

LINK21

CONNECT NORTHERN CALIFORNIA

MARKET ANALYSIS REPORT

APPENDIX H: BAY AREA RAIL TRANSIT MARKET ANALYSIS WITH EMERGENT NETWORK TECHNICAL MEMORANDUM

October 2022

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ACRONYMS AND ABBREVIATIONS

ACRONYM/ABBREVIATION	DEFINITION
BART	San Francisco Bay Area Rapid Transit
CCJPA	Capitol Corridor Joint Powers Authority
FT	facility type
HWY	highway
MTC	Metropolitan Transportation Commission
SFCTA	San Francisco County Transportation Authority
TAZ	transportation analysis zones

LINK21 PROGRAM TEAM NAMES

TEAM NAME	TEAM MEMBERS
PMC	The HNTB Team
PMT	BART/CCJPA + PMC
Consultants	Consultants supporting program identification/project selection
Link21 Team	PMT + Consultants

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1. OVERVIEW

This appendix summarizes an assessment of the market potential for future rail services in the Bay Area using the Emergent Network Modeling Framework, which is a methodology used by the San Francisco County Transportation Authority (SFCTA) to assess rail transit market potential.

This assessment was conducted to test the robustness of the market analysis findings and, in doing so, support the identification of promising rail corridors in the Bay Area for the Link21 Program (Link21). Link21 will include a new transbay passenger rail crossing between Oakland and San Francisco as well as other rail improvements in the Northern California Megaregion that support ridership through the new crossing.

A key limitation of the emergent network assessment is that it could only cover the nine-county Bay Area, while Link21 covers the 21-county Megaregion. Thus, other methodologies were used to identify promising corridors for Link21 outside of the Bay Area.

This appendix contains the following sections:

- Objective
- Emergent Network Modeling Framework
- Emergent Network Modeling with the Metropolitan Transportation Commission (MTC) Model
- Rail Potential Ridership Results

2. OBJECTIVE

The objective of this analysis is to assess the market potential for future rail services in the Bay Area by implementing the SFCTA Emergent Network Modeling Framework using the MTC Model. It is intended to supplement the market potential analysis that was done in the main Link21 market analysis.

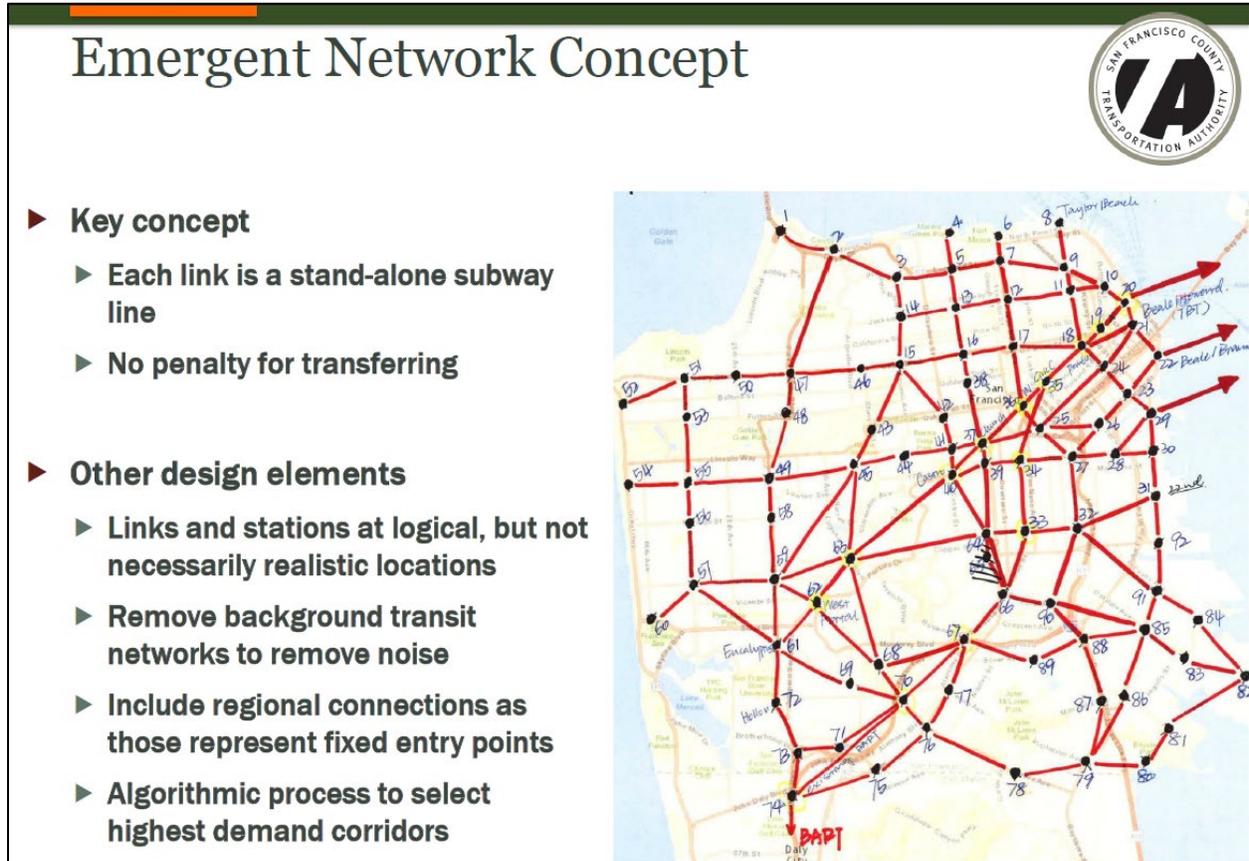
3. EMERGENT NETWORK MODELING FRAMEWORK

The Emergent Network Modeling Framework features an abstract transit network of seamless/ubiquitous rail transit services covering the nine-county Bay Area, which is referred to as the Emergent Network in this appendix. Examining ridership results from providing seamless/ubiquitous rail transit throughout the Emergent Network provides an indication of which rail corridors travelers might use if good rail transit is provided.

The Emergent Network Modeling Framework was designed to identify promising, but not yet studied, rail transit corridors for San Francisco's Subway Vision project. It was

implemented by SFCTA using the SF-CHAMP¹ activity-based travel demand model. The emergent network and model results from the Subway Vision project are shown in **Figure 1** and **Figure 2**, respectively. The results identified promising corridors for expanded rail transit in San Francisco for further study.

Figure 1. San Francisco Subway Vision Emergent Network

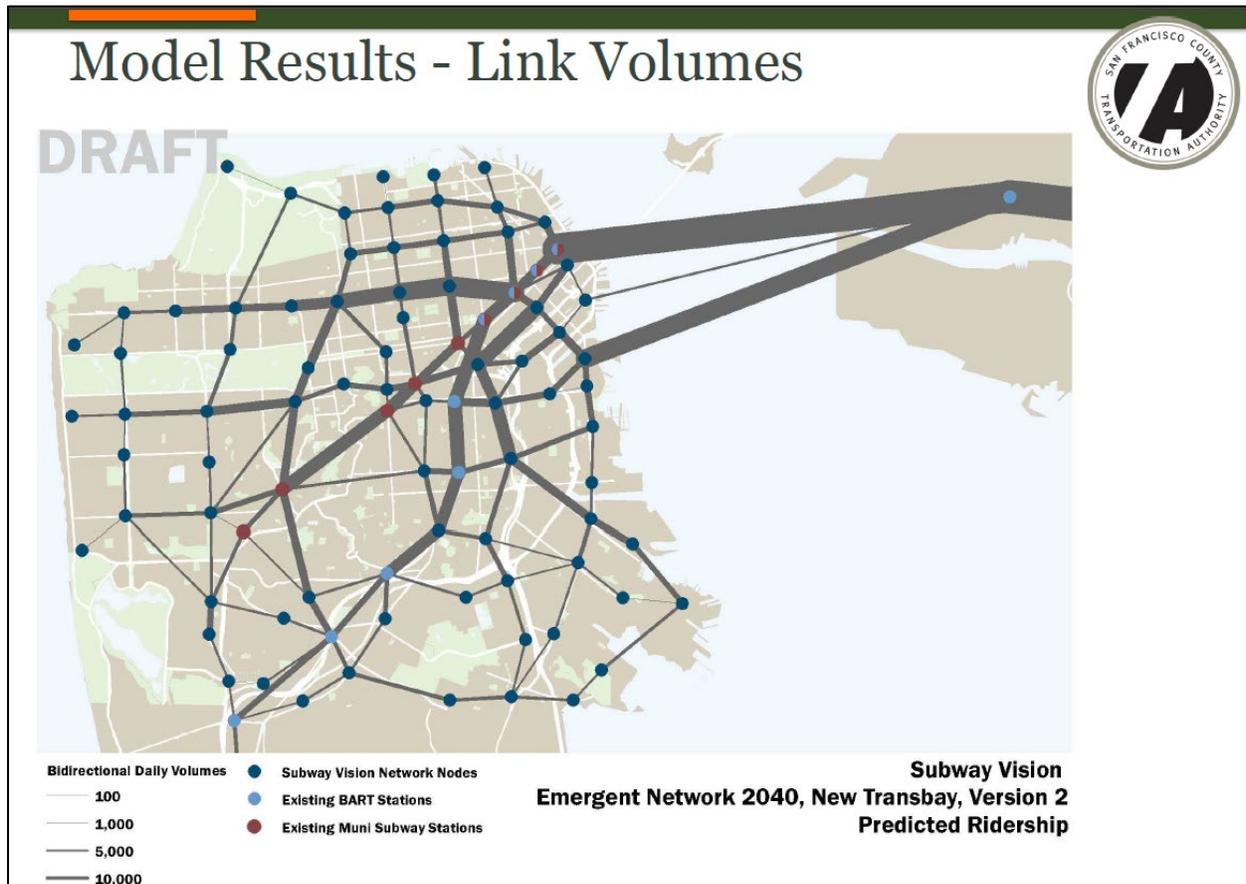


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¹ San Francisco Chained Activity Modeling Process



Figure 2. San Francisco Subway Vision Model Results



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4. EMERGENT NETWORK MODELING WITH THE MTC MODEL

To support the identification of promising corridors in the Bay Area for Link21, the Emergent Network Modeling Framework was implemented using the MTC Travel Model 1.5 (MTC Model). The “2040_06_694_Amd2” scenario from *Plan Bay Area 2040* was used as the baseline scenario. Because the MTC Model only covers the Bay Area, promising Link21 corridors could only be identified in the Bay Area using this methodology. *Plan Bay Area 2040* was developed prior to the COVID-19 pandemic.

There are six primary transit modes in the MTC Model, which are:

1. Local bus
2. Express bus
3. Ferry service
4. Light rail
5. Heavy rail
6. Commuter rail

The MTC Model scripts were revised to utilize the Emergent Network as the only transit service, replacing the six primary transit modes.



A full MTC Model run includes a feedback loop where the congested travel times from a highway assignment are “fed back” into the demand models. This is to ensure consistency between travel times used as input for the demand choices and the output travel times that are computed after assignment of these trips to the network. It is well documented that the feedback loop process introduces some level of variability into the results. This variability can make it difficult to isolate the impacts solely based on a project. To mitigate this effect, only one additional iteration using the Emergent Network as the transit network was run in the same folder of the baseline scenario to assess the impacts of the Emergent Network as a Build scenario.

