EAST AVENUE CORRIDOR STUDY

Final Report

June 2022

Acknowledgements

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...And the East Avenue Community

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1. INTRODUCTION

The purpose of the East Avenue Corridor Study is to develop a corridor improvement plan that identifies recommendations to enhance mobility and safety for all modes of travel. The study was initiated at the request of the residents near East Avenue, to evaluate overall operation and safety conditions on East Avenue. The Livermore Bicycle, Pedestrian, and Trails Active Transportation Plan (ATP) also identifies East Avenue as a priority corridor for walking and bicycling improvements.

The Phase I of the study evaluates the existing conditions, identifies issues and alternatives, and provides recommendations and solutions. During the course of study, the City of Livermore received Sustainable Transportation Planning Grant from California Department of Transportation (Caltrans) to evaluate the alternatives through temporary installation of proposed physical improvements (tactical urbanism). The Phase II of the study has kicked off in November 2021, and will start field implementation in Fall 2022. More details will be later discussed in the Phase II of the study.

Study Area

East Avenue is a major street that runs east-west direction connecting Downtown Livermore to Lawrence Livermore National Laboratory. It is a four-lane roadway with intermittent left- turn lanes. The East Avenue Study Corridor is defined as a 2.5-mile stretch between South Livermore Avenue in the west and South Vasco Road in the east. It serves as a major thoroughfare primarily for the residential, commute, and school traffic, as well as for people visiting small commercials, community centers, offices, and St. Michael Cemetery & Funeral Center. Figure 1 shows the local and regional context.

The corridor is predominantly bordered by low-to-medium density residences. Typologies of such residences include single-family residences, townhomes, two-to-three story condominiums and rental housing. A few commercial stores are also located on East Avenue between Hillcrest Avenue and Hayes Avenue. A couple of blocks on the southside along East Avenue between Charlotte Way and South Vasco Road serve as light industrial land use, and blocks between Charlotte Way and North Mines Road serve as an agricultural open space. A part of this agricultural land is in the Alameda County jurisdiction and is preserved and protected under the South Valley Area Specific Plan.

East Avenue provides direct access to several educational institutes, such as Livermore High School, East Avenue Middle School, the Ark School, and indirect access to Vineyard School. It also provides access to recreational land uses such as Robert Livermore Park, and multi-use bicycle trails such as Arroyo bike trail.

This mix of land uses adjacent to East Avenue makes it a preferred location for people working and living close by to commute via walking and biking. Once additional bike, pedestrian and other safety-related (e.g. lighting) infrastructures are implemented, the number of bicycles/pedestrians are expected to be significantly increased.

Study Focus

To conduct a comprehensive and thorough analysis, the East Avenue Corridor is further divided into four homogeneous segments based on adjacent land use and roadway geometrics as shown in Figure 1-2. The four segments are:

1. South Livermore Avenue to Estates Street
2. Estates Street to Madison Avenue
3. Madison Avenue to North Mines Road
4. North Mines Road to South Vasco Road

The study evaluates 26 intersections located in the study corridor. The study intersections and associated traffic controls are also shown in Figure 1-2.

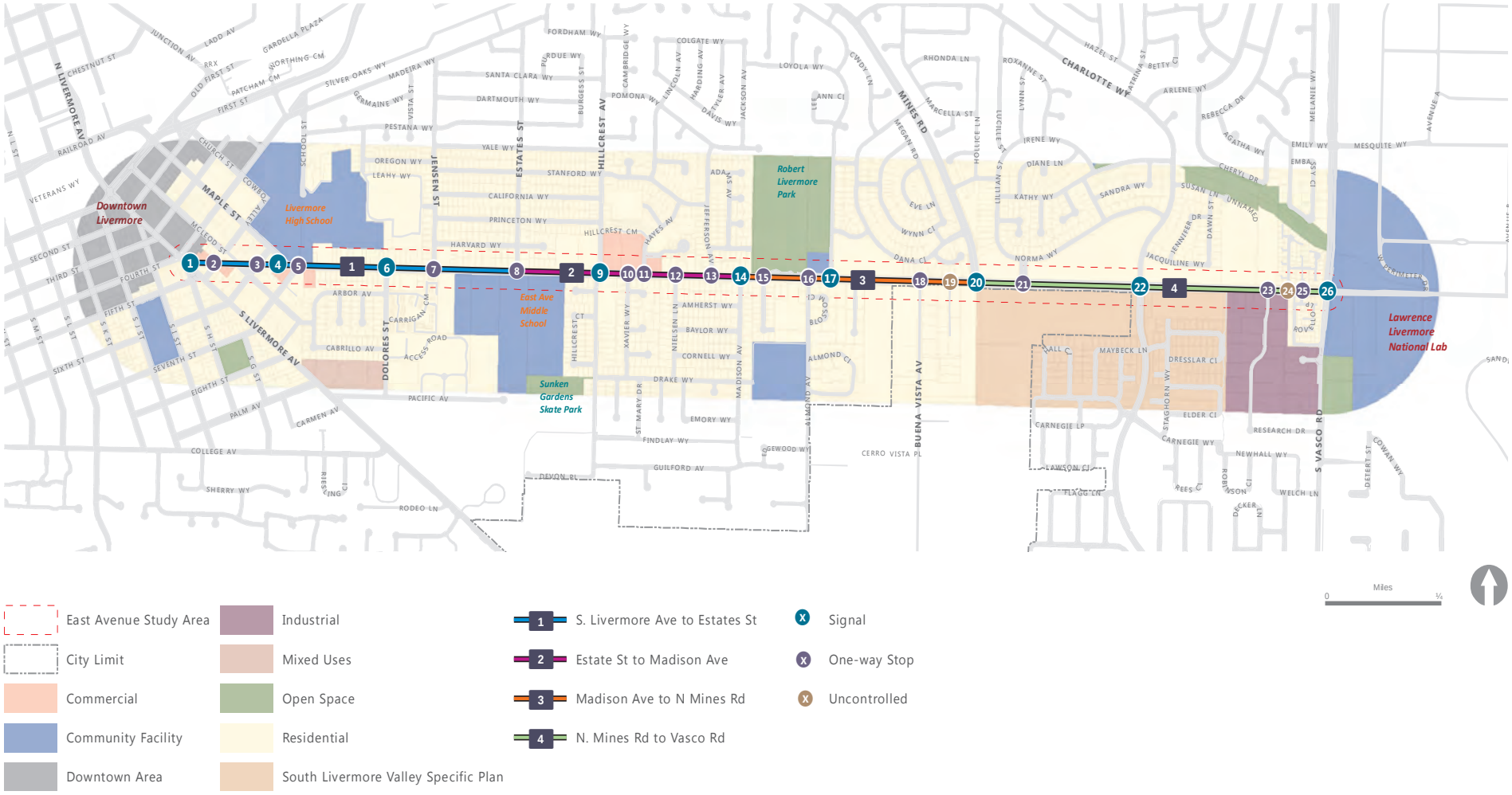
The longest burning light bulb in history, is located inside Livermore's fire station 6 on East Avenue. Manufactured by the Shelby Electrical Company, the bulb was first installed in 1901.

Source: Tri-Valley History Council

Photo Courtesy: Bill Nale

Figure 1-1: Local and Regional Context

Figure 1-2: Roadway Segments and Study Intersections



Study Phase I Timeline

APR 20 — Project Start
- Field Review
- Preliminary Analysis

APR 20 — Data Collection
- Demographic Trends
- Safety
- Connectivity
- Comfort

JUN 20 — Visioning
- Community Outreach Plan
- TAC meeting #1

JUL 20 — Needs Analysis
- Online Survey
- Map Inputs

AUG 20 — Define Goals and Objectives
- Community Workshop #1
- Understanding Community needs and concerns

AUG 20 — Developing Recommendation
- Researching best practices

OCT 20 — Design Alternatives
- Draft Alternatives
- TAC Meeting #2

NOV 20 — Community Input
- Community workshop #2 (Preliminary Alternatives)

JUN 21 — Community Input
- Community Workshop #3 (Refined Alternatives)

OCT 21 — Draft Report

JUN 22 — Final Report
- Phase II Kick-off

Literature Review

Several documents have acknowledged goals, policies, and potential improvements that are partially or fully applicable to the East Avenue Corridor. The following list of documents is relevant to the corridor study.

- City of Livermore General Plan (Circulation Element), 2004, Amend. 2014
- Design Standards and Guidelines (Streets), 2004
- Livermore Bicycle, Pedestrian, and Trails Active Transportation Plan (ATP), 2018
- Livermore Bicycle, Pedestrian, & Trails Active Transportation Plan (Design guidelines), 2018
- Neighborhood Traffic Calming Program, 2004 (rev. 2020)
- Other Planning Documents:
    - Safe Routes to School Plan – East Avenue Middle School Improvement Plan
    - Alameda County-wide Active Transportation Plan, 2019
    - Alameda County-wide Multimodal Arterial Plan, 2016
    - LAVTA Short Range Transit Plan, 2016

The General Plan (Plan) classifies East Avenue as a major street that is usually a medium-speed, high-capacity route (ranging from 20,000 to 50,000 vehicles per day) for intra-city, cross-town travel, and local access to freeways, highways, and the sub-regional road system via interchanges and signal-controlled intersections. Major streets are typically four- to six-lane divided facilities. The Plan proposes the development of Class II Bike Lanes on East Avenue from Maple Street to Madison Ave.

The ATP identifies East Avenue as a key location that needs bicycle facilities and crossing improvements. Furthermore, East Avenue is also recognized as a key connecting street that could benefit from network and crossing improvements so that bicyclists and pedestrians can more easily traverse the network. The ATP proposes Class II buffered bicycle lanes on East Avenue between South Livermore Avenue and South Vasco Road, and other pedestrian crossing enhancements. For complete literature review including goals and policies, please see Appendix 1.

2. EXISTING CONDITIONS

This chapter provides an overview of the current conditions based on the on-site observations and preliminary analysis from secondary data sources such as census data and other planning studies reviewed in the literature review. The following topics are addressed in this chapter.

- Demographics and Socioeconomics
- Bicycle Facilities
- Pedestrian Facilities
- Transit Facilities
- Roadway Network

This chapter discusses the key assets, challenges, and opportunities for the Corridor. A detailed discussion of gaps and deficiencies is available in Chapter 4. The basic understanding of the study and findings established in this Chapter was presented during community workshop #1.

Demographics and Socioeconomics

Demographic analysis will help us in understanding the type of investments and services that are suitable for the Study Area. The demographic data has been collected from the 2018 American Community Survey (ACS) for Census Tracts and Block Groups around East Avenue.

Population

According to the 2018 ACS 5-year estimate data, the population around East Avenue Corridor is 16,671. The population grew by 10.7% between 2010 and 2018 from 15,064. During that same period, the City of Livermore had an 11.4% increase in population.

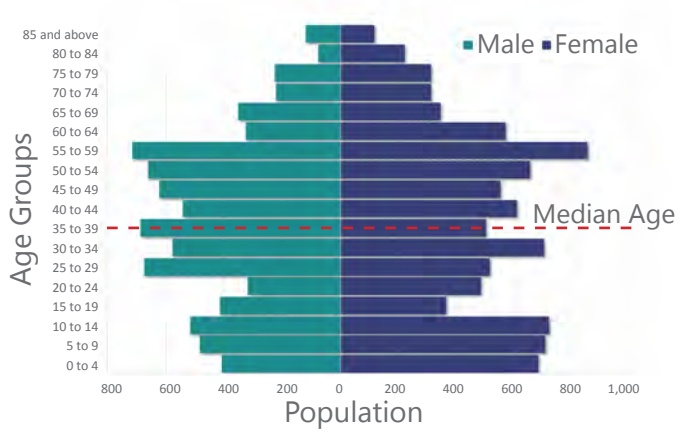
Household Size and Median Household Income

The 2018 ACS 5-year estimates reports that 5,547 households are residing near the East Ave. Of these, approximately 60% of the households are owner-occupied. The average household size is computed around 2.75. The median household income near the East Avenue Corridor is $122,006.

Age

Age is an important factor while determining various corridor improvement elements such as way-finding, walkability, and roadway safety. Additionally, such improvements are a form of public health infrastructure, enabling active transportation for people of all ages. According to the 2018 ACS 5-Year Estimates data, approximately 21% of the population is 55-years of age and older, and 21% are below 15 years old. The median age is 36 years.

Selected Census Block Groups



16,671
Population around East Ave

$122K
Median Household Income

2.75
Average Household Size

Commute to Work and Travel Time Patterns

Approximately 85% of East Avenue residents travel by cars or vans to work, out of which 77% drive alone and 8% carpool. About 4% residents use transit, while a little higher than 1% of residents walk and 2% of residents bike to work. The 2018 ACS 5-year estimates observed a slight increase in walking, biking and telecommuting among the East Avenue residents from 2017.

The average travel time to work is 32 minutes and approximately 22% residents take 20 to 35 minutes. Approximately 30% of residents take less than 14 minutes for commute suggesting short trip lengths mostly within the City limits. A few residents (19 percent) travel more than 60 minutes to work.

Since the COVID -19 pandemic, a cycling boom has been under way arcoss the nation (Eco-counter, 2021). If this trend continues, City will have to reconsider its transportation policies and investments.

Compared to the county of Alameda which has 61.5 percent workers who drive alone to work. The drive alone trips for East Avenue residents is much higher.

Source: ACS 5-yr estimates, 2018

32 Mins

	2017	2018	Change
Drove Alone	78.2%	77.8%	↓ 0.4%
Carpool	8.6%	8.4%	↓ 0.2%
Transit	4.9%	4.2%	↓ 0.7%
Walk	1.2%	1.6%	↑ 0.4%
Bike	1.2%	1.7%	↑ 0.5%
Motorcycle, Taxi and Other	1.7%	1.5%	↓ 0.2%
Work from home	4.3%	4.9%	↑ 0.6%

Source: ACS 5-yr estimates 2017 and 2018

Bicycle Facilities

A well-connected and seamless bicycle network is crucial to encourage multi-modal usage along the study corridor. Bicycle facility enhances neighborhood livability and social well-being. It increases accessibility to transit and schools. The existing bicycle facilities on and around East Avenue are shown in Figure 2-1.

On-Road Bicycle Network

Currently, there are no designated bicycle facilities on East Avenue between South Livermore Avenue and Madison Avenue. The remaining 1.3 miles stretch features a Class II bike lane, without buffer, between Madison Avenue and South Vasco Road. The width of the bike lane varies from 6 feet to 9 feet at various segments (from intersection-to-intersection) within the study corridor. This bicycle facility on East Avenue provides a direct connection to Class I paved multi-use path through Robert Livermore Park, Charlotte Way (south of East Avenue) and South Vasco Road (south of East Avenue). The facility also provides direct connections to residential neighborhoods, downtown and schools through Class II bike lanes on North Mines Road, Charlotte Way (north of East Ave), South Vasco Road (north of East Avenue), Maple Street, and 7th Street.

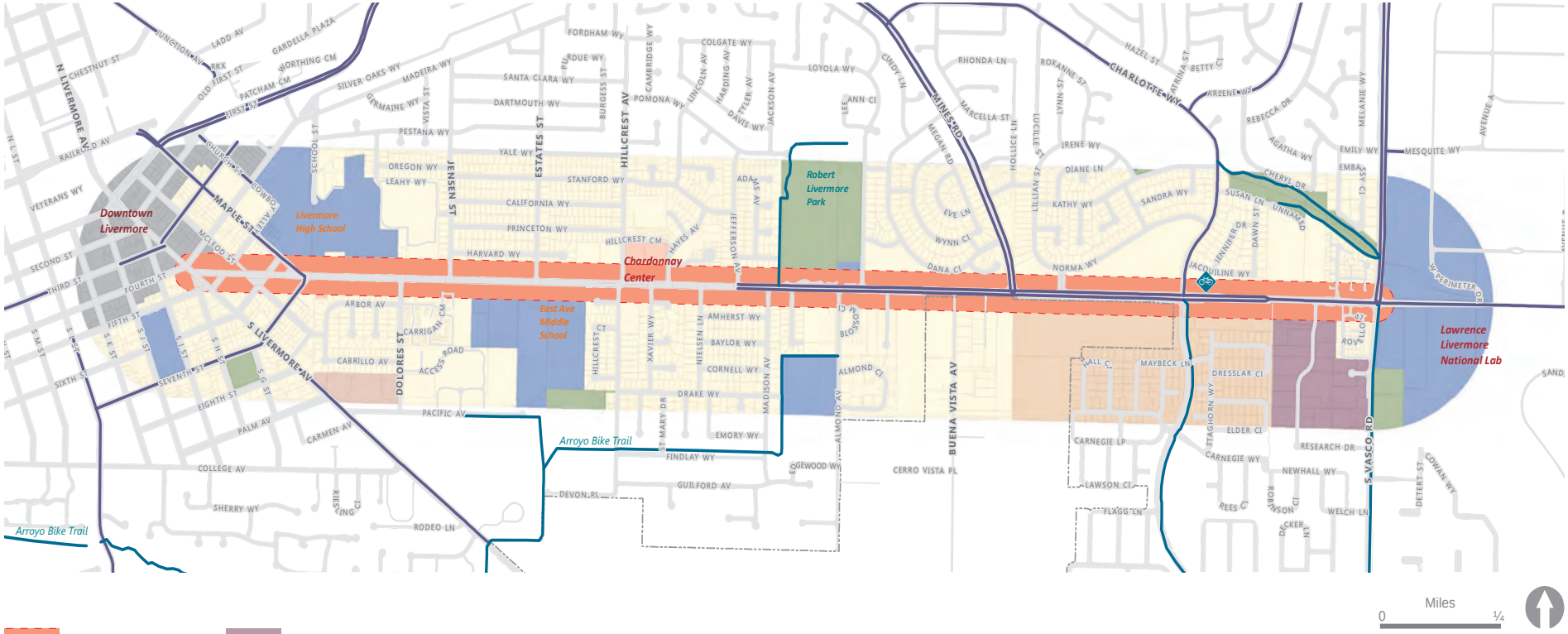
Bicycle Parking

The bicycle racks for parking bicycles can only be found adjacent to the transit stop near the intersection of Charlotte Way and East Ave. The ATP promotes the provision of supporting facilities such as bicycle parking, rest areas, water fountains, and other facilities on public properties. Open spaces near 5th Street and 6th Street, Livermore High School, East Avenue Middle School, and Chardonnay Center could be considered for the supply of additional bicycle parking facilities.

Bike Lane Marking near Loyola Way

Bicycle Rack on East Avenue near the intersection at Charlotte Way.

Figure 2-1: Existing Bicycle Facilities



Pedestrian Facilities

Pedestrian facilities are comprised of sidewalk networks, crosswalks, and pedestrian signals. These facilities determine the ability to walk comfortably within the study corridor without depending on automobiles or other motorized travels. The existing pedestrian facilities with crosswalks and missing sidewalks on East Avenue are shown in Figure 2-2.

Sidewalk Network

The sidewalk width on East Avenue range between 5 feet to 10 feet wide between South Livermore Avenue and South Vasco Road. It can be noted that sidewalks characteristics differ by land-use frontages. Most multi-family residences and commercial frontages are adorned with trees and planting strips on wide sidewalks, whereas most sidewalks with single-family and industrial frontages are narrower and devoid of greenery. There are no sidewalks between 6th Street and Maple Street (northside), and between Charlotte Way and Research Drive (southside). The segment between Pegan Common and North Mines Road has discontinuous sidewalks. Most intersections end in curb ramps, except at the intersection of East Avenue and Buena Vista Avenue.

Crosswalks

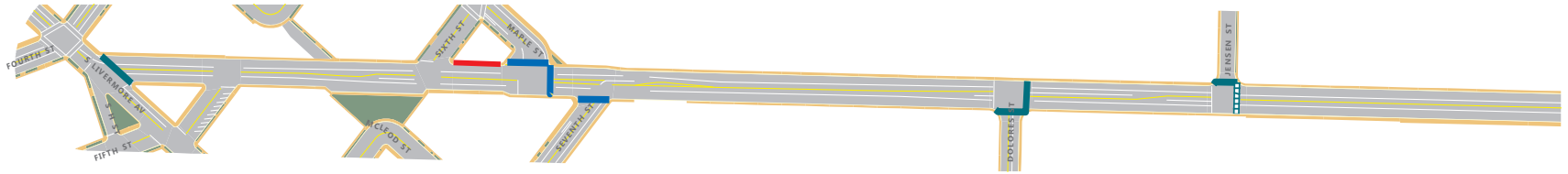
There are 14 intersections with marked (or ladder) crosswalk for crossing East Avenue within the study area. Most crossings on East Avenue are at signalized intersections. These signalized intersections are marked with standard crosswalks and have pedestrian-activated countdown signal heads for safe crossing. Non-signalized intersections at Jensen Street, Estates Street, Nielsen Lane, and Research Drive, with one-way stop control from minor approaches, are equipped with Rectangular Rapid Flashing Beacons (RRFBs). One of the non-signalized intersections, at Mitra Street, is equipped with a pedestrian crossing sign. Most crossings are marked with standard crosswalks, with the exception of ladder crosswalks at the intersection of Jensen Street, Estates Street, and Nielsen Lane.

Tree obstruction near Xavier Way at sidewalk resulting in reduced effective walk way to two feet

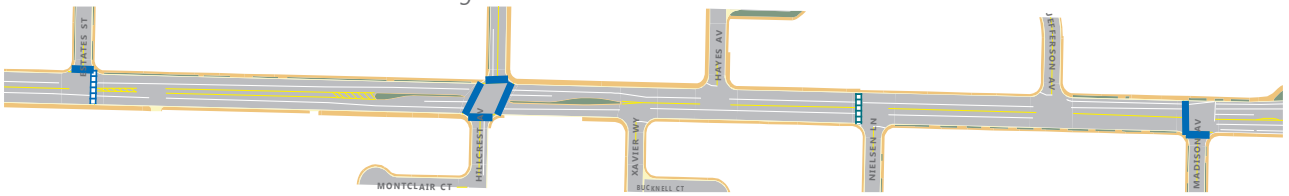
Missing sidewalk between Maple Street and Sixth Street on North Side

Figure 2-2: Existing Pedestrian Facilities

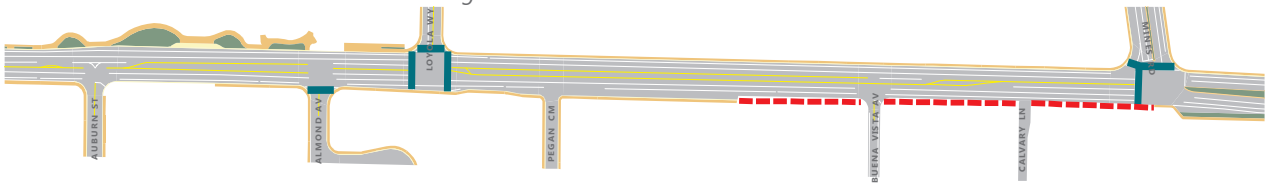
Segment 1: N. Livermore Ave to Estates St



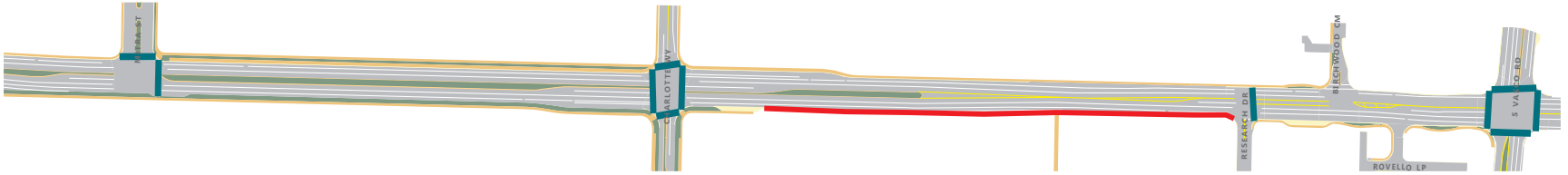
Segment 2: Estates St to Madison Ave



Segment 3: Madison Ave to N. Mines Rd



Segment 4: N. Mines Rd to S. Vasco Rd



Discontinous Sidewalk
No Sidewalk
Ladder Crosswalk
Ladder Crosswalk (Yellow)
Marked Crosswalk
Marked Crosswalk (Yellow)

Feet
0
200

Transit Facilities

Transit Routes

There are three local bus routes currently operated by Livermore Amador Valley Transit Authority (LAVTA) that run through the East Avenue study corridor. These routes include Route 30R that operates between the entire study corridor, Route 14 between Maple Street and Dolores Street and Route 20X between North Mines Road and South Vasco Road.

