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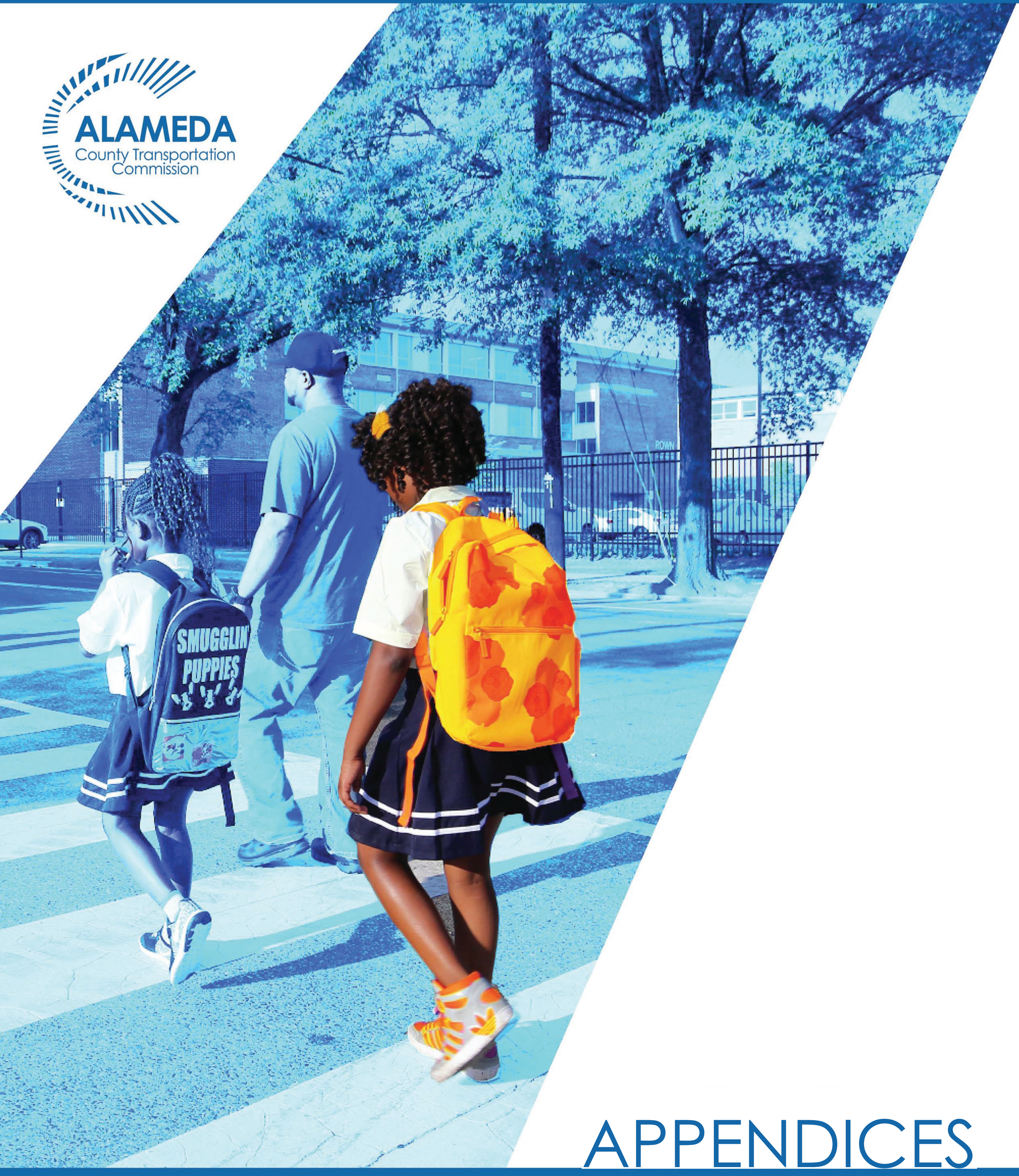

APPENDICES

June 2019

Appendices

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B
APPENDIX

Methodology Memorandum

June 2019

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MEMORANDUM

Date:	July 27, 2018	Project #: 21257
To:	Cathleen Sullivan and Christopher Marks Alameda CTC	
From:	Mike Alston; Erin Ferguson, PE – Kittelson & Associates, Inc.	
Project:	Alameda CTC - CATP	
Subject:	Subtask 1.3 High Injury Corridor Analysis Framework	

This memorandum presents the methodology used for identifying the high injury corridors (HIC) for the Alameda CTC's Countywide Active Transportation Plan (CATP). It is organized into the following sections:

- Data Sources
- Scope of Analysis and Approach to Analysis
- Deliverables from the Analysis

The results of the analysis will inform proposed bicycle network improvements (Task 3), geographic priorities for investments (Task 4), and training for local agency staff regarding the types of treatments that could be beneficial to implement systemically to improve safety (Task 6).

DATA SOURCES

Kittelson obtained the five most recent years of reported crash data involving bicyclists and pedestrians from the University of California, Berkeley, Transportation Injury Mapping System (TIMS) database and the California Statewide Integrated Traffic Records System (SWITRS) database. Currently, the five most recent years of complete data are years 2012 through 2016.

Kittelson used Open Street Map (OSM) for the basis of geo-locating crashes. OSM enables the team to incorporate roadway characteristics into analysis where available, including the following: geometry, roadway characteristics, including number of travel lanes, speed limit, bicycle facility presence and type, and functional class. It also ensures the HIC work is mapped and analyzed on a consistent base with the level of traffic stress analysis (Subtask 1.2). This enables integration and comparison to the level of traffic stress analysis if desired by the team.

SCOPE OF ANALYSIS AND APPROACH TO ANALYSIS

Crashes

Kittelson worked with TIMS crash data, which are the geo-located injury and fatal crashes recorded in the SWITRS database. To be confident that the TIMS data included all reported bicycle and pedestrian injury and fatal crashes, Kittelson pulled SWITRS data for the same time period and compared the number of injury and fatal collisions to the number recorded in TIMS. Kittelson added property damage only (PDO) crashes from the SWITRS database to the HIC analysis database, geo-locating those manually.

The analysis included pedestrian and bicycle crashes of all severity levels. Kittelson recommends including the full range of injury crashes (minor, moderate, and severe); police-cited injuries have been found to be inaccurate. Restricting data analysis based on level of injury can result in excluding crashes that actually did result in a severe injury. Recent work by the San Francisco Department of Public Health (SFDPH) to reconcile trauma data with police-reported crashes found that when medical staff re-evaluated police-reported injury severity, 39% of crashes were downgraded from severe, while 20% of moderate injury and 12% of minor injury crashes were upgraded to severe. This resulted in a net addition of 41% more severe injury crashes to the data set (SFDPH, 2017). The SFDPH also found that police-reported data underreported severe injuries, 39% of total cyclist severe injuries were unreported and 24% of total pedestrian severe injuries were unreported. Furthermore, the age and health of the pedestrian or bicyclist also can be the difference between the injury-severity levels.

Street Network

The analysis evaluated crashes that occurred on public streets within unincorporated and incorporated areas of Alameda County. It excluded freeway mainlines (e.g., interstates such as I-580, grade-separated and access-controlled highways such as Highway 24). It will include the ramp terminal intersections of freeways.

Analysis Steps

The following steps describe the basic analysis approach to identifying the HICs.

1. Establish the HIC database using the data described above.
2. Conduct descriptive crash analysis to identify and describe countywide crash patterns and trends.
3. Evaluate the frequency and severity of reported crashes using Equivalent Property Damage Only (EPDO) screening and sliding window methodology from the *Highway Safety Manual* with adjusted severity weighting based on conversations with ACTC (specifics of this methodology described below).

4. Use 2016 5 year-estimates from Table S0801 produced by the American Community Survey to categorize HIC results based on the background walking or biking commute levels within each roadway segment's city.
5. Select approximately the top 20 percent of EPDO scores within each category (high, medium, or low) to be HICs.
6. Document HIC via maps and figures and prepare written text describing findings as part of the Existing Conditions Memo (Subtask 1.5).

Steps 2 through 6 were conducted separately for pedestrian and bicycle crashes. The results were compared to see where the HIC for each may overlap, providing additional emphasis for safety improvements on these corridors (i.e.., establishing a combined bicycle and pedestrian HIC network).

Equivalent Property Damage Only (EPDO)

Kittelson used an equivalent property damage only (EPDO) performance measure, which assigns weighting factors to crashes by severity relative to property damage only (PDO) crashes. For this analysis, the following weights were assigned in concurrence with Alameda CTC:

- **Fatal and severe injury crashes:** 10 equivalent PDOs
- **Visual injury or complaint of pain crashes:** 5 equivalent PDOs
- **PDO crashes:** 1 equivalent PDO.

The weighting factors intentionally weigh fatal and severe injuries equally to recognize that the difference between a severe injury crash versus a fatal crash are often more of a function of the individuals involved – therefore, both represent locations where the County may want to prioritize improvements.

The EPDO score is calculated by multiplying each crash severity total by its associated weight and summing the results, using the following formula:

*EPDO Score = Fatal weight * # of fatal crashes + severe injury weight * # of severe injury crashes + other visible injury weight * # of other visible injury crashes + complaint of pain injury weight * # of complaint of pain injury weight crashes + PDO crashes*

The EPDO score is annualized by dividing the score by the number of years (five) of crash data used in the analysis.