4.1. Emergent Network Development

The following steps were taken to develop the Emergent Network for the Bay Area:

1. Use the major links in the MTC highway network to build an initial Emergent Network. There is a facility type (FT) link attribute in the MTC highway network (values are shown in **Figure 3**). All major highway links, including freeways, expressways, ramps/connectors, and major arterials, were included in the initial Emergent Network, and they are identified by FT=1, 2, 3, 5, 7. The initial Emergent Network identified is shown in **Figure 4**. Rail links are not included because each rail link is paralleled and therefore adequately represented by a nearby highway or roadway link.
2. In the initial Emergent Network, it was assumed that:
 - a. Every link is a transit line.
 - b. Every transit node is a transit stop.
3. Link21 will include a new transbay passenger rail crossing between Oakland and San Francisco. To represent the possible alignments for this crossing, several links were added to the initial Emergent Network, shown in **Figure 5**. These links were chosen based on a combination of prior studies identifying potential crossing endpoints and professional judgment.
4. There were certain existing and planned future rail transit services not represented in the initial Emergent Network. Those gaps were filled to finalize the Emergent Network, shown in **Figure 6** to **Figure 8**.



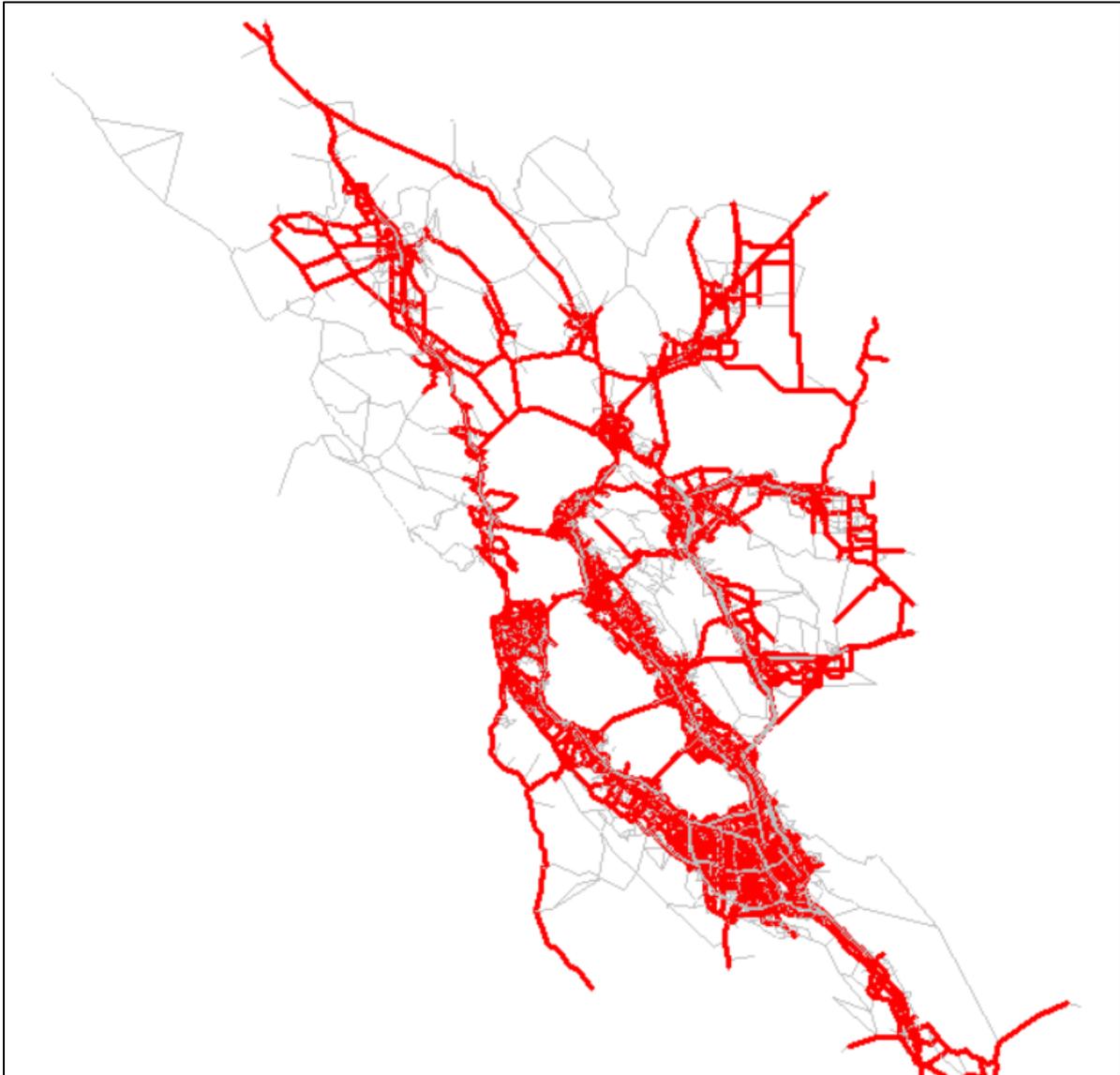
Figure 3. MTC Highway Network Facility Types Used to Develop the Initial Emergent Network

Facility Type (FT)	
FT	Definition
1	Freeway-to-freeway connector
2	Freeway
3	Expressway
4	Collector
5	Freeway ramp
6	Dummy link
7	Major arterial
8	Managed Freeway
9	Special facility
10	Toll plaza

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Figure 4. Initial Emergent Network



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Figure 5. Potential Link21 Transbay Crossing Alignments

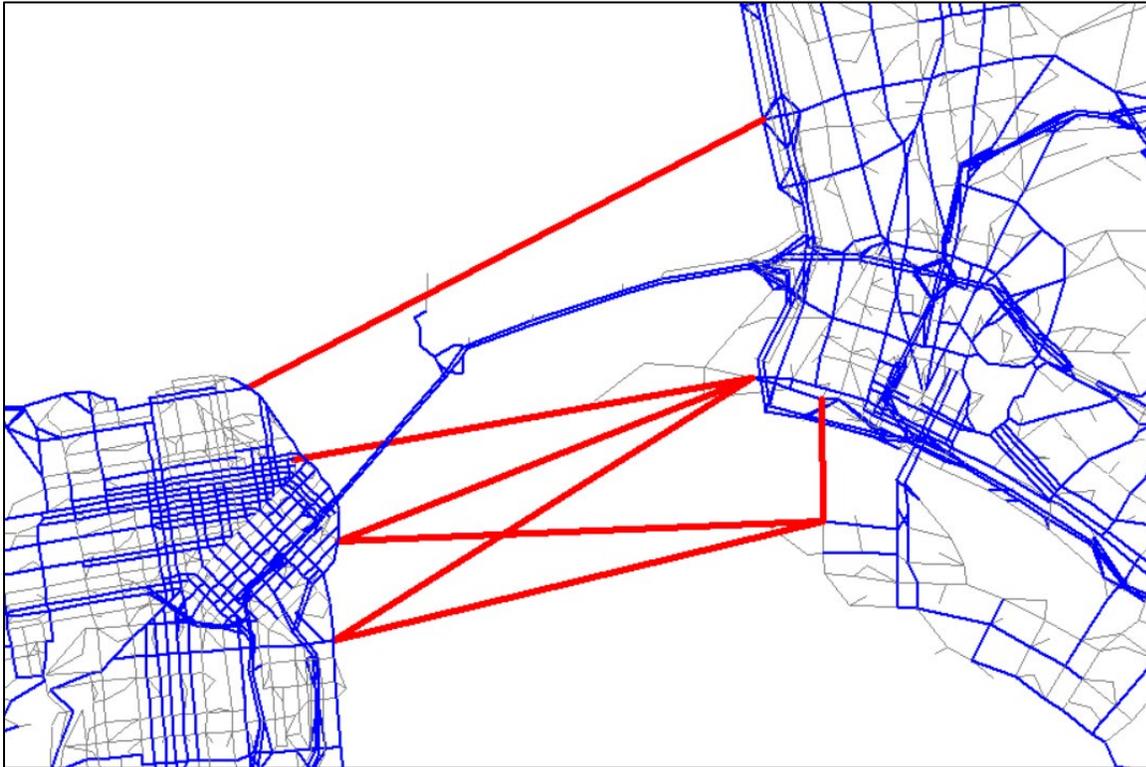
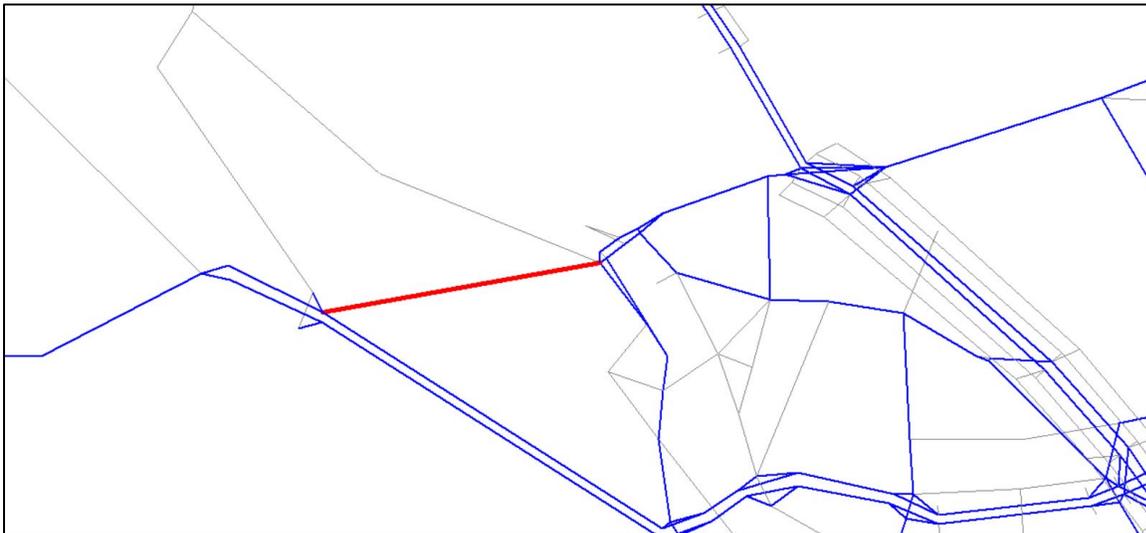


Figure 6. Connection between Martinez Downtown and State Route (SR) 4 Representing the Existing Capitol Corridor Alignment

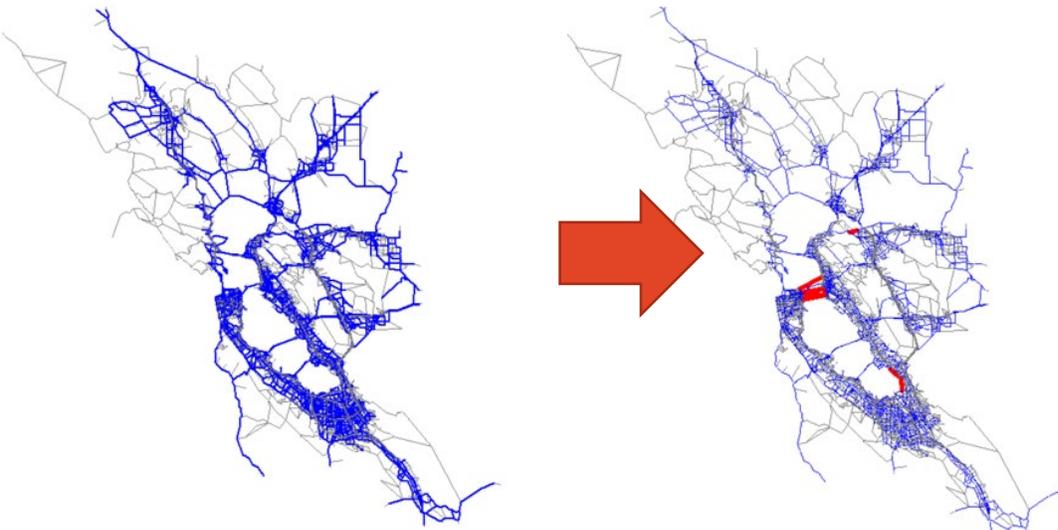


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Figure 7. Connections in the South Bay Representing Capitol Corridor's Future South Bay Connect Alignment



Figure 8. Finalized Emergent Network



4.2. Access Links to Emergent Network

To ensure all transportation analysis zones (TAZ) in the MTC Model can access the Emergent Network, the generation of access/egress links to/from the Emergent Network was relaxed. The access link generation parameters in MTC Model were modified as follows:

- Walk access links
 - Can walk up to 10 links to get to a stop
 - Can walk up to 0.75 miles to get to a stop



- Drive access links
 - Can use any existing park-and-ride lots
 - Can drive up to 40 minutes to a park-and-ride lot

4.3. Service Characteristics

To assess the market potential for rail services, a high level of service was assumed for the Emergent Network.