Transit Stops

There are 15 transit stops along the study corridor. The stops at 7th St, Dolores Street, Jensen Street, Robert Livermore Park, and Charlotte Way (westbound) are sheltered. Table 2-1 summarizes the transit service routes operating on the study corridor and their approximate service spans and headways. The existing transit facilities along the study corridor are shown in Figure 2-3.

Table 2-1: Existing Transit Services

Service ID	Name	Approximate Span	Headway (High/Low) (min)
Route 30R	W Dublin BART to East & Vasco LLNL	6 a.m. to 11 p.m.	60 / 120
Route 14	E BART Station to Transit Center	8 a.m. to 10 p.m.	40 / 80
Route 20X	Express - E BART Station to Livermore Transit Center	7:30 a.m. to 9:00 a.m. and 4:30 p.m. to 6:30 p.m.	30 / 60

Source: Livermore Amador Valley Transit Authority (LAVTA)

Figure 2-3: Existing Transit Facilities

Roadway Network

Connectivity

Classified as a major street , East Avenue provides east-west access through the City of Livermore. It is a popular route that provides major connections to downtown, to interstates and state highways such as I-580 and SR-84, and to other major streets such as South Livermore Avenue, North Mines Road and Vasco Road as shown in Figure 1-1. East Avenue provides direct access to adjacent land uses which includes commercial hubs, industries, schools, parks, transit, and residences.

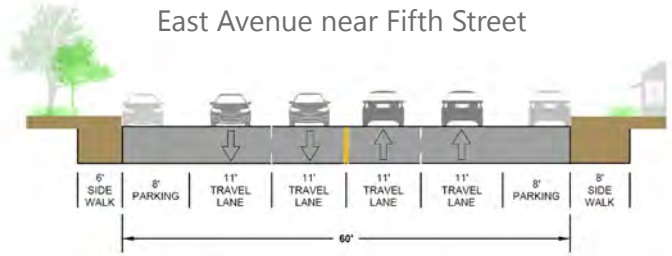
Physical Characteristics

East Avenue is a 4-lane roadway (two eastbound and two westbound) between South Livermore Avenue and South Vasco Road. It has two-way left turn lanes between Estates Street and Hillcrest Avenue, Xavier Way and Madison Avenue, Auburn Street and N Mines Road, and partially between Charlotte Way and Birchwood Common. Segments between Hillcrest Avenue and Xavier Way, North Mines Road and Charlotte Way, Birchwood Commons and South Vasco Road, and partially between Charlotte Way and Research Dr, have medians separating the eastbound and westbound lanes. Most intersections have designated left-turn pockets with the exception at Maple Street and Estates Street.

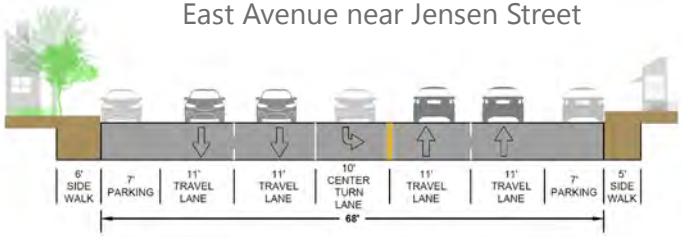
The right-of-way width, for the 2.5 mile long study corridor, varies from 60 feet to 80 feet at various segments (from intersection to intersection).

Figure 2-4 Existing Cross-sections

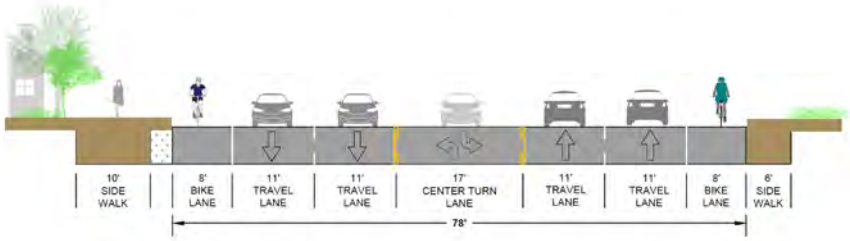
East Avenue near Fifth Street



East Avenue near Jensen Street



East Avenue near Almond Avenue

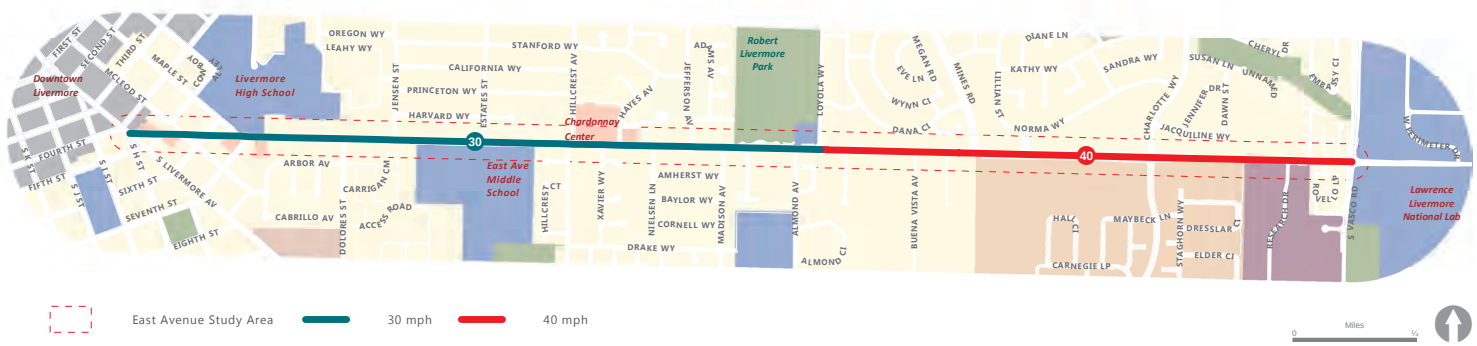


Speed Limit

Speed limit is an important factor in determining actual and perceived safety for both motorized and non-motorized travelers when they use a roadway. Higher speed limits have often been associated with increased frequency and severity of collisions. The posted speed limit on East Avenue between South Livermore Avenue and Loyola Way is 30 miles per hour (mph), and between Loyola Way and South Vasco Road is 40 mph. The limit changes to 25 mph when children are present between Dolores Street and Hillcrest Avenue near East Avenue Middle School. The distribution of posted speed limit on East Avenue is shown in Figure 2-5.

Speed Limit sign near Loyola Way

Figure 2-5: Posted Speed Limit



Parking

The on-street parking is available between North Livermore Avenue and Madison Avenue as shown in Figure 2-6 and has around 215 spaces. The average number of vehicles parked in space during a day (parking turnover) is low as compared to the parking facilities available in Downtown Livermore. In addition, the average length of stay is more than 90 minutes suggesting that the available parking space is mostly used by the residents rather than the customers or visitors (Downtown Parking Management Study, 2014). Furthermore, the available on-street parking space is not helping in addressing the lack of parking facilities in Downtown Livermore due to distant and uncomfortable walking between East Avenue and Downtown shops.

The City of Livermore conducted a parking analysis on East Avenue in 2016 and 2017. The parking analysis concluded 29% average and 43% peak period parking utilization in 2017. The peak parking period utilization for the south side is 64% as compared to 33% for the north side. The segment between Seventh Street and Estates Street has more parking utilization as compared to the rest of the corridor.

Parked Vehicles near Dolores Street

Figure 2-6: On-Street Parking

3. COMMUNITY OUTREACH

The East Avenue Corridor Study is for everyone who lives, works, or commutes through East Avenue. To address the needs of this large and diverse group during the COVID-19 pandemic, the study team was poised with a challenge to rethink the entire public engagement process. Like many other agencies facing this situation, the study team started coming up with creative approaches for virtual engagement such as using the video-conferencing application and online surveys. Three community workshops were held on August 12, 2020, November 12, 2020 and June 8, 2021. In addition, two online surveys were conducted in the mid and the end of the year 2020.

The public outreach process was divided into three stages in chronological order:

- Listening and Visioning
- Identifying Solutions and Alternatives
- Refining Alternatives

Community outreach plays a vital role in successful development of corridor study. To provide constant updates and information about the project, an interactive project website was created at the beginning of the project (eastavecorridorstudy.com). The project website was intended to engage the community to submit their ideas and concerns on priorities, desired facility, and streetscape elements. The website had 3,596 unique visitors with 5,085 total site sessions (as of June 1, 2021). The project website information was provided using the social media channels, postcards and the City of Livermore Traffic and Transportation Webpage. The project website provided information on project overview, upcoming events, alternatives, frequently asked questions (FAQs), survey, and feedback forms. Around 532 residents subscribed to receive constant updates about the project (as of June 1, 2021).

Technical Advisory Committee (TAC)

The TAC members were represented by the Police Department, Fire Department, Livermore Amador Valley Transit Authority (LAVTA), Streets and Sanitation Department, Livermore Valley Joint Unified School District, and Livermore Area Recreation and Park District (LARPD). The TAC members were responsible to review and provide feedback on the project scope and deliverables for the study. Other responsibilities included providing assistance with the articulation of study goals, providing recommendations and key information, and confirming support for the draft plan. The two TAC meetings were held on June 18, 2020, and October 29, 2020. The meeting minutes are available in Appendix 2.

Listening and Visioning

In this stage, the study was introduced to the residents and stakeholders, preliminary findings were presented and community input were collected through online surveys and a virtual workshop. The intend was to develop a common vision for the corridor and study goals. Furthermore, the responses created the foundation for the development of alternatives and performance measures.

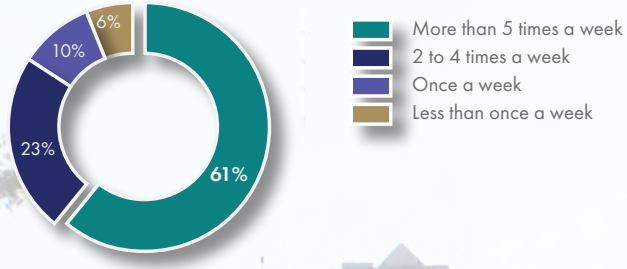
Needs Survey

An online survey was conducted to elicit feedback on specific issues, trip types, and destinations that should be considered for prioritization. The survey was hosted on the project website for two months (July and August, 2020). The survey was closed on August 31, 2020, with notifications provided using email blasts to project website subscribers and social media channels. A total of 880 surveys were received. The results from the survey are summarized below.

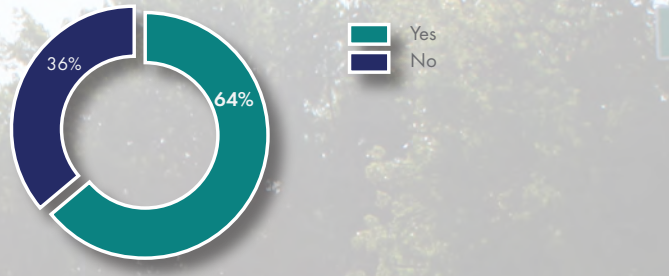
Respondent description

*This is nominal

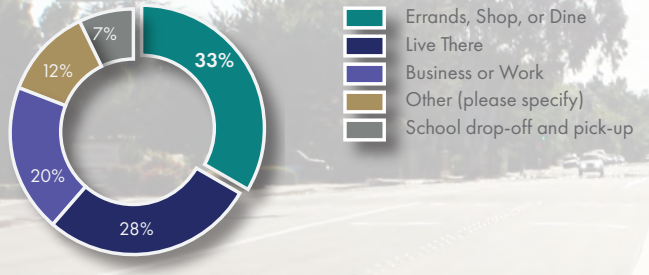
Frequency (Corridor Usage)



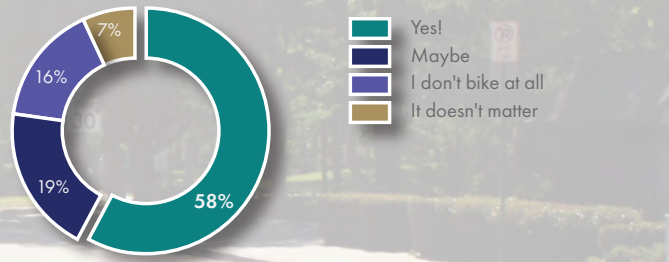
Do you use bike lanes and sidewalk?



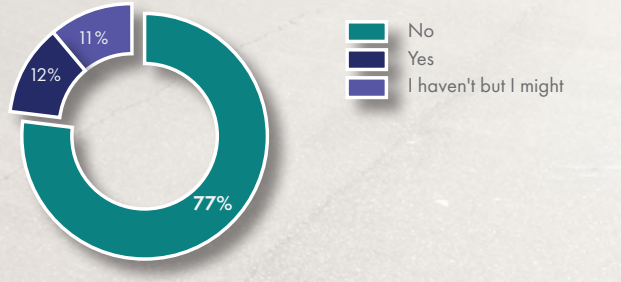
Purpose of trip



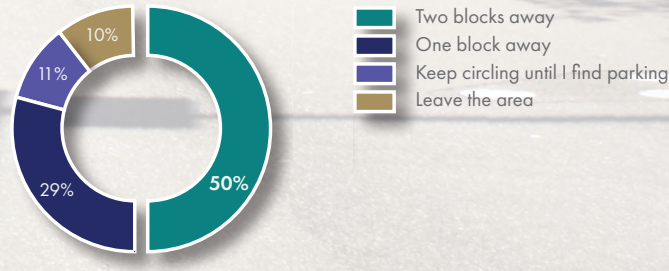
Would you bike more if buffered bike lanes are provided?



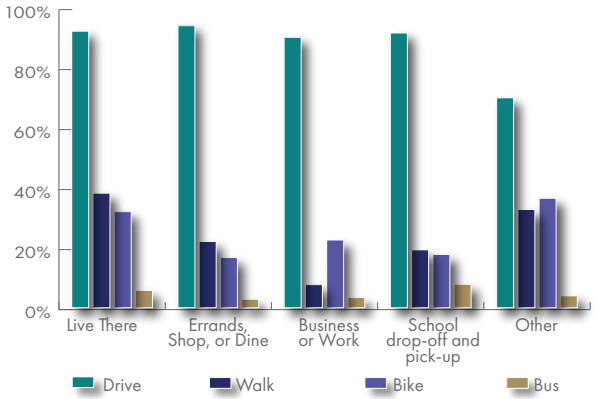
Do you use on-street parking?



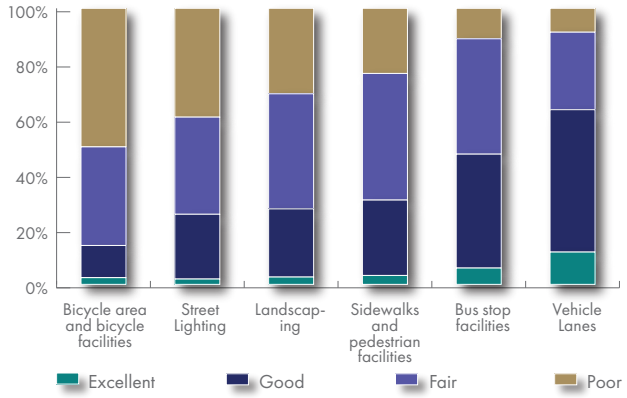
How far are you willing to walk if there is no parking?



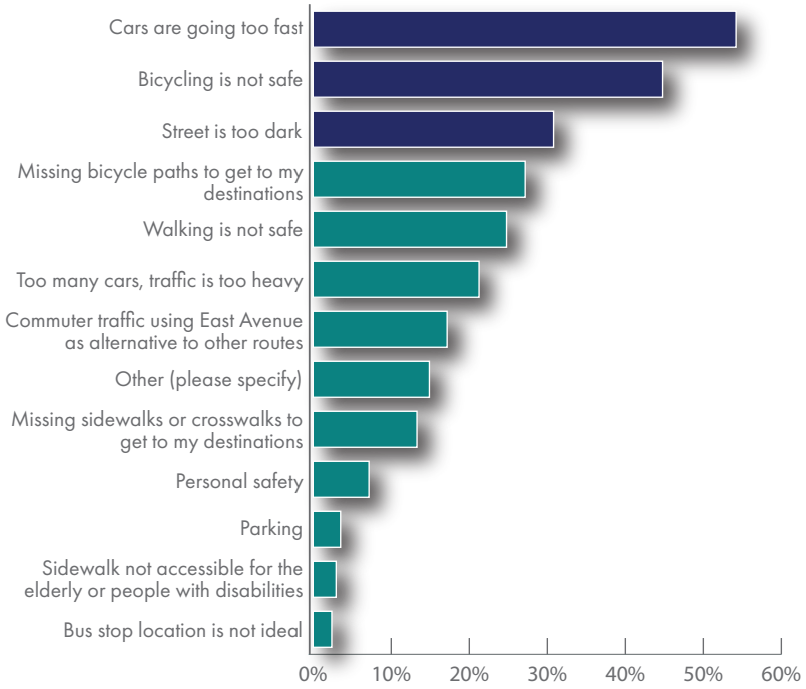
Travel Mode



Facility Rating



Major Concerns



Likelihood of Walking, Biking and Taking Bus

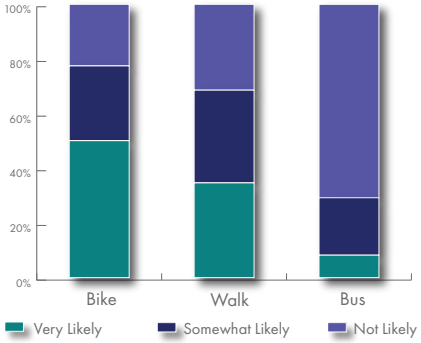
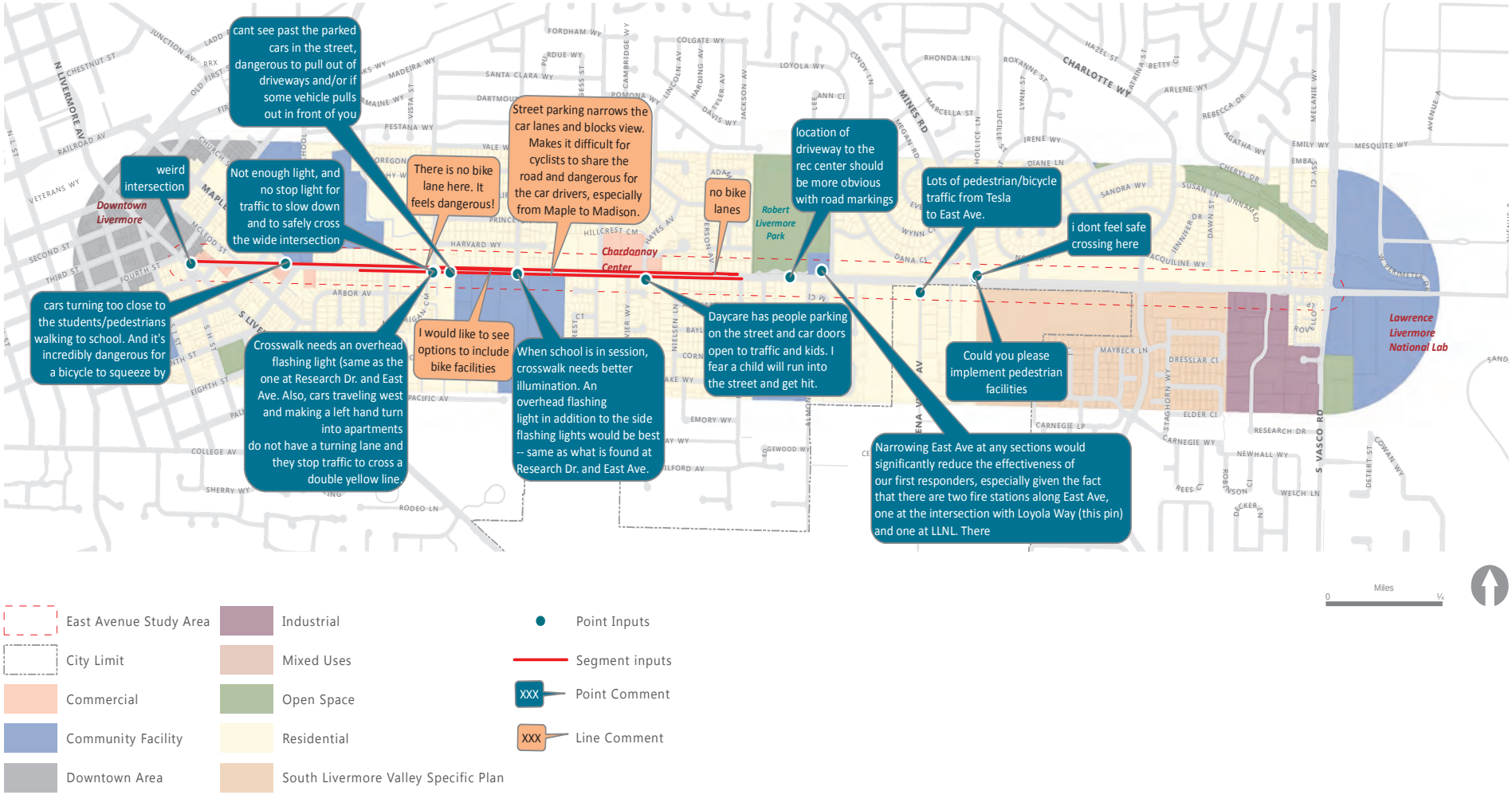


Figure 3-1: Map Inputs



Interactive Map Inputs

In addition to hosting an online form type survey, the website also featured an interactive map input application where residents could mark a location or a segment on the corridor. The results of the map inputs are shown in Figure 3-1.

General Feedback Forms

The feedback forms were also hosted on the project website in order to collect general comments about the study. As of June 01, 2021, 197 forms were received.

Community Workshop #1

The first community workshop for the East Avenue Corridor Study was organized virtually on Wednesday, August 12, 2020 using the Zoom video-conferencing application. The workshop event details were broadcasted using the City of Livermore social media outlets, local news, project website, and e-mail blasts. The virtual workshop was attended by 51 residents.

The purpose of Community Workshop #1 was to introduce the project and the scope to the community, present preliminary findings, and seek input from the community members. The poll results from the workshop are summarized in Table 3-1. It is important to note that not all the participants logged in from the zoom application and there were not able to participate in the polls.

Table 3-1: Community Workshop #1 Poll Results

How did you hear about us?	
City of Livermore Website	3
City of Livermore Social Media	14
Postcards/Mail	10
Other	13
Total Participants	40

How satisfied or dissatisfied are you with the survey results so far?	
Very Satisfied	10
Somewhat Satisfied	18
Neither satisfied nor dissatisfied	3
Somewhat dissatisfied	1
Very dissatisfied	0
Total Participants	32

How helpful was the content presented at the community workshop?	
Extremely helpful	3
Very helpful	18
Somewhat helpful	8
Not so helpful	0
Not at all helpful	0
Total Participants	29

Breakout Room Exercises

After the main presentation, the participants were divided into four group with twelve to thirteen attendees per breakroom. The purpose of this exercise was to broadly understand their opinion about the corridor. The comments and feedback were collected on all four segments. The facilitators were involved with annotating the comments on the maps and helping the participants navigate the corridor. The comments and feedback from each breakroom is summarized below.

