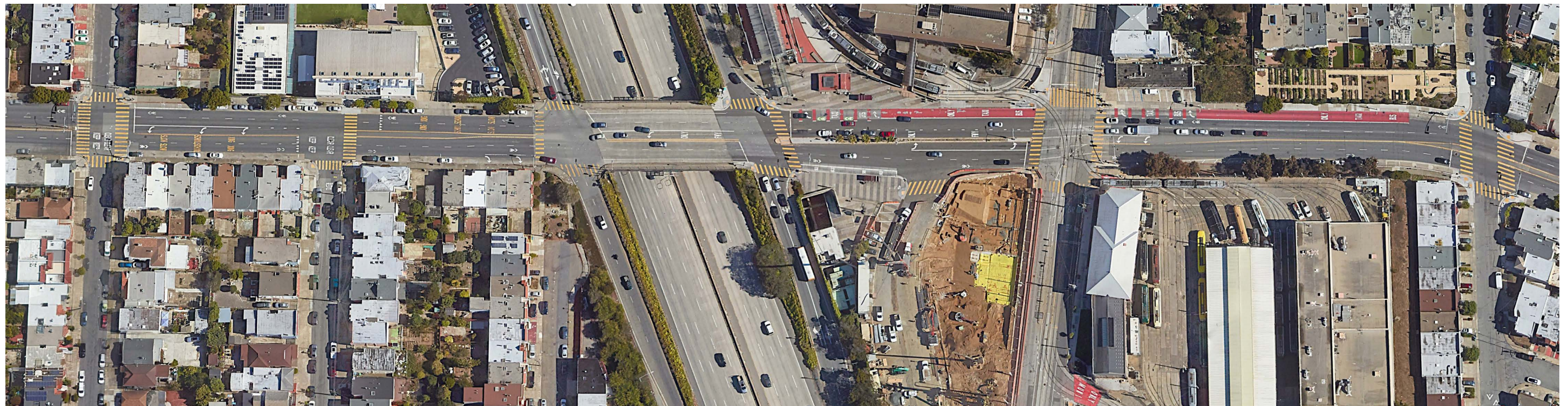
This traffic signal phasing plan was implemented by Caltrans during mid 2022 for the afternoon commute peak to address the intermodal conflict issues raised by this study (3.3). This phasing plan largely mitigates the issues identified for the non-PM peak signal phasing plan (4.5.1), as noted in underline. The project team, including Caltrans and SFMTA, implemented this phasing plan in August 2023 and took new traffic counts. Please see Appendix A for a post-implementation analysis. The new phasing plan improved pedestrian safety by fixing a pedestrian crossing conflict at the southbound on-ramp intersection.

PH. 1 SOUTHBOUND RAMP INTERSECTION	2 NORTHBOUND RAMP INTERSECTION
<p>A Off-ramp traffic gets the green phase. Vehicles are able to queue in the empty lanes.</p>	<p>Off-ramp traffic gets the green phase. Vehicles are able to queue in the empty lanes.</p>
<p>B Eastbound and westbound through traffic gets the green phase. Westbound left turns are allowed as a permissive turn (green ball). Vehicles can clear both intersections.</p>	<p>Eastbound and westbound through traffic gets the green phase. Eastbound left turns are allowed as a permissive turn (green ball). Vehicles can clear both NB off ramp and SB on ramp intersections.</p>
<p>C Westbound left turn and through traffic gets the green phase. Queues between ramp intersections are cleared by the end of the signal phase.</p>	<p>Eastbound left turn and through traffic gets the green phase. Queues between ramp intersections are cleared by the end of the signal phase.</p>

Figure 17. PM Peak Phasing Plan.



Map data from OpenStreetMap.



Geneva Avenue From Howth Street To Delano Avenue.

Source: Google Earth

5. Potential Improvement Measures

The following section presents near- and mid-term concepts that would address the operational and physical deficiencies of the project study area.

5.1 NEAR-TERM ACTIONS / AREAS FOR FURTHER STUDY

Improvements undertaken by Caltrans since this study's inception are (1) modified signal timing to lagging left on westbound Geneva Ave turn operations during the PM commute peak and (2) an outstanding request for landscape maintenance at the southwest corner of the northbound off-ramp intersection.