- Every link is a transit line.
- Every node is a transit stop.
- There are no boarding fares.
- There are no transfer fares, penalties or wait times.
- Operating speed equals 70 mph.
- Service Frequency equals 15 minutes for all time periods.

4.4. Running the MTC Model with the Emergent Network

The initial results from running an additional iteration of the MTC Model with the Emergent Network had transit trip lengths that were very short. This was caused by a limit in the transit module (TRNBUILD) of CUBE that no more than 10 transfers are allowed on a transit path. Because the Emergent Network assumes that “each link is a transit line,” the transit paths between many origin and destination TAZs will have more than 10 transfers.

To overcome this limit, the following approach was implemented:

1. Convert the transit network built from the Emergent Network into a highway network, which will be referred to as the HWY (highway) Emergent Network. This is feasible because the Emergent Network was originally developed from the MTC highway network, and all the access/egress support links can be represented as a highway link.
2. The transit network path-building and skimming on the Emergent Network can be implemented using highway network path-building and skimming methods on the HWY Emergent Network. This is because “each link is a transit line” in the Emergent Network. So, there is no need to consider a situation where there are multiple transit lines over one segment. In this case, the transit path-building problem is the same as the highway shortest path-building problem.
3. The steps to implement the HWY Emergent Network approach are:
 - a. Build transit networks from the Emergent Network.



- b. Convert transit network into the HWY Emergent Network.
- c. Skim transit level of service from the HWY Emergent Network using highway skimming methods.
- d. Use skims from the HWY Emergent Network as transit skims in the core CT-RAMP program.
- e. Assign the resulting transit trips to the HWY Emergent Network using the highway assignment all-or-nothing method. The link volume of each link in the HWY Emergent Network corresponds to the ridership of the equivalent transit line in the Emergent Network.

With the HWY Emergent Network approach, the issue with 10 transfers or less was resolved.

4.5. Reasonableness Check

The Emergent Network Analysis Framework was implemented with the MTC Model. The mode shares from the additional iteration with the Emergent Network were compared to the original mode shares for reasonableness.

A comparison of the original mode shares (ORIGINAL), and the mode shares from the Emergent Network method (EMERGENT) is shown in **Figure 9**. As expected, transit mode share increased significantly with the majority of the mode shift from the auto mode. Walk and bike trips also decreased due to transit becoming a significantly more attractive and/or feasible mode of travel for short- and medium-distance trips. There was a 3% loss of total person trips, which was deemed reasonable. This loss is likely due to the significant changes in accessibility introduced by the Emergent Network.

Figure 9. Mode Share Comparison

		AUTO	Walk	Bike	Transit	TOTAL
ORIGINAL	DAILY	26,191,734	3,291,638	352,400	2,203,964	32,039,736
EMERGENT	DAILY	18,761,326	2,381,124	180,216	9,872,780	31,195,446
Delta		(7,430,408)	(910,514)	(172,184)	7,668,816	(844,290)
% Delta		-28%	-27.7%	-49%	348%	-3%

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5. RAIL TRANSIT POTENTIAL RIDERSHIP RESULTS

This section provides the results of the Emergent Network assessment of the market rail potential² for possible rail service in the Bay Area. The Link21 market analysis also sought to identify market unmet rail potential for the Megaregion (its methodology is described in Chapters 7 through 10 of this report); these results are intended primarily to compare and validate the market analysis results.

The Emergent Network transit assignment results were generated using highway bandwidth plots on the HWY Emergent Network because each transit line in the Emergent Network corresponds to a highway link in the HWY Emergent Network. Additionally, Emergent Network transit select link results were generated with the HWY Emergent Network by the same principle.

Transit select link and transit ridership results are shown in the following figures. These results are based on the following assumed service characteristics of the Emergent Network:

- Operating speed = 70 mph
- Service frequency = 15 minutes for all time periods
- No boarding fares
- No transfer fares, penalties, or wait times

5.1. Emergent Network Transit Select Link Results

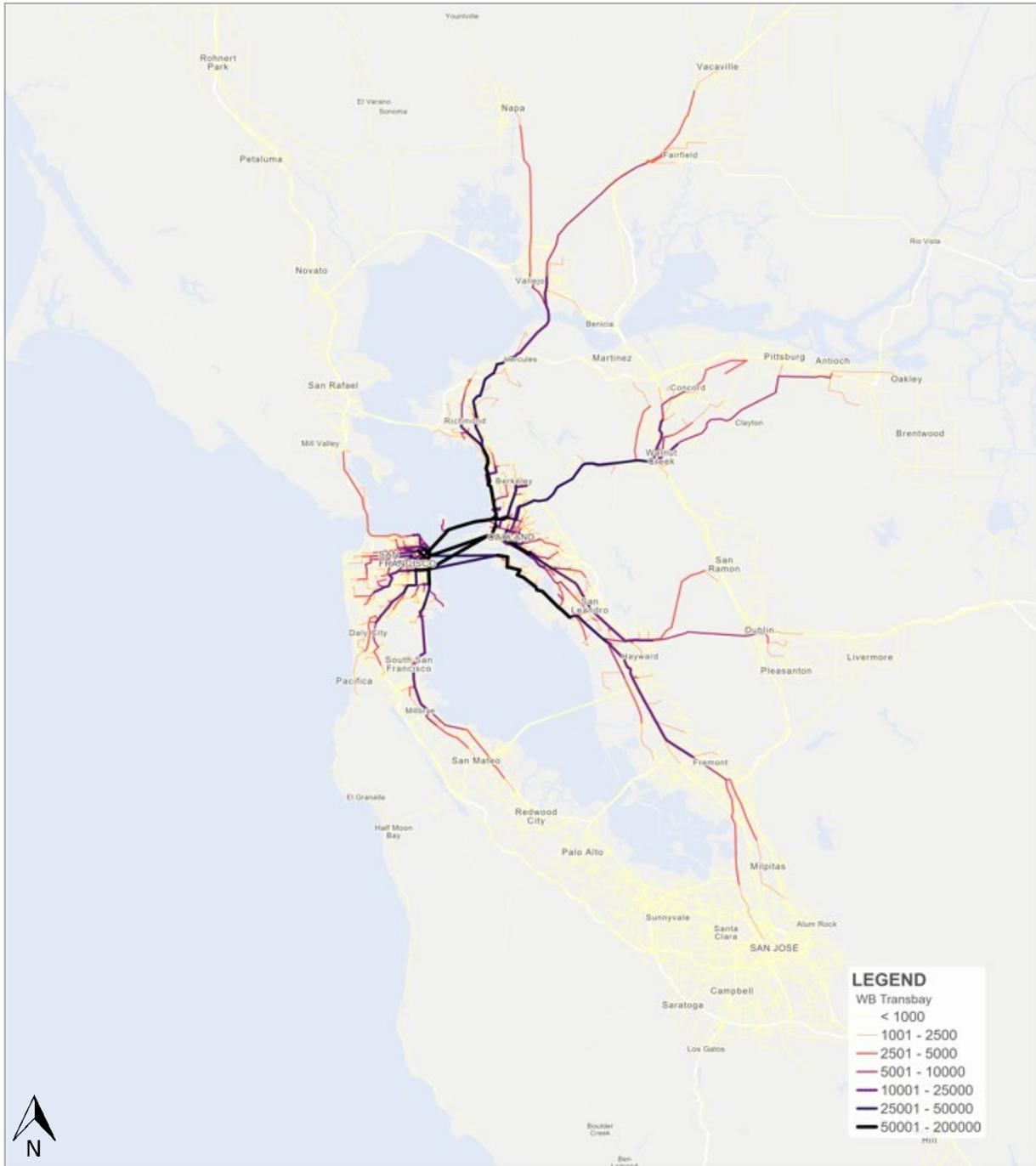
Figure 10 shows westbound select link weekday daily transit volumes and pattern for the Transbay Corridor within the Emergent Network. Total weekday daily westbound transit volume for the Transbay Corridor with the emergent network is 425,000. To the east, there is significant volume in several corridors in Oakland and Berkeley; north to Emeryville, Richmond, San Pablo, Hercules, Vallejo, and Fairfield; northeast to Walnut Creek, Concord, and Antioch; southeast to San Leandro and Dublin; and south to Alameda, Hayward, and Fremont. To the west, there is significant volume in several corridors in San Francisco; southwest to Daly City; south to Millbrae; and west to Inner Richmond and Inner Sunset. These results suggest significant market potential for transbay rail service along these corridors.

Unmet rail potential could be significant, particularly on those corridors and markets where there is poor or no existing or planned rail service. These include potentially strong markets in the Oakland-Emeryville-Vallejo-Fairfield corridor, Alameda-Bay Fair and western San Francisco, and moderate other new markets, such as San Ramon.

² Rail potential includes baseline ridership for 2040 plus unmet rail potential.