Breakout Room 1: The general comment was about having balanced striping that accommodates bicyclists and provides bike lanes on East Avenue. The lack of bike facility on the west end makes it difficult for everyday commute. The participants were also concerned if lane or parking reduction will have an adverse impact on the residents along the study corridor.

Breakout Room 2: The residents were concerned about the traffic congestion and safety measures near the schools. One of the participant suggested signalization of East Avenue and Estate Street intersection. Other concerns includes bus stop locations, trail connections between downtown and wine country, unsafe crosswalks.

Breakout Room 3: The participants in this group were concerned that if the bike lanes are provided next to parking lane would result in "dooring" type collisions. The residents were concerned about the congestion near Livermore High School, pedestrian crossing especially near Estates Street and Seventh Street, street lighting, signal coordination, crossings near bus stops, trail access, and speeding especially at segment 4.

Breakout Room 4: The participants in this group were mainly concerned about the bicycle facilities and pedestrian crossings. The other issues that were highlighted are poor roadway geometry, traffic congestion near the schools, speeding, street lighting, truck traffic loading and unloading zones, traffic noise for the residents and access to bus stops.

Identifying Solutions and Preferred Alternative

The purpose of this stage was to present draft alternative concepts developed based on the community input received in the listening and visioning stage. The following three draft alternatives were presented to the community. Table 3-2 shows the summary for the draft alternatives.

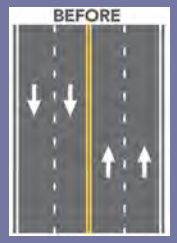
- **Existing Conditions**: Four travel lanes, parking from Livermore Avenue to Madison Avenue, and bike lanes from Madison Avenue to Vasco Road
- **Alternative 1**: Maintains four travel lanes, removes parking and provides buffered bike lanes
- **Alternative 2**: Partial road-diet and four travel lanes, maintains parking, sidewalk widening and provides buffered bike lanes
- **Alternative 3:** Complete road-diet, reduces nearly half the parking and provides protected bike lanes

The conceptual plans and photo simulations for the draft alternatives were posted on the project website prior to the community workshop. The detailed design concepts for the alternatives are explained in the next chapter. The draft alternatives plans are provided in Appendix 11 and photo simulations are provided in Appendix 3.

What is a Road Diet?

Road diet is a roadway reconfiguration technique that offers several high-value improvements at a low cost. A typical road-diet involves converting an existing four-lane undivided roadway segment to a three-lane segment. However, road diet can have many forms. In addition to low cost, the primary benefits of a Road Diet include enhanced safety, mobility and access for all road users and a "complete streets" environment to accommodate a variety of transportation modes.

-Federal Highway Administration (FHWA)



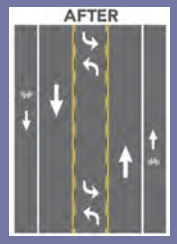


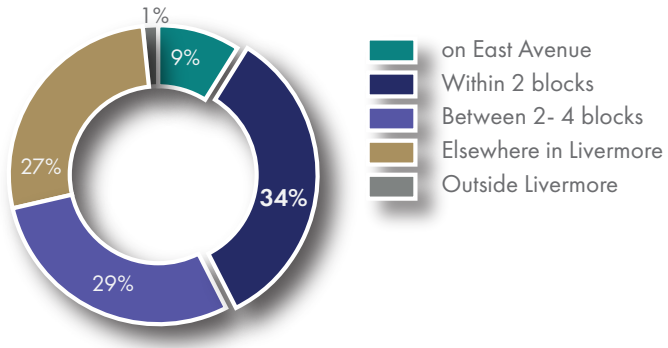
Table 3-2: Draft Alternatives Summary

Alternative	Travel Lanes	Medians/Center Turn Lanes	Bicycle Lane		Bike Buffer	Sidewalk Width	Parking Spaces	Bulbouts- Refuge Island	Road Diet
Existing	4 (10'/13')	Center turn lane (10')	6' – 9'	Class II	0	5' – 8'	215	None	NA
1	4 (10'/11')	Center turn lane (10')	6'	Class II	2'	No change	8	None	None
2	4 and 2 (11')	Center turn lane (12')	6'	Class II	3'	Increases by 2' in some parts	198	Bulbouts	Partial
3	2 (11')	Center turn lane (12')	6'	Class IV (parking protected)	3' -11'	No change	109	Corner Refuge Islands	Complete

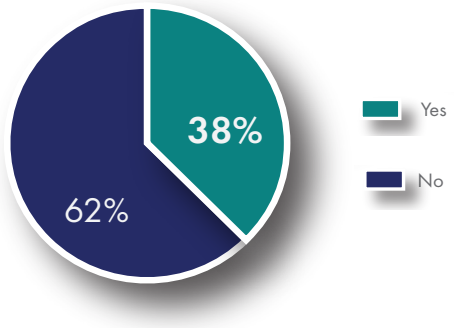
Alternative Selection Survey

An online survey was conducted to get the community input and identify the preferred alternative for the corridor. The survey was hosted on the project website for nearly two months (November and December, 2020). The survey was closed on December 31, 2020, with notifications provided using email blasts to project website subscribers and social media platforms. A total of 473 surveys were received. The survey results are presented below.

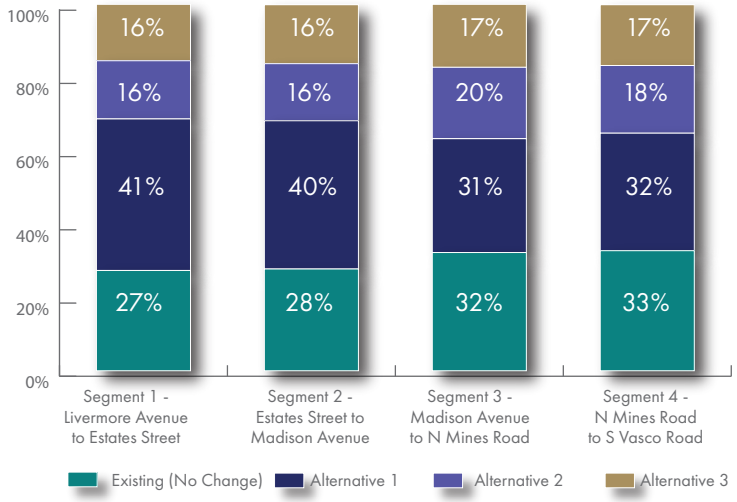
Respondent Location



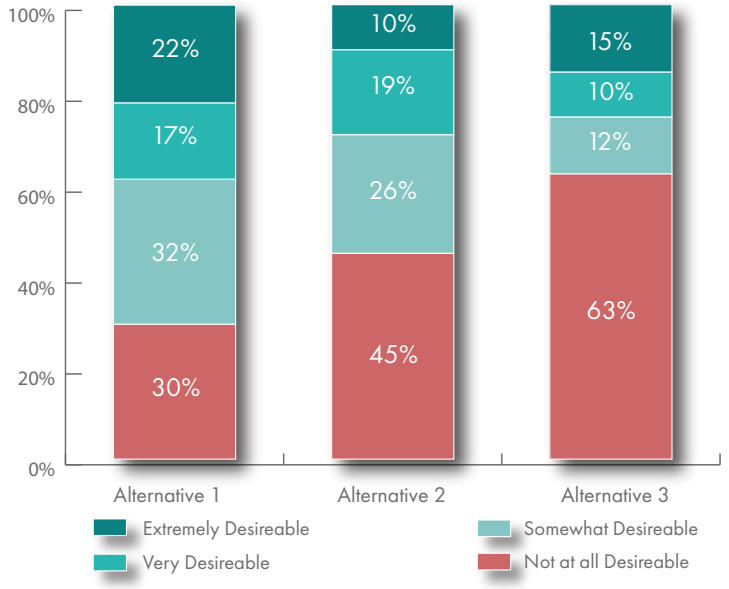
If you live near East Avenue, do you park on East Avenue?



Preferred Alternative



Rate the alternatives in terms of desirability



Community Workshop #2

The second community workshop for the Study was organized virtually on Thursday, November 12, 2020 using the Zoom video-conferencing application. The workshop event details were broadcasted using the City of Livermore social media outlets, local news, project website, and e-mail blasts. The virtual workshop was attended by 42 residents.

The purpose of Community Workshop #2 is to present draft alternative concepts and:

1) to solicit feedback from the community members on the three draft alternative concepts developed based on technical analysis and community input to date
2) conceptualize the hybrid alternative with the help of the community members.

The main presentation began with the study introduction and recap of the community workshop #1. The study team presented the survey results, map inputs, and summarized the resident concerns. The team explained the three draft alternatives prepared based on the community input. The presentation included a general summary, conceptual plans, and photo simulations for the three alternatives and for all the four segments. A comparison of each alternative and explanation of the merits and demerits were also highlighted during the presentation. Finally, an alternative evaluation methodology along with examples of bicycle level of stress and cost estimates were explained to the participants.

Table 3-2: Community Workshop #2 Poll Results

How did you hear about the workshop?	
City of Livermore Social Media	9
Email subscription	15
Project website	3
Other	10
Total Participants	37

How satisfied or dissatisfied are you with the community input so far?	
Very Satisfied	13
Somewhat Satisfied	13
Neither satisfied nor dissatisfied	3
Somewhat dissatisfied	6
Very dissatisfied	1
Total Participants	36

How satisfied or dissatisfied are you with the alternative evaluation process?	
Very Satisfied	13
Somewhat Satisfied	13
Neither satisfied nor dissatisfied	2
Somewhat dissatisfied	8
Very dissatisfied	2
Total Participants	38

Breakout Room Exercises

Following the main presentation, the participants were divided into three group with thirteen to fourteen attendees per breakroom. The purpose of this exercise was to broadly understand their opinion about the three preliminary alternatives. The comments and feedback were collected on all four segments similar to the previous workshop. The facilitators were involved with annotating the comments on the maps and helping the participants navigate the corridor. The comments and feedback from each breakroom are summarized below.

Breakout Room 1: The participants inquired about the road diets in general and how this project will be further linked to the existing bicycle, pedestrian, and trail system. The participants also asked about the method of providing feedback effectively. The residents raised a concern about the delivery vehicles especially for loading and unloading purposes for the commercial establishments. The residents were concerned that the removal of parking on East Avenue would result in spilling of parking to the side streets and making the situation worse at the side streets. The participants found the addition of pedestrian-islands and bulb-outs will be helpful for safety especially near Jensen Street and Estate Street. The participants discussed the lane reduction impacts on the traffic flow and shifting of bicycles to some other streets. The residents also shared their experience from other cities which have taken a similar road diet measures and found it successful. The residents were also concerned about the emergency vehicle movement with the lane reduction alternatives. Another issue that was highlighted during the breakout room was pickup and drop-off at the two schools. Overall the alternative 3 with some improvements seemed like a preferred choice.

Breakout Room 2: The participants were concern about the safety concerns near Livermore Avenue and East Avenue. The participants also argued that the lane reduction might deteriorate the conditions near the East Avenue Middle School. The participants also highlighted that the lane reduction and other proposed improvements will be beneficial for eliminating the cut-through traffic at East Avenue and simultaneously encouraging walking and biking along the corridor. Additionally, the improvements can be accommodated by shifting time of travel and staggering school bell times. The participants who bike along East Avenue stated the reasons behind East Avenue being an ideal corridor for biking as it is straight, connects downtown and recreation center. The presence of a large number of driveways and speeding along the corridor results in rear-end collisions. The higher number of lanes gives a false sense of higher speed as compared to the posted speed, reducing the number of lanes will surely result in mitigation of speeding and hence, making it safer for the community. Another issue that was highlighted was the parked car getting hit in the existing conditions. Both alternatives 2 and 3 were equally favored in this breakout room.

Breakout Room 3: The participants in this group were concerned that if the roadway is reduced to one lane per direction, it will result in gridlock during the school drop-off period. The residents were also concerned that if the bulbouts would hinder their vision to see the oncoming traffic resulting in a safety risk. The resident also raised the issue about no alternative roadway present to divert the traffic from East Avenue and lane reduction will result in spilling of traffic to side streets especially along Madeira Way. Participants also commented that the trade-offs regarding the bike facilities and vehicle lanes need more explanation before conducting surveys. The elimination of parking will result in cars being parked at the nearby street. The

participants also discussed pedestrian safety near the intersections and driveways. The west end of the corridor near the downtown is too dangerous for the cyclists. Alternative 1 will not be able to address all the safety and cyclist concerns. The bus stops location must also be kept in mind during the design exercise. To sum, the group preferred Alternative 2 and would like to see more data (analysis) conducted before alternative selection.

Refining Alternatives

Community Workshop #3

The last workshop for Phase I of the corridor study concluded on June 8, 2021. Acknowledging the concerns from the community regarding the past outreach efforts, the study team extended the efforts by distributing more than 9,500 postcards to the nearby residents, flyers to the businesses near East Avenue and Downtown, and placed posters at the Downtown Kiosks in addition to announcing the workshop on various social media outlets, Independent News, and Livermore Patch. The virtual workshop was attended by 140 residents.

The workshop presented hybrid alternative concepts developed based on further analysis and community input from the previous public outreach efforts. Furthermore, this workshop briefly introduced Phase II of the study. Phase II aims to evaluate multiple complete streets alternatives through tactical urbanism and ultimately prioritize an alternative for this major arterial.

During this workshop, participants raised concerns over speeding vehicles on the corridor. Participants were also concerned that if the driveway in-and-out movements will conflict with the provision of bike lanes on the corridor.

Participants were also concerned if there are cut-through traffic movements from the I-580 freeway. As in the previous workshop, participants raised concerns over streetlighting and congestion during school drop-off and pick-up times.

Table 3-3: Community Workshop #3 Poll Results

How did you hear about the workshop?	
City of Livermore Social Media	11
Email subscription	46
Other (News Article, Friends or Neighbors)	53
Total Participants	110

How satisfied or dissatisfied are you with the City's responses to questions?	
Very Satisfied	28
Somewhat Satisfied	26
Neither satisfied nor dissatisfied	19
Somewhat dissatisfied	26
Very dissatisfied	23
Total Participants	115

Please select for your preferred alternative?	
Existing	37
Alternative 1 - Maintain Four Lanes	10
Alternative 2 - Partial Road Diet	10
Alternative 3 - Road Diet	25
Alternative 4 - Hybrid Alternative	12
Total Participants	94

4. NEEDS ANALYSIS

This chapter identifies the existing conditions of the existing East Avenue corridor. The following analysis is conducted to identify deficiencies, gaps and opportunities.

1. Traffic Safety Analysis
2. Bicycle Level of Traffic Stress
3. Pedestrian Evaluation
4. Transit Level of Service
5. Traffic Operations Analysis
6. Midblock Traffic Volumes
7. Street Lighting Lumen Study

The conceptual alternatives were drafted based on the understanding of community needs (Chapter 3) and the technical assessment of the corridor.

Transportation Safety Analysis

The traffic safety analysis or collision analysis looks at recent collision trends at the project corridor. The collision history is assessed using the City of Livermore's Crossroads Traffic Collision Database. Crossroads dataset includes collisions of four levels of severity, and property damage only (PDO). The information analyzed includes collision severity, types of collision, primary violation factors, time of day, lighting conditions, and coordinates. The detailed collision analysis memorandum is provided in the Appendix 4.

Collisions reported along East Avenue are obtained for a period of five years from January 2015 to December 2019. Based on the collision data, a total of 110 collisions were reported in that period. One of those collisions involved a person who was severely injured and one resulted in a fatality. Both the severe injury collisions and the fatal collision involved a pedestrian. The fatal collision occurred at night.

Out of the total collisions, 80% (88) collisions were observed to have occurred at an intersection and 20% (22) collisions were observed to have occurred on roadway segments. The number of collisions that occurred every year, as per facility type, is listed in Table 4-1 and shown in Figure 4-1. The collisions are classified based on facility type - Roadway Segment and Intersection.

Roadway Segment Collisions

Collisions occurring at the mid-block (or roadway segments are generally referred as roadway segment collisions. The most common roadway segment collision types were broadside (32%), rear-end (32%), and sideswipe (27%) collisions. The primary factors for such collisions were improper turning (32%), automobile right-of-way (23%), driving under the influence of alcohol or drugs (18%), and unsafe speed (18%).

Table 4-1: Collision trend by facility type

Facility Type	2015	2016	2017	2018	2019	Total
Roadway Segment	6	5	1	3	7	22
Intersection	16	18	21	18	15	88
Total	22	23	22	21	22	110

Intersection Collisions

The collision that occurred within a 150-foot radius of an intersection were considered as intersection collisions. Broadside (26%) and rear-end (25%) collisions were the most commonly occurring collision types at intersections. The primary factors for such collisions were improper turning (20%), unsafe speed (19%), and automobile right-of-way violation (16%).

Collision Rate Analysis

A collision rate analysis is conducted to compare the collision rates along the corridor to Caltrans statewide mean collision rates for roadways with similar characteristics, such as roadway type, number of lanes, and speed limits. This analysis found that seven out of twenty-six intersections had a higher collision rate than the state average while all four roadway segments had a collision rate lower than the state average as shown in Figure 4-2.

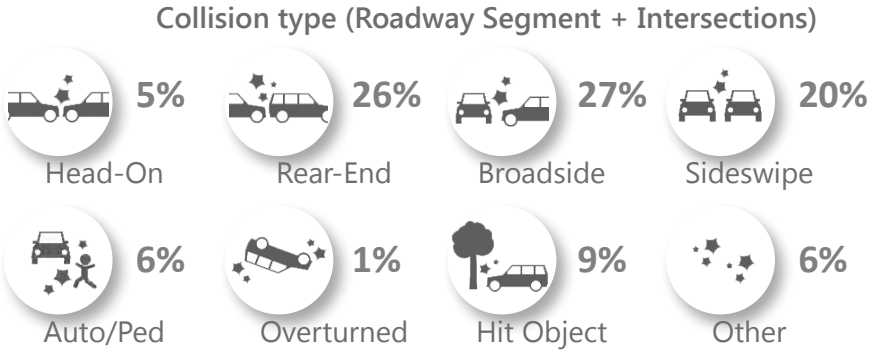


Figure 4-1: Collisions by Facility Type

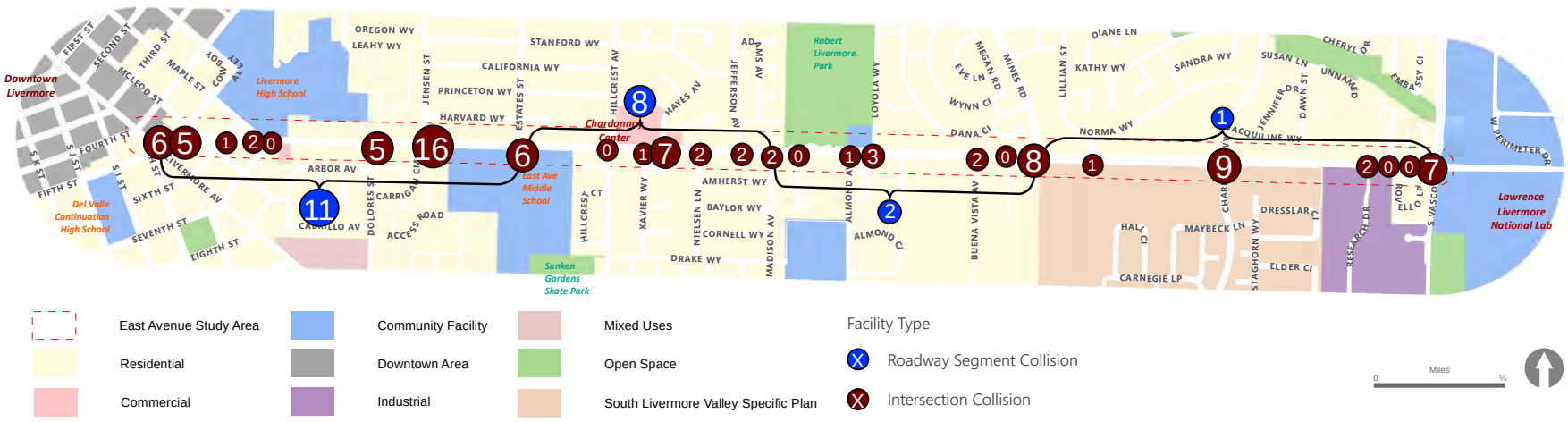
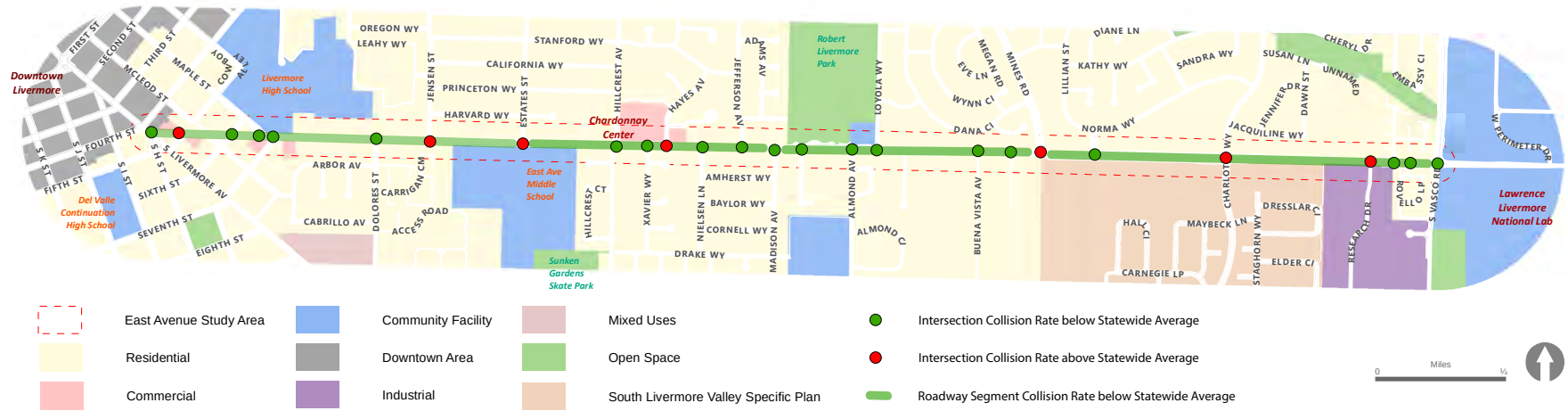


Figure 4-2: Collision Rates by Segment



Bicycle Level of Traffic Stress

This section summarizes the existing conditions performance measure for bicyclists. The Bicycle Level of Traffic Stress (BLTS) approach was used to comprehensively evaluate bicycle facilities and bicycle users' experience. The BLTS approach quantifies the amount of discomfort that people feel when bicycling. It assigns a numeric stress level to roadway segments and intersections based on attributes such as motor vehicle speed, volume, number of lanes, lane blockage, on-street parking, and ease of intersection crossing. BLTS 1 represents a facility type that is suitable for all types of cyclists including children, while BLTS 4 represents a high amount of traffic stress. BLTS patterns are mapped spatially with the purpose of identifying opportunities for infrastructure improvements. The BLTS analysis for East Avenue computed both road segments and intersections to obtain a comprehensive assessment of the street network comfort.

The BLTS analysis for East Avenue results are summarized below in Figures 4-3 and 4-4. The analysis concluded that the higher priority needs to be provided to the segments west of Madison Ave. Only one intersection has a BLTS of 4, the intersection of Mitra Street and East Avenue, meaning it is relatively high-stress for bicycling. Roadway segments between Madison Avenue and South Vasco Road have slightly better conditions for biking. These results suggest that segment and intersection improvements are needed for East Avenue to be comfortable for all ages and abilities to bike along. The major factors that might be considered leading to the poor BLTS levels are lack of bicycle facilities, presence of on-street parking, higher speeds, and lack of median refuge. The detailed BLTS analysis memorandum is provided in the Appendix 5.