Other potential near-term changes under consideration are listed below along with a summary of the concept benefits, tradeoffs, fulfillment of project goals, and status. Near-term actions could be implemented within two years.

5.1.1 Modify the Signal Phasing & Timing to Provide Lagging Left Turns During Other Parts of the Day

- 1. Benefits:** Improves pedestrian safety, reduces driver red light violations, and improves intersection operations.
- 2. Tradeoffs:** If the relative share of signal time remains equal for each phase, there should be marginal negative effect on traffic operations.
- 3. Goals supported:** Pedestrian and traffic safety, improved intersection operations.
- 4. Status:** The project team, including Caltrans and SFMTA, implemented this phasing plan in August 2023 and took new traffic counts. Please see Appendix A for a post-implementation analysis.

5.1.2 Program a Much Longer Signal Cycle Time

- 1. Benefits:** Benefits major street (e.g., Geneva Avenue) traffic progression across long blocks.
- 2. Tradeoffs:** Improved major street operations are typically at the expense of the minor-streets (e.g., I-280 off-ramps). Long cycle times tend to result in larger vehicle headways, i.e., lower vehicle density, later in the phase, which undermines some of the efficiencies gained with less lost time.¹
- 3. Goals supported:** Improved arterial traffic operations along Geneva Avenue for Muni bus service.
- 4. Status:** Under evaluation by SFCTA and SFMTA.

[Inset A on this page](#) presents the model forecast results based on the actions described in Sections 5.1.1 and 5.1.2.

NOTE: Section 5.4 discusses other near-term concepts that were evaluated but not recommended for further consideration due to their significant tradeoffs or conflicts with existing Transit-First and Vision Zero policies. These include:

1. Constructing a dual northbound right turn lane,
2. Removing the crosswalk across Geneva Avenue at the northbound ramp intersection,
3. Programming a dedicated pedestrian-only crossing phase, and
4. Modifying the LRT preemption to prioritize Geneva Avenue traffic.

¹ National Cooperative Highway Research Program (NCHRP, 2015) Signal Timing Manual, 2nd Edition. Section 5.2.4.

Table 4. Summary of additional performance metrics for the near-term concepts under evaluation.

CRITERIA	CONCEPT	
	PROGRAM LAGGING LEFT TURN PHASE TO OTHER TIMES OF DAY	PROGRAM A LONGER SIGNAL CYCLE TIME
Conformance to design standards (CA HDM & CA MUTCD, SFMTA)	Conforms to standards.	Conforms to standards.
Impacts to Caltrans, BART and Muni facilities	Improved traffic progression and reduced queueing along Geneva Avenue.	Mild benefit to bus stops and delay on Geneva Ave.
Environmental, regulatory, and right of way impacts	No impacts.	No impacts.
Planning-level cost estimate	N/A – Part of agency operations.	N/A – Part of agency operations.
Construction feasibility and staging	No impacts.	No impacts.
Risks and issues / potential mitigation	Requires continued monitoring for traffic queues and delay.	Requires continued monitoring for traffic queues and delay.

INSET A: FORECAST MODEL RESULTS, MODIFIED SIGNAL PHASING AND TIMING (5.1.1/5.1.2)

This section presents a comparison between peak hour traffic models created in SimTraffic 11 software (Trafficware). The existing conditions model reflects the Nov/Dec 2021 traffic counts and the existing traffic signal phasing and timing. The "Existing plus Project" model uses the same traffic counts, lagging left turn signal phasing as described above (5.1.1), and a signal cycle time (existing 90s, modified 95s). The existing and "Existing plus Project" SimTraffic models simulate individual vehicle movements across one continuous hour; the results of three model runs are averaged to produce vehicle delay and queuing results.

The SimTraffic model forecasts the following changes to AM and PM peak hour delay and queuing:

DELAY	% CHANGE W/ PROJECT		AVG QUEUE	% CHANGE W/ PROJECT		95%ILE QUEUE	% CHANGE W/ PROJECT	
	AM	PM		AM	PM		AM	PM
280 NB Ramp	17%	-3%	280 NB Ramp	11%	-17%	280 NB Ramp	16%	-11%
280 SB Ramp	-50%	-81%	280 SB Ramp	-30%	-72%	280 SB Ramp	-28%	-73%
EB Geneva	-13%	29%	EB Geneva	-29%	6%	EB Geneva	-22%	-12%
WB Geneva	-62%	-60%	WB Geneva	-40%	-31%	WB Geneva	-5%	-11%
Network Avg	-41%	-54%						

According to the model, nearly all approaches will experience less delay and shorter queues with the modified signal phasing and timing. On average, delay will decrease by between 40 and 55% and average queues will decrease by between 35 and 70%. The two exceptions are the I-280 Northbound ramp during the AM peak hour and eastbound Geneva Avenue during the PM peak hour.