Screening Categories

Kittelson performed a network screening to calculate the EPDO score for quarter-mile segments throughout the incorporated County[1]. Results were then categorized based on the background walking or biking commute levels within each city or community. This categorization enabled comparison among cities with roughly similar levels of biking or pedestrian commuting activity as a proxy for overall activity. Within each category, the top 20 percent of roadway segments (highest EPDO scores) were identified as high injury corridors.

Table 1 presents the categories established for bicycling results comparison. The countywide bicycling commute share over the same time period was 2.1 percent; any cities below that threshold were considered *low* while Berkeley and Albany were considered a separate *high* category based on a natural breakpoint in the data.

Table 1: Bicycling Categorization Based on 2012-2016 Commute Share

City	Bicycling Commute Share	Level
Berkeley	8.2%	High
Albany	6.1%	High
Oakland	3.1%	Medium
Emeryville	2.9%	Medium
Countywide Average	**2.1%**	
Alameda	1.7%	Low
Piedmont	1.4%	Low
Livermore	1.1%	Low
Pleasanton	1.1%	Low
San Leandro	1.0%	Low
San Lorenzo	*0.7%*	*Low*
Fremont	0.6%	Low
Hayward	0.6%	Low
Castro Valley	*0.5%*	*Low*
Ashland	*0.4%*	*Low*
Fairview	*0.4%*	*Low*
Newark	0.4%	Low
Dublin	0.3%	Low
Cherryland	*0.2%*	*Low*

[1] If a street's extents constitute less than one quarter-mile, that street was screened for its entire length.

City	Bicycling Commute Share	Level
Union City	0.2%	Low
Sunol	*< 0.1%*	*Low*

Source: American Community Survey 2016 5-year estimates, Table S0801

Table 2 presents the categories established for walking results comparison. The countywide walk commute share over the time period was 3.6 percent. The categories were established based on natural breakpoints in the data, yielding three categories. Berkeley was assigned to its own *high* category based on a substantially higher walk commute share compared to other cities.

Table 2: Walking Categorization Based on 2012-2016 Commute Share

City	Walking Commute Share	Level
Berkeley	17.3%	High
Emeryville	6.9%	Medium
Albany	5.4%	Medium
Oakland	4.0%	Medium
Countywide Average	**3.6%**	
Alameda	3.3%	Medium
Ashland	*2.1%*	*Low*
Hayward	2.1%	Low
Pleasanton	2.1%	Low
San Leandro	1.5%	Low
Union City	1.3%	Low
Newark	1.3%	Low
Fremont	1.3%	Low
Livermore	1.2%	Low
Piedmont	1.2%	Low
Sunol	*1.2%*	*Low*
Cherryland	*1.1%*	*Low*
Dublin	1.0%	Low
Castro Valley	*0.7%*	*Low*
San Lorenzo	*0.7%*	*Low*
Fairview	*0.3%*	*Low*

Note: *Italics* denote unincorporated communities.

Source: American Community Survey 2016 5-year estimates, Table S0801

Sliding Window Methodology

As part of geo-coding the crash data, Kittelson used a Python script in ArcGIS. This script segmented the street network into one-fourth (1/4) of a mile segments, incrementing the segments by one-tenth (1/10) of a mile. The EPDO score was calculated per increment of each segment as the script “slides” along each street in the network. It includes intersections as part of the analysis. This methodology helps to identify portions of roadways with the greatest potential for safety improvements. Kittelson aggregated the results, based on their EPDO scores and via visual inspection of the results, into continuous corridors that make up the HIC results.

DELIVERABLES FROM THE ANALYSIS

The analysis results from HIC work consist of the following:

1. Maps showing the location of the HIC for pedestrians and location of the HIC for bicyclists
2. Graphs and figures highlighting the recurring crash patterns and trends
3. Supporting text of the graphs and figures.

Items #2 and #3 above are provided in draft form as part of the Existing Conditions Memo. Item #1 was provided as an interim deliverable for Alameda CTC review. The final versions of Item #1 are included in Existing Conditions Memo.

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C
APPENDIX

Collision Trends & Profiles

June 2019

Collision Trends & Profiles

This appendix describes countywide trends emerging from historical bicycle and pedestrian collisions countywide, based on 2012 to 2016 collision data. Detailed collision information provided in this appendix consists of:

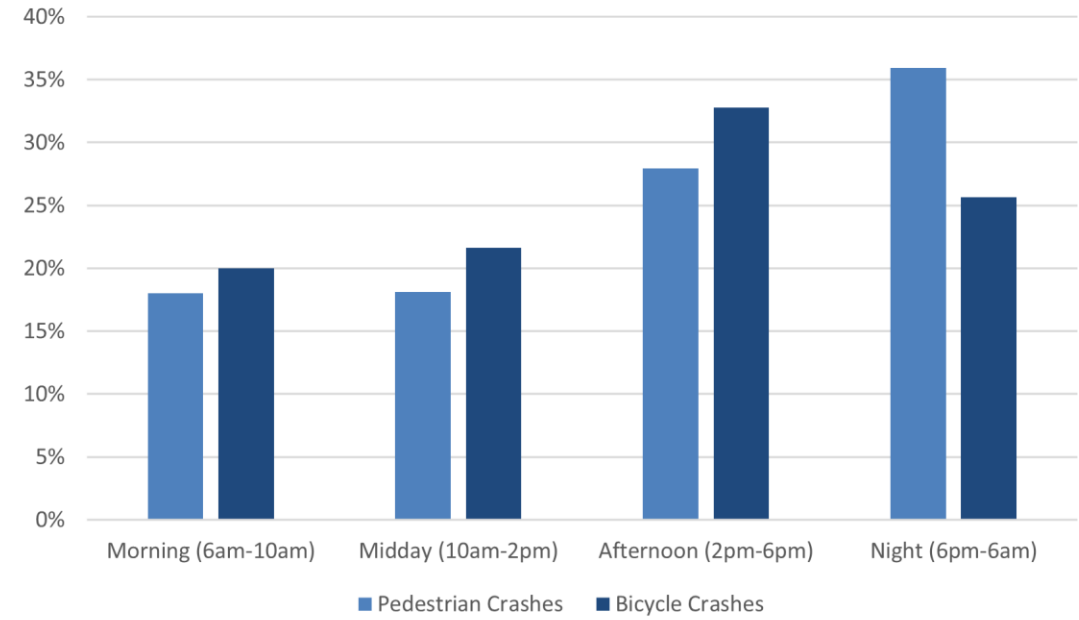
- Time-of-day trends;
- Information about individuals involved, including movements and violations (e.g. age, sobriety, and road user behavior);
- Characteristics unique to bicyclists (e.g., motor vehicle involvement vs. solo collisions); and,
- Characteristics unique to pedestrians (e.g., crossing locations).

1.1 Time-of-Day Trends

Thirty-six (36) percent of pedestrian collisions occurred at night (6:00 p.m. to 6:00 a.m.) while 28% of pedestrian collisions occurred in the afternoon (2:00 p.m. to 6:00 p.m.). Of collisions that occurred at night, 6% occurred with no street lights or with street lights not functioning. The night-time and low light condition collisions indicate that the quality of illumination is critical to help motorists see pedestrians. Pedestrian scale lighting and lighting that illuminates the conflict areas at intersections and crosswalks are important for enabling motorists to see pedestrians and improve safety.

Thirty-three (36) percent of bike collisions occurred in the afternoon (between 2:00 p.m. and 6:00 p.m.), while 26% of bike collisions occurred at night (after 6:00 p.m.). Overall, Alameda County has average performance relative to other California counties related to nighttime collisions. **Exhibit 1** presents historical bicycle and pedestrian collisions by time of day.

Exhibit 1: Bicyclist and Pedestrian Collisions by Time of Day (Alameda County, 2012-2016)



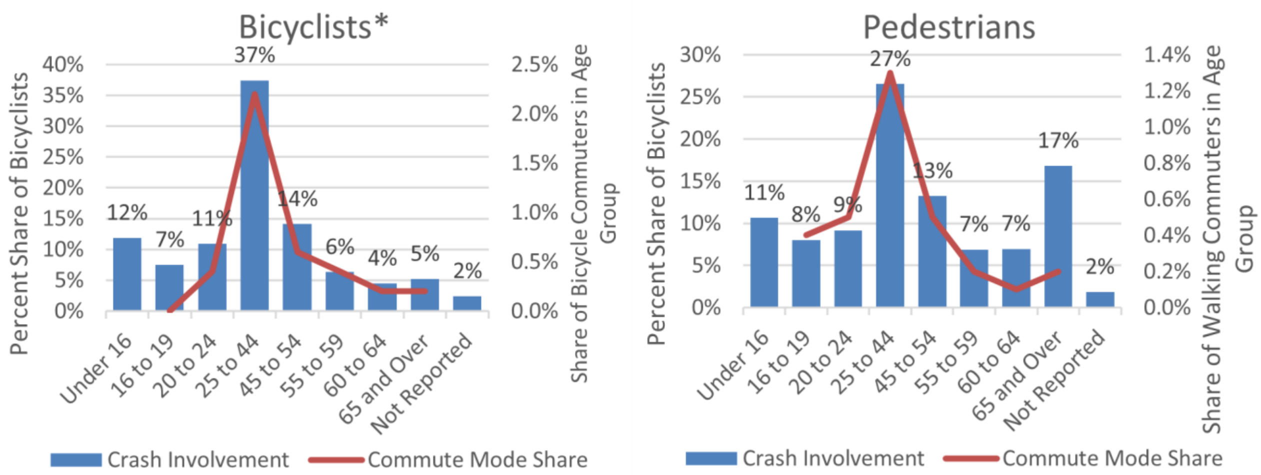
1.2 Party Characteristics

The following presents information about the individuals (i.e., parties) involved in the reported collisions including information regarding age, sobriety, and road user behavior.