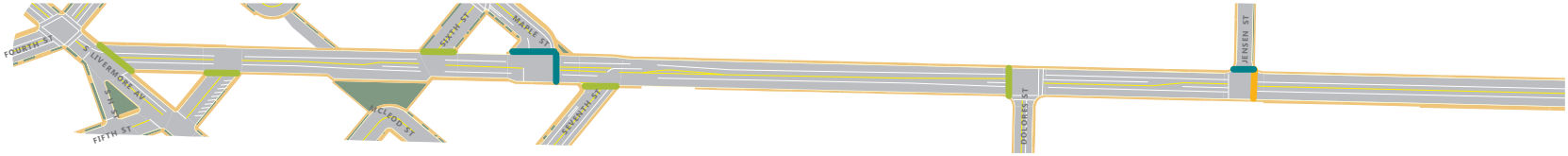
According to the National Association of City Transportation Officials' (NACTO) Designing for All Ages & Abilities Guidelines, roadways like East Avenue with over 6,000 average daily traffic and posted speed limit over 25 MPH-require a protected bicycle lane or a buffered bike lane in order to safely accommodate people of all ages and abilities.

Figure 4-5 shows the bicycle and pedestrian counts during the vehicle peak hour. This data is for informational purposes only, as the bicycling and walking peak hour can vary from the vehicle peak hour. Additionally, as per the Caltrans Bikeway Facility Selection Guidance, the bikeway facility selection is not dependent on the existing bicycle counts. Due to the lack of bicycle facility or high stress corridor, most users are discouraged from using the corridor. These counts could be used for monitoring the success of the future facility.

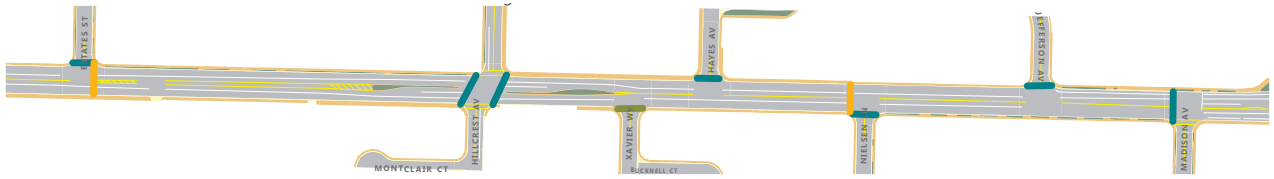
Figure 4-3: Bicycle Level of Traffic Stress - Roadway Segments

Figure 4-4: Bicycle Level of Traffic Stress - Intersections

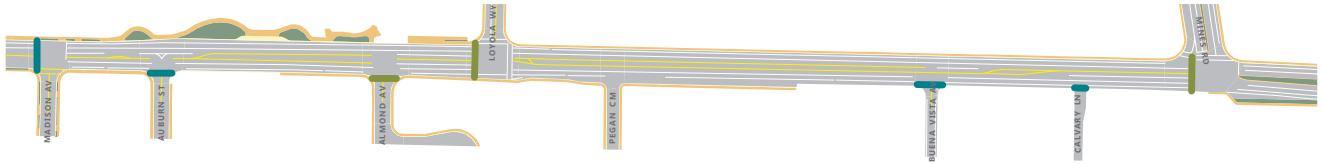
Segment 1: N. Livermore Ave to Estates St



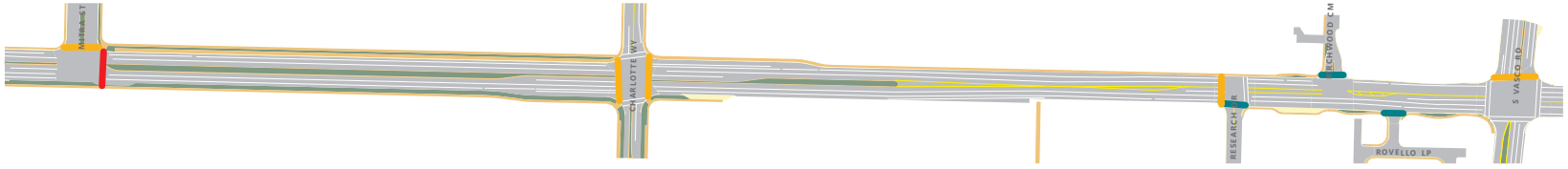
Segment 2: Estates St to Madison Ave



Segment 3: Madison Ave to N. Mines Rd



Segment 4: N. Mines Rd to S. Vasco Rd



LTS 1 LEAST STRESSFUL

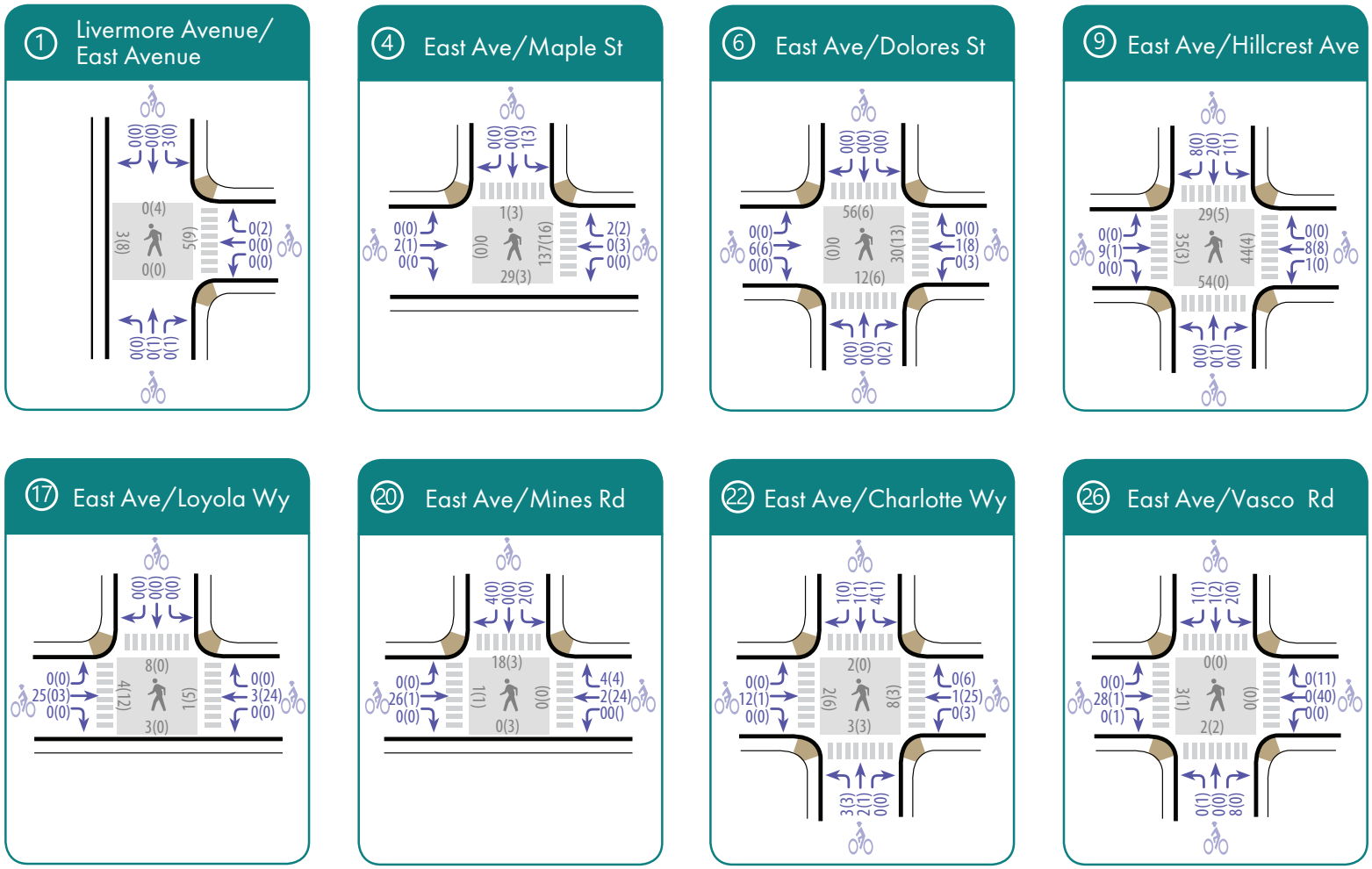
LTS 2

LTS 3

LTS 4 MOST STRESSFUL

Feet
0 200
Date: 8/24/2021

Figure 4-5: Bicycle and Pedestrian Counts at Major Intersections



Note: The bicycle and pedestrian counts were collected during 2018 and 2019.

Pedestrian Evaluation

This section summarizes the existing conditions performance measure for pedestrians. Two different approaches were used to comprehensively evaluate pedestrian facilities, Pedestrian Level of Service (PLOS) approach and the Pedestrian Level of Traffic Stress (PLTS) approach. The PLOS methodology evaluates both road segments and signalized intersection, and PLTS for unsignalized intersections.

PLOS is a quantitative measure that predicts travel perceptions of quality of service and performance indicators. This performance indicator is expressed as a letter grade A-F, with A representing exceptional performance and F representing degraded performance. The Highway Capacity Manual (HCM) 6th edition details the method used to calculate PLOS for road segments and intersections. While the full PLOS method as published in the HCM 6th edition offers a robust quantitative analysis, the following analysis uses a modified version developed by the Oregon Department of Transportation (ODOT). This simplified version of the HCM methods eliminates the onerous and data-intensive parts of the calculations, while still providing a comprehensive quantitative analysis that can compare alternatives.

The results of the PLOS signalized intersection is presented in Table 4-2. PLOS for signalized intersections take many factors into account to estimate pedestrian perception such as crossing distance, presence of a median refuge island, left turn and right turn conflicts, corner radius, and estimated pedestrian delay. To score each intersection, characteristics of each pedestrian leg is computed and then averaged for the intersection. Among all the signalized intersections, East Avenue and Vasco Road scored the least with an LOS E, largely due to the long crossing distance and the many travel lanes pedestrians must cross. The intersection of East Avenue and Maple Street scored the highest on the corridor, mainly due to the large pedestrian refuge island and lack of left-turn conflicts for the southbound leg.

Table 4-2: Pedestrian LOS Signalized Intersection Results Summary

#	Intersection Name	PLOS	Score
1	East Avenue and South Livermore Avenue/ H Street	D	50
2	East Avenue and Maple Street	B	82
3	East Avenue and Dolores Street	D	54
4	East Avenue and Hillcrest Avenue	D	51
5	East Avenue and Madison Avenue	C	59
6	East Avenue and Loyola Way	C	58
7	East Avenue and North Mines Road	C	61
8	East Avenue and Charlotte Way	D	40
9	East Avenue and South Vasco Road	E	34

The PLOS segment results are presented below in Table 4-3. The PLOS segment analysis takes into account sidewalk width, posted vehicle travel speeds, and the adjacent road volume. The results show that pedestrian experience is average on the majority of the corridor but degrades towards the east end of the corridor as the speed limit increases.

In addition to the PLOS calculations, a PLTS analysis was also performed for the uncontrolled pedestrian crossings. These crossings are of particular importance to pedestrian safety, comfort, and experience. A different methodology was used for the uncontrolled crossings because the PLOS methodology is not applicable to unsignalized intersections. Table 4-4 presents the results of this calculation. Most crossings have PLTS 3, except the East Avenue and Mitra Street east leg crossing which has a PLTS 4. The Mitra Street crossing is rated as lower than the other crossing largely because

Table 4-3: Pedestrian LOS Segment Results Summary

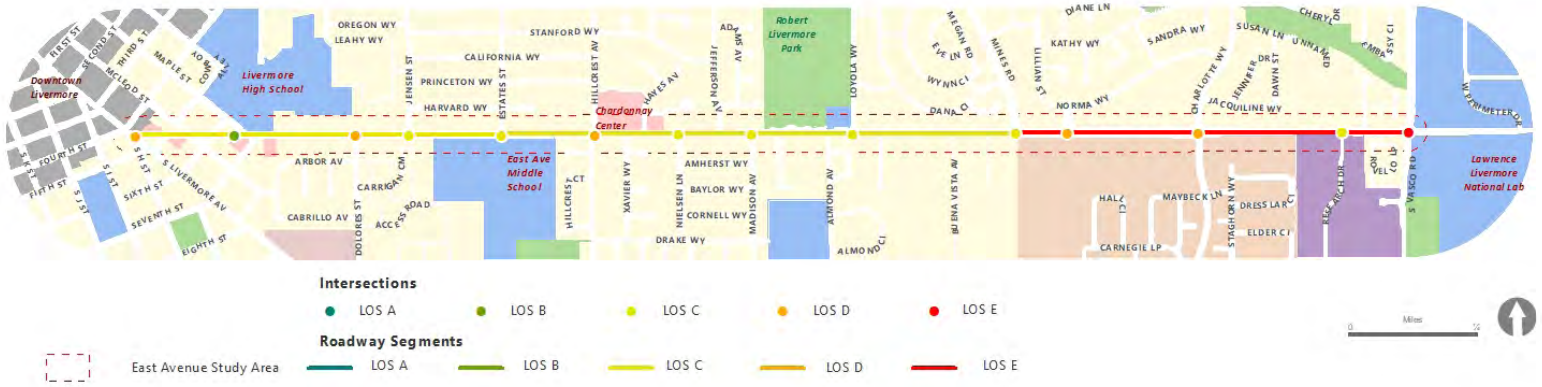
#	Segment	No. of Travel Lanes	Posted Speed Limit (mph)	PLOS
1	S Livermore Avenue to Estates Street	4	30	C
2	Estates Street to Madison Avenue	4	30	C
3	Madison Avenue to N Mines Road	4	30/40	C
4	N Mines Road to S Vasco Road	4	40	E

it lacks a rectangular flashing beacon (RRFB) which is present on all other major uncontrolled crossings. The combined results for intersections and roadway segments is presented in Figure 4-6. The summary and Pedestrian LOS calculation table is provided in the Appendix 6.

Table 4-4: Pedestrian LTS for Major Uncontrolled Crossings

#	Intersection	Prevailing Speed (mph)	Average Daily Traffic	Lanes	Treatments	PLTS
1	East Avenue and Jensen Street	36	21,269	4	RRFB, Markings	3
2	East Avenue and Estates Street	36	21,269	4	RRFB, Markings	3
3	East Avenue and Nielsen Lane	36	17,842	4	RRFB, Markings	3
4	East Avenue and Mitra Street	44	17,842	4	Median Refuge, Signage	4
5	East Avenue and Research Drive	44	11,032	5	RRFB, Markings	3

Figure 4-6: Pedestrian Level of Service



Transit Level of Service

This section summarizes the existing conditions performance measures for transit users. The Transit LOS methodology and a bus stop amenities inventory was used to comprehensively evaluate transit user experiences.

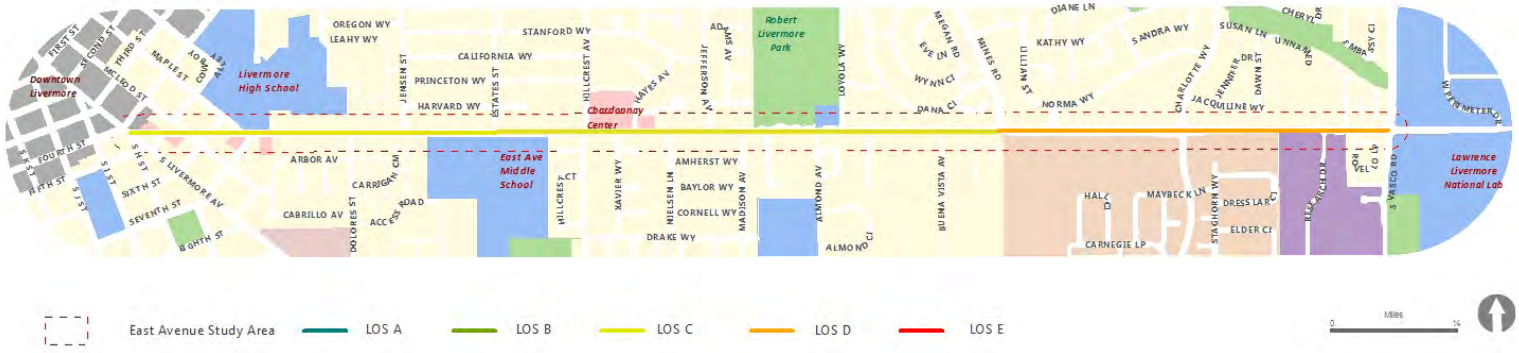
Transit LOS is a subsection of the Multimodal LOS methodology detailed in the HCM 6th edition. The following analysis uses a modified version developed by the Oregon Department of Transportation (ODOT). Transit LOS score results are presented below in Table 4-5 and Figure 4-7. The transit LOS is similar throughout the corridor as the main transit performance factors remain constant, i.e. scheduled speed and transit frequency. The transit LOS analysis also takes into account the pedestrian segment LOS segment score, so as pedestrian segment LOS degrades N. Mines Road to Vasco Road, so does transit LOS.

In addition to the Transit LOS methodology, an inventory of the existing bus stops was collected. While most bus stops have many amenities such as benches, trash cans, shelters and real-time information, some bus stops lack such amenities. The bus stop amenity inventory also includes the current bus stop spacing. The bus provider Livermore Amador Valley Transit Authority (LAVTA) has a bus stop spacing policy detailed in the Short Range Transit Plan 2008-2017 that states the agency's desired spacing is 0.33 miles or 1,760 feet. Most of the bus stops along this corridor are close to that goal.

Table 4-5: Transit LTS Segment Results Summary

#	Segment	Scheduled Speed (mph)	Frequency (Veh/hr)	Ped LOS	Transit LOS
1	S Livermore Avenue to Estates Street	20	2	C	C
2	Estates Street to Madison Avenue	20	2	C	C
3	Madison Avenue to N Mines Road	20	2	C	C
4	N Mines Road to S Vasco Road	20	2	D	D

Figure 4-7: Transit Level of Service



Traffic Operations Analysis

Data Collection

As the COVID-19 pandemic limited our ability to collect new traffic counts, the study developed a traffic volume methodology to obtain traffic volumes for pre-pandemic conditions.

The study uses traffic counts that were available from the previous projects (2018 and 2019) for most signalized intersections as shown in Figure 4-8. New a.m. and p.m. peak hour traffic movement counts were also collected at all the intersections on the corridor during September 2020. In accordance with the City, 14 study intersections were selected as it was determined those intersections would reflect a more realistic LOS. These counts were then factored in to bring them to pre-pandemic levels. Additionally, Big Data (Streetlight Data) was referenced for both current and historical counts. Finally, minor adjustments were done to the traffic volumes to address any discrepancies between adjacent locations.

Level of Service Methodology

Level of Service (LOS) is a qualitative measure that describes operational conditions as they relate to the traffic stream and perceptions by motorists and passengers. The LOS generally describes these conditions in terms of such factors as speed and travel time, delays, freedom to maneuver, traffic interruptions, comfort, convenience and safety. The operational LOS are given letter designations from A to F, with A representing the free-flow operating conditions and F representing the severely congested flow with high delays. Typically, LOS C/D is considered as an ideal condition as it represents stable flow and efficient use of transportation facility.

City of Livermore Notable Impact Criteria

According to the City's adopted 2004 General Plan (Circulation element, amended 2014), the intersection LOS standard for signalized intersections is mid-level D (up to 45 seconds of average vehicle delay), except in the Downtown Area and near freeway interchanges where LOS E is acceptable. The intersection standard for all-way stop-controlled intersections is mid-level E (up to 45 seconds of average vehicle delay). The intersection standard for one-way or two-way stop controlled intersections is up to 90 seconds of average delay for the critical movement.

A signalized or all-way stop-controlled intersection already operating at an unacceptable LOS would experience a notable impact if the addition of project traffic would increase average delay by five seconds or more, and project traffic increases the overall v/c value by 0.03 or more, or increases the critical v/c value by 0.05 or more. A one-way or side-street stop-controlled intersection operating at an unacceptable LOS would experience a notable impact if the project increases the critical v/c value by 0.05 or more.

Signalized Intersections

The study intersections under traffic signal control were analyzed using the HCM 6th Operations Methodology for signalized intersections, where applicable. This methodology determines LOS based on average control delay per vehicle for the overall intersection during peak hour intersection operating conditions. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay.

Unsignalized Intersections

The study intersections under stop control (unsignalized) were analyzed using the HCM 6th Operations Methodology for unsignalized intersections). LOS ratings for stop-sign controlled intersections are

based on the average control delay expressed in seconds per vehicle. At the side street, controlled intersections or two-way stop sign intersections, the control delay is calculated for each movement, not for the intersection as a whole. For approaches composed of a single lane, the control delay is computed as the average of all movements in that lane. The weighted average delay for the entire intersections is presented for all-way stop controlled intersections.

The intersection LOS at signalized and unsignalized intersections were calculated using Synchro software. It should be noted that if the upstream intersection is operating overcapacity, the metered arrival rate at the downstream intersection will be less than the volume for the intersection. Since metering is performed only with the 95th percentile queue, the 95th percentile queue may be less than the 50th percentile queue at the downstream intersection. Hence the LOS at the intersection may not represent the congestion at the intersection in the field.

Intersection LOS Analysis – Existing Conditions

Existing intersection lane configurations, peak hour turning movement volumes, and existing signal timings were used to calculate the level of service (LOS) at the study intersections during the peak hours. The results of the LOS analysis using the Synchro 10.0 software program for Existing Conditions are summarized in Table 4-6 and Figure 4-9. Under Existing Conditions, all study intersections operate within the acceptable LOS thresholds adopted by the City of Livermore. LOS worksheets are available in Appendix 8. Figure 4-10 illustrates the existing a.m. and p.m. peak hour turning movement volumes at the study intersections.