5.2 MID-TERM PROJECT CONCEPT – SIGNAL SYSTEM UPGRADE

Mid-term actions could be implemented within the next 5 - 10 years. The existing traffic signal system at the I-280/Geneva Avenue ramp intersections should be upgraded to add overhead signal heads mounted on mast arm poles and vehicle detection equipment to adjust to vehicle demand. The redesigned signal may include elements of Intelligent Transportation Systems (ITS) that allow the signal controller to adjust the phase times to respond to traffic demand.

A preliminary geotechnical analysis indicates that the subsoils in the area are dense sand. A more detailed geotechnical analysis would need to be conducted to determine the potential interactions between new traffic signal pole foundations and existing slope and retaining walls.

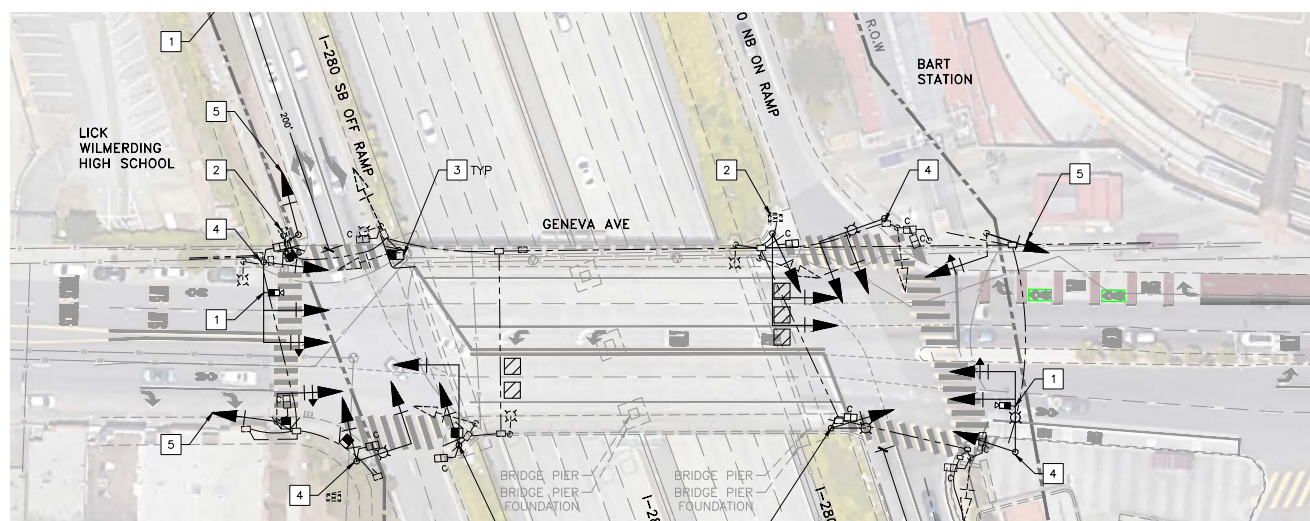
The list below summarizes the concept benefits, tradeoffs, fulfillment of project goals, and status.

1. **Benefits:** Improves visibility of traffic signals to drivers, improves nighttime lighting levels, and improves intersection operations by allowing actuated (i.e., demand responsive) signal operations.
2. **Tradeoffs:** Temporary adverse effects on operations during construction.
3. **Goals supported:** Pedestrian and driver safety, improved intersection operations, improved Muni transit operations.
4. **Status:** Requires initiating the project study report - project development support (PSR-PDS) project initiation document (PID) with Caltrans. The PSR-PDS is required by Caltrans to document the project purpose and need, scope, and schedule for the project. A detailed design process that produces plans, specifications, and cost estimates (PS&E) and finding funding would follow.

Additional considerations are summarized below.