1.2.1 Age

Exhibit 2 presents the age range of bicyclists and pedestrians involved in collisions.

Exhibit 2: Age of Bicyclists and Pedestrians Involved in Collisions (Alameda County, 2012-2016)



*Note: Census data category lists "Taxicab, Motorcycle, Bicycle, or Other means" together. This number may be an overestimate of true bicycle share.
Source: TIMS, SWITRS, ACS (1-year estimate), Kittelson 2018.

Working-age adults (18 to 64) comprise 77% of bicyclists involved in collisions, while children under 18 years old account for 15%. Relative to the OTS ranking shown in Table 1, Alameda County is the sixth (6th) worst county in California for collisions involving bicyclists under the age of 15 years old.

1.2.2 Alcohol Impairment

Pedestrian collisions ranged from involving two to eight parties in each collision; among all parties to collisions, 5% were cited with some level of alcohol impairment. The share of pedestrians with some level of impairment was reported as 6%. Four (4) percent of drivers were cited with some level of impairment. Overall, 44 bicycle collisions – 1% of the total—involved a citation for driving or bicycling under the influence. Four such collisions were fatal.

Bicycle collisions ranged from involving one to five parties in each collision; among all parties to collisions, 3% were cited with some level of alcohol impairment. The share of bicyclists with some level of impairment was 4%. Two (2) percent of drivers were cited with some level of impairment. Overall, 35 bicycle collisions—1% of the total—involved a citation for driving or bicycling under the influence.

Among pedestrian collisions, a total of 8,390 parties were involved.[1] Of these, 404 (5%) of parties were cited with some level of alcohol impairment. The share of pedestrians with some level of impairment was reported as 6%. Four (4) percent of drivers were cited with some level of impairment. Overall, 44 bicycle collisions – 1% of the total—involved a citation for driving or bicycling under the influence. Four such collisions were fatal.

Alameda County's collision history pertaining to alcohol involvement compares favorably (i.e., is among the lowest level of alcohol involvement) to most other California counties.

[1] Collisions in the data range from one to eight parties involved; hence, the markedly higher number of parties than collisions.

1.2.3 Party at Fault and Violations

Bicycle Collisions

Overall, 9% of bicycle collisions analyzed were single-party collisions—i.e., a bicyclist was in a solo collision. Among these solo collisions, the most frequently cited factor was unsafe speed (46% of cases). Among the remaining 91% of bicycle collisions, officers cited a bicyclist at fault in 45% of collisions and a motorist in 43% of collisions.

Assigning fault is up to the officer's discretion and understanding of events as he or she can learn from parties involved and witnesses. Regardless of the party at fault, there could be engineering treatments or education that could help address the issue.

For example, "wrong-way riding" by bicyclists often results in bicyclists being assigned as at fault for a collision. However, the person biking may be "wrong-way riding" in the shoulder or on the sidewalk to be able to reach a destination that would otherwise be infeasible to access due to missing crossings or connections in the street network for bicyclists. The prevalence of bicyclists being cited at fault may be a result of more than bicyclists needing to be educated on the rules of the road. It can reflect the need for better facilities for them to reach the desired destinations.

Motorists being cited at fault can be indicative of opportunities to make bicyclists more visible to vehicles and provide either more physical space between them or use tools such as signal phasing and timing to separate conflicting movements that need to occur through the same space (e.g., intersection).

Table 1 presents the top reported primary collision factors among bicycle collisions in which either a bicyclist or motorist was recorded at fault.

Table 1: Top Primary Collision Factors, Bicycle Collisions by Party at Fault, Alameda County, 2012-2016

Bicycle collisions, Bicyclist Cited at Fault		Bicycle collisions, Motorist Cited at Fault	
Top Primary Collision Factor	Count (Share) of Collisions	Top Primary Collision Factor	Count (Share) of Collisions
Wrong Side of Road	424 (25%)	Automobile Right-of Way	417 (31%)
Traffic Signals and Signs	295 (18%)	Improper Turning	339 (25%)
Unsafe Speed	249 (15%)	Other Hazardous Violation	204 (15%)
Automobile Right-of - Way	248 (15%)	Traffic Signals and Signs	114 (8%)
Improper Turning	227 (14%)	Unsafe Speed	93 (7%)

Note: In this table, share represents share among bicycle collisions in which the particular road user was cited at fault.
Source: TIMS, SWITRS, Kittelson 2018.

Riding on the wrong side of the road was the most frequently cited factor—occurring 25% of the time—for collisions in which the reporting officer cited the bicyclist at fault. When motorists were cited at fault in collisions, they were most often either cited for violating a bicyclist's right-of-way or improper turning. Both violation categories include left- or right-turning drivers; in fact, the most common driver movement among these two violation categories was turning left. As noted above, there are engineering treatments that can be considered and applied systemically to many locations to help reduce the risk of such collisions.

Pedestrian Collisions

As noted previously, assessments of party at fault should be interpreted with the understanding that there are many factors that shape non-motorist road use behavior, and data regarding party fault is a result of the reporting officer's discretion and understanding of events as he or she can learn from parties involved and witnesses. Regardless of the party at fault, there could be engineering treatments or education that could help address the issue. With this in mind, pedestrians were the party cited at fault in 22 % of pedestrian collisions but cited as at-fault in 46% of fatal collisions.

Table 2 summarizes the general location of the pedestrian-vehicle collisions.

Table 2: Pedestrian Action/Location, Pedestrian Collisions, Alameda County, 2012-2016

Pedestrian Action / Location	Count (Share) of Pedestrian Collisions, Pedestrian Cited at Fault	Count (Share) of Pedestrian Collisions, Motorist Cited at Fault
Crossing, Not in Crosswalk	449 (57%)	144 (6%)
Crossing in Crosswalk at Intersection	195 (25%)	1,659 (74%)
In Road, Including Shoulder	103 (13%)	178 (8%)
Other*	45 (6%)	267 (12%)
Total	**792 (100%)**	**2,248 (100%)**

Note: Other includes Not Stated, Crossing in Crosswalk Not at Intersection, and Not in Road.
Source: TIMS, SWITRS, Kittelson 2018.

The most common general location for a pedestrian to be struck by a motor vehicle is in a crosswalk at an intersection. This underscores the importance of signal timing and phasing changes to implement treatments such as leading pedestrian intervals, right-turn on red prohibitions, or separating the phases of turning vehicles and crossing pedestrians particularly at locations where there are two turning lanes (e.g., double left-turn lanes).

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D APPENDIX

Maps by Planning Area

June 2019

Maps by Planning Area

The existing and planned bike facilities, which are presented at the county level and the jurisdiction level in the Plan, are presented by planning area in this appendix:

- Existing BNA scores by planning area
- Planned BNA scores by planning area
- Existing and Planned bike facilities by planning area

ALAMEDA County Transportation Commission

Existing BNA Scores

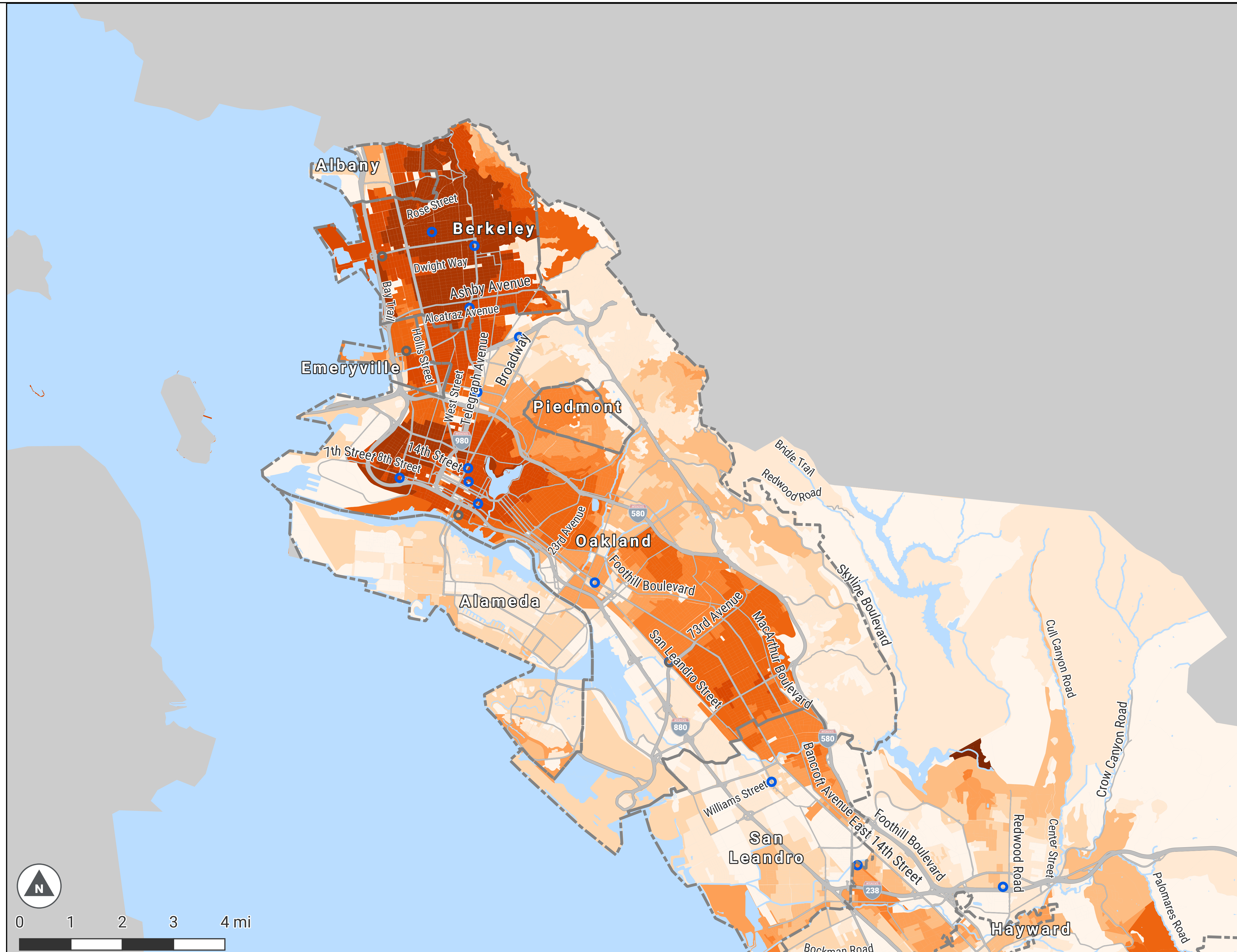
North Planning Area

Existing BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART Station
- Amtrak Station
- BART Lines



Note: Bicycle facility data used for this analysis were those received from local staff, current as of March 2018.