Figure 10. Weekday Daily Transbay – Westbound Select Link Volumes



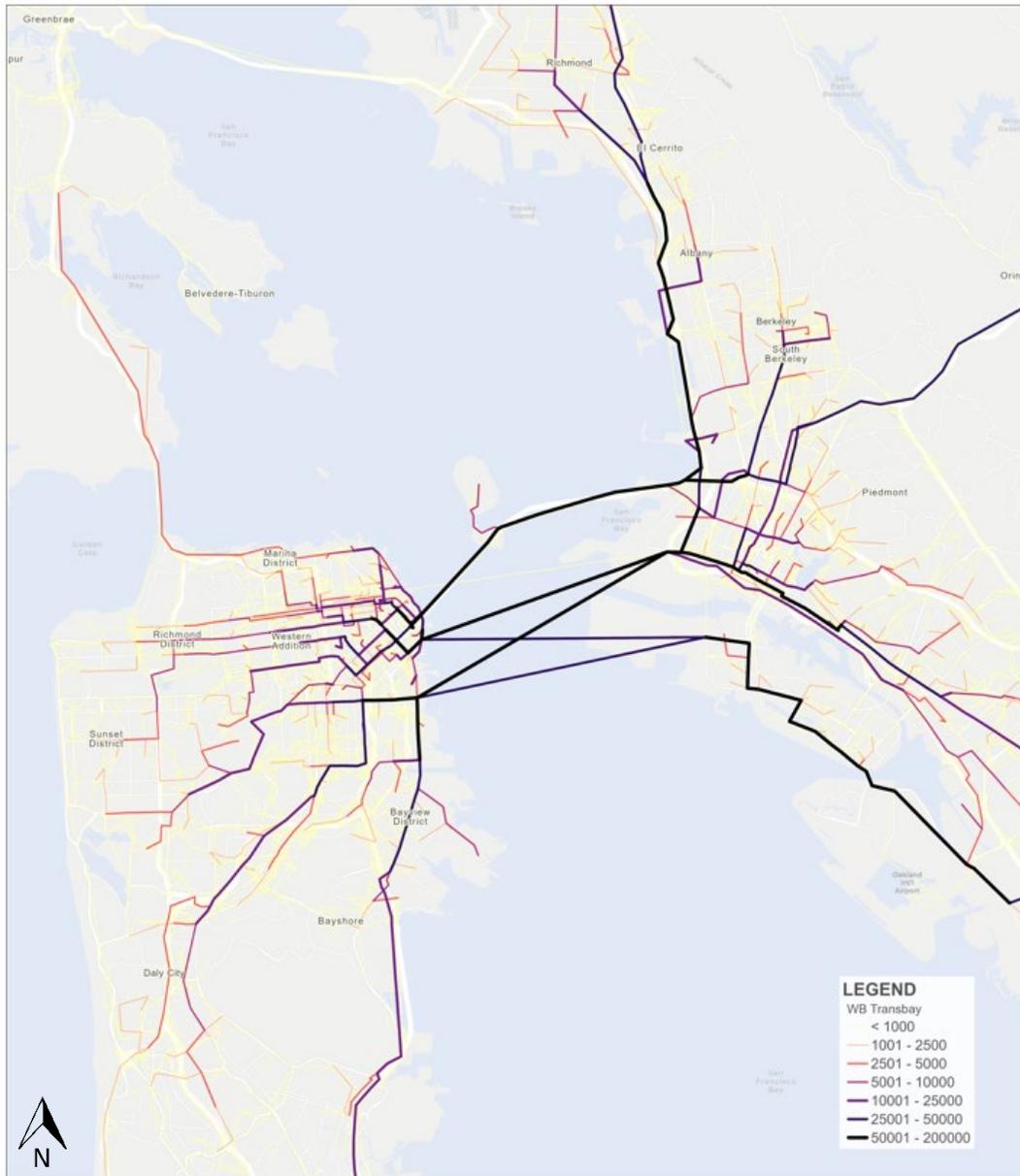
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Figure 11 is a focused view of westbound select link weekday daily transit volumes and patterns for the Transbay Corridor with the Emergent Network, providing a detailed view of corridors in San Francisco, Oakland, Alameda, and Berkeley. In San Francisco, there is significant volume along corridors to the south to Bayview, southwest through the Mission to Balboa Park and the Outer Mission, southwest to Twin Peaks and the West Portal, and west to Inner Richmond and Inner Sunset. In the east, there is significant volume along the International Boulevard corridor through Oakland, through Alameda to East Oakland, along the Telegraph Avenue corridor through Oakland to Berkeley, and along the I-80 corridor to El Cerrito. These results suggest significant market potential for transbay rail service along these corridors and particularly strong unmet rail potential in those corridors and markets that are poorly or not served by rail, such as the western San Francisco corridor and Alameda, and more modest unmet potential in other corridors, such as International Boulevard.



Figure 11. Weekday Daily Transbay – Westbound Select Link Volumes

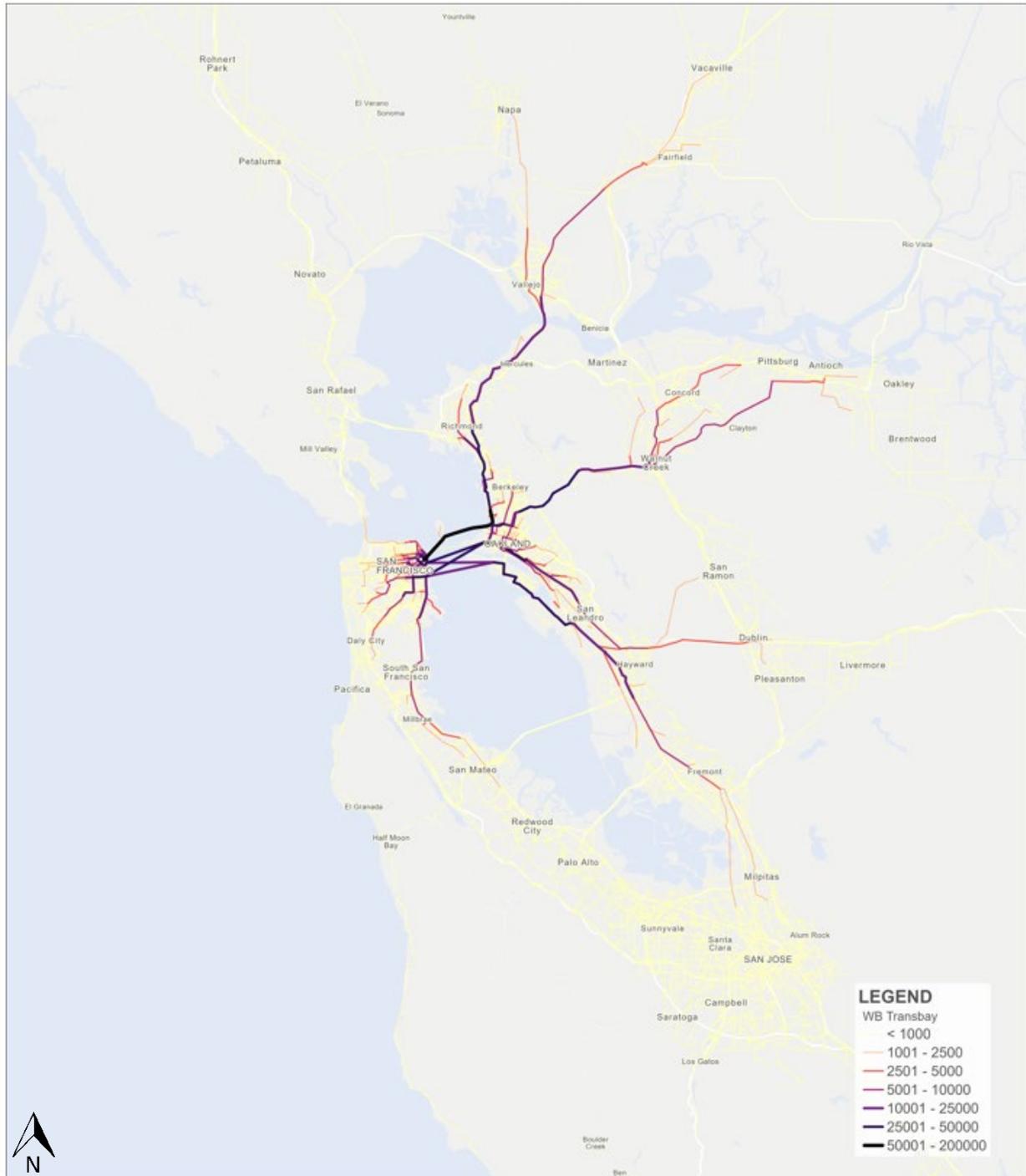


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Figure 12 shows westbound select link weekday AM peak 4-hour period transit volumes and patterns for the Transbay Corridor with the Emergent Network. The pattern is similar to the weekday daily pattern shown in Figure 10.

Figure 12. AM Peak 4-Hour Period Transbay – Westbound Select Link Volumes

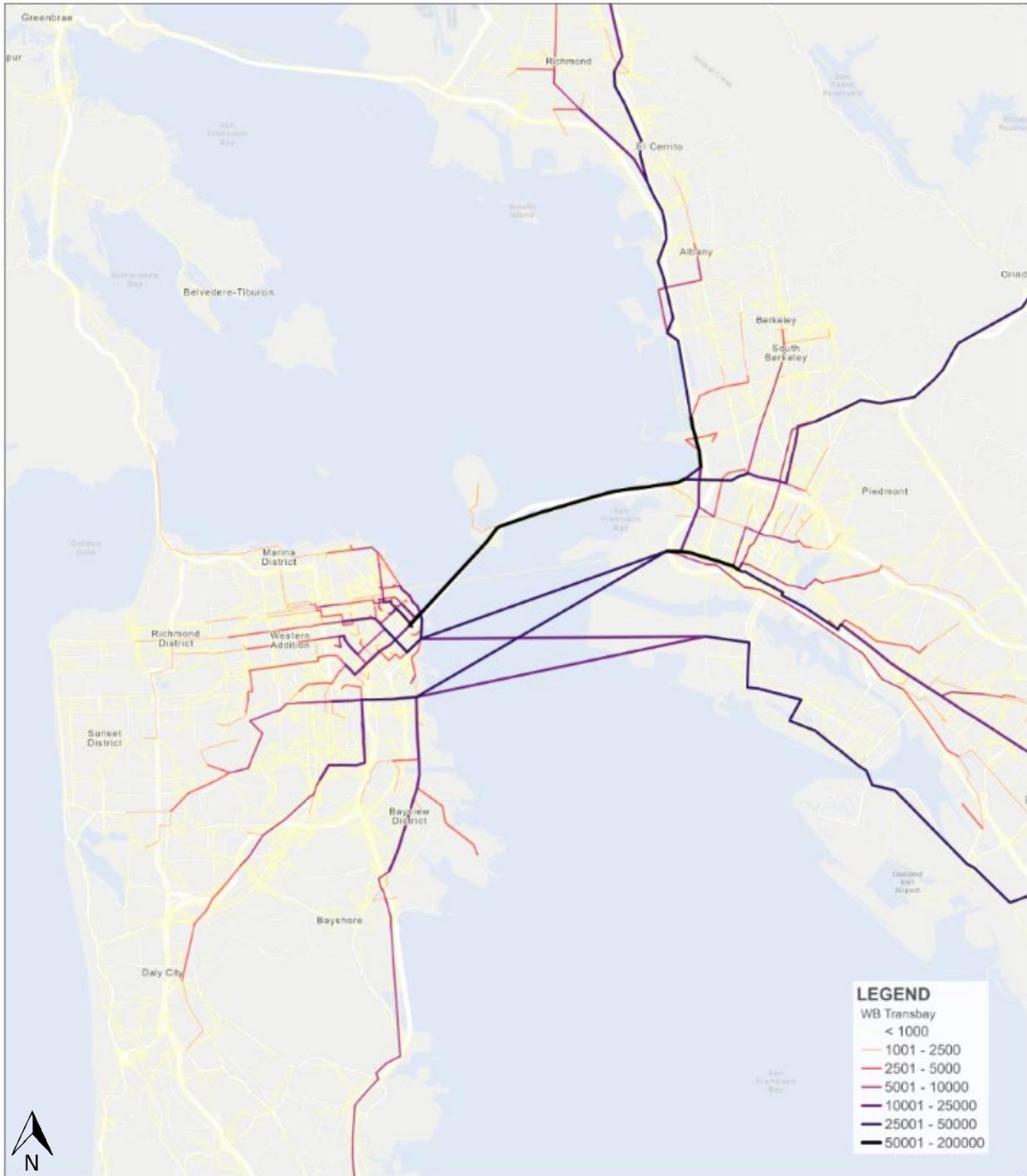


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Figure 13 provides a focused view of westbound select link weekday AM peak -4-hour period transit volumes and pattern for the Transbay Corridor with the Emergent Network. The pattern is similar to the weekday daily pattern shown in Figure 9.