CRITERIA	TRAFFIC SIGNAL SYSTEM UPGRADE
Traffic analysis results	Lowered delay and improved operations with actuated signal operations.
Conformance to design standards (CA HDM & CA MUTCD, SFMTA)	Traffic signal upgrades will bring the traffic signal system into conformance with current design standards.
Impacts to Caltrans, BART and Muni facilities	Work will occur solely within Caltrans right of way. Work may need to be coordinated with BART to identify and mitigate potential impact to BART underground facilities.
Environmental, regulatory, and right of way impacts	Signal work that is not capacity inducing may be categorically exempt from CEQA.
Planning-level cost estimate	\$175K for project study (PSR/PDS). \$500K for design (PS&E). \$3.5 - 5 million for construction depending on the number of traffic signals and street lights to be upgraded at both ramp intersections. Construction estimate includes 30% contingency.
Construction feasibility and staging	Traffic signal work will require traffic lane closures on Geneva Avenue. Work may be limited to nighttime hours to minimize negative impacts to Muni.
Risks and issues / potential mitigation	Future pole foundations will need geotechnical evaluation due to existing slopes and bridge abutment walls.

Figure 18. Improvement Concept, Upgrade Traffic Signal System
Solid arrows indicate new signal equipment.



Source: Parisi Transportation Consulting, 2022

Photo 1: Existing short mast-arm poles at Geneva Ave. / I-280 northbound Ramps. (Source: Parisi, 2022)



Photo 2: Example of signals on a mast-arm pole aligned to the vehicle lane. (Source: Parisi, 2022)



5.3 MID-TERM LANE LENGTHENING STUDY

The project team is also considering a mid-term study focusing specifically on the lengthening of the off-ramp exit lane to provide additional storage capacity for vehicles exiting the I-280 northbound freeway. Lengthening the existing two-lane exit ramp would potentially reduce the frequency and severity of rear-end and sideswipe collisions in the project study area. The study can also examine how far south of Geneva Avenue to extend the exit lane, particularly with the San Jose Avenue Bridge as a pinch point. Lengthening can also be accomplished by using the shoulder and possibly be combined with narrowing the existing travel lanes on the mainline without affecting the existing highway barrier on the left and the retaining wall and BART tunnel to the right. Narrowing lanes would slow traffic speeds through the area, an identified crash factor. This proposal for non-standard travel lane and shoulder widths would be subject to a design exception from Caltrans headquarters.

The mid-term study can evaluate the potential to include dynamic highway ITS signage to manage speeds. The study can also address the mainline freeway's various design deficiencies resulting from the hilly terrain, inadequate width, and horizontal curves that limit sight distances. Another factor is the BART tunnel right-of-way and how it may affect the project. The findings from this study can help prepare the project for the Caltrans preliminary engineering and environmental phase. This step is necessary before the project can receive Caltrans approval to proceed to design and construction phases.

The list below summarizes the benefits, tradeoffs, fulfillment of project goals, and status.