Alameda CTC Countywide Active Transportation Plan

ALAMEDA County Transportation Commission

Existing BNA Scores

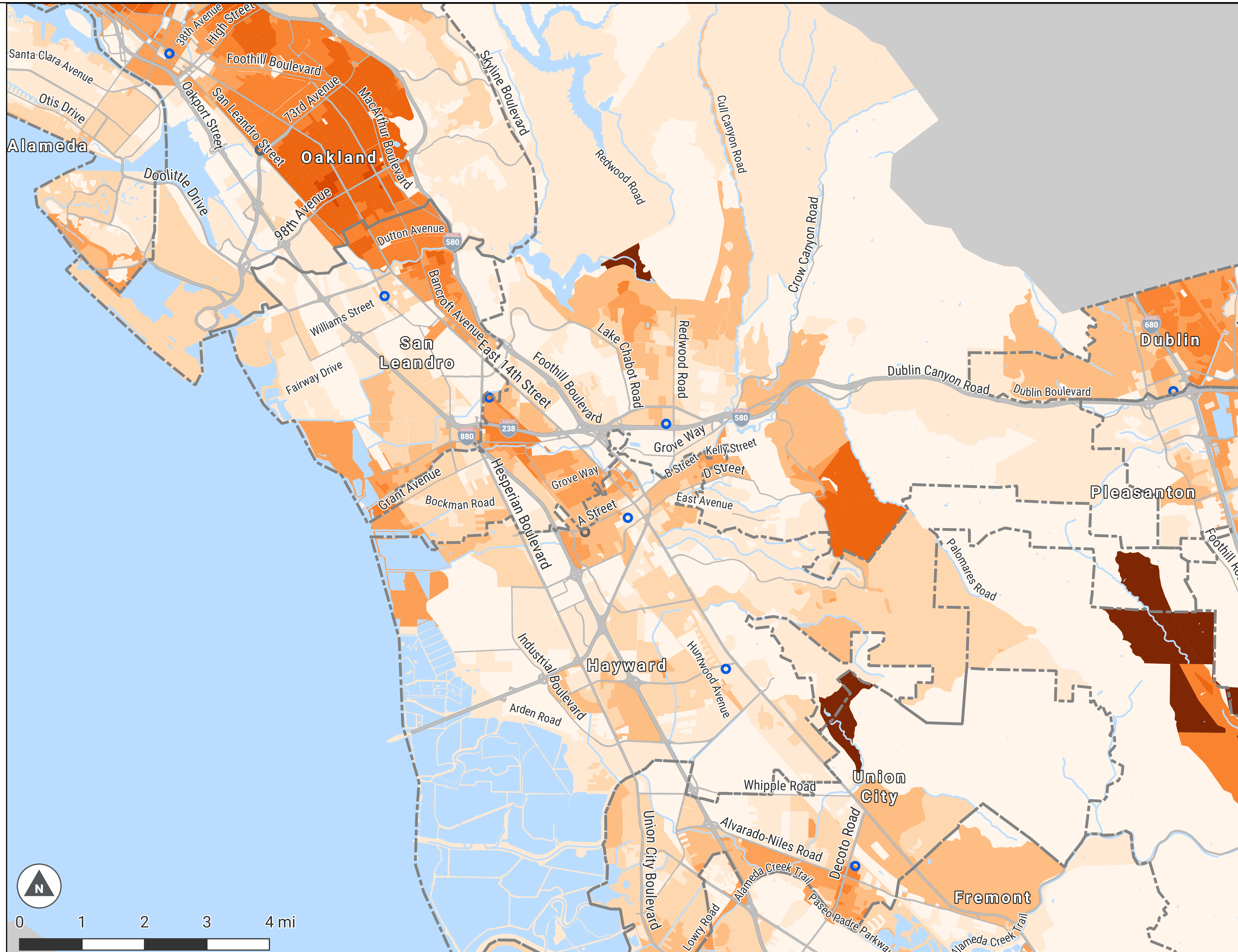
Central Planning Area

Existing BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART Station
- Amtrak Station
- BART Lines



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Alameda CTC Countywide Active Transportation Plan

ALAMEDA County Transportation Commission

Existing BNA Scores

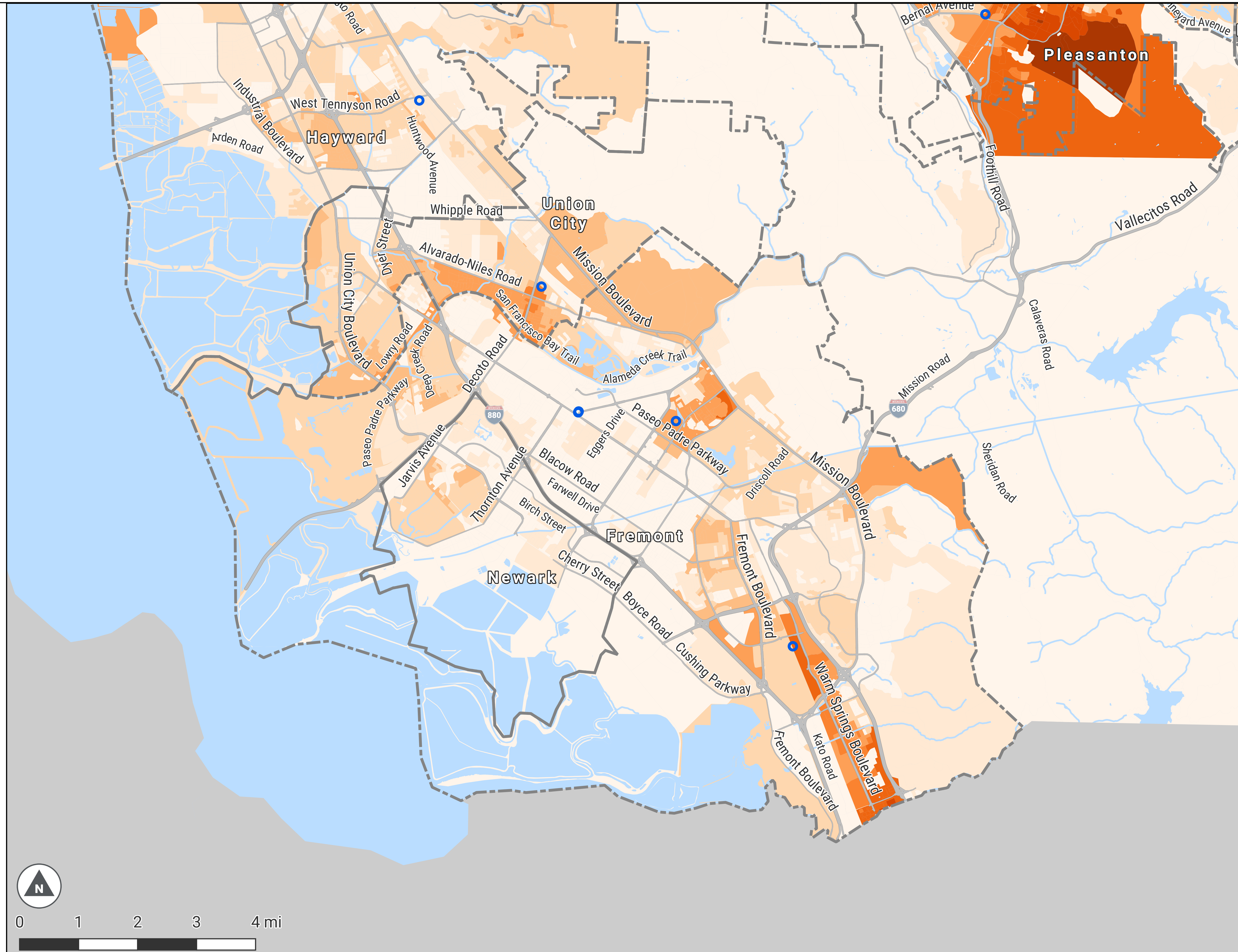
South Planning Area

Existing BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART, ACE and Capitol Corridor Stations



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Alameda CTC Countywide Active Transportation Plan