Figure 13. AM Peak 4-hour Period Transbay – Westbound Select Link Volumes (Focused View)

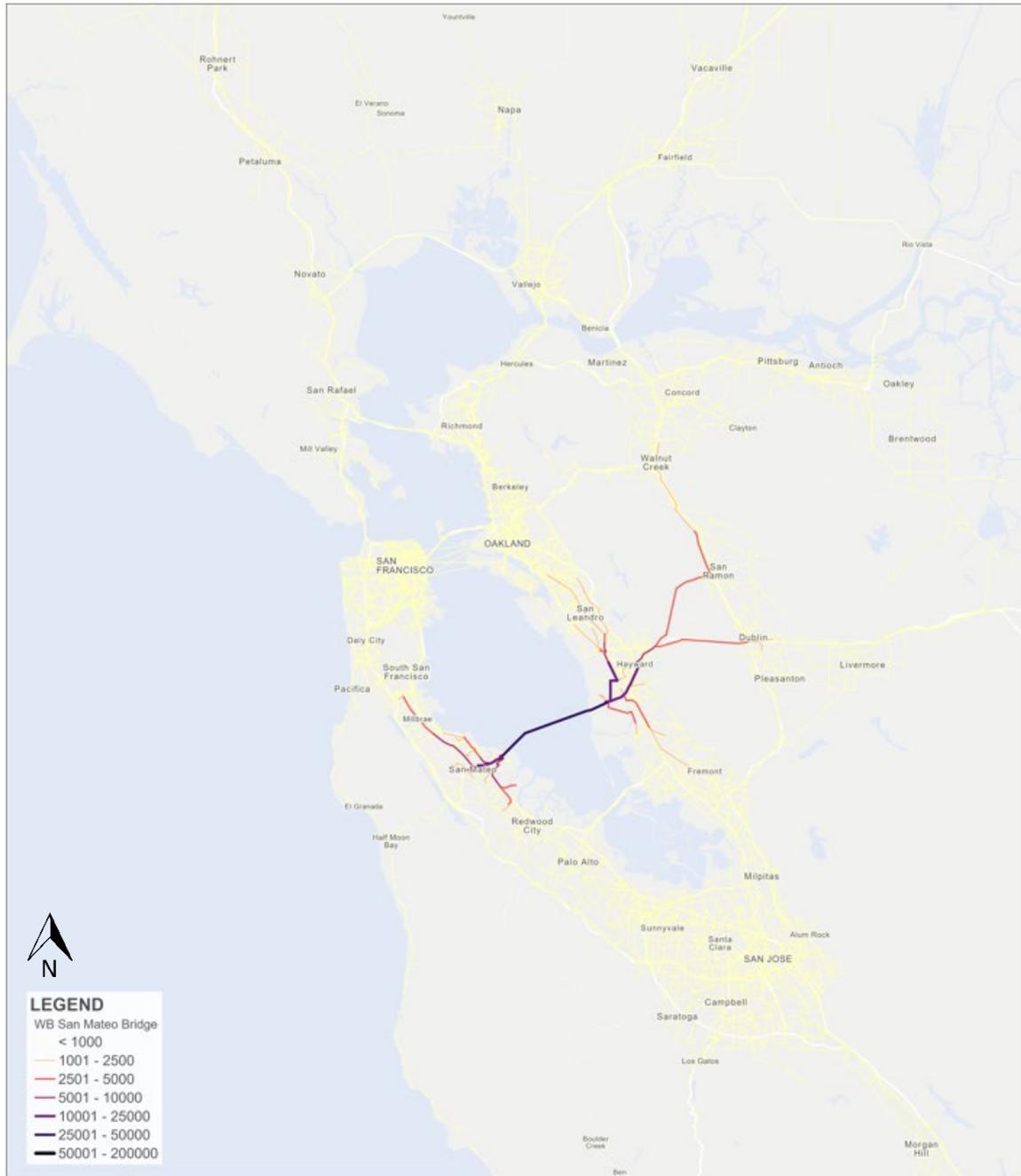


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Figure 14 shows westbound select link weekday daily transit volumes and patterns for the San Mateo-Hayward Bridge corridor with the Emergent Network. Total weekday daily westbound transit volume for the San Mateo-Hayward Bridge corridor is 40,000. The catchment areas with significant volume to both the east and west are limited, likely because travelers to the north of the San Mateo-Hayward Bridge corridor would use the Transbay Corridor and those to the south would use the Dumbarton Bridge corridor.

Figure 14. Weekday Daily San Mateo-Hayward Bridge – Westbound Select Link Volumes

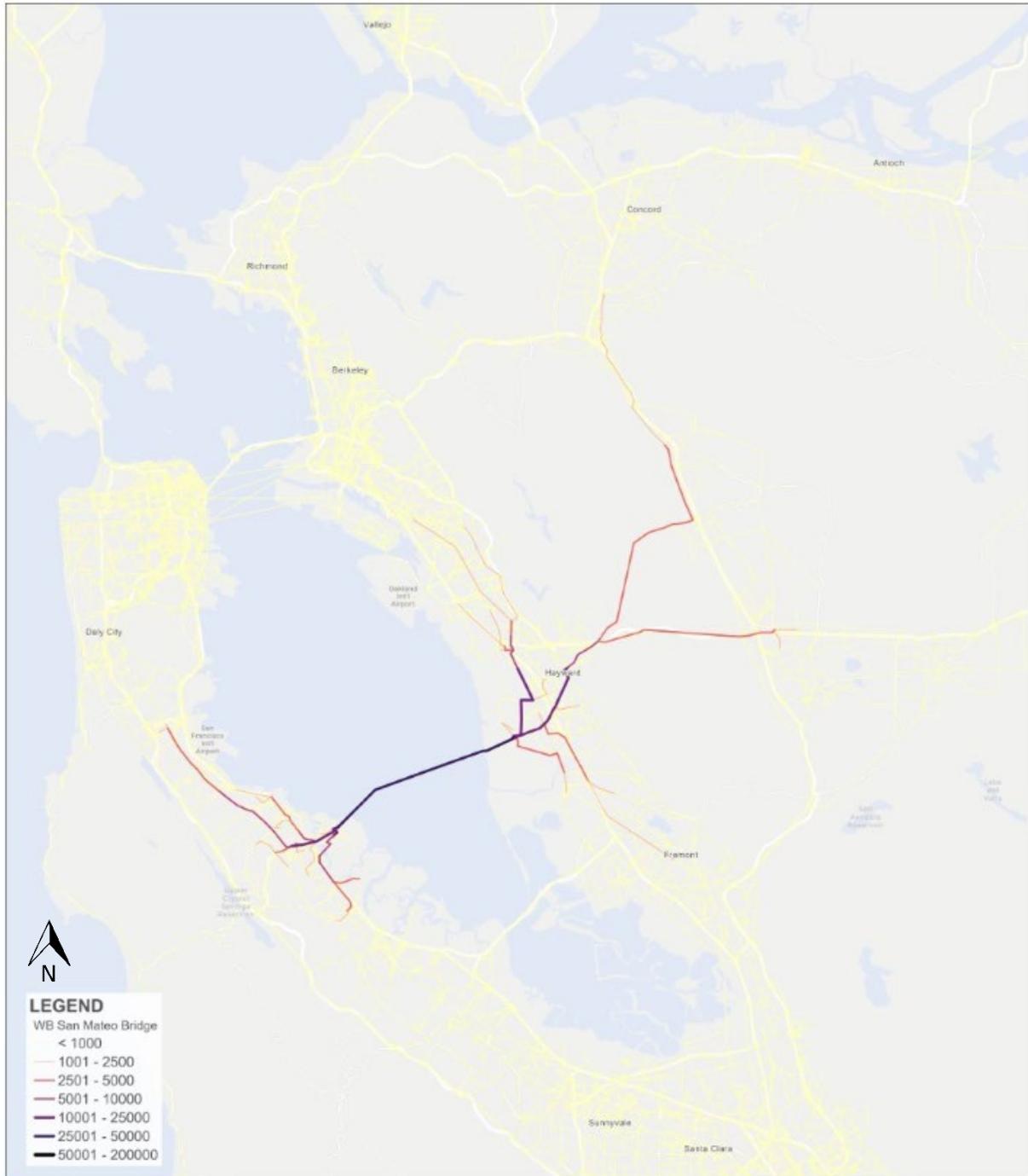


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Figure 15 provides a focused view of westbound select link weekday daily transit volumes and pattern for the San Mateo-Hayward Bridge corridor with the Emergent Network.

Figure 15. Weekday Daily San Mateo-Hayward Bridge – Westbound Select Link Volumes (Focused View)

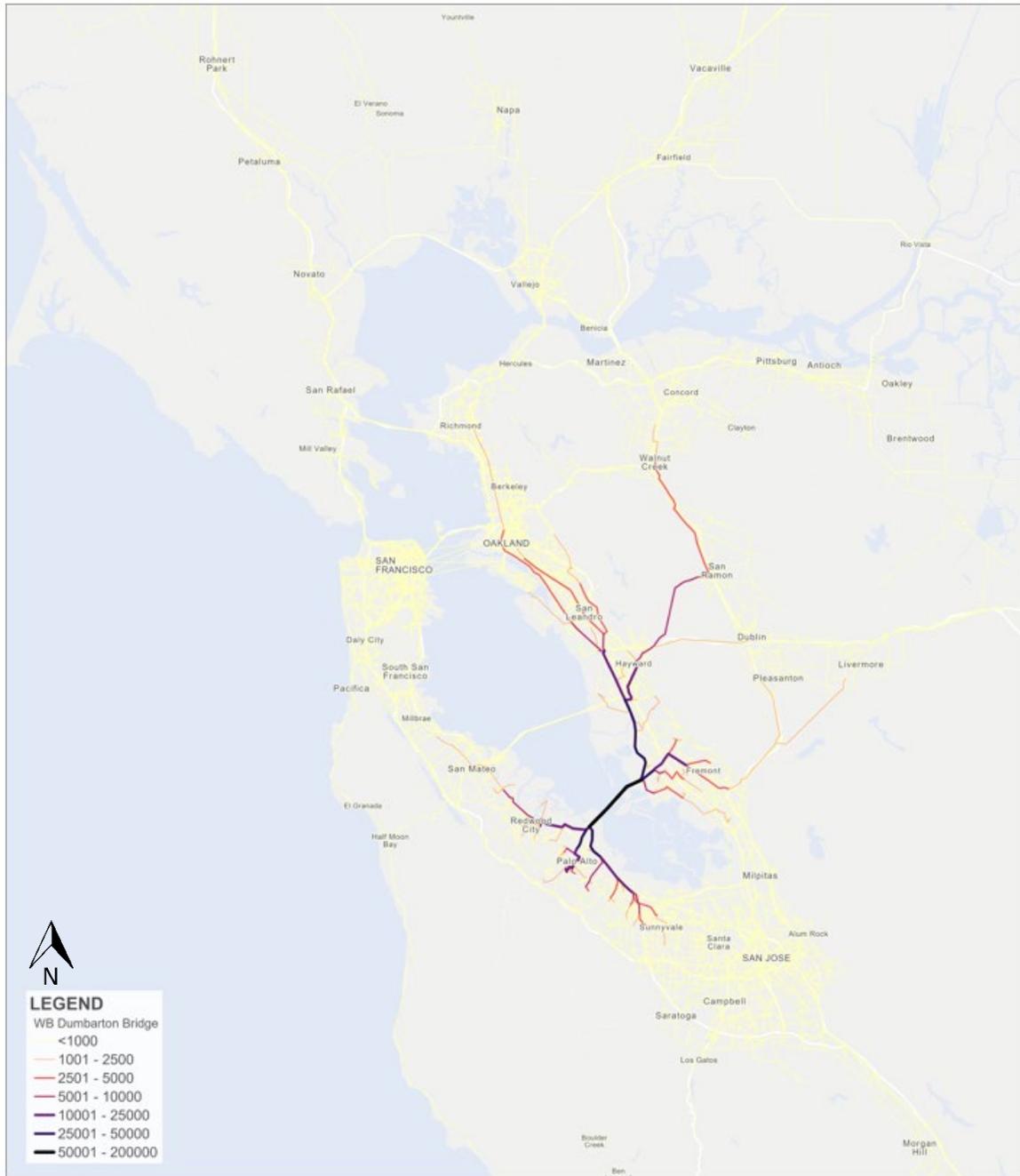


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Figure 16 shows westbound select link weekday daily transit volumes and patterns for the Dumbarton Bridge corridor with the Emergent Network. Total weekday daily westbound transit volume for the Dumbarton Bridge corridor is 80,000. To the east, there is significant volume throughout Fremont and north to San Leandro and San Ramon. To the west, there is significant volume throughout Palo Alto and north to Redwood City and south to Sunnyvale.