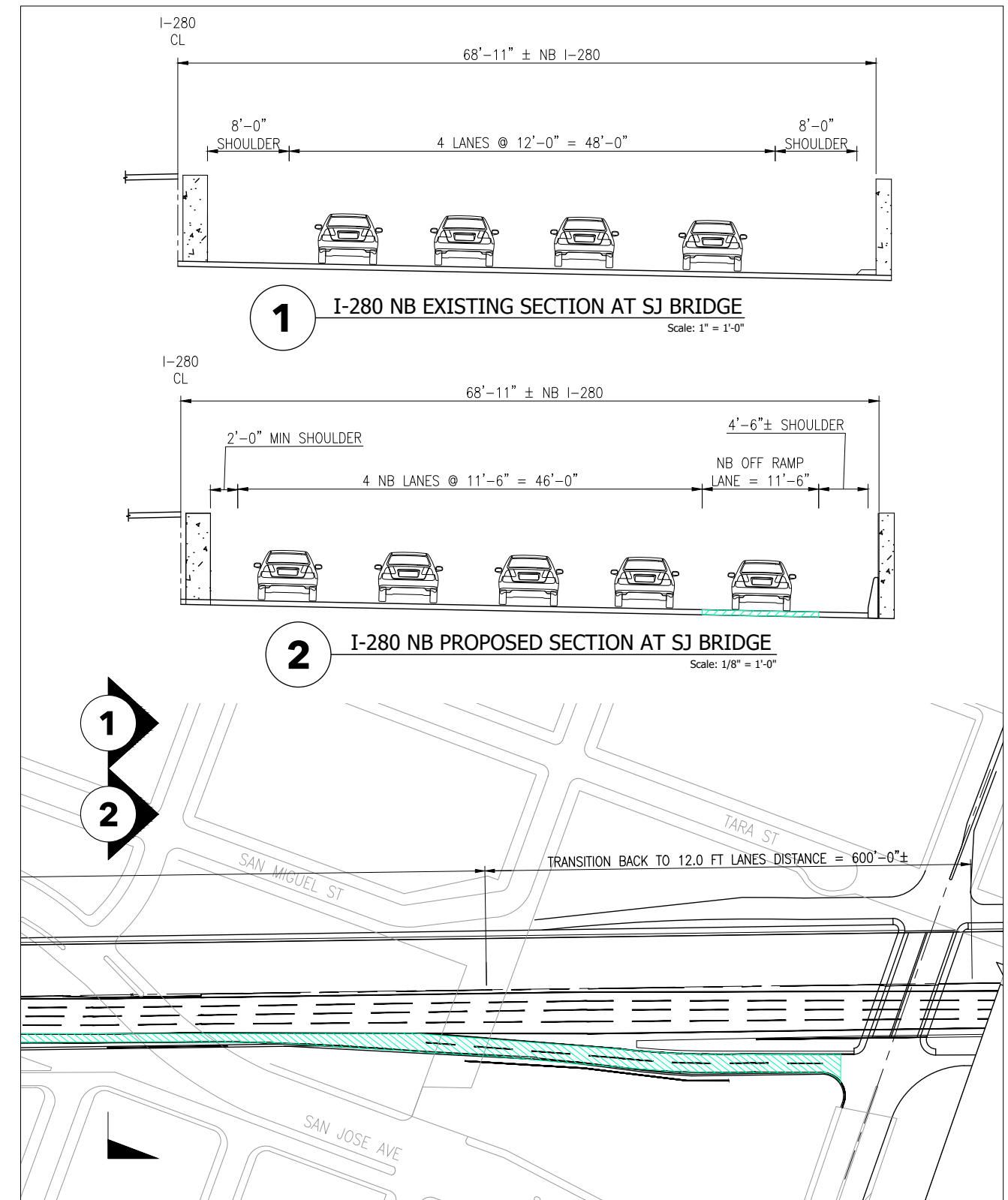
1. **Benefits:** Improves overall traffic safety / speed reduction and potentially reduces crash severity.
2. **Tradeoffs:** Potential increase in crashes associated with narrow traffic lanes, e.g., sideswipe crashes.
3. **Goals supported:** Traffic safety and improved operations.
4. **Status:** Requires initiating the PSR-PDS, PID, and Design Standard Decision Document (DSDD) with Caltrans. Requires identifying funding for the design and construction phase.

Additional considerations are summarized below.

CRITERIA	LENGTHEN NORTHBOUND I-280 EXIT LANE
Traffic analysis results	Subject to further study during the PSR-PDS process.
Conformance to design standards (CA HDM & CA MUTCD, SFMTA)	Require additional analysis for two-lane exit ramp lengthening. Narrowing lane would not conform to CA HDM standards for freeway lane widths (504.3(1)(b)).
Impacts to Caltrans, BART and Muni facilities	Operational impacts to the highway and ramp during construction. No effect on BART and Muni facilities.
Environmental, regulatory, and right of way impacts	Lengthening lanes less than one mile long are listed as a project type not likely to lead to a measurable and substantial increase in vehicle miles traveled (VMT). ²
Planning-level cost estimate	\$150K for mid-term study. \$275K for PSR/PDS
Risks and issues / potential mitigation	Design may not be approved by Caltrans HQ for a design exception. Issue to be addressed during the PSR/PDS process. Challenges with proximity to BART Right-of-Way.

² Office of Planning & Research, Technical Advisory on Evaluating Transportation Impacts in CEQA (Dec. 2018), 20-21.

Figure 19. Improvement Concept, Add an Auxiliary Lane to Northbound I-280 by Narrowing Lanes



Source: ConnectSF / MSA Design & Consulting, 2020.

5.4 CONCEPTS NOT RECOMMENDED FOR FURTHER CONSIDERATION

The list below summarizes project concepts raised during this study but that have significant tradeoffs or conflicts with existing plans and policies.