ALAMEDA County Transportation Commission

Existing BNA Scores

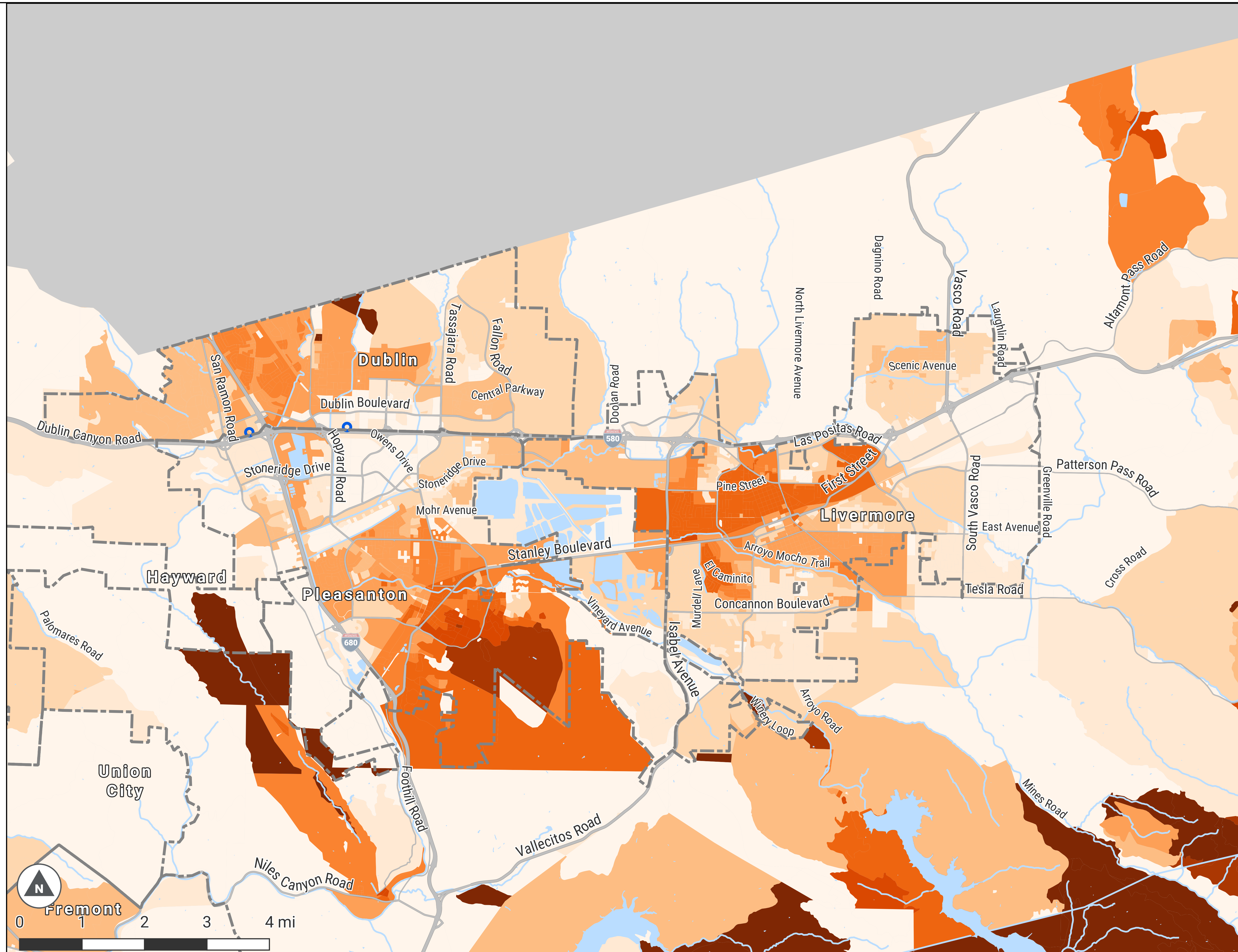
East Planning Area

Existing BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART Station
- Amtrak Station
- BART Lines



Note: Bicycle facility data used for this analysis were those received from local staff, current as of March 2018.

Alameda CTC Countywide Active Transportation Plan

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Planned BNA Scores

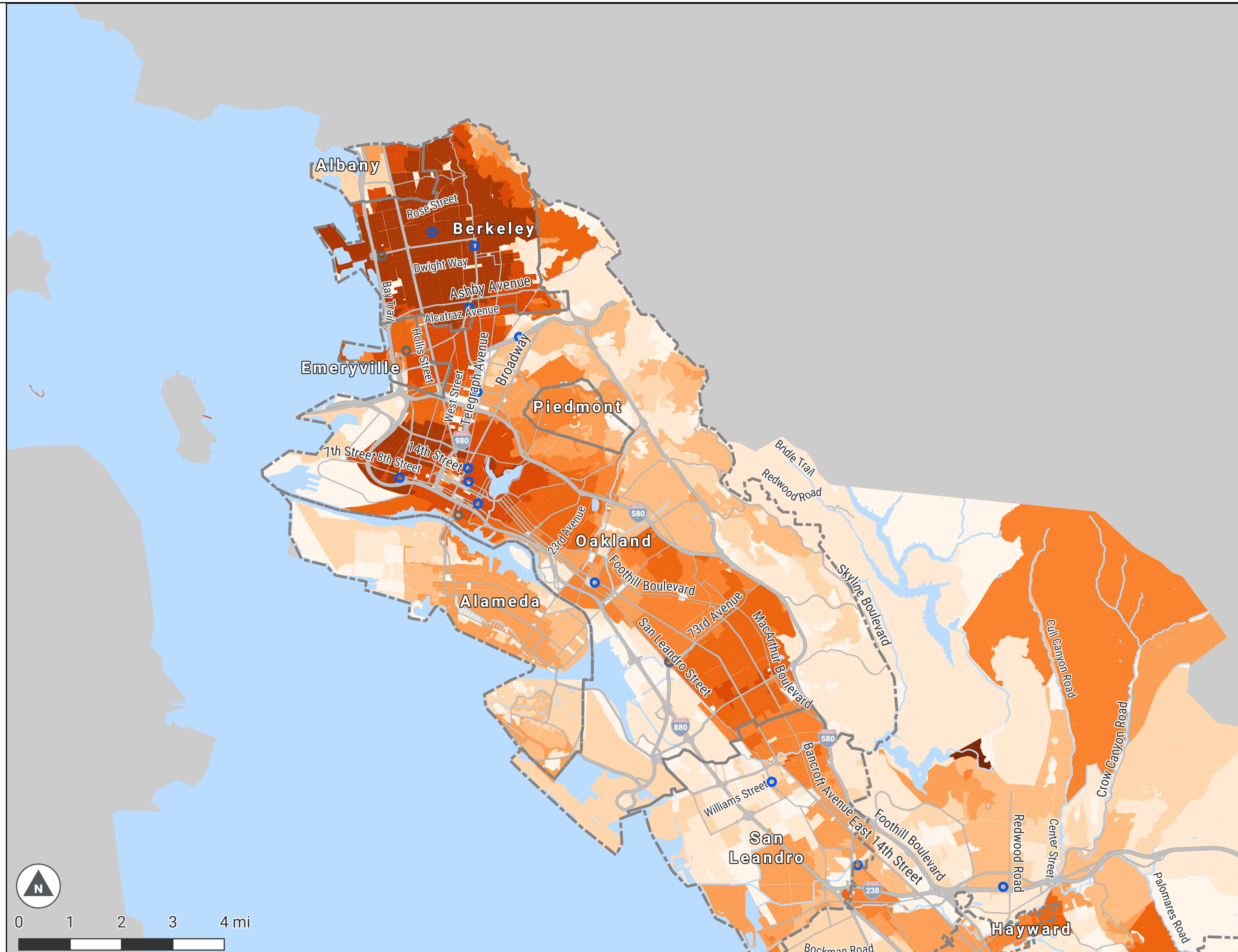
North Planning Area

Planned BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART Station
- Amtrak Station
- BART Lines



Note: Bicycle facility data used for this analysis were those received from local staff, current as of March 2018.