Figure 16. Weekday Daily Dumbarton Bridge – Westbound Select Link Volumes

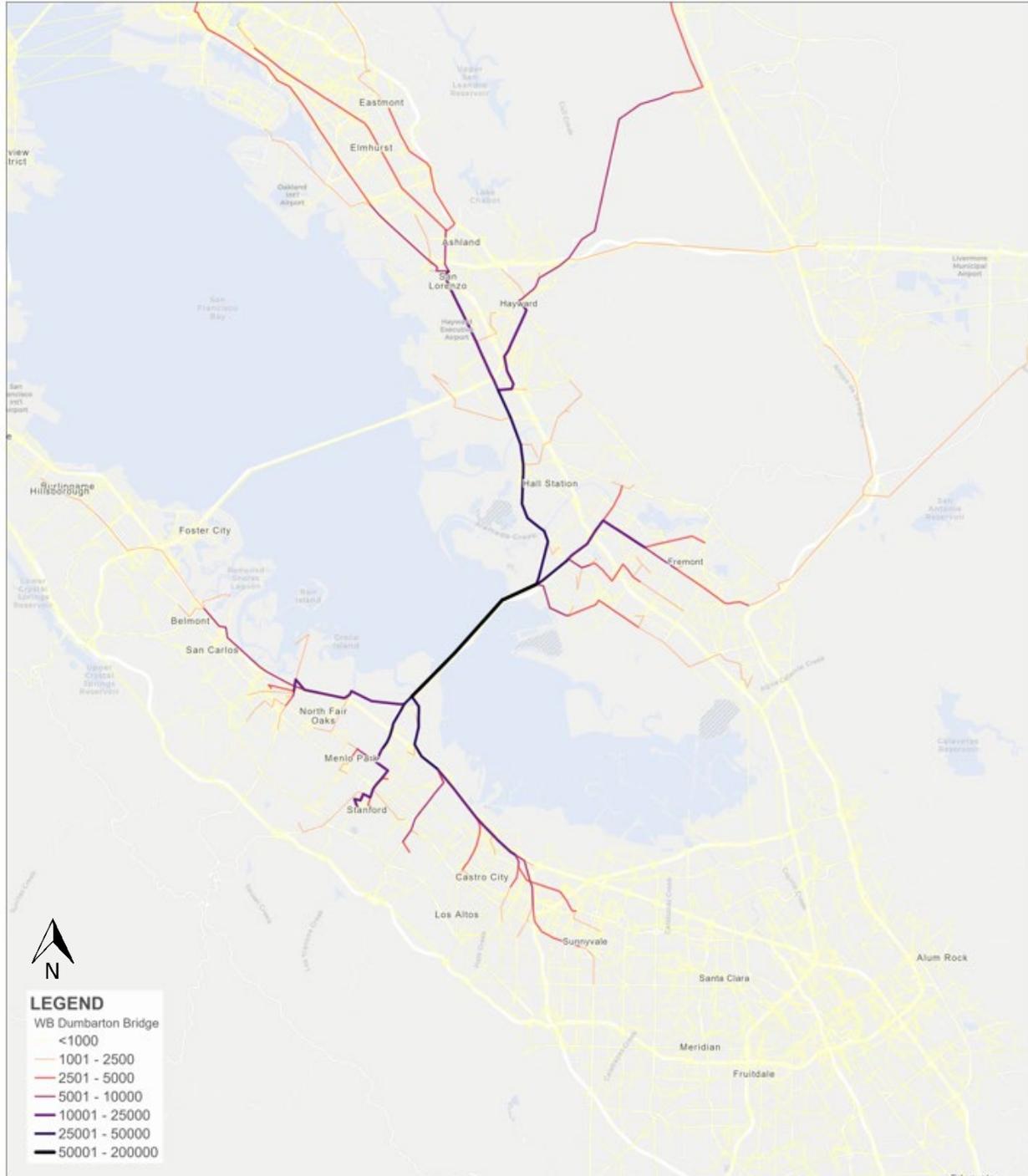


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Figure 17 provides a focused view of westbound select link weekday daily transit volumes and patterns for the Dumbarton Bridge corridor with the Emergent Network.

Figure 17. Weekday Daily Dumbarton Bridge – Westbound Select Link Volumes (Focused View)

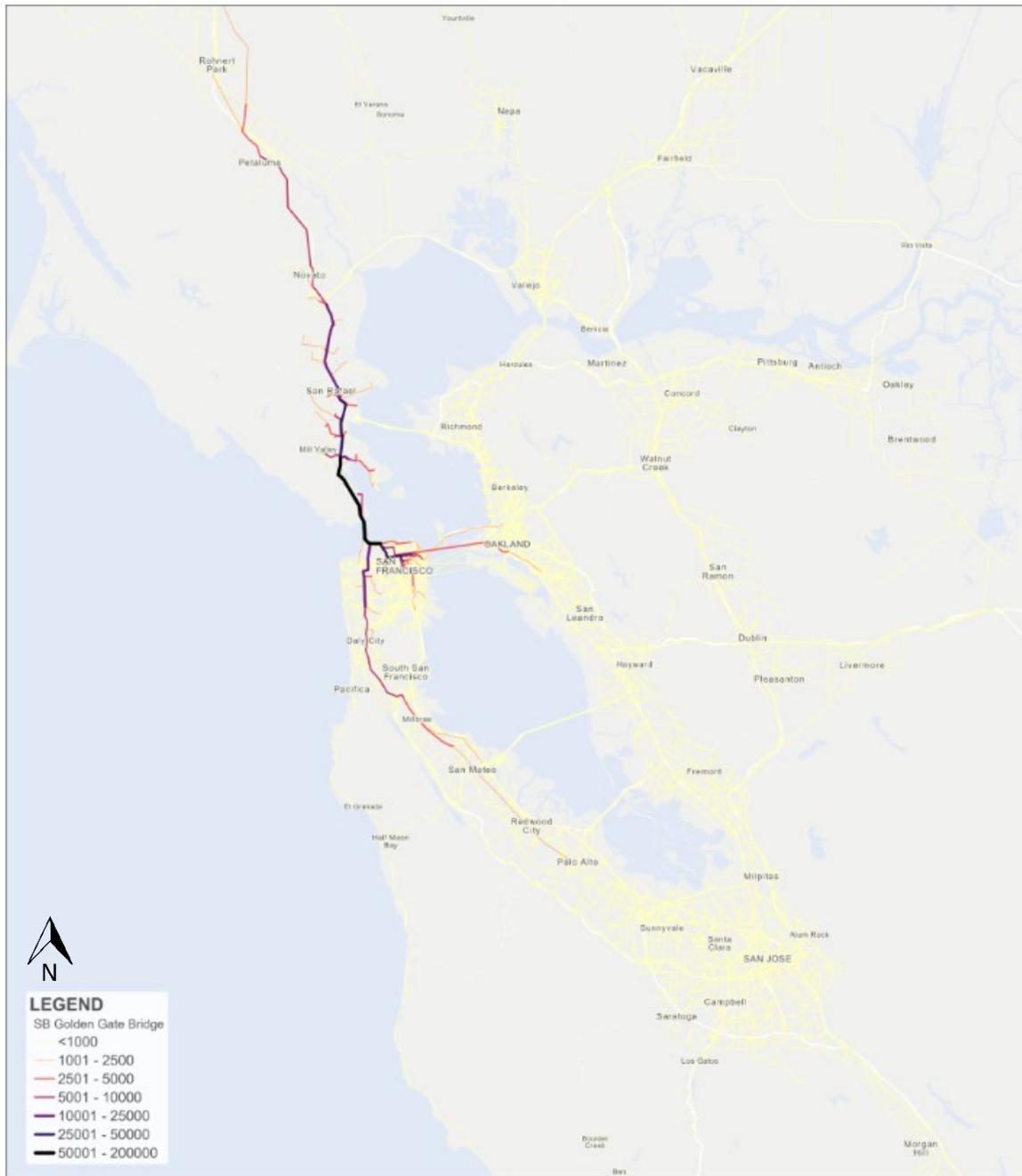


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Figure 18 shows southbound select link weekday daily transit volumes and patterns for the Golden Gate Bridge corridor with the Emergent Network. Total weekday daily southbound transit volume for the Golden Gate Bridge corridor is 75,000. To the north, there is significant volume to San Rafael, Novato, and Petaluma. To the south, there is significant volume to downtown San Francisco and south through San Francisco to Daly City and South San Francisco.