5.4.1 Construct a Dual Northbound Right Turn Lane

This proposal would allow right turns from the left and right lanes with the existing two-lane ramp or from the center and right lanes with a widened three lane northbound off-ramp (5.3.2). Drivers would be expected to yield if there are people in the crosswalk.

According to the CA HDM, "If there is a pedestrian crossing on the receiving leg of multiple right-turn-only lanes, the intersection should be controlled by a pedestrian signal head, or geometrically designed such that pedestrians cross only one turning lane at a time." (CA HDM 403.6). Although the crossing is controlled by a pedestrian signal, allowing right turns from two lanes is not recommended because this would create a multiple-threat situation without an exclusive pedestrian crossing phase

Current SFMTA direction does not allow dual right turns except in unique circumstances..

1. **Benefits:** Reduces northbound ramp delay and queues.
2. **Tradeoffs:** Worsens pedestrian safety.
3. **Goals supported:** Improved traffic operations from the northbound off-ramp.
4. **Status:** Not recommended for further study.

5.4.2 Remove The Crosswalk Across Geneva Avenue at the Northbound Ramp Intersection

This proposal would remove the marked crosswalk across Geneva Avenue at the NB off-ramp intersection. People walking would be directed to use the underground BART station to travel between the two sides of Geneva Avenue. Drivers would benefit from greater vehicle capacity during the northbound signal phase.

This proposal would increase the difficulty of crossing Geneva Avenue on foot for the benefit of drivers, which runs contrary to the City's Vision Zero and SFMTA Strategic Plan to increase the number of walking trips and build safer, better streets for people walking.

1. **Benefits:** Reduces northbound ramp delay and queues.
2. **Tradeoffs:** Worsens the pedestrian experience on Geneva Avenue. Increases the likelihood of people crossing on foot outside of a marked crosswalk.
3. **Goals supported:** Improved traffic operations from the northbound off-ramp.
4. **Status:** Not recommended for further study.

5.4.3 Program a Dedicated Pedestrian-Only Crossing Phase

1. **Benefits:** Improves pedestrian safety.
2. **Tradeoffs:** Increased (worsened) vehicle stops and delay. Evaluated and found to be unsuitable for the Geneva / San Jose intersection due to increased pedestrian delay, increased transit delay, and incompatibility with coordinated signal operations along Geneva Avenue.³

3. **Goals supported:** Pedestrian safety.
4. **Status:** Not recommended for further study.

5.4.4 Modify The LRT Preemption to Prioritize Geneva Avenue Traffic

This proposal would begin the LRT preemption event at the end of the eastbound and westbound Geneva Avenue signal phase, and then return to the eastbound and westbound Geneva signal phase. Geneva Avenue traffic, including Muni buses, would benefit from lower traffic delay. Traffic on San Jose Avenue, including Muni LRTs, would suffer from greater delay and increased queues.

1. **Benefits:** Reduces vehicle delay and queues along Geneva Avenue.
2. **Tradeoffs:** Increases vehicle delay and queues on San Jose Avenue. Worsens Muni LRT operations.
3. **Goals supported:** Improved traffic operations from the northbound off-ramp.
4. **Status:** Not recommended for further study.

5.5 TRAVEL DEMAND MANAGEMENT STRATEGIES

The list below summarizes management strategies to reduce vehicle demand at the Geneva Avenue ramp intersections.

5.5.1 Travel Demand Management at Major Vehicle Trip Generators

This proposal would implement travel demand management strategies at major trip generators in the study area, e.g., City College of San Francisco, Lick Wilmerding High School, and the Cow Palace, to reduce vehicle demand at peak times.

1. **Benefits:** Reduces vehicle demand during peak periods
2. **Tradeoffs:** Requires regular monitoring for to ensure effectiveness. Drivers may adjust their behavior to take advantage of the extra capacity.
3. **Goals supported:** Improved operations.
4. **Status:** May be included in travel demand management strategies when major trip generators are subject to revisions to their use permits.

5.5.2 Managed Drop-Off and Pick-Up Operations at BART and Muni Stations

This proposal would use traffic control officers or station area ambassadors to direct drivers to use designated drop-off and pick-up zones rather than curbside areas on the off-ramp and bus stop areas on Geneva Avenue.