Alameda CTC Countywide Active Transportation Plan

Planned BNA Scores

Central Planning Area

Planned BNA Scores

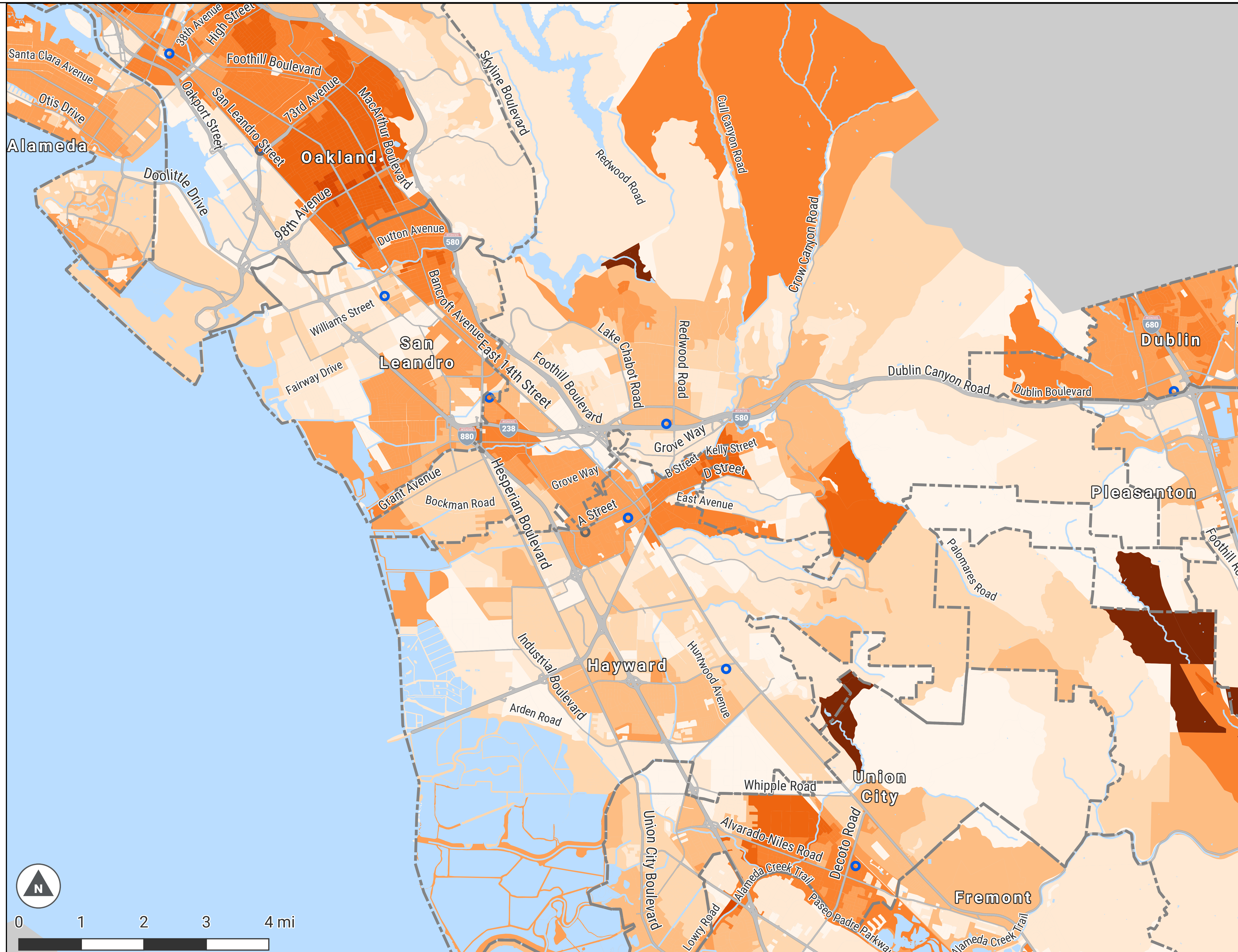
- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART Station
- Amtrak Station
- BART Lines

Note: Bicycle facility data used for this analysis were those received from local staff, current as of March 2018.

Alameda CTC Countywide Active Transportation Plan



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ALAMEDA County Transportation Commission

Planned BNA Scores

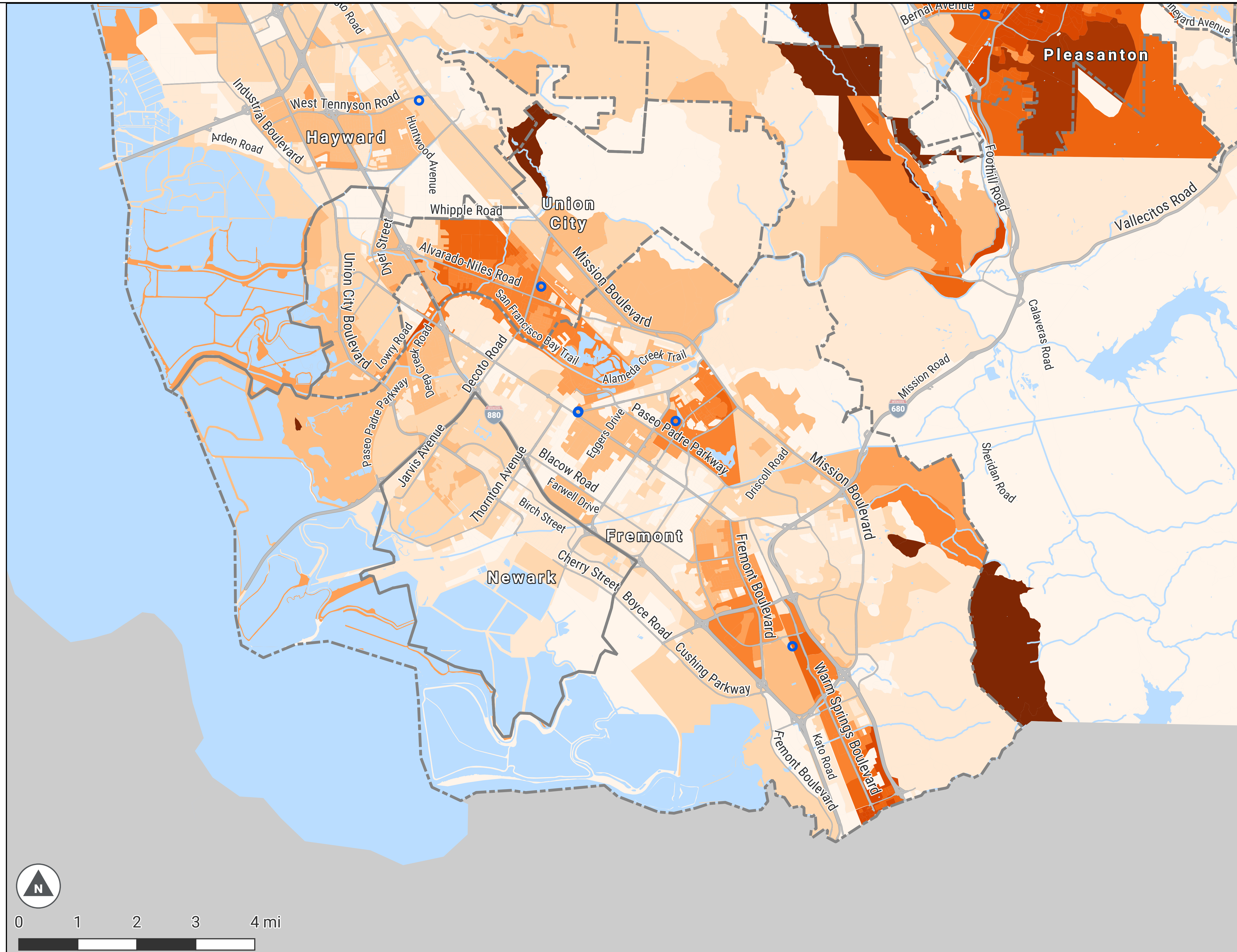
South Planning Area

Planned BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART, ACE and Capitol Corridor Stations



Note: Bicycle facility data used for this analysis were those received from local staff, current as of March 2018.

Alameda CTC Countywide Active Transportation Plan

ALAMEDA County Transportation Commission

Planned BNA Scores

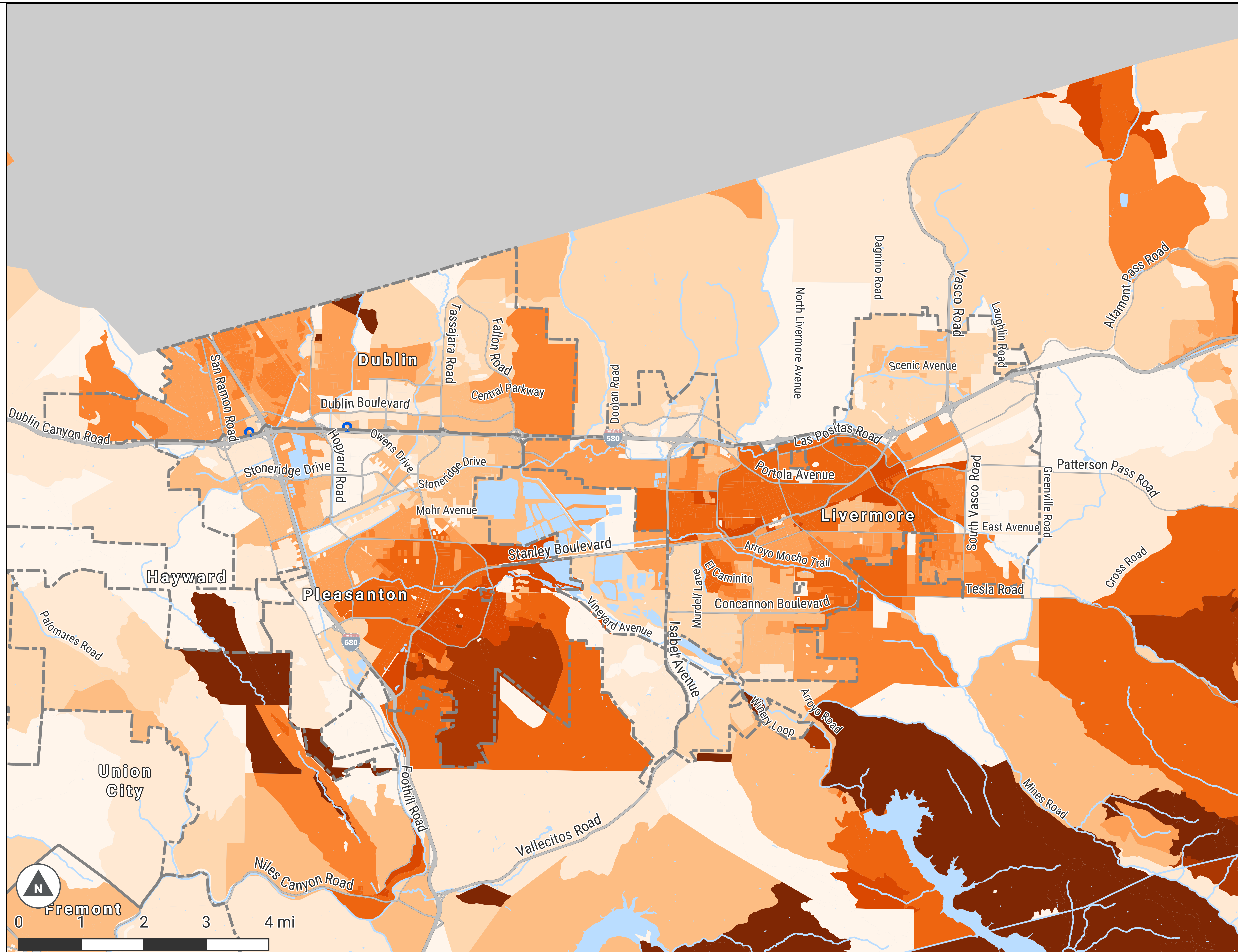
East Planning Area

Planned BNA Scores

- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10

Other

- BART Station
- Amtrak Station
- BART Lines



Note: Bicycle facility data used for this analysis were those received from local staff, current as of March 2018.