Figure 4-8: Intersection Data Collection Year

Figure 4-9: Vehicle Level of Service - Existing Conditions

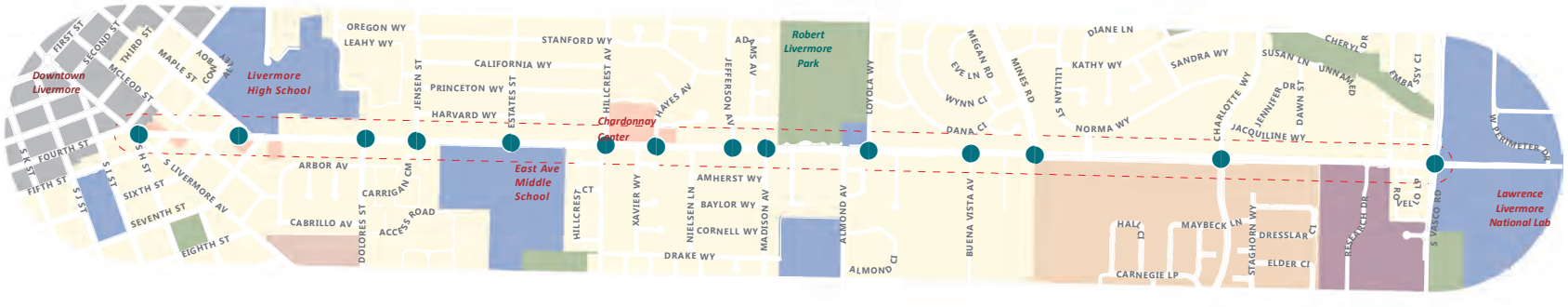
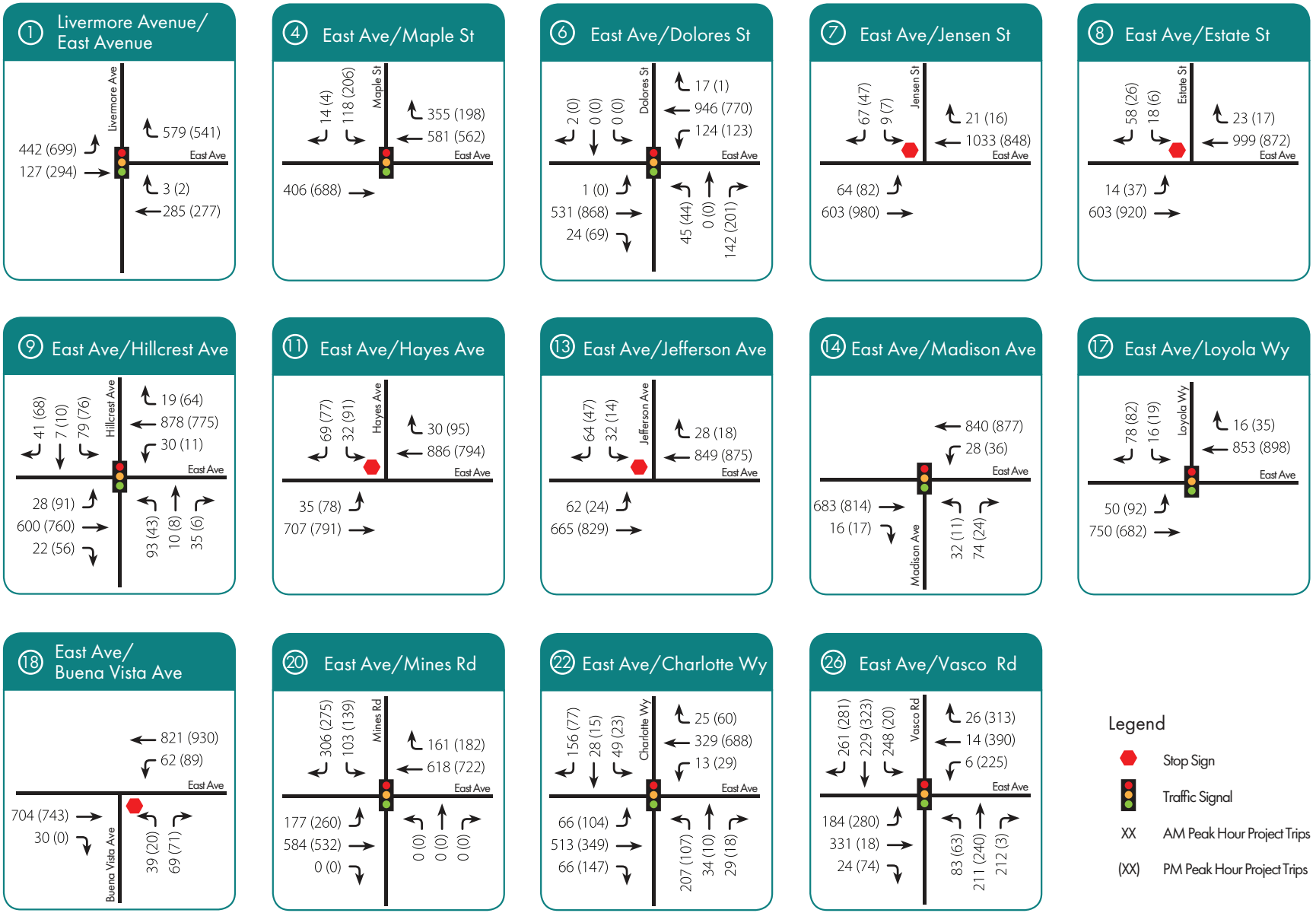


Table 4-6: Vehicle Level of Service - Existing Conditions

#	Intersection	Control	Peak Hour	Livermore LOS Standard	Delay	LOS
1	North Livermore Avenue and East Avenue	Signal	A.M.	Mid LOS D (45.0 sec)	24.3	C
			P.M.		22.5	C
4	East Avenue and Maple Street	Signal	A.M.	Mid LOS D (45 sec)	17.7	B
			P.M.		12.1	B
6	East Avenue and Dolores Street	Signal	A.M.	Mid LOS D (45 sec)	13.6	B
			P.M.		13.0	B
7	East Avenue and Jensen Street	One-Way Stop	A.M.	Less than 90.0 sec	21.3	C
			P.M.		19.4	C
8	East Avenue and Estate Street	One-Way Stop	A.M.	Less than 90.0 sec	17.5	C
			P.M.		14.6	B
9	East Avenue and Hillcrest Avenue	Signal	A.M.	Mid LOS D (45 sec)	27.6	C
			P.M.		17.5	B
11	East Avenue and Hayes Avenue	One-Way Stop	A.M.	Less than 90.0 sec	18.7	C
			P.M.		34.5	D
13	East Avenue and Jefferson Avenue	One-Way Stop	A.M.	Less than 90.0 sec	18.5	C
			P.M.		15.5	C
14	East Avenue and Madison Avenue	Signal	A.M.	Mid LOS D (45 sec)	3.9	A
			P.M.		2.5	A
17	East Avenue and Loyola Way	Signal	A.M.	Mid LOS D (45 sec)	7.6	A
			P.M.		10.5	B
18	East Avenue and Buena Vista Avenue	One-Way Stop	A.M.	Less than 90.0 sec	17.3	C
			P.M.		15.6	C
20	East Avenue and North Mines Road	Signal	A.M.	Mid LOS D (45 sec)	15.8	B
			P.M.		19.1	B
22	East Avenue and Charlotte Way	Signal	A.M.	Mid LOS D (45 sec)	15.5	B
			P.M.		12.4	B
26	East Avenue and Vasco Road	Signal	A.M.	Mid LOS D (45 sec)	24.1	C
			P.M.		33.9	C

Note: 1. LOS = Level of Service;
2. Average intersection delay expressed in seconds per vehicle for signalized intersections and all way stop controlled intersections. Total control delay for the worst approach is presented for side-street stop controlled intersections.

Figure 4-10: Existing Conditions Traffic Volumes



Intersection LOS Analysis – Future Conditions (2040)

Existing intersection lane configurations, peak hour turning movement volumes, and optimized signal timings were used to calculate the level of service (LOS) at the study intersections during the peak hours. The traffic growth percentage was calculated using various data sources and methods to determine an appropriate growth percentage (30 percent) along the corridor, see Appendix 7.

The results of the LOS analysis for Future Conditions are summarized in Table 4-7 and Figure 4-11. Under Future Conditions, all study intersections operate within the acceptable LOS thresholds adopted by the City of Livermore except the signalized intersection of East Avenue and Vasco Road during the p.m. peak hour. LOS worksheets are available in Appendix 9. Figure 4-12 illustrates the future a.m. and p.m. peak hour turning movement volumes at the study intersections.

Table 4-7: Vehicle Level of Service - Future Conditions (2040)

#	Intersection	Control	Peak Hour	Livermore LOS Standard	Future (2040)	
					Delay[1]	LOS[2]
1	North Livermore Avenue and East Avenue	Signal	A.M.	Mid LOS D (45.0 sec)	24.3	C
			P.M.		20.5	C
4	East Avenue and Maple Street	Signal	A.M.	Mid LOS D (45 sec)	17.6	B
			P.M.		14.2	B
6	East Avenue and Dolores Street	Signal	A.M.	Mid LOS D (45 sec)	16.3	B
			P.M.		18.3	B
7	East Avenue and Jensen Street	One-Way Stop	A.M.	Less than 90.0 sec	37.8	E
			P.M.		31.8	D
8	East Avenue and Estate Street	One-Way Stop	A.M.	Less than 90.0 sec	24.0	C
			P.M.		18.5	C
9	East Avenue and Hillcrest Avenue	Signal	A.M.	Mid LOS D (45 sec)	28.2	C
			P.M.		21.1	C
11	East Avenue and Hayes Avenue	One-Way Stop	A.M.	Less than 90.0 sec	26.0	D
			P.M.		70.2	F
13	East Avenue and Jefferson Avenue	One-Way Stop	A.M.	Less than 90.0 sec	25.3	D
			P.M.		19.6	C
14	East Avenue and Madison Avenue	Signal	A.M.	Mid LOS D (45 sec)	4.6	A
			P.M.		2.6	A
17	East Avenue and Loyola Way	Signal	A.M.	Mid LOS D (45 sec)	6.5	A
			P.M.		11.1	B

Table 4-8 (Continued): Vehicle Level of Service - Future Conditions (2040)

#	Intersection	Control	Peak Hour	Livermore LOS Standard	Future (2040)	
					Delay[1]	LOS[2]
18	East Avenue and Buena Vista Avenue	One-Way Stop	A.M.	Less than 90.0 sec	27.1	D
			P.M.		20.1	C
20	East Avenue and North Mines Road	Signal	A.M.	Mid LOS D (45 sec)	15.6	B
			P.M.		23.6	C
22	East Avenue and Charlotte Way	Signal	A.M.	Mid LOS D (45 sec)	16.6	B
			P.M.		12.5	B
26	East Avenue and South Vasco Road	Signal	A.M.	Mid LOS D (45 sec)	26.6	C
			P.M.		**45.2**	**D**

Note: 1. LOS = Level of Service;
2. Average intersection delay expressed in seconds per vehicle for signalized intersections and all way stop controlled
intersections. Total control delay for the worst approach is presented for side-street stop controlled intersections.
Bold indicates intersections that operate at a deficient Level of Service.

Figure 4-11: Vehicle Level of Service - Future Conditions (2040)

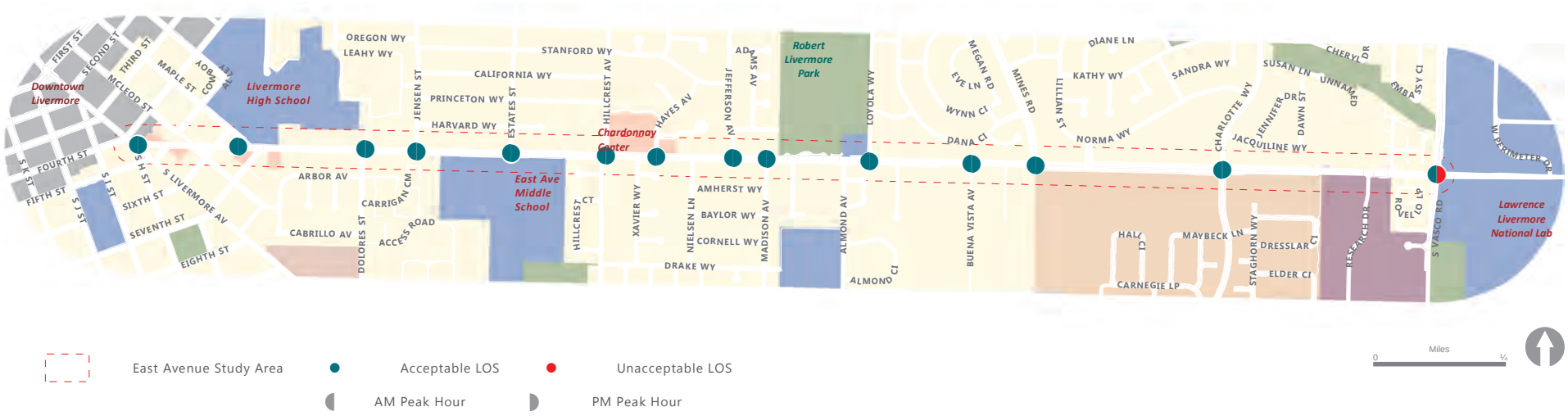
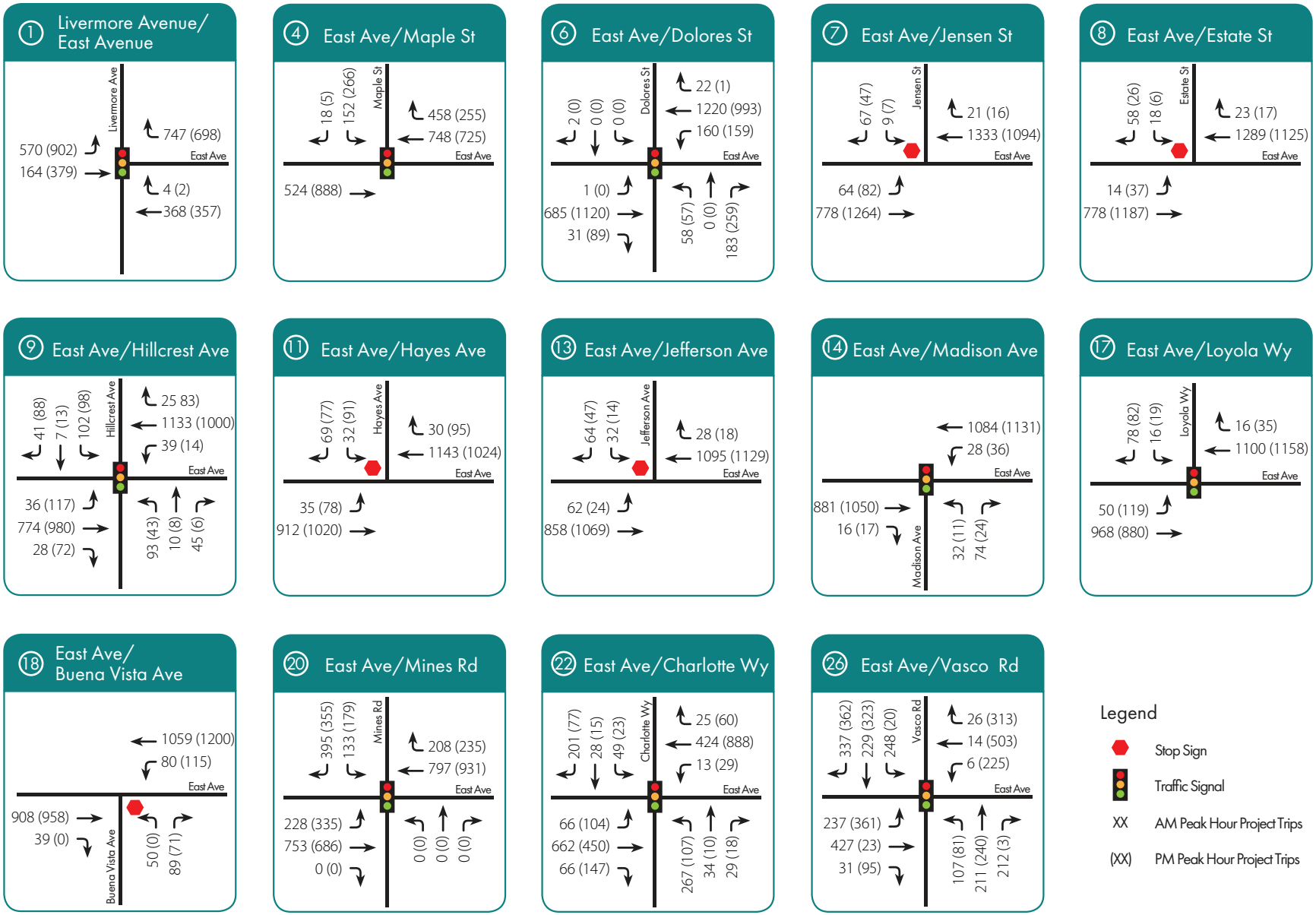


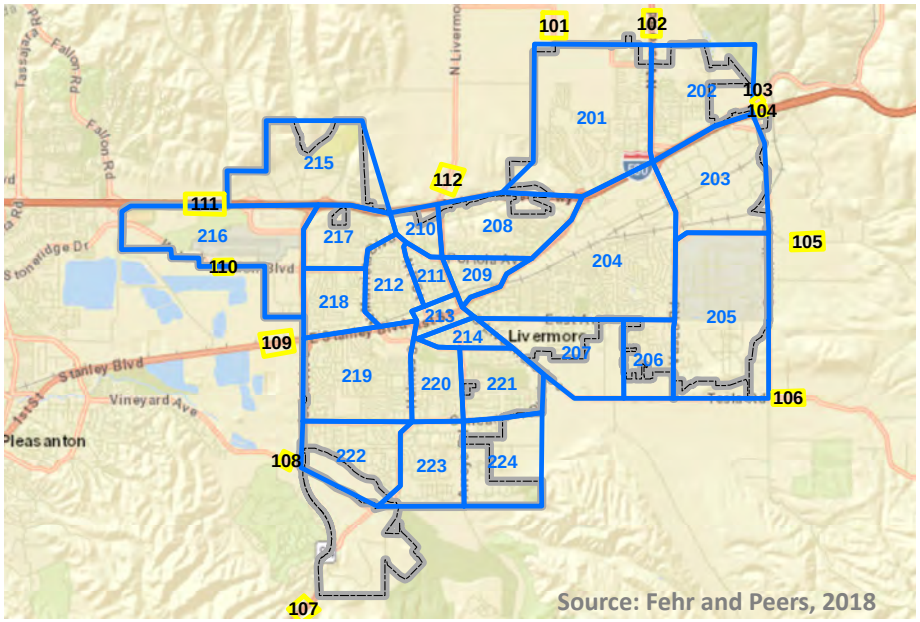
Figure 4-12: Future Conditions (2040) Traffic Volumes



East Avenue Regional Traffic Analysis

The City of Livermore conducted an origin-destination analysis using Transportation Analysis Zones (TAZs) in Fall 2018 for major roadways to estimate the number of regional trips.

The data shows that only 2-3% of the daily traffic on East Avenue is regional traffic. The data also shows over 75% of the East Avenue daily trips are from Zone 204 (north of East Avenue) and Zones 206 and 207 (south of East Avenue) .

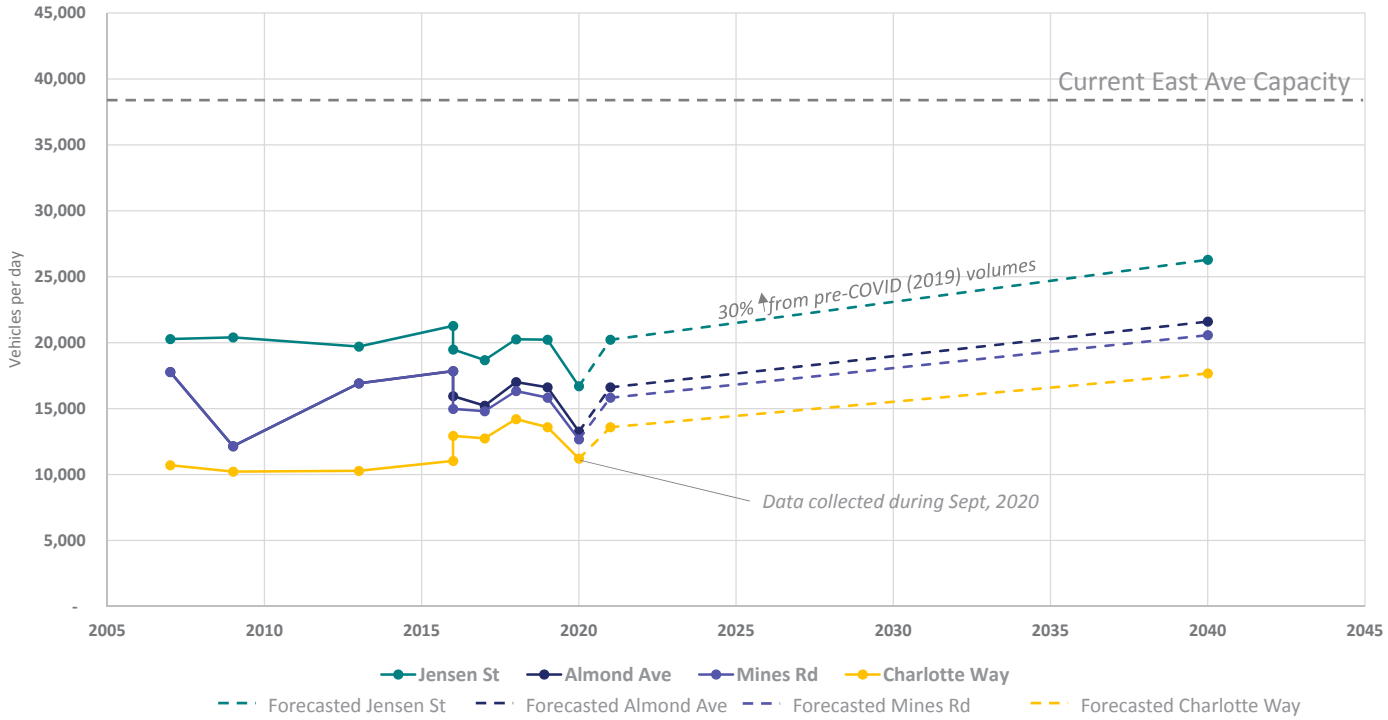


Midblock Traffic Volumes

Knowledge of existing and future midblock or segment traffic volumes expressed as Average Daily Traffic (ADT) can also help in developing recommendations for alternative improvements. Typically a four-lane road with left-turn lanes can carry up to 36,800 vehicles per day (vpd)[1]. With proper signal coordination and optimization, that carrying capacity can be increased up to 40,000 vpd. The Federal Highway Administration (FHWA) advises that roadways with ADT of 20,000 vpd or less may be good candidates for a road diet and should be evaluated for feasibility. However, many agencies throughout the nation have considered road diet for roadways with ADTs equivalent to 25,000 vpd.

The average daily traffic trend and forecasting was conducted for East Avenue near four major locations, i.e. Jensen Street, Almond Avenue, North Mines Road and Charlotte Way. The data was collected using the historical traffic volumes available with the City and Streetlight Data. The future (2040) traffic volumes were determined using various data sources and methods including Alameda County Transportation Commission (Alameda CTC) Travel Demand Model, See Appendix 7. The results are shown below in Figure 4-13.

Figure 4-13: Average Daily Traffic Trend and Forecast



Source: 2005-2016 City of Livermore Traffic Counts; 2016 – 2020 Streetlight Data (Big Data);
Note: Streetlight Data has several limitations and caution must be exercised before drawing any conclusions

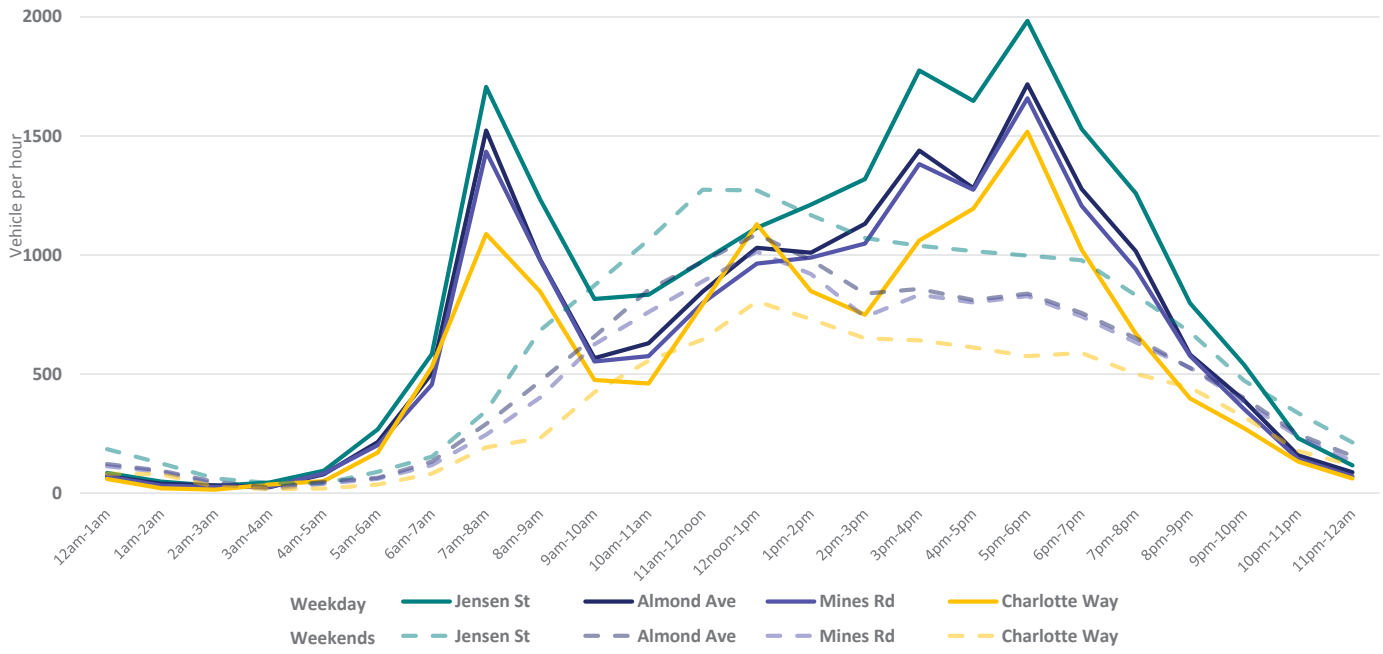
[1]*Source: Simplified Highway Capacity Calculation Method for the Highway Performance Monitoring System, FHWA, October 2017*

Hour-by-Hour Analysis

Streets designed for peak intervals of traffic flow may relieve rush-hour congestion but may fail to provide a safe and attractive environment during other portion of the day. ADT and peak volumes alone do not reveal a streets' utilization. Ideally, a single motor vehicle travel lane carry up to 1,900 vehicle per hour[2]. However, due to various factors such as geometric characteristics of the road, traffic characteristics such as presence of trucks and public buses can have an impact on the roadway capacity. The *Highway Capacity Manual* recommends a capacity of 860 vehicle per hour per lane for urban arterial road with the free flow speed of 35 mph. Based on that, East Avenue has a current capacity of 3,440 vehicle per hour. From the operational point of view, FHWA suggests that road diet is feasible at or below 750 vehicle per lane per direction, assuming a 50/50 directional split and 10 percent of the ADT during the peak hour.