1. **Benefits:** Improves Muni operations at curbside stops. Improves intersection operations.
2. **Tradeoffs:** Requires regular enforcement to ensure driver and passenger compliance.
3. **Goals supported:** Improved operations.
4. **Status:** May be incorporated into a Balboa Park Station area travel demand management strategy and operational plan.

³ SFMTA (2020) Geneva Avenue / San Jose Avenue Intersection Study, p. 17.

6. Preliminary Environmental Clearance Assessment

The table below lists the potential improvement measures presented in the prior chapter and a preliminary assessment of whether the concept is capacity-increasing project type likely to lead to an increase in VMT based on the CEQA checklist provided by Caltrans and the Governor’s Office of Planning and Research.⁴

#	CONCEPT	LIKELY TO LEAD TO INCREASED VMT?
5.1.1	Modify the signal phasing and timing to provide lagging left turns during other parts of the day.	Not likely – falls under category of “Timing of signals to optimize vehicle, bicycle, or pedestrian flow” (Caltrans, p. 13).
5.2	Signal system upgrade	Not likely – falls under category of “Rehabilitation, maintenance, replacement, safety, and repair projects designed to improve the condition of existing transportation assets (e.g., ...Transportation Management System field elements such as ...detection, or signals.” (Caltrans p. 13).
5.3.1	Lengthen NB 1-280 exit lane	Not likely – falls under category of “Addition of lane of less than one mile in length designed to improve roadway safety.” (Caltrans, p. 14).

7. Recommendations & Next Steps





The issues and improvement measures identified in this study are the first steps in a longer-term process for improving Geneva Avenue in the Balboa Park station area. The foreseeable next steps in this process are:

- Implementing the recommended near-term signal phasing improvements with the Caltrans District 4 signal operations group and SFMTA and analyzing the operational and safety changes. The project team implemented this recommendation. Please see Appendix A for post-implementation analysis.
- Pursuing the recommended mid-term traffic signal system modernization to replace the current aging system as it reaches the end of its life cycle.
- Pursuing potential street lighting improvement.
- Share findings with neighborhood, business, City, and agency stakeholders (e.g., BART and Caltrans) ahead of next steps for each capital or study recommendation.
- Identifying and programming funding by partner agencies for further operational studies and detailed design of mid-term concept.
- Identifying opportunities to incorporate improvements planned by other agencies (e.g., BART and the SFMTA).
- Collecting detailed topographic survey, utility, structural, and geotechnical data to facilitate preliminary and detailed design.

Potential funding sources for the traffic signal system modernization, roadway lighting improvements, and PSR-PDS PID process for the I-280 corridor include State Highway Operation and Protection Program (SHOPP), Prop L, SF Public Utilities Commission, SB 1 Local Partnership Program formula funds, and other federal, state, and local sources.



⁴ Caltrans (2020) Transportation Analysis under CEQA, First Edition.; Governor’s Office of Planning and Research (2018) Technical Advisory on Evaluating Transportation Impacts in CEQA.

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APPENDIX A:

I-280 / Geneva Avenue Ramp Near-Term Signal Phasing and Timing Change Post Implementation Analysis

New Signal Phasing and Timing Plan and Implementation

The project team started with the goal of analyzing the NB I-280 Geneva Ave off-ramp traffic flow and ramp intersections traffic circulation in order to develop recommendations for future improvements. In the course of the project, the team decided to move forward with implementing the near-term recommendation. This new traffic signal phasing and timing change plan was developed collectively with SFMTA and Caltrans District 4 staff to enhance traffic circulation and fix a pedestrian crossing conflict requested by the public. This plan improved the storage capacity of the Geneva Ave bridge in order for it to clear vehicles often blocking the ramp intersections, and to receive more traffic flow from the northbound off-ramp left lane. It also increased the total cycle time and synchronized the timing of off-ramp movement which helps the northbound off-ramp right lane movement. The 2023 phasing plan was implemented for both commute peak and off-peak periods in August 2023. The project team also took traffic counts to compare results before and after implementation.

Between 2021 and 2023, the total traffic handled by the ramp intersections tended to decrease by between three and seven percent, or between 30 and 200 vehicles per peak hour. Traffic volumes along Geneva Avenue tended to go down for most movements, as did most of the I-280 southbound off-ramp movements. The I-280 northbound ramp was the sole approach where the traffic volumes consistently increased, by between three and 24 percent.