Alameda CTC Countywide Active Transportation Plan

April, 2019

ALAMEDA County Transportation Commission

Existing and Planned Bicycle Facilities

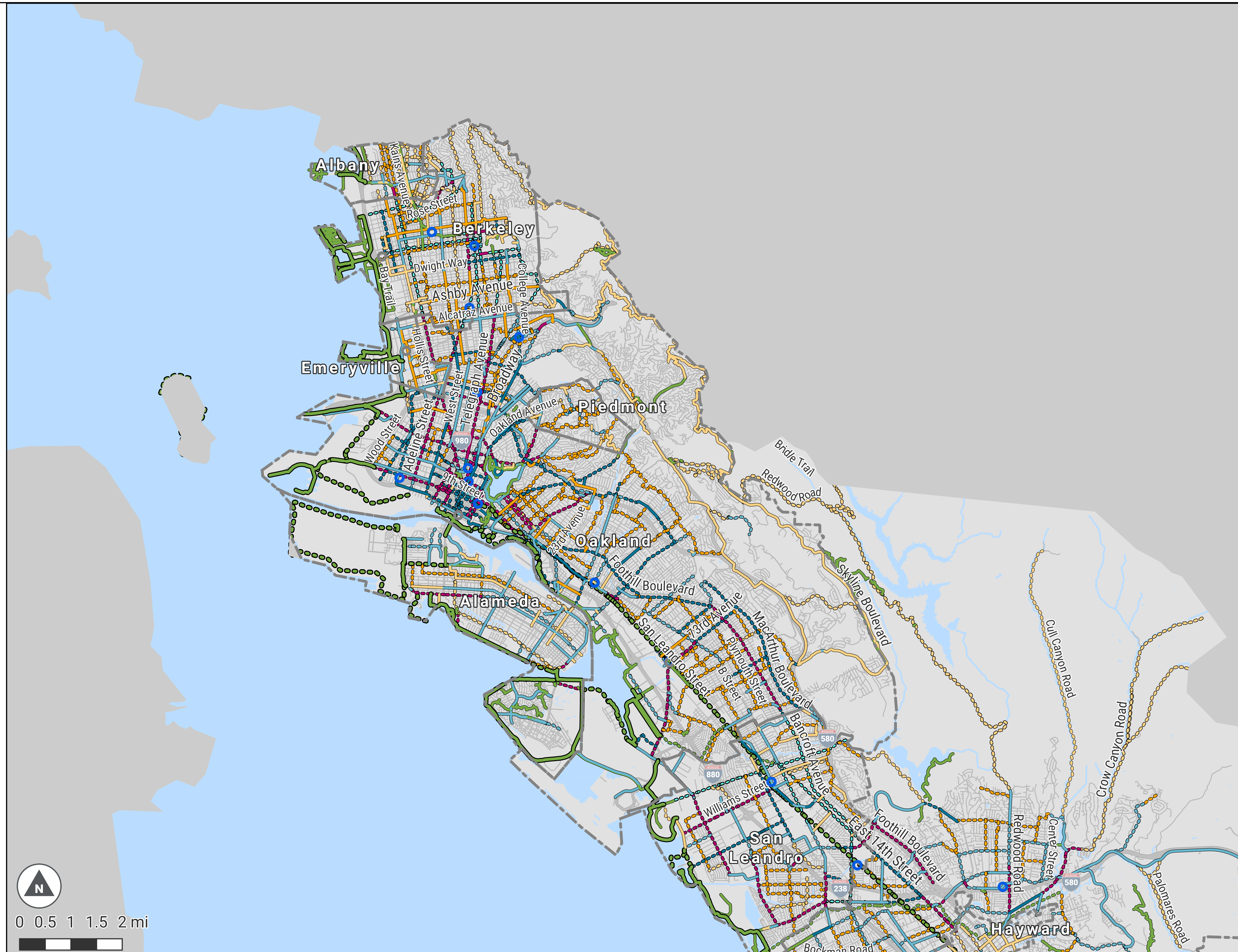
North Planning Area

Bicycle Facilities

- Major Regional Trails
- Class I - Shared Use Path
- Class II - Bike Lane
- Class II - Buffered Bike Lane
- Class III - Shared Lane
- Class III - Bike Boulevard
- Class IV - Separated Bike Lane
- Existing
- Planned
- Study Corridor

Other

- BART Station
- Amtrak Station
- ACE



Note: Data are accurate as of October 31, 2018 and do not include jurisdiction plans updated after that date. Where planned facilities are located on streets with existing facilities, only planned facility types are shown. For the purposes of map clarity, all jurisdiction recommendations for further study or where a facility type is not defined in a jurisdiction plan are included under the header 'Study Corridor'.

Alameda CTC Countywide Active Transportation Plan

April, 2019

ALAMEDA
County Transportation Commission

Existing and Planned Bicycle Facilities

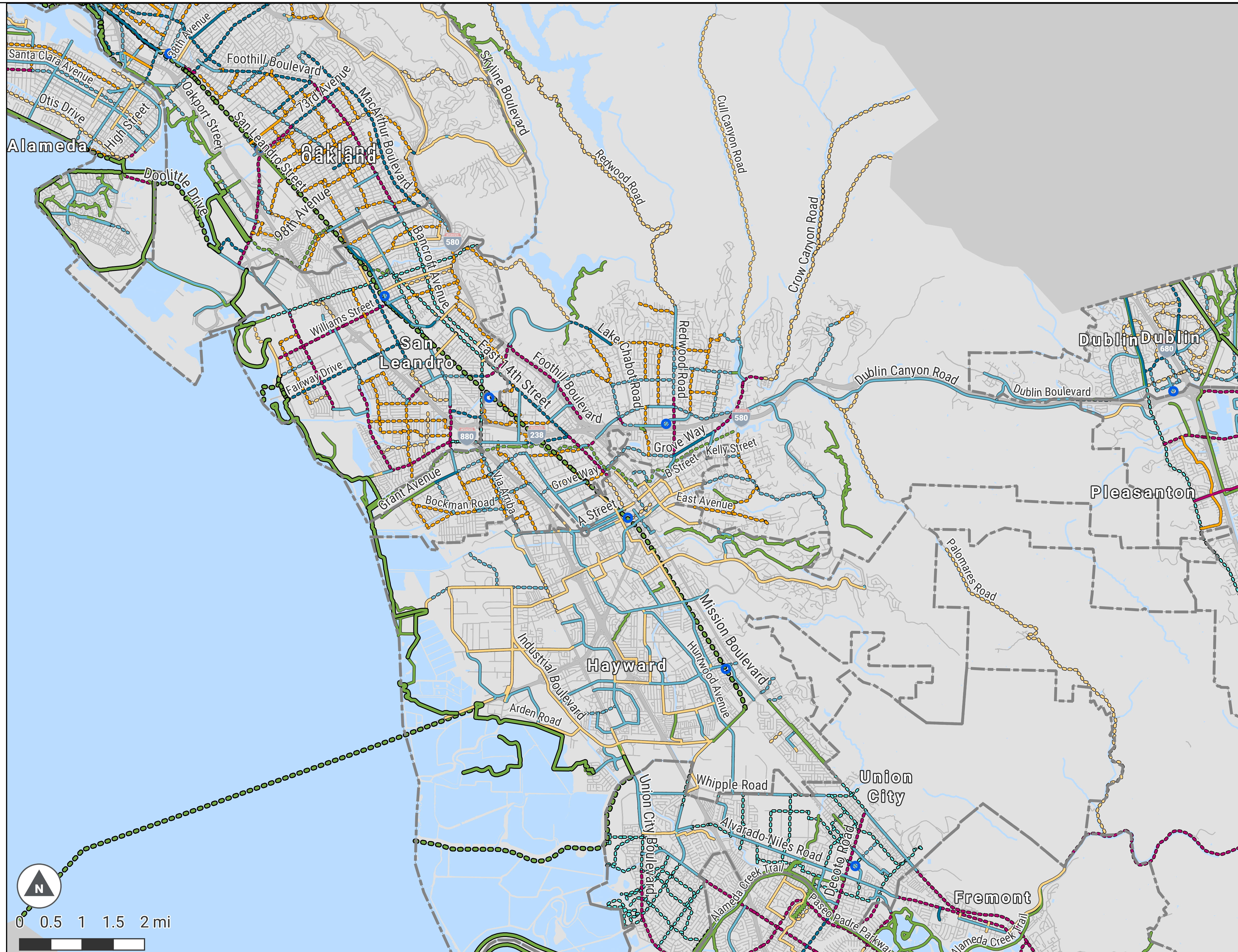
Central Planning Area

Bicycle Facilities

- Major Regional Trails
- Class I - Shared Use Path
- Class II - Bike Lane
- Class II - Buffered Bike Lane
- Class III - Shared Lane
- Class III - Bike Boulevard
- Class IV - Separated Bike Lane
- Existing
- Planned
- Study Corridor