Figure 4-14 shows the bi-directional hourly traffic distribution for East Avenue at various locations under pre-covid conditions. It is evident that the traffic peaks up during the normal rush hours and school departure.

Figure 4-14: Hourly Traffic Volume Distribution



Source: Streetlight Data, 2019

Note: Streetlight Data has several limitations and caution must be exercised before drawing any conclusions

[2]*Source: Procedures for Estimating Highway Capacity- HPMS Field Manual, FHWA, June 2017*

Street Lighting Lumen Study

Streetlighting along the study corridor consists of 72 LED cobra-head style fixtures (for roadway lighting) all mounted on either power-utility owned wood poles or Caltrans Type 15 type galvanized metal poles.

These fixtures are generally mounted on either 8-ft or 12-ft luminaire arms at an approximately 30-ft height level relative to the roadway surface. Safety lighting at signalized intersections along the study corridor also consist of LED cobra-head style fixtures.

Streetlight fixtures along the project corridor were observed to be comprised of mainly Bridgelux and Leotek Brands fixtures ranging from 29W to 158W for roadway and safety lighting, respectively. Model years of the fixtures are estimated to be at 11-12 years old. The lumen study was performed during June 2020 and the following points were concluded:

- Caltrans Intersection Analysis - Under Caltrans intersection guideline methodology – light levels at 10 of 27 intersections along the project corridor are compliant with Caltrans. The other 17 intersections are sub-standard to the Caltrans methodology.

- Livermore Intersection Guideline Analysis - Under the City of Livermore Downtown Lighting Guideline and Requirements, dated August 7, 2017 – all intersections studied did not meet City lighting guidelines.

- Livermore Roadway Guideline Analysis - Under the City of Livermore Downtown Lighting Guidelines and Requirements, dated August 7, 2017 – the East Avenue roadway does not meet City lighting guidelines for roadways 100%. The highest roadway illuminance reading captured on East Avenue was 0.5 fc whereas the minimum requirement is 0.8 fc.

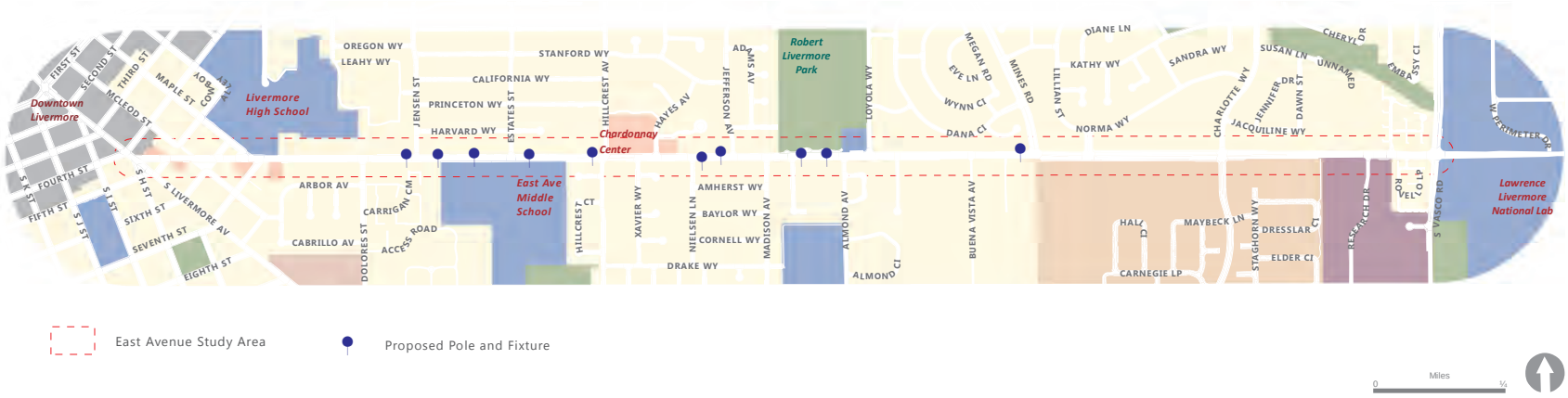
- Livermore Pedestrian and Bikeway Guideline Analysis - Under the City of Livermore Downtown Lighting Guideline and Requirements, dated August 7, 2017 – the pedestrian and bikeway areas were not specifically studied as part of this study as no readings were taken at the sidewalk area; however based on data collected it seems that light levels barely meet the 0.5 fc illuminance for pedestrian and bikeways throughout the corridor.

It is strongly recommended that a formal lighting design for this corridor be performed if City guidelines are to be met.
At a minimum, the following enhancements are recommended:

- Upgrade all existing lighting fixtures to the newer model LED technology;
- Add 10 new streetlight pole locations;

All light readings captured for this study were performed by the illuminance method. No luminance readings were conducted. More details are available in Appendix 10.

Figure 4-15: Lumen Study (Proposed Pole and Fixture Locations)



5. DESIGN CONCEPTS

This chapter describes the four conceptual alternatives prepared for the East Avenue Corridor. These alternatives are based on the community input and understanding of the existing conditions. All the alternatives ensure the provision of buffered bicycle lanes throughout the segment as proposed in the Active Transportation Plan.

The four alternatives are as follows:

- Alternative 1 - Maintains Four Travel Lanes
- Alternative 2 - Partial Road Diet
- Alternative 3 - Road Diet
- Alternative 4 - Hybrid Alternative

Alternative 1 - Maintains Four Travel Lanes

In this alternative, the on-street parking from N. Livermore Avenue to Madison Avenue is replaced with buffered bicycle lanes. The alternative has relatively consistent striping throughout the corridor and has similar vehicular capacity with the existing configuration. However, the eastbound left-turn lane on Sixth Street is converted to a shared through-left turn and might result in rear-end safety concerns. Also, all but eight parking spaces will be removed. The other downside of this alternative is that it cannot accommodate considerable pedestrian crossing enhancements. The enlarged plan is available in Appendix 11.

Figure 5-2: Alternative 1 Cross Sections

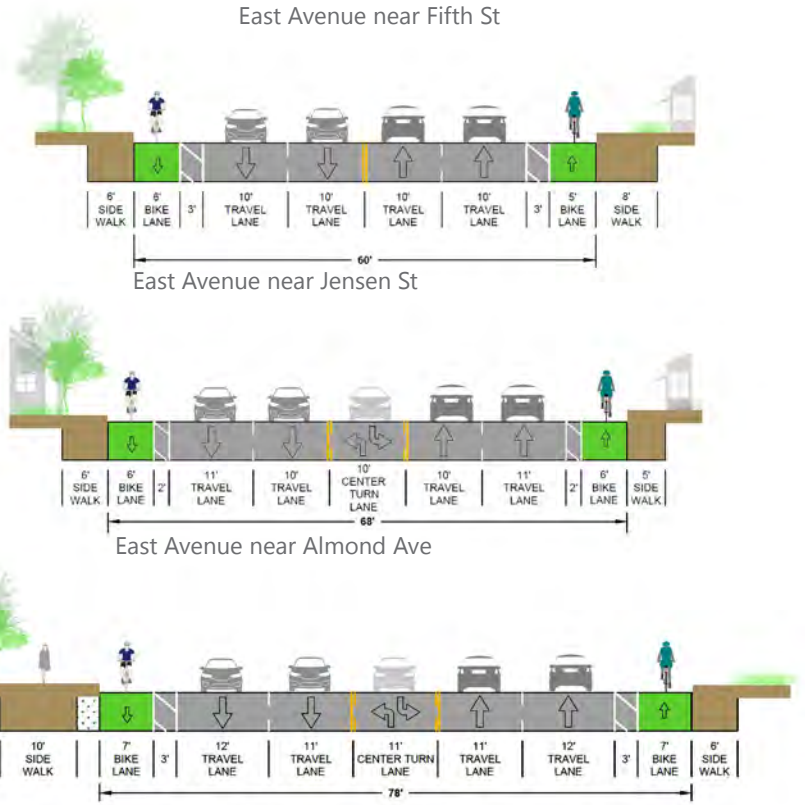
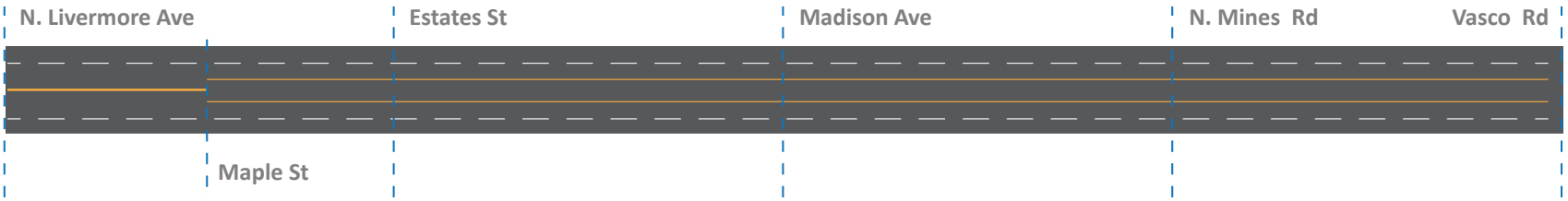


Table 5-1: Alternative 1 Summary

Characteristics	Alternative 1
Number of Travel Lanes	4 (10′ - 12′)
Median/Center Turn Lanes	Center Turn Lane(10′-11′)
Bicycle Lane Class	Buffered Class II
Bicycle Lane Width (ft.)	5′ - 7′
Bicycle Buffer Width (ft.)	2′ - 3′
Sidewalk Width (ft.)	5′ - 8′ (no change)
Pedestrian Crossing Improvements	None
Parking Spaces	8

Figure 5-1: Alternative 1 Lane Allocation Diagram



Driving Conditions

For Alternative 1, all major study intersections operate within the acceptable LOS thresholds adopted by the City of Livermore. As there has been no significant update to the vehicle lane geometry, the LOS results resemble the existing conditions LOS results shown in Chapter 4. The proposed shared through-left turn lane on Sixth Street might cause delays near the Livermore High School area during peak hours. LOS worksheets are available in Appendix 12. The results of the LOS analysis for Existing (2020) and Future (2040) Conditions are summarized in Figures 5-3 and 5-4 respectively.

Figure 5-3: Alternative 1- Vehicle Level of Service (2020)

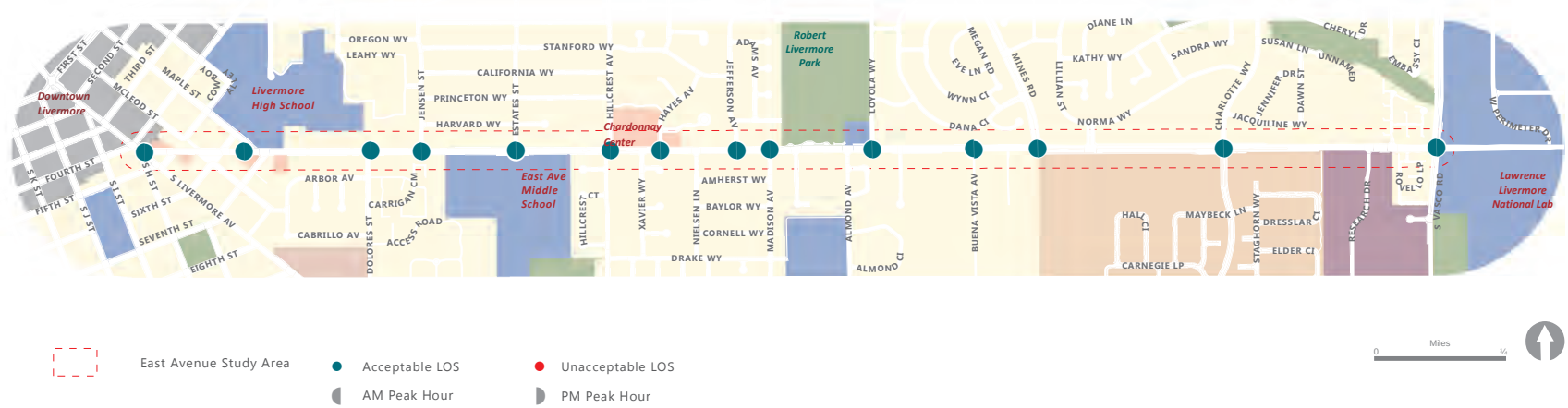
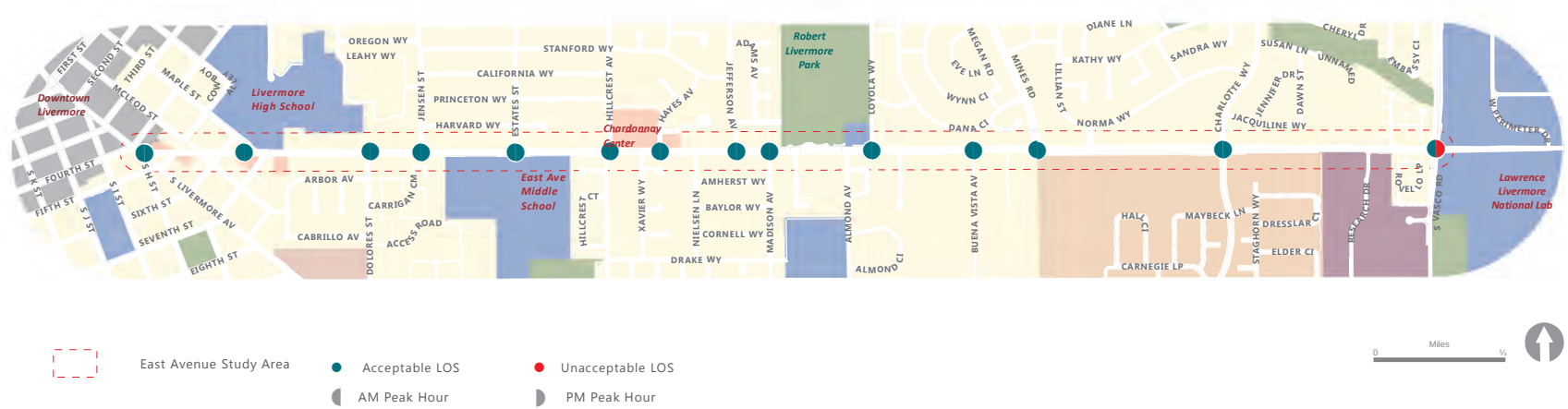


Figure 5-4: Alternative 1- Vehicle Level of Service (2040)



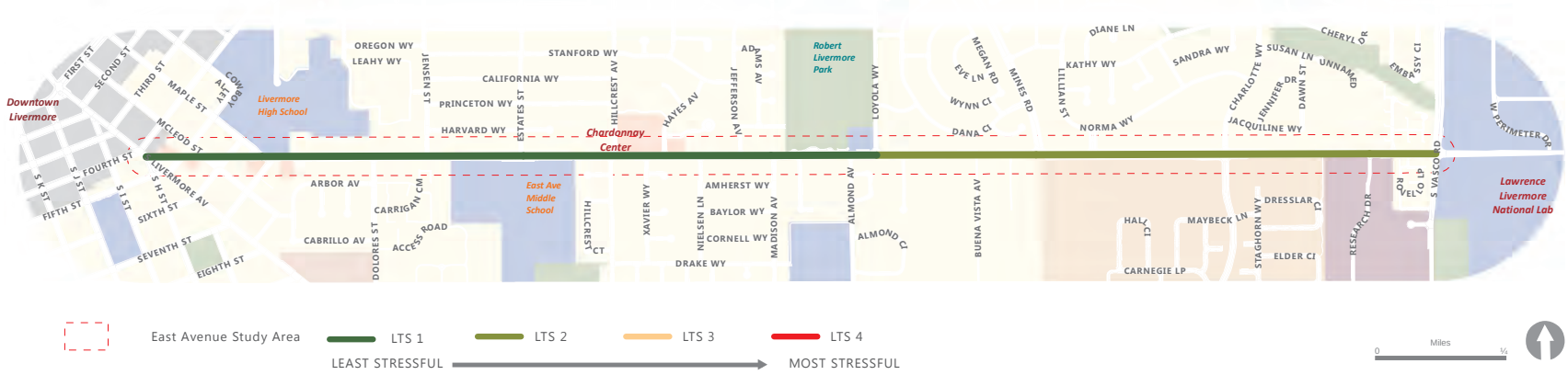
Bicycling Conditions

The bicycling condition is impacted due to various factors such as the proposed bicycle facility, number of lanes, presence of on-street parking and design speed limit. The bicycling condition is anticipated to improve with the addition of buffered bicycle lanes throughout the corridor. The Bicycle Level of Traffic Stress (LTS) evaluation for this alternative shows that the LTS for the segment between North Livermore Avenue to Loyola Way will result in LTS 1 (Low traffic stress) and the segment between Loyola Way to Vasco Road will result in LTS 2 (low-moderate traffic stress). This change can mainly be attributed to the change in the posted speed levels. Figure 5-5 summarizes the segment LTS for alternative 1. LTS calculations and assumptions are summarized in Appendix 13.

Walking Conditions

For walking conditions, it is important to evaluate both intersections as well as along the segment improvements. Pedestrians are more vulnerable at intersections while crossing the streets than along the segments. At intersections, the factors that influence walking condition include type of pedestrian facility, crossing distance, number of lanes and design speed limit. The alternative 1 will not result in significant improvement to walking condition as there has been no change to number of lanes or crossing distance. Similarly, there is no significant improvement on walking conditions along the segment. However, narrower lane widths might result in lowering posted speed which could potentially make the walk more pleasant than under existing conditions.

Figure 5-5: Alternative 1- Bicycle Level of Traffic Stress



Alternative 2 - Partial Road Diet

This alternative starts with a road diet from North Livermore Avenue to Madison Avenue and transitions back to a four-lane configuration as the roadway widens at Madison Avenue. This alternative maintains 198 parking spaces. This alternative also proposes sidewalk widening between Auburn Street and Almond Avenue. The pedestrian crossing is improved using bulbouts. The enlarged plan is available in Appendix 11.

Figure 5-7: Alternative 2 Cross Sections

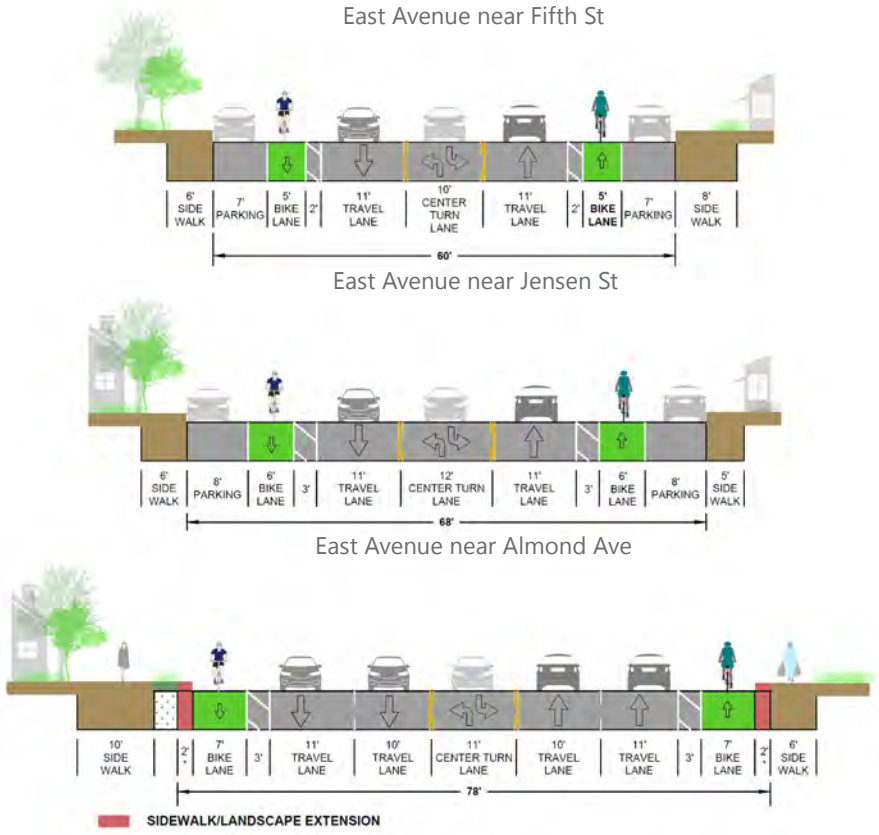
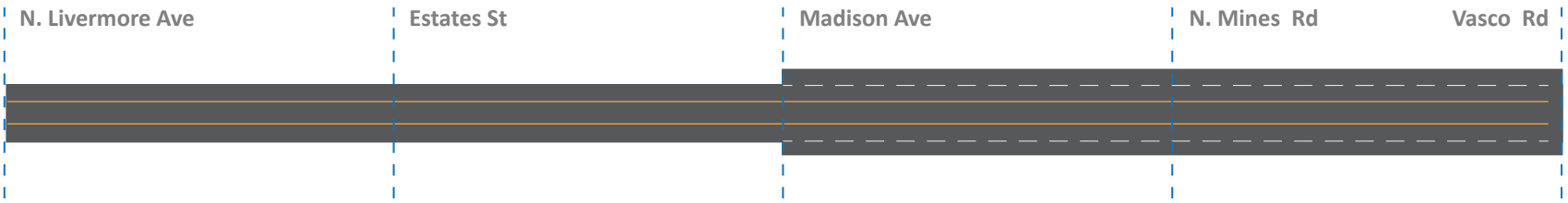


Table 5-2: Alternative 2 Summary

Characteristics	Alternative 2
Number of Travel Lanes	4 and 2 (10′-11′)
Median/Center Turn Lanes	Center turn lane (10′-12′)
Bicycle Lane Class	Buffered Class II
Bicycle Lane Width (ft.)	5′ - 6′
Bicycle Buffer Width (ft.)	2′ - 3′
Sidewalk Width (ft.)	5′ - 10′ (Increases by 2′ in some parts)
Pedestrian Crossing Improvements	Bulbouts
Parking Spaces	198

Figure 5-6: Alternative 2 Lane Allocation Diagram



Driving Conditions

Under alternative 2 existing (2020) conditions, all major study intersections except East Avenue and Hillcrest Avenue operate within the acceptable LOS thresholds. In future (2040) conditions, East Avenue and Dolores Street intersection along with East Avenue and Hillcrest Avenue will operate under unacceptable conditions. East Avenue and Hillcrest Avenue have irregular geometry causing a split-phase at the intersection resulting in higher delays.