Counts of people walking and biking showed little change between 2021 and 2023. Most people walking along Geneva Avenue tended to traverse the south side of the street and cross Geneva Avenue at the northbound ramp, near the Balboa Park BART and Muni station. There were more people observed walking in the morning than the afternoon (AM peak hour, 80 - 100+ pedestrians; PM peak hour, 70 - 90 pedestrians). There were fewer than 10 people observed on bikes in both 2021 and 2023.

OPERATIONAL NOTES

The modified traffic signal phasing and timing plan implemented in 2023 yielded these operational benefits.

Improved signal progression through the ramp intersections. Under the previous phasing and timing plan, some vehicles failed to clear (i.e., enter and exit) the second ramp intersection. The westbound Geneva Avenue left turn queue regularly blocked the subsequent northbound ramp left turn movement. With the 2023 modified phasing and timing, vehicles approaching from Geneva Avenue and the ramp intersections can clear both ramp intersections in a single signal cycle; the westbound Geneva Avenue left turn queue is cleared prior to the northbound ramp left turn.

Pedestrian and vehicle safety improvements. The lagging left turn phasing eliminated instances of Geneva Avenue vehicle left turn red light running and reduced instances of drivers turning left to the southbound on-ramp in conflict with people walking in the crosswalk.

VEHICLE FLOW RATE COMPARISON

The 2023 signal phasing and timing plan during the AM and PM peak hours changed the signal timing in the following ways:

- Reduced the protected eastbound and westbound Geneva Avenue left turn green time
- Kept equal or increased the Geneva Avenue through movement green time
- Increased the southbound ramp movement green time
- Kept equal the northbound ramp movement green time
- Increased the total cycle time from 90 seconds to 95 seconds.

FINDINGS

As indicated in Table 1, the traffic signal and phasing changes implemented by the project team were successful in improving the capacity of the I-280 northbound off-ramp. The vehicle flow rate, i.e., the vehicles serviced per second of phase time, increased for the northbound off-ramp movements. During the AM Peak Hour, the northbound off ramp left lane flow rate (vehicles/second) improved from 0.25 to 0.34, a 36% increase in flow and the right lane flow rate improved from 0.27 to 0.30, an 11% increase. During the PM Peak Hour, the northbound off ramp left lane flow rate (vehicles/second) improved from 0.23 to 0.28, a 22% increase in flow and the right lane flow rate improved from 0.29 to 0.35, a 21% increase. These results suggest that the project was successful in partially satisfying the goals and objectives of study, which were to improve:

1. Traffic operations and efficiency, including increasing off-ramp capacity (emphasis added).
2. Traffic safety, including reducing collisions at I-280 mainline.
3. Improving pedestrian safety at the ramp intersections.

The traffic flow also improved for Geneva Avenue westbound left turn onto I-280, and eastbound left turns onto I-280. These critical movements were also the movements observed experiencing safety issues related to red light running, queue spillback into the adjacent ramp intersection, and pedestrian conflicts. The potential drawback suggested by the traffic count sample is a decrease in the eastbound Geneva Ave overall vehicle traffic capacity of the ramp intersections.

NEXT STEPS

Based on the findings of this post-project assessment, signal operations and safety can be further improved with the following actions:

- Work with the SFMTA and Caltrans to install signal detection technology to allow actuated, i.e., demand-responsive, signal operations.
- Work with the SFMTA and Caltrans to secure funding for an overall traffic signal system upgrade.

Table 1. 2021 – 2023 Traffic Flowrate Comparison

I-280 NB OFF-RAMP / GENEVA AVENUE			
NB OFF-RAMP TRAFFIC MOVEMENT	FLOW RATE (VEH/S)		
	DEC 1 2021	NOV 8 2023	PERCENT CHANGE
AM Peak Hour (7:45 AM)			
Northbound Left Lane	0.25	0.34	36%
Northbound Right Lane	0.27	0.30	11%
PM Peak Hour (4:45 PM)			
Northbound Left Lane	0.23	0.28	22%
Northbound Right Lane	0.29	0.35	21%

1. NB - Northbound

Dec. 1/2, 2021 – 90s cycle = 40 cycles / peak hour

Nov. 8, 2023 – 95s cycle = 38 cycles / peak hour