Figure 18. Weekday Daily Golden Gate Bridge – Southbound Select Link Volumes

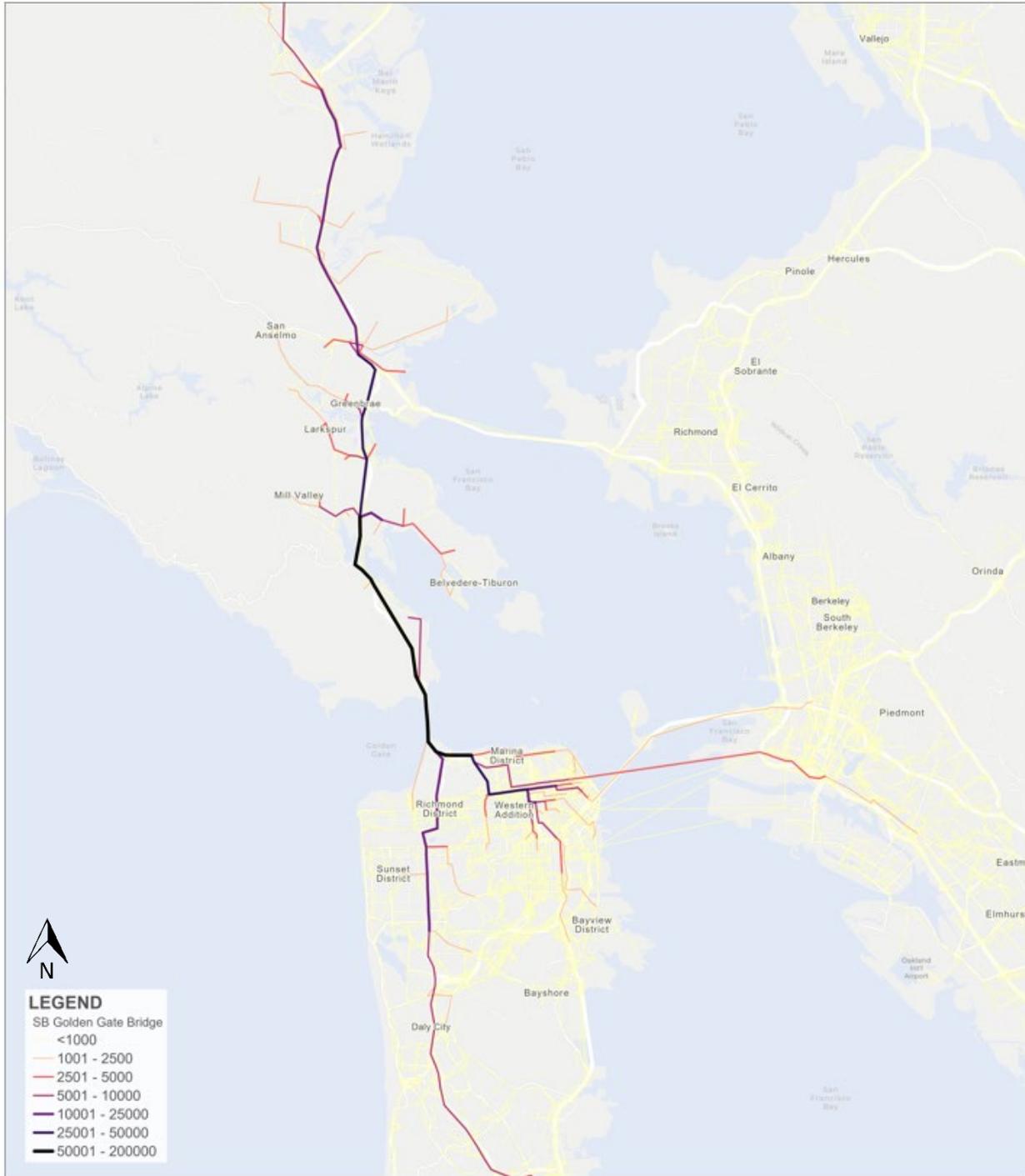


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Figure 19 provides a focused view of southbound select link weekday daily transit volumes and patterns for the Golden Gate Bridge corridor with the Emergent Network.

Figure 19. Weekday Daily Golden Gate Bridge – Southbound Select Link Volumes (Focused View)

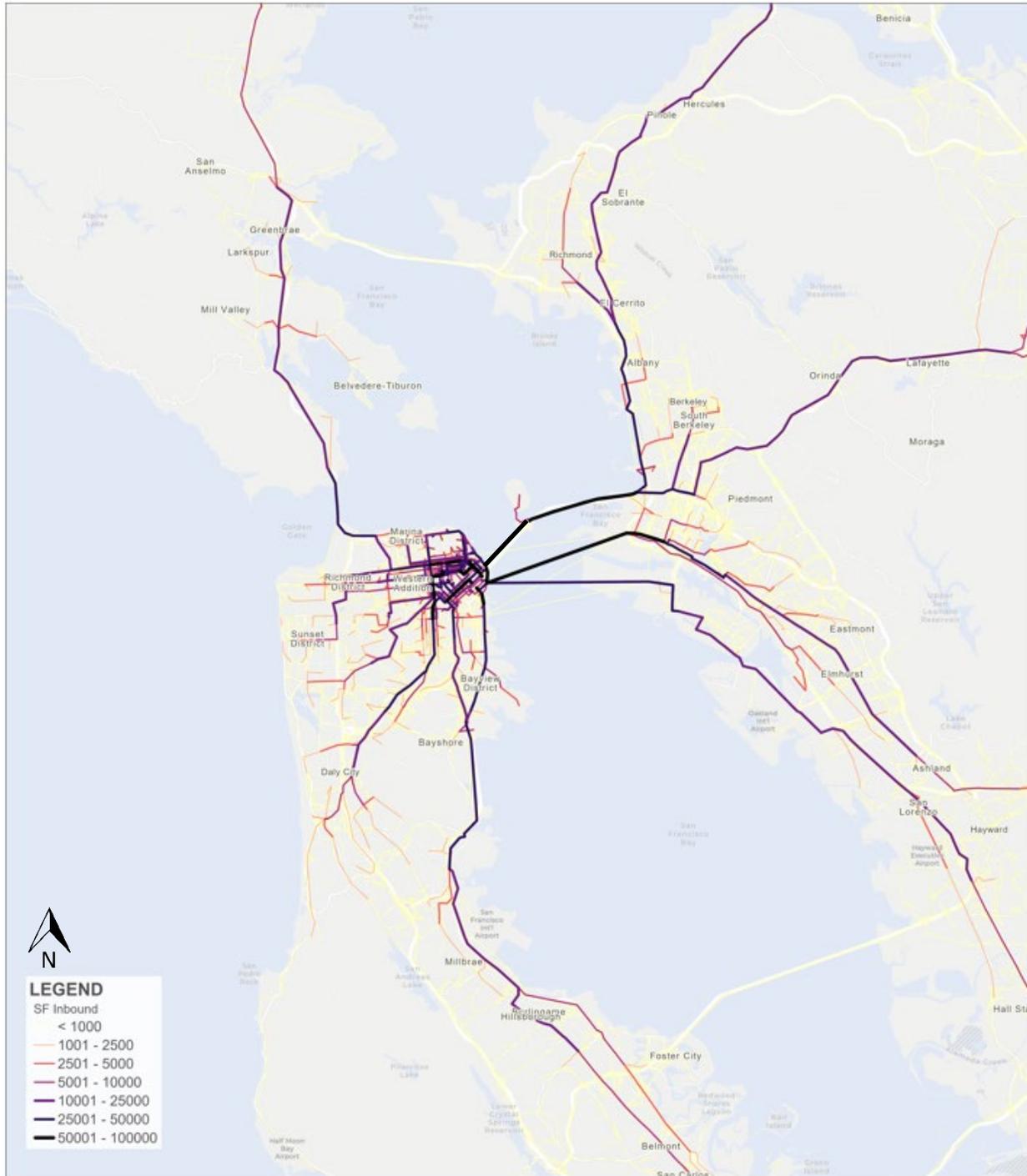


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Figure 20 shows weekday daily transit volumes and patterns inbound to downtown San Francisco with the Emergent Network.

Figure 20. Weekday Daily San Francisco - Inbound Select Zone Volumes

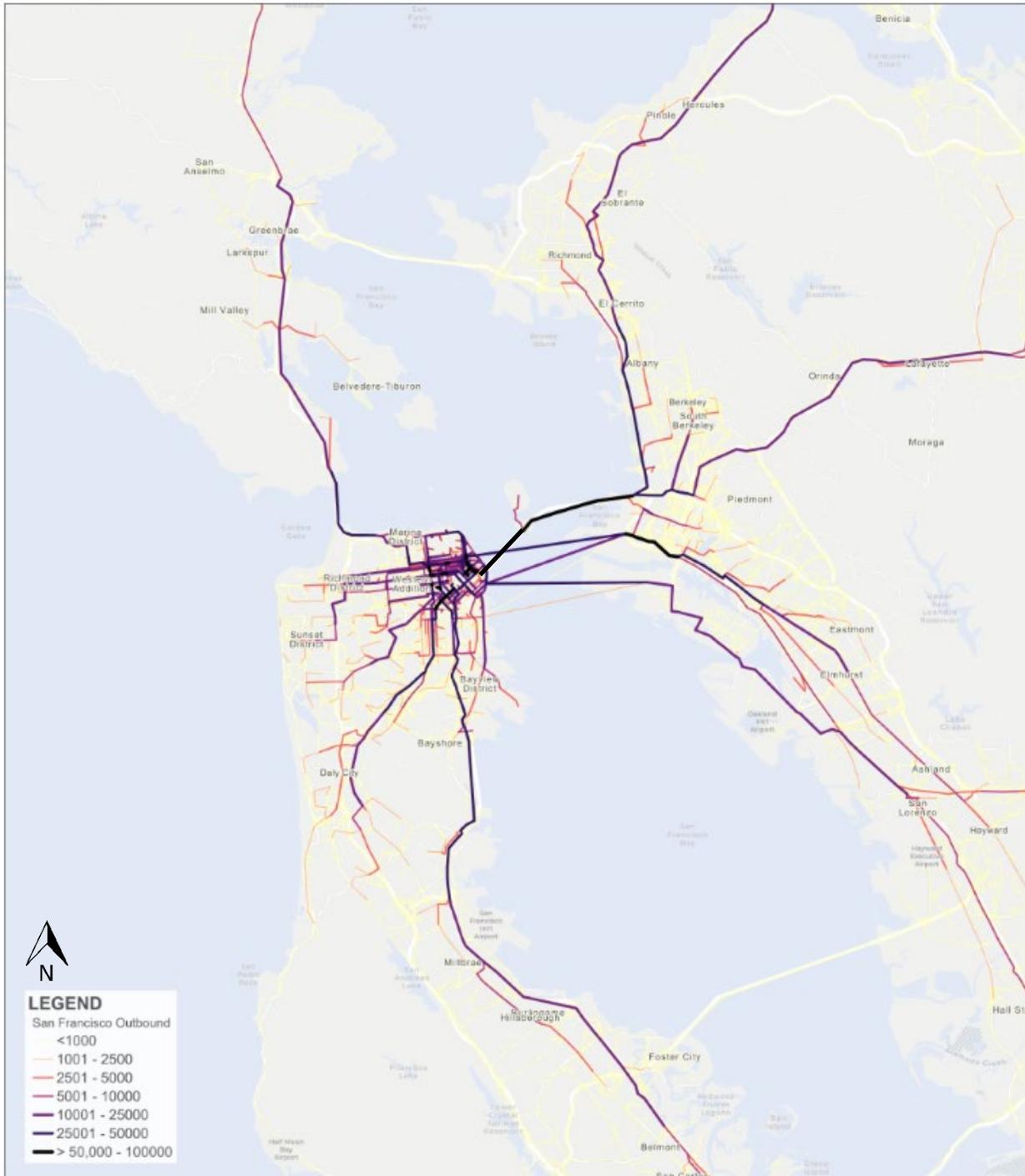


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Figure 21 shows weekday daily transit volumes and pattern outbound from downtown San Francisco with the Emergent Network.