LOS worksheets are available in Appendix 12. The results of the LOS analysis using the Synchro 10.0 software program for Existing (2020) and Future (2040) Conditions are summarized in Figures 5-8 and 5-9 respectively.

Figure 5-8: Alternative 2- Vehicle Level of Service (2020)

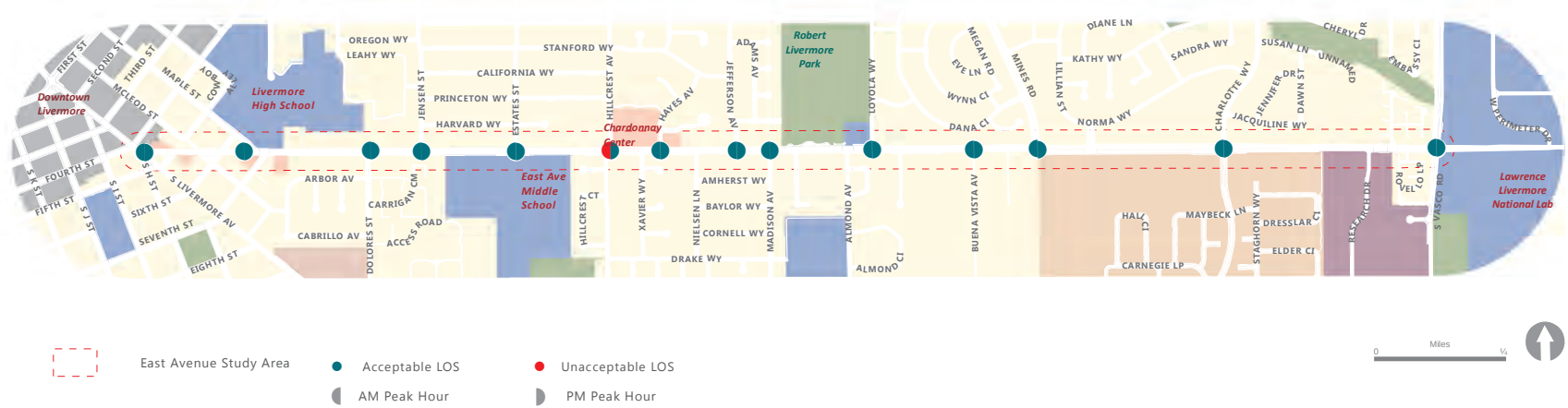
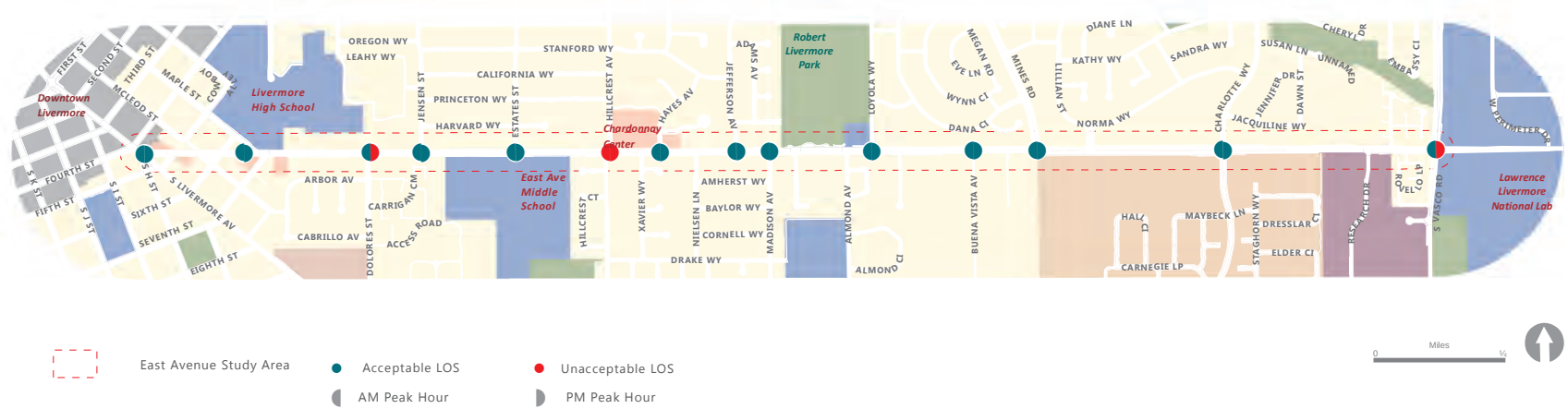


Figure 5-9: Alternative 2- Vehicle Level of Service (2040)



Bicycling Conditions

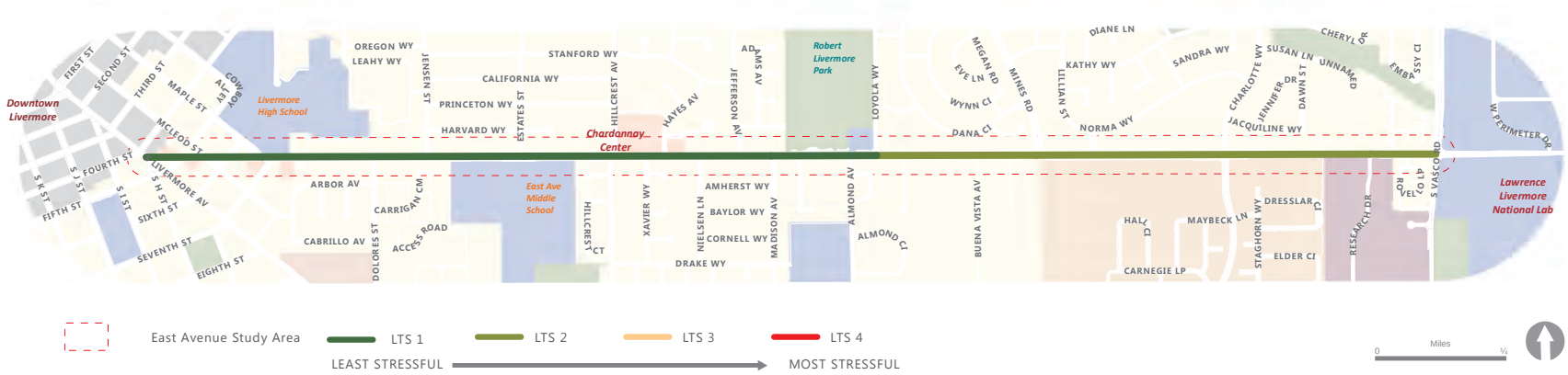
The bicycling conditions under partial road diet alternative will be very similar to alternative 1 in terms of segment LTS analysis. However, bicyclists are likely to be impacted by door zone conflicts. This impact could be mitigated using Dutch Reach and Parking Marking techniques. Dutch Reach is a practice for drivers where, rather than using your hand closest to the door to open it, you use your far hand. This will force the drivers to look in the rear mirror for bicyclists. Marking parking spots will force the drivers to park closer to the curb. This will provide a bicyclist with more space to avoid door zone conflict. Figure 5-10 summarizes the segment LTS for alternative 2. LTS calculations and assumptions are summarized in Appendix 13.

Walking Conditions

Walking conditions are anticipated to improve significantly with the provision of additional sidewalk space along the corridor. This alternative introduces bulbouts on major pedestrian intersection crossings. Bulbouts, also known as curb extensions, extend the sidewalk or curb line out into the parking lane, which reduces the effective street width. Bulbouts significantly improve pedestrian crossings by reducing the pedestrian crossing distance, visually and physically narrowing the roadway, improving the ability of pedestrians and motorists to see each other, reducing the time that pedestrians are in the street, and allowing space for the installation of ADA-compliant pedestrian ramps (pedbikesafe.org).

Marked Parking Space (Source: NACTO)

Figure 5-10: Alternative 2- Bicycle Level of Traffic Stress



Alternative 3 - Road Diet

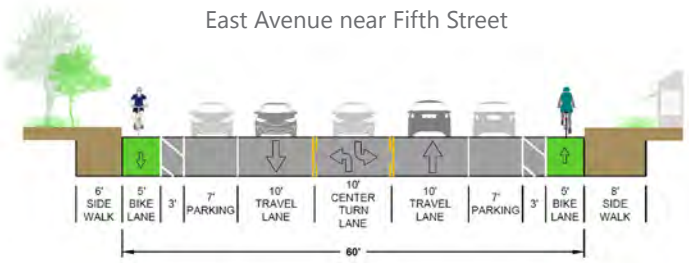
This alternative proposes a road diet throughout the corridor to maintain one travel lane in both directions. This option has the greatest benefits to bicyclists and pedestrians by offering greater buffer sizes and shorter crosswalk distances. The removal of travel lanes will result in significant delays to vehicular traffic during peak periods. This alternative proposes parking protected bike lane configuration. Due to the driveways and intersection sight distance requirements, the alternative will result in 109 parking spaces. The enlarged plan is available in Appendix 11.

Table 5-3: Alternative 3 Summary

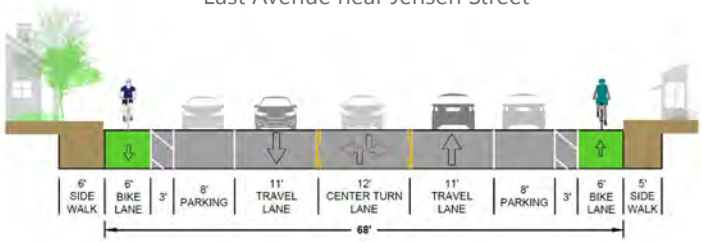
Characteristics	Alternative 3
Number of Travel Lanes	2 (11')
Median/Center Turn Lanes	Center turn lane(12')
Bicycle Lane Class	Class IV (Parking Protected)
Bicycle Lane Width (ft.)	5' - 6'
Bicycle Buffer Width (ft.)	3' - 9'
Sidewalk Width (ft.)	5' - 8' (no change)
Pedestrian Crossing Improvements	Corner Refuge Islands
Parking Spaces	109

Figure 5-12: Alternative 3 Cross Sections

East Avenue near Fifth Street



East Avenue near Jensen Street



East Avenue near Almond Avenue

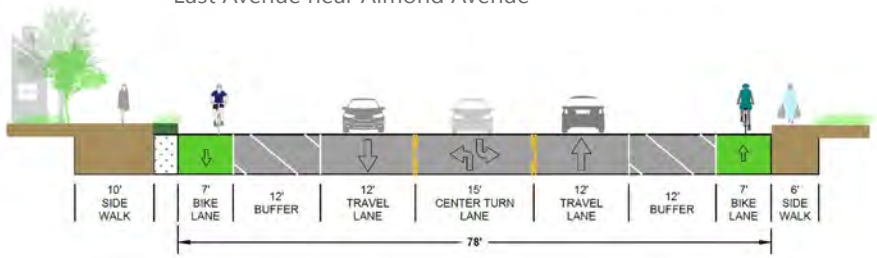
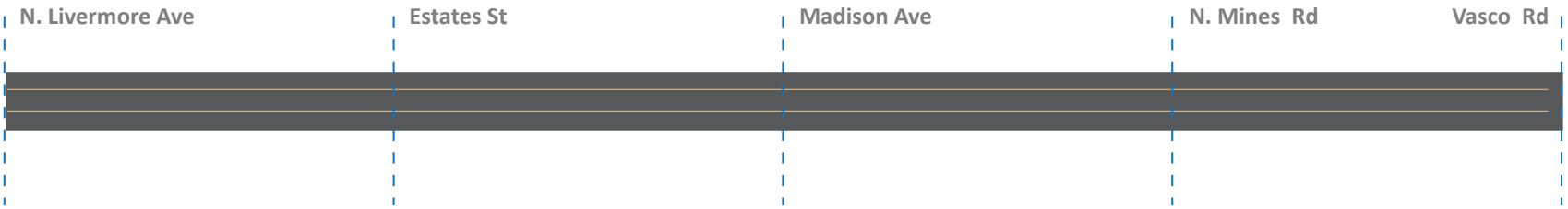


Figure 5-11: Alternative 3 Lane Allocation Diagram



Driving Conditions

Under road diet alternative during existing (2020) conditions, only East Avenue and Hillcrest Avenue intersection will operate at unacceptable LOS. In future (2040) conditions, intersections at Dolores Street, Hillcrest Avenue, Mitra Street and Vasco Road will operate at unacceptable LOS. Signal timing and coordination between adjacent signals will help in mitigating some of the adverse impacts on traffic operations. Additionally, reduction in pedestrian crossing distance was also considered during the analysis, resulting in reduced delays at intersections. LOS worksheets are available in Appendix 12. The results of the LOS analysis using the Synchro 10.0 software program for Existing (2020) and Future (2040) Conditions are summarized in Figures 5-13 and 5-14 respectively.

Figure 5-13: Alternative 3- Vehicle Level of Service (2020)

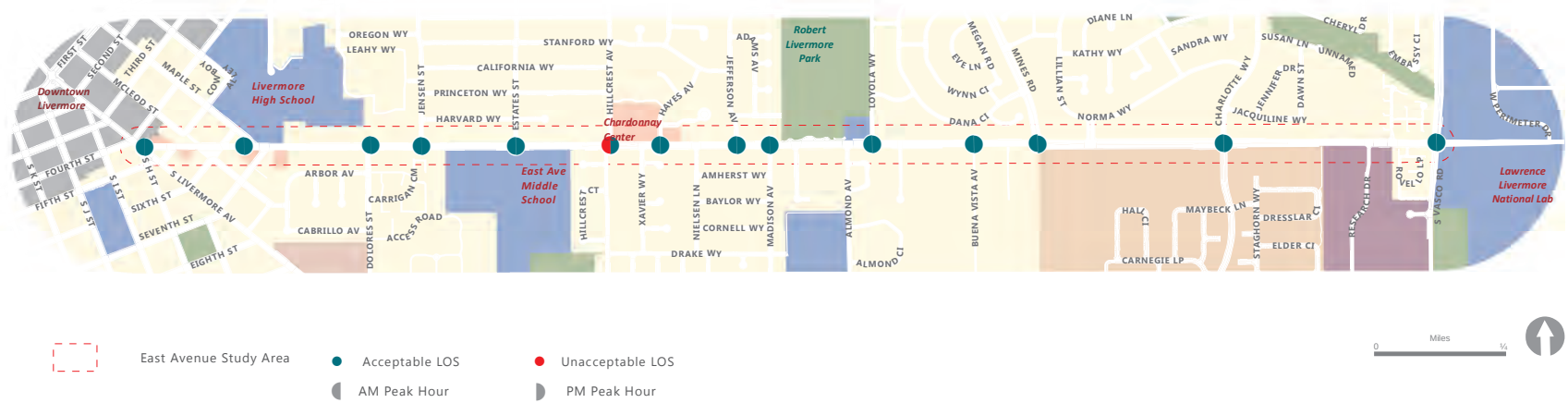
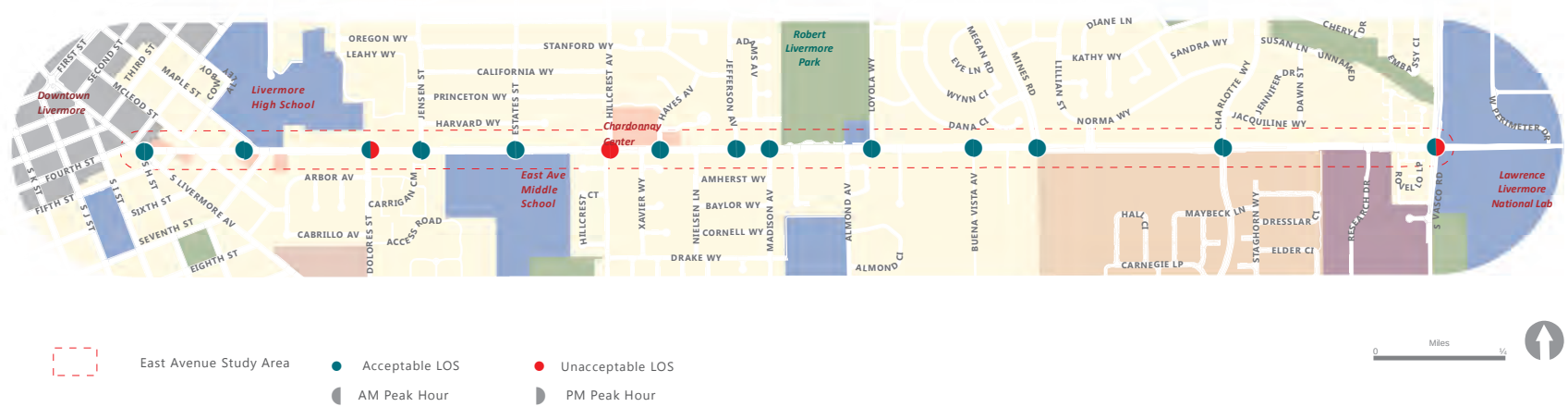


Figure 5-14: Alternative 3- Vehicle Level of Service (2040)



Bicycling Conditions

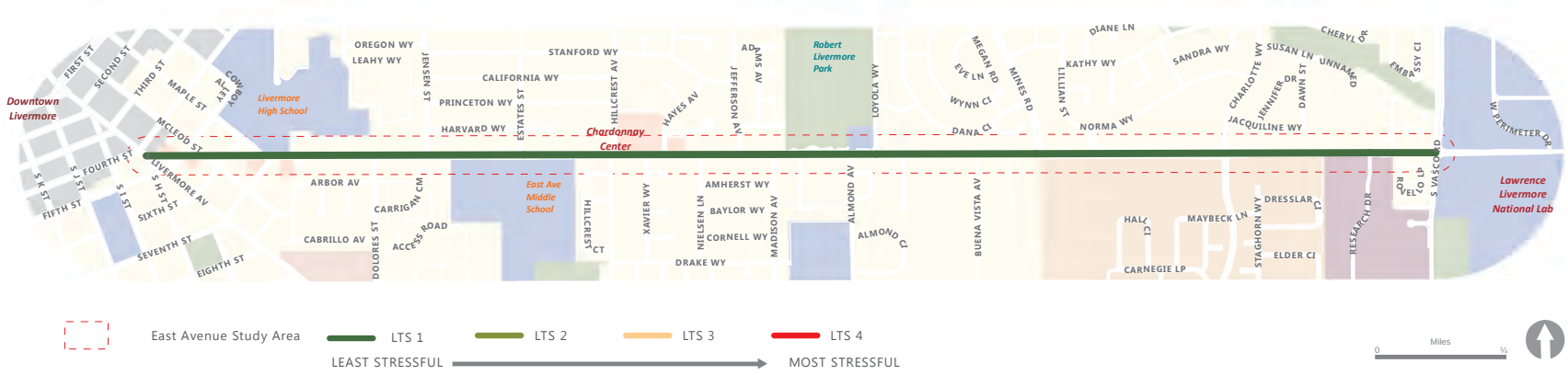
The road diet alternative proposes parking-protected bicycle facilities where parking acts as a physical barrier between the parked vehicles and bicyclist resulting in a more comfortable environment for the bicyclist. The buffer between the bike lane and parking is provided to avoid any door-zone conflicts and to eliminate the risk of a doored bicyclist being run over by a motor vehicle. The 10 to 12 foot buffer is provided west of Madison Avenue as a flex zone that could be utilized for providing space to emergency responders, curbside access for delivery, or pick-up and drop-off between Madison Avenue and Research Dr. The LTS analysis evaluation shows that out of all the alternatives, the road-diet alternative will result in the best bicycling conditions for the bicyclist. Figure 15 summarizes the segment LTS for alternative 3. LTS calculations and assumptions are summarized in Appendix 13.

Walking Conditions

The road diet alternative proposes corner refuge islands near major intersections that will provide more protection to the pedestrians at the intersection. As the number of travel lanes are decreased, pedestrians feel less exposed and safer entering the intersection especially at the unsignalized intersections. Additionally, reduction in conflict points at intersections, improved sight distance, easier maneuverability for vehicles turning left, and the elimination of weaving will also contribute towards the safety of pedestrians.

Door Zone Conflicts (Source: NACTO)

Figure 5-15: Alternative 3- Bicycle Level of Traffic Stress



Alternative 4 - Hybrid Alternative

This hybrid alternative attempts to addresses the concerns of the community especially regarding significant delays near the schools. The alternative proposes a road diet from N. Livermore Avenue to Maple Street, three lanes (two westbound and one eastbound) between Maple Street and Estates Street, and four lanes from Estates Street to Vasco Road. This alternative also provides sidewalk widening near the Robert Livermore Community Center. Furthermore, this alternative furnishes both bulbouts and median refuge islands for pedestrian crossing improvements. The number of parking spaces will reduce to 82 spaces. The enlarged plan is available in Appendix 11.

Figure 5-17: Alternative 4 Cross Sections

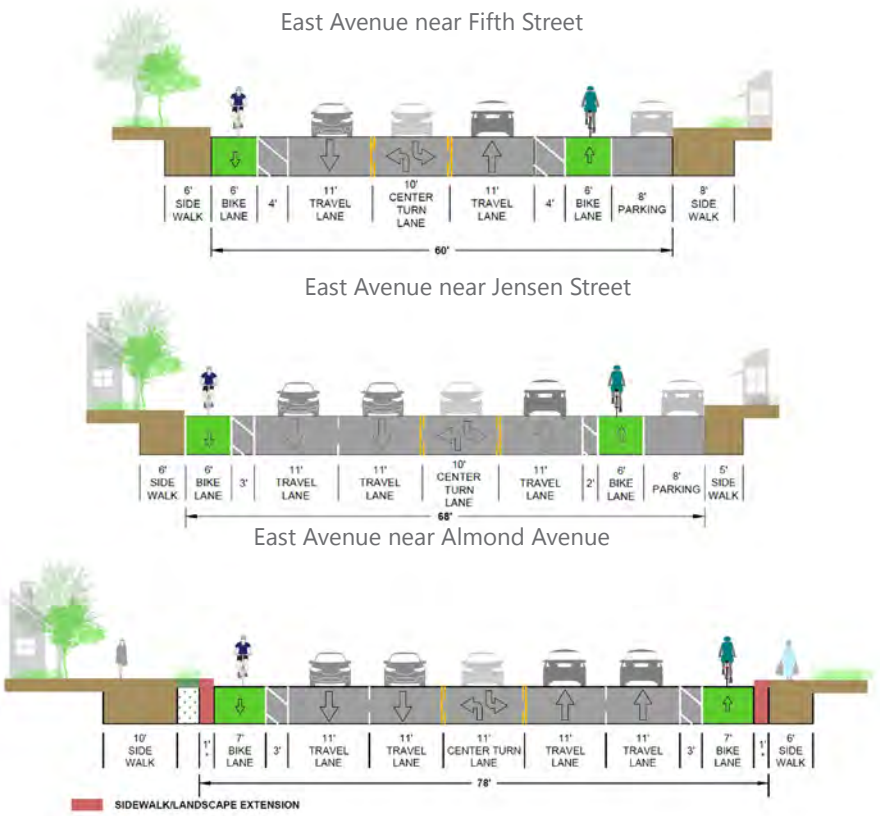
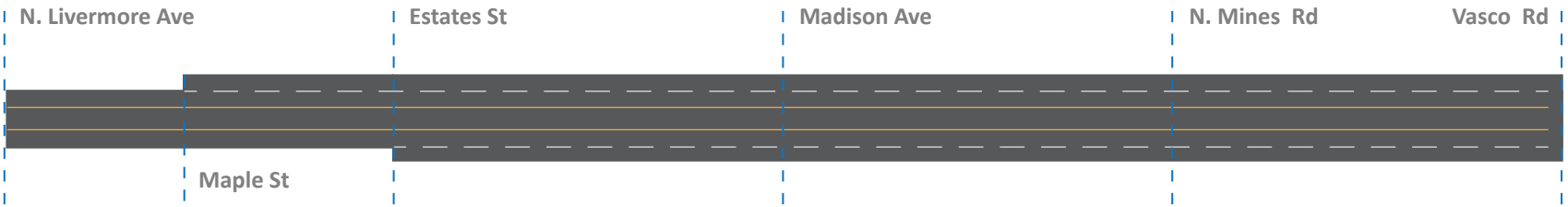


Table 5-4: Alternative 4 Summary

Characteristics	Alternative 4
Number of Travel Lanes	4, 3, and 2 (10′ - 11′)
Median/Center Turn Lanes	Center turn lane(10′ - 11′)
Bicycle Lane Class	Buffered Class II
Bicycle Lane Width (ft.)	6′ - 7′
Bicycle Buffer Width (ft.)	2′ - 4′
Sidewalk Width (ft.)	5′ - 10′ (Increases by 1′ in some parts)
Pedestrian Crossing Improvements	Bulbouts, median refuge Islands
Parking Spaces	82

Figure 5-16: Alternative 4 Lane Allocation Diagram



Driving Conditions

Under the hybrid alternative, all major study intersections operate within the acceptable LOS thresholds for Existing (2020) Conditions. For future (2040) conditions, only the intersections at Dolores Street and Vasco Road will operate at unacceptable LOS thresholds, the rest of the major intersections will continue to operate at acceptable LOS thresholds. LOS worksheets are available in Appendix 12. The results of the LOS analysis using the Synchro 10.0 software program for Existing (2020) and Future (2040) Conditions are summarized in Figures 5-18 and 5-19 respectively.