Other

- BART Station
- Amtrak Station
- ACE



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Alameda CTC Countywide Active Transportation Plan

June, 2019

Existing and Planned Bicycle Facilities

South Planning Area

Bicycle Facilities

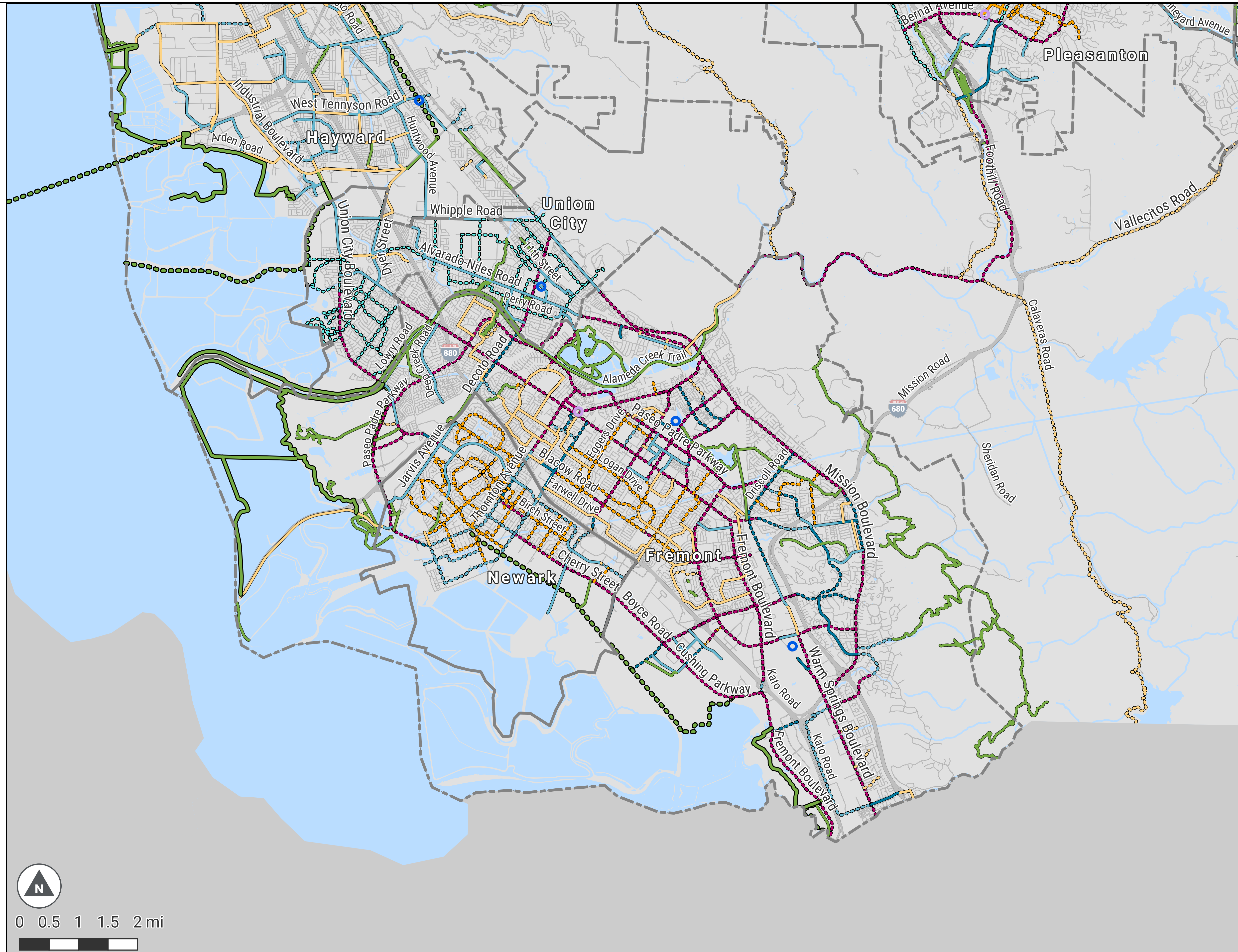
- Major Regional Trails
- Class I - Shared Use Path
- Class II - Bike Lane
- Class II - Buffered Bike Lane
- Class III - Shared Lane
- Class III - Bike Boulevard
- Class IV - Separated Bike Lane
- Existing
- Planned
- Study Corridor

Other

- BART Station
- Amtrak Station
- ACE

Note: Data are accurate as of October 31, 2018 and do not include jurisdiction plans updated after that date. Where planned facilities are located on streets with existing facilities, only planned facility types are shown. For the purposes of map clarity, all jurisdiction recommendations for further study or where a facility type is not defined in a jurisdiction plan are included under the header 'Study Corridor'.

Alameda CTC Countywide Active Transportation Plan



April, 2019

ALAMEDA
County Transportation Commission

Existing and Planned Bicycle Facilities

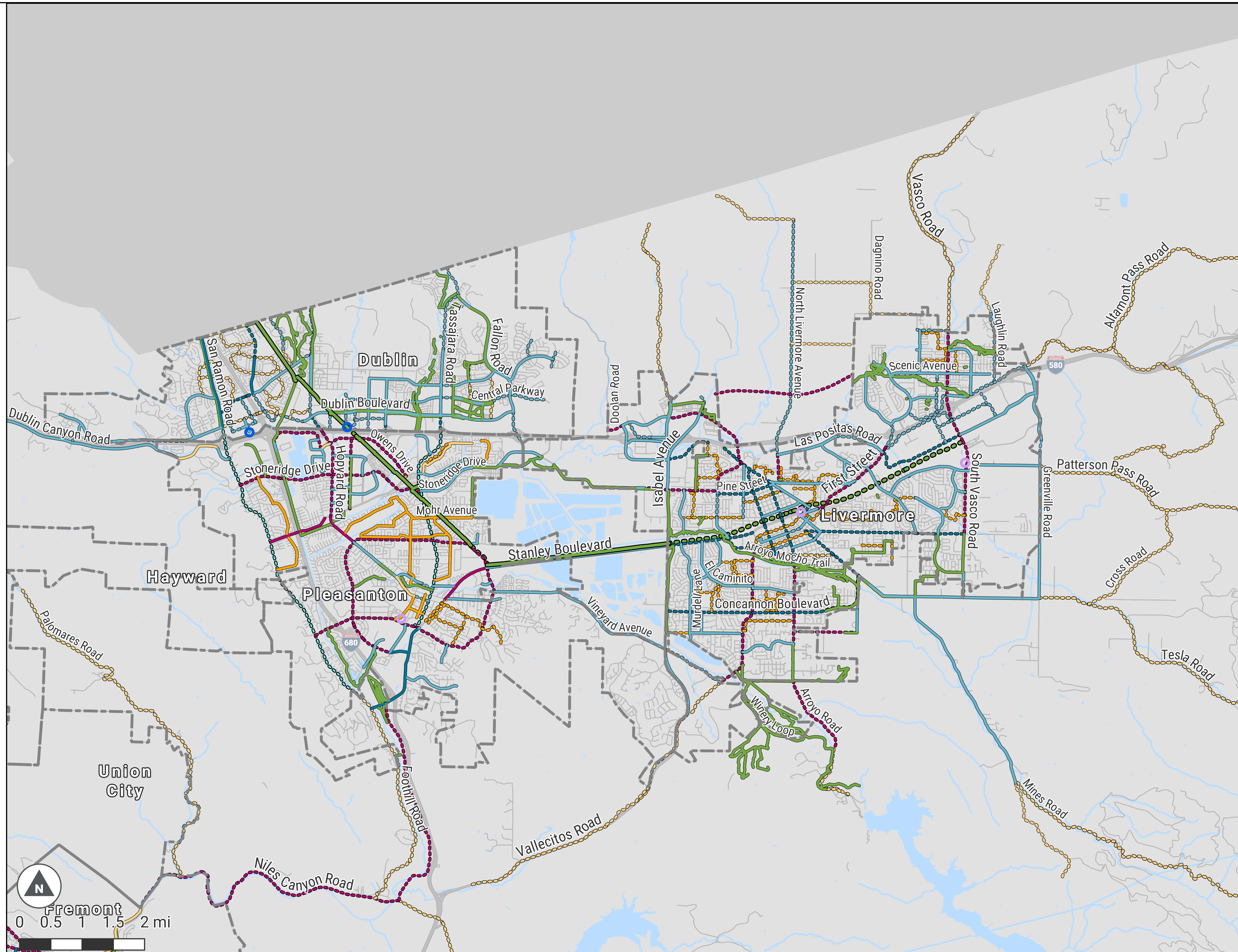
East Planning Area

Bicycle Facilities

- Major Regional Trails
- Class I - Shared Use Path
- Class II - Bike Lane
- Class II - Buffered Bike Lane
- Class III - Shared Lane
- Class III - Bike Boulevard
- Class IV - Separated Bike Lane
- Existing
- Planned
- Study Corridor

Other

- BART Station
- Amtrak Station
- ACE



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