Figure 21. Weekday Daily Downtown San Francisco - Outbound Select Zone Volumes



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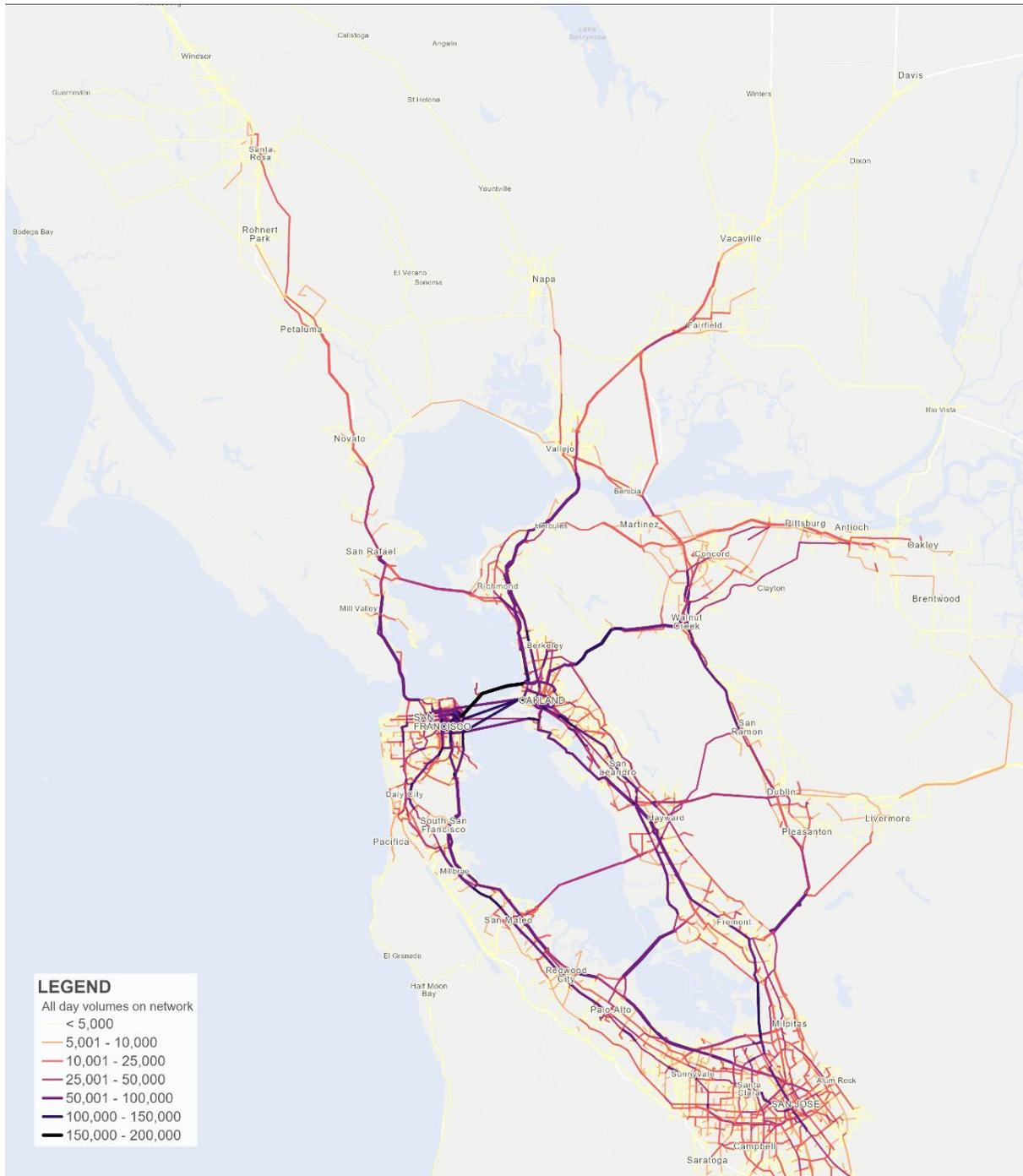
5.1.1. Emergent Network Transit Ridership Results

Figures 22 to 29 show weekday daily transit volumes and patterns for the entire Bay Area Emergent Network. It indicates those corridors where there might be significant market potential for rail transit throughout the Bay Area. Note that the scale for Figures 22 to 29 differs from the other figures in this section.

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Figure 22. Weekday Daily Transit Ridership - Bay Area



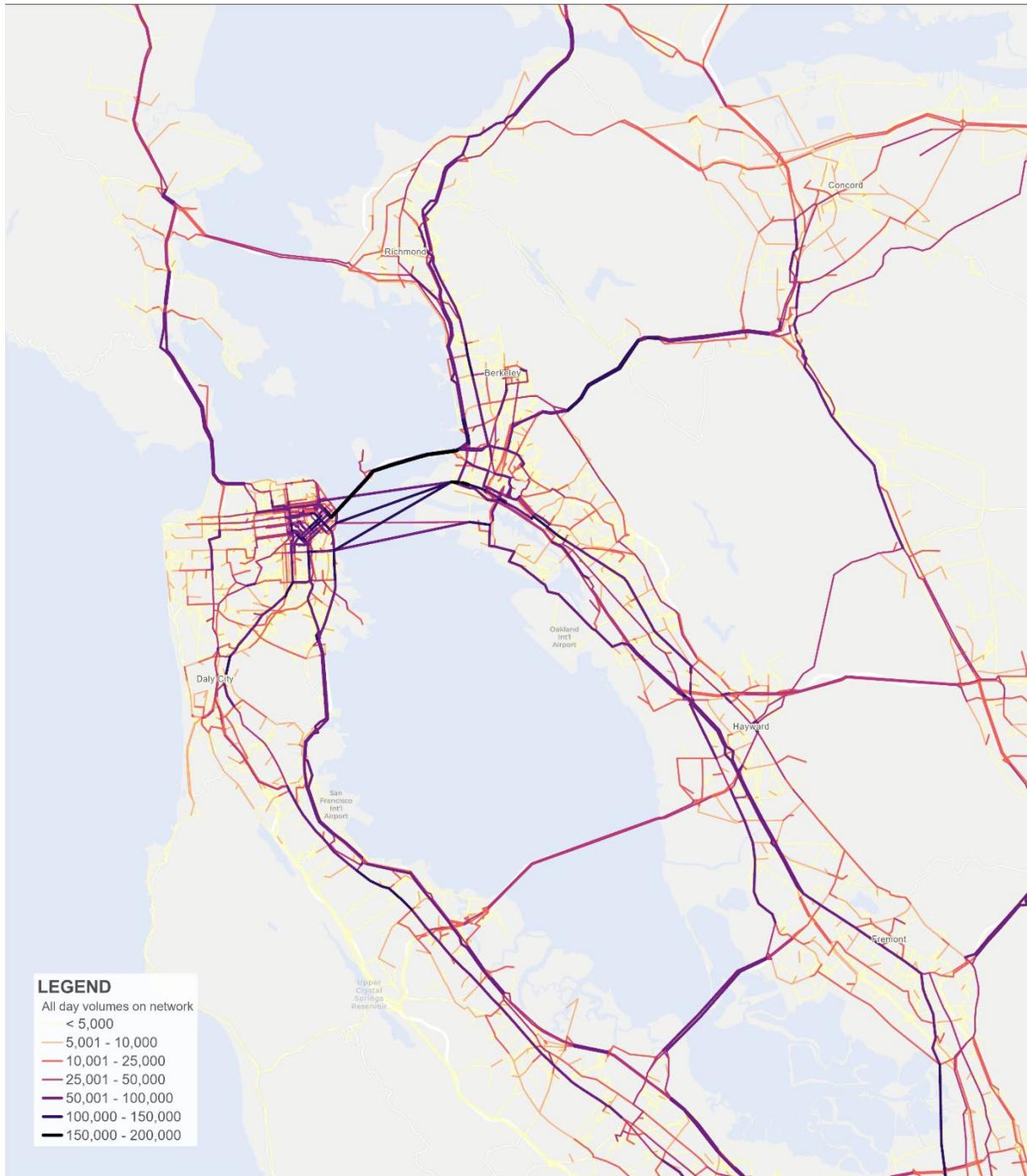
MARKET ANALYSIS
All Day Volumes on Network



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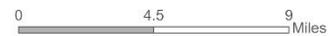
Figure 23. Weekday Daily Transit Ridership – Inner Bay Area



LEGEND
All day volumes on network

< 5,000
5,001 - 10,000
10,001 - 25,000
25,001 - 50,000
50,001 - 100,000
100,000 - 150,000
150,000 - 200,000

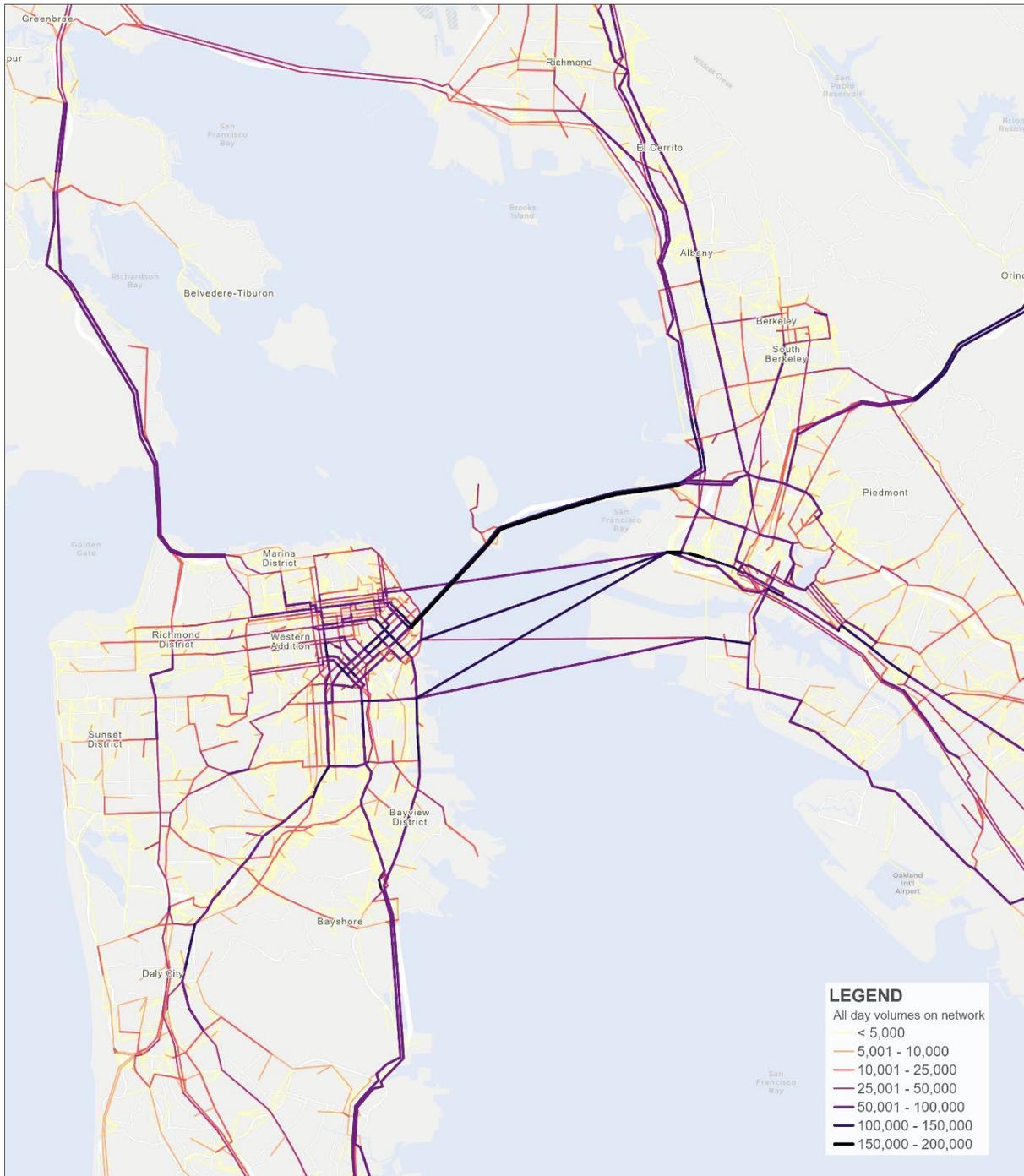
MARKET ANALYSIS
All Day Volumes on Network



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Figure 24. Weekday Daily Transit Ridership – San Francisco/Oakland Detail