Figure 5-18: Alternative 4- Vehicle Level of Service (2020)

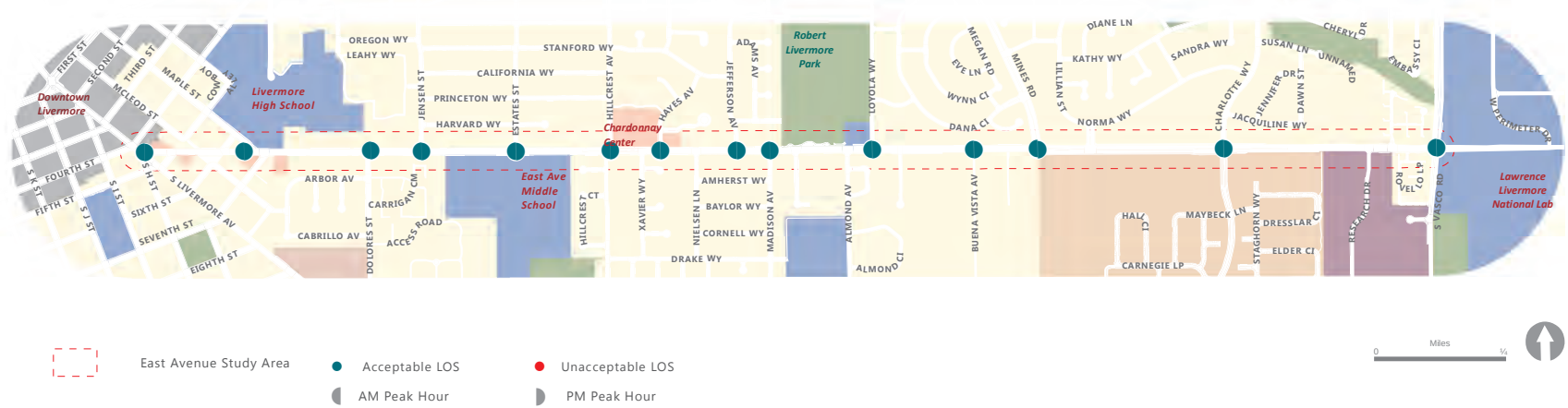
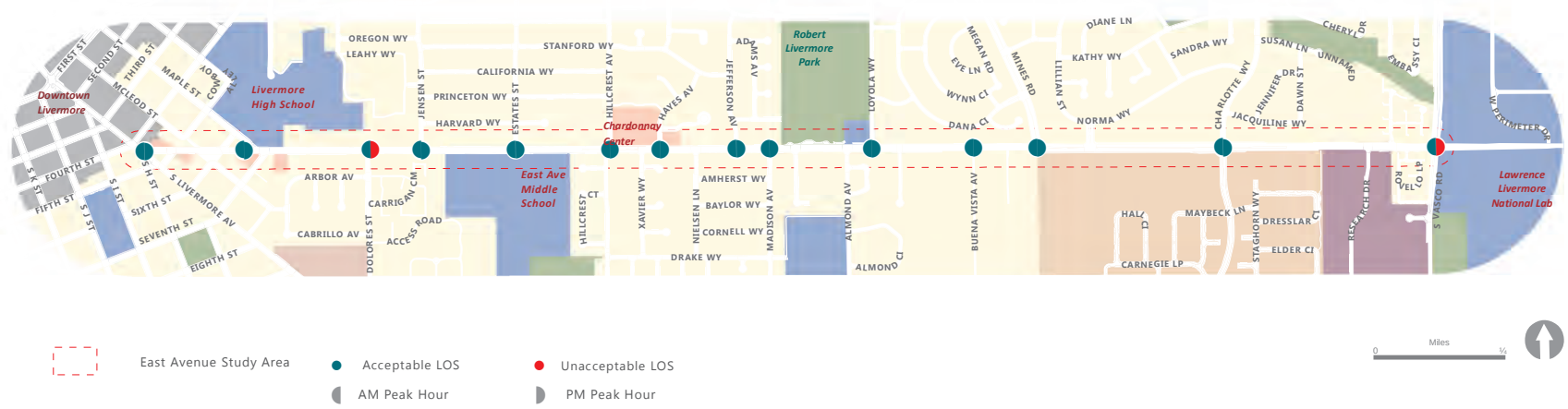


Figure 5-19: Alternative 4- Vehicle Level of Service (2040)



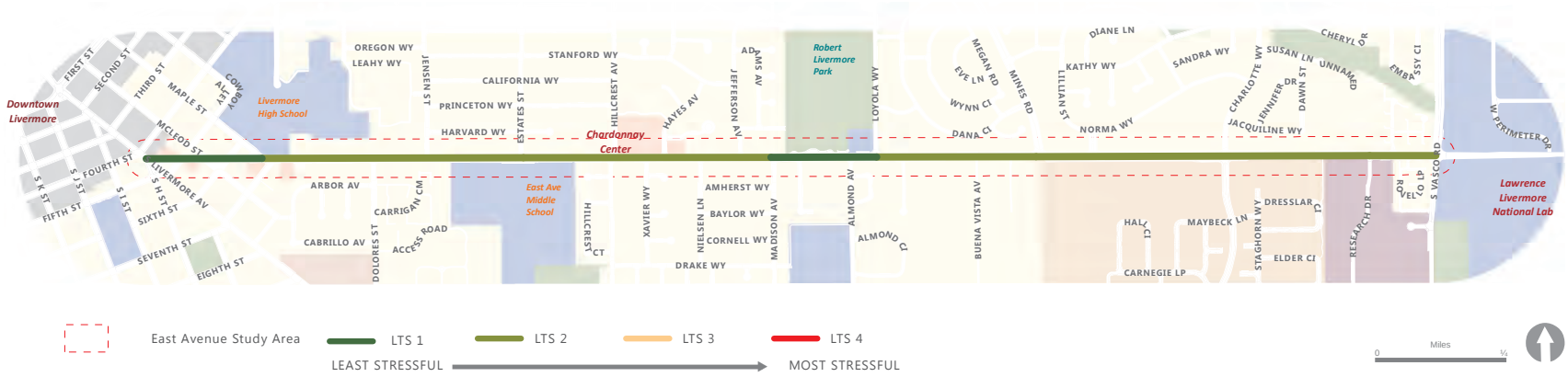
Bicycling Conditions

The asymmetrical cross-section under hybrid alternative from N. Livermore Avenue to Estates Street results in varying levels of comfort for bicyclists on the north versus south side of East Avenue. The north side is impacted due to the higher number of lanes and the south side is impacted due to the presence of on-street parking facilities. The LTS evaluation results are summarized based on the lower stress option (better of the two sides) in Figure 5-20. LTS calculations and assumptions are summarized in Appendix 13.

Walking Conditions

The hybrid alternative introduces both bulbouts and pedestrian islands. The walking condition is expected to improve significantly with the pedestrian crossing improvements between N. Livermore Avenue and Estates Street. The sidewalk widening between Auburn Street and Loyola Way is also expected to encourage walking.

Figure 5-20: Alternative 4- Bicycle Level of Traffic Stress



Traffic Simulation

To understand the queueing near the school and congestion along the corridor, the study team developed a vehicle traffic simulation model using SimTrafffic 10 software for the East Avenue corridor, between Livermore Avenue and Nielsen Lane for the scenarios: No Project, Road Diet (two lanes with TWLTL), and Hybrid Alternative (two westbound and one eastbound lane). Traffic simulation models allow us to visualize the congestion along the corridor taking into account the metering at the upstream intersection and represent the 95th percentile queue that will be experienced. The peak hour trips for the two schools (Livermore High School and East Avenue Middle School) along the East Avenue corridor were estimated based on rates provided in ITE Trip Generation Manual. Traffic simulation was developed under existing and future (2040) conditions during a.m., and school p.m. peak periods. Synchro models were calibrated and validated to reflect field conditions. The average vehicle length is assumed as 25 feet.

Queue Analysis Results – Existing Conditions

Existing Conditions with Road Diet

As shown in Table 5-5, the following signalized intersections have an increase in vehicle queues that exceed the lane capacity during a.m., and school p.m. peak hours under existing conditions with road diet option.

- East Avenue/Maple Street: Queue increases by maximum of 4 vehicles for EBT during a.m. peak hour and 20 vehicles during school p.m. peak hour extending eastbound queue up to 5th Street. In addition to this, queue increases by maximum of 14 vehicles for WBT during a.m. peak hour, and 13 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Livermore Valley Senior Living Center.
- East Avenue/Dolores Street: Queue increases by maximum of 5 vehicles for EBT during school p.m. peak hour extending eastbound queue up to Maple Street. In addition to this, queue increases by maximum of 13 vehicles for WBT during a.m. peak hour resulting in westbound queues to extend beyond Jensen Street.
- East Avenue/Hillcrest Avenue: Queue increases by maximum of 20 vehicles for EBT during a.m. peak hour and 36 vehicles during school p.m. peak hour extending eastbound queue up to beyond Estates Street. In addition to this, queue increases by maximum of 42 vehicles for WBT during a.m. peak hour, and 56 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Auburn Street.

Existing Conditions with Hybrid Alternative

As shown in Table 5-5, the following signalized intersections have an increase in vehicle queues that exceed the lane capacity during a.m., and school p.m. peak hours under existing conditions with hybrid alternative.

- East Avenue/Maple Street: Queue increases by maximum of 4 vehicles for EBT during a.m. peak hour and 20 vehicles during school p.m. peak hour extending eastbound queue up to 5th Street. In addition to this, queue increases by maximum of 14 vehicles for WBT during a.m. peak hour, and 13 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Livermore Valley Senior Living Center.
- East Avenue/Dolores Street: Queue increases by maximum of 5 vehicles for EBT during school p.m. peak hour extending eastbound queue up to Maple Street.
- East Avenue/Hillcrest Avenue: Queue increases by maximum of 4 vehicles for EBT during school p.m. peak hour extending eastbound queue up to East Avenue Middle School entry point.

Table 5-5: Queue Lengths Summary - Existing Conditions

#	Intersection	Control	Lane Group	Number of Lanes*	Storage Length per lane (ft.)	Existing No Project Conditions		Existing Road Diet		Existing Hybrid Alternative	
						95th Percentile Queue (ft.)		95th Percentile Queue (ft.)		95th Percentile Queue (ft.)	
						AM	School PM	AM	School PM	AM	School PM
4	East Avenue and Maple Street	Signal	EBT	2/1/1.	200	110	**235**	**300**	**705**	**300**	**705**
			WBT	2/1/1.	175	**250**	**245**	**530**	**500**	**530**	**500**
			WBR	S/1/1.	125	0	0	55	45	55	45
			SBL	1/1/1.	30	**115**	**205**	**125**	**205**	**125**	**205**
			SBR	1/1/1.	30	20	10	20	10	20	10
6	East Avenue and Dolores Street	Signal	EBL	1/1/1.	50	5	0	5	0	5	0
			EBT	2/1/1.	935	205	295	480	**1050**	480	**1050**
			WBL	1/1/1.	265	130	155	140	210	140	210
			WBT	2/1/2.	465	285	145	**930**	395	275	135
			NBL	1/1/1.	180	55	50	55	65	55	65
			NBT	S/S/S.	180	0	45	0	50	0	50
			SBT	S/S/S.	25	0	0	0	0	0	0
9	East Avenue and Hillcrest Avenue	Signal	EBL	1/1/1.	105	50	**155**	65	**155**	65	**155**
			EBT	2/1/2.	305	235	**390**	**805**	**1205**	280	**390**
			WBL	1/1/1.	100	50	35	80	35	80	35
			WBT	2/1/2.	280	**370**	**470**	**1335**	**1415**	**445**	**470**
			NBL	1/1/1.	120	110	70	120	70	120	70
			NBT	S/S/S.	120	60	30	65	30	65	30
			SBL	1/1/1.	160	95	115	105	115	105	115
			SBT	S/S/S.	160	65	120	70	120	70	120

Notes:
EB, WB, NB, SB - Eastbound, Westbound, Northbound, Southbound respectively
L-left-turn, T-through, R-right-turn; S-Shared lane

*Number of Lanes – Existing number of lanes/proposed road diet/hybrid alternative

In addition to this, queue increases by maximum of 7 vehicles for WBT during a.m. peak hour, and 8 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Nilelsen Lane.

As shown in Table 5-6, the following signalized intersections have an increase in vehicle queues that exceed the lane capacity during a.m., and school p.m. peak hours under future conditions with road diet option.

- East Avenue/Maple Street: Queue increases by maximum of 10 vehicles for EBT during a.m. peak hour and 46 vehicles during school p.m. peak hour extending eastbound queue up to Livermore Avenue. In addition to this, queue increases by maximum of 11 vehicles for WBT during a.m. peak hour, and 20 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Dolores Street.
- East Avenue/Dolores Street: Queue increases by maximum of 52 vehicles for EBT during school p.m. peak hour extending eastbound queue up to beyond Livermore Avenue. In addition to this, queue increases by maximum of 46 vehicles for WBT during a.m. peak hour resulting in westbound queues to extend beyond Estate Street.
- East Avenue/Hillcrest Avenue: Queue increases by maximum of 34 vehicles for EBT during a.m. peak hour and 87 vehicles during school p.m. peak hour extending eastbound queue up to Dolores Street. In addition to this, queue increases by maximum of 69 vehicles for WBT during a.m. peak hour, and 46 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Almond Avenue.

Future Conditions with Hybrid Alternative

As shown in Table 5-6, the following signalized intersections have an increase in vehicle queues that exceed the lane capacity during a.m., and p.m. peak hours under future conditions with hybrid alternative.

- East Avenue/Maple Street: Queue increases by maximum of 9 vehicles for EBT during a.m. peak hour and 46 vehicles during school p.m. peak hour extending eastbound queue up to Livermore Avenue. In addition to this, queue increases by maximum of 25 vehicles for WBT during a.m. peak hour, and 20 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Jensen Street.
- East Avenue/Dolores Street: Queue increases by maximum of 52 vehicles for EBT during school p.m. peak hour extending eastbound queue up to Livermore Avenue.
- East Avenue/Hillcrest Avenue: Queue increases by maximum of 3 vehicles for EBT during a.m. peak hour, and 24 vehicles during school p.m. peak hour extending eastbound queue up to Estates Street. In addition to this, queue increases by maximum of 15 vehicles for WBT during a.m. peak hour, and 8 vehicles during school p.m. peak hour resulting in westbound queues to extend up to Jefferson Avenue.

Table 5-6: Queue Lengths Summary - Future Conditions

#	Intersection	Control	Lane Group	Number of Lanes*	Storage Length (ft.)	Future No Project Conditions		Future Road Diet		Future Hybrid Alternative	
						95th Percentile Queue (ft.)		95th Percentile Queue (ft.)		95th Percentile Queue (ft.)	
						AM	School PM	AM	School PM	AM	School PM
4	East Avenue and Maple Street	Signal	EBT	2/1/1.	200	175	**450**	**450**	**1345**	**435**	**1345**
			WBT	2/1/1.	175	**510**	**370**	**455**	**665**	**795**	**665**
			WBR	S/1/1.	125	0	0	15	90	115	90
			SBL	1/1/1.	30	**155**	**945**	**230**	**1000**	**155**	**1000**
			SBR	1/1/1.	30	25	25	**35**	25	25	25
6	East Avenue and Dolores Street	Signal	EBL	1/1/1.	50	5	0	5	0	5	0
			EBT	2/1/1.	935	275	540	465	**2215**	760	**2215**
			WBL	1/1/1.	265	160	**290**	230	**290**	205	**290**
			WBT	2/1/2.	465	395	140	**1615**	410	375	140
			NBL	1/1/1.	180	65	95	100	95	70	95
			NBT	S/S/S.	180	0	**245**	0	**250**	0	**250**
			SBT	S/S/S.	25	0	0	0	0	0	0
9	East Avenue and Hillcrest Avenue	Signal	EBL	1/1/1.	105	75	**270**	105	**270**	80	**270**
			EBT	2/1/2.	305	**405**	**905**	**1140**	**2485**	**375**	**905**
			WBL	1/1/1.	100	85	35	**115**	35	**115**	35
			WBT	2/1/2.	280	**670**	**475**	**1995**	**1415**	**640**	**475**
			NBL	1/1/1.	120	**145**	75	**155**	75	**145**	75
			NBT	S/S/S.	120	95	35	100	35	95	35
			SBL	1/1/1.	160	155	120	**170**	120	155	120
			SBT	S/S/S.	160	85	125	95	125	85	125

Notes:

EB, WB, NB, SB - Eastbound, Westbound, Northbound, Southbound respectively

L-left-turn, T-through, R-right-turn; S-Shared lane

*Number of Lanes – Existing number of lanes/proposed road diet/hybrid alternative

Improvement Summary

Table 5-7 summarizes some potential intersection improvements for the major intersections.

Table 5-7: Intersection Improvement Summary

Intersections	Alternative 1	Alternative 2	Alternative 3	Alternative 4
East Avenue and Maple Street	None	None	None	None
East Avenue and Dolores Street	None	Bulbouts	Corner Refuge Island	Bulbouts
East Avenue and Jensen Street	None	Bulbouts	Corner Refuge Island	Bulbouts
East Avenue and Estates Street	None	Bulbouts	Corner Refuge Island	None
East Avenue and Nielson Lane	None	Bulbouts	Corner Refuge Island	Median Refuge Island
East Avenue and Hillcrest Avenue	None	Bulbouts	Corner Refuge Island	None
East Avenue and Madison Avenue	None	None	Corner Refuge Island	None
East Avenue and Loyola Way	None	Bulbouts	Bulbouts	Bulbouts
East Avenue and Mitra Street	RRFB	RRFB	RRFB	RRFB
East Avenue and Mines Road	None	None	Corner Refuge Island	None
East Avenue and Charlotte Way	None	None	None	None
East Avenue and Research Drive	None	None	None	None

Design Elements

Narrowing Down Lane Widths

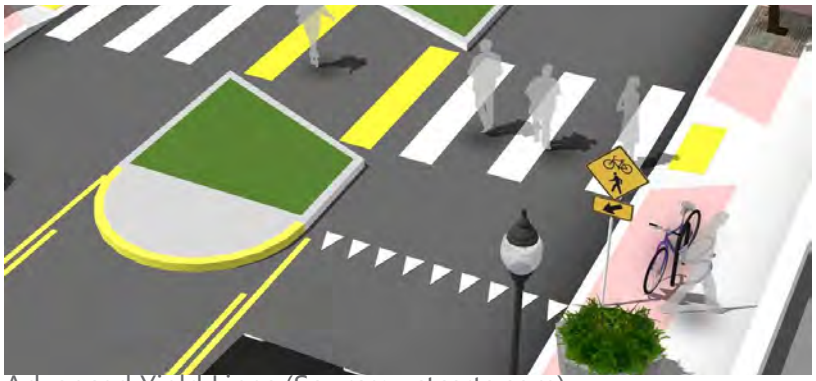
One of the major concern highlighted during the public outreach efforts has been related to speeding of vehicles. Narrowing down travel lane width could be the most cost-effective solutions to reduce vehicle travel speeds. Guidelines from the National Association of City Transportation Officials (NACTO) recommend motor vehicle lane widths of 10′ in urban areas and 11′ for designated truck or transit routes. Table 5-8 summarizes the proposed lane widths for all the alternatives.

Table 5-8: Lane Width Summary

Segments	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Livermore Avenue to Maple Street	11′ Outer travel lane 10′ Inner travel lane No center turn lane	11′ travel lane 10′ center turn lane	10′ travel lane 10′ center turn lane	11′ travel lane 10′ center turn lane
Maple Street to Estates Street	11′ Outer travel lane 10′ Inner travel lane 10′ Center turn lane	11′ travel lane 12′ Center turn lane	11′ travel lane 12′ center turn lane	11′ travel lane (10′ inner travel lane in westbound direction only) 10′ Center turn lane
Estates Street to Madison Avenue	11′ Outer travel lane 10′ Inner travel lane 10′ Center turn lane	11′ travel lane 12′ Center turn lane	11′ travel lane 12′ center turn lane	11′ outer travel lane 10′ inner travel lane 10′ Center turn lane
Madison Avenue to North Mines Road	12′ Outer Travel Lane 11′ Inner Travel Lane 11′ Center turn lane	11′ Outer travel lane 10′ Inner travel lane 11′ Center turn lane	12′ Travel Lane 12′ Center turn lane	11′ Outer Travel Lane 11′ Inner Travel Lane 12′ Center turn lane
North Mines Road to Vasco Road	12′ Outer Travel Lane 11′ Inner Travel Lane	11′ Outer Travel Lane 10′ Inner Travel Lane	12′ Travel Lane	11′ Outer Travel Lane 11′ Inner Travel Lane

Advance Yield/Stop Lines

Advance yield/stop line include the stop bar or "sharks teeth" yield markings placed 20 to 50 feet in advance of a marked crosswalk to indicate where vehicles are required to stop or yield to the pedestrian. This safety measure can greatly reduce the likelihood of a multiple-threat crash at unsignalized midblock crossings such as Jensen Street and Estates Street. It discourages drivers from stopping too close to crosswalks and blocking other drivers' views of pedestrians and pedestrians' views of vehicles (pedbikesafe.org). The yield lines are proposed at existing and proposed RRFBs for all alternatives.



Advanced Yield Lines (Source: uctcsrts.com)

Rectangular Rapid-Flashing Beacon (RRFB)

RRFBs are pedestrian-actuated conspicuity enhancements used in combination with a pedestrian, school, or trail crossing warning sign to improve safety at uncontrolled, marked crosswalks. The East Avenue corridor currently features RRFBs on Jensen Street, Estates Street, Nielsen Lane, and Research Drive. The crosswalk at Mitra Street could be potentially enhanced by the provision of RRFB for all alternatives.

High Visibility Crosswalk

East Avenue corridor also acts as a gateway to Downtown Livermore and provides an opportunity for the provision of Downtown style crosswalk. The Downtown style crosswalk are highly visible to approaching vehicles and have been shown to improve yield behavior. Although it heightens awareness of crossing locations, oversubscribing will lessen its impact on motorists. Therefore, it should be only considered at intersections with high pedestrian crossing volumes such as Livermore Avenue, Maple Street, Dolores Street and Jensen Street.

High Visibility Crosswalk (Source: urbanplacesandspaces.blogspot.com)

RRFBs (Source: pedbikesafe.org)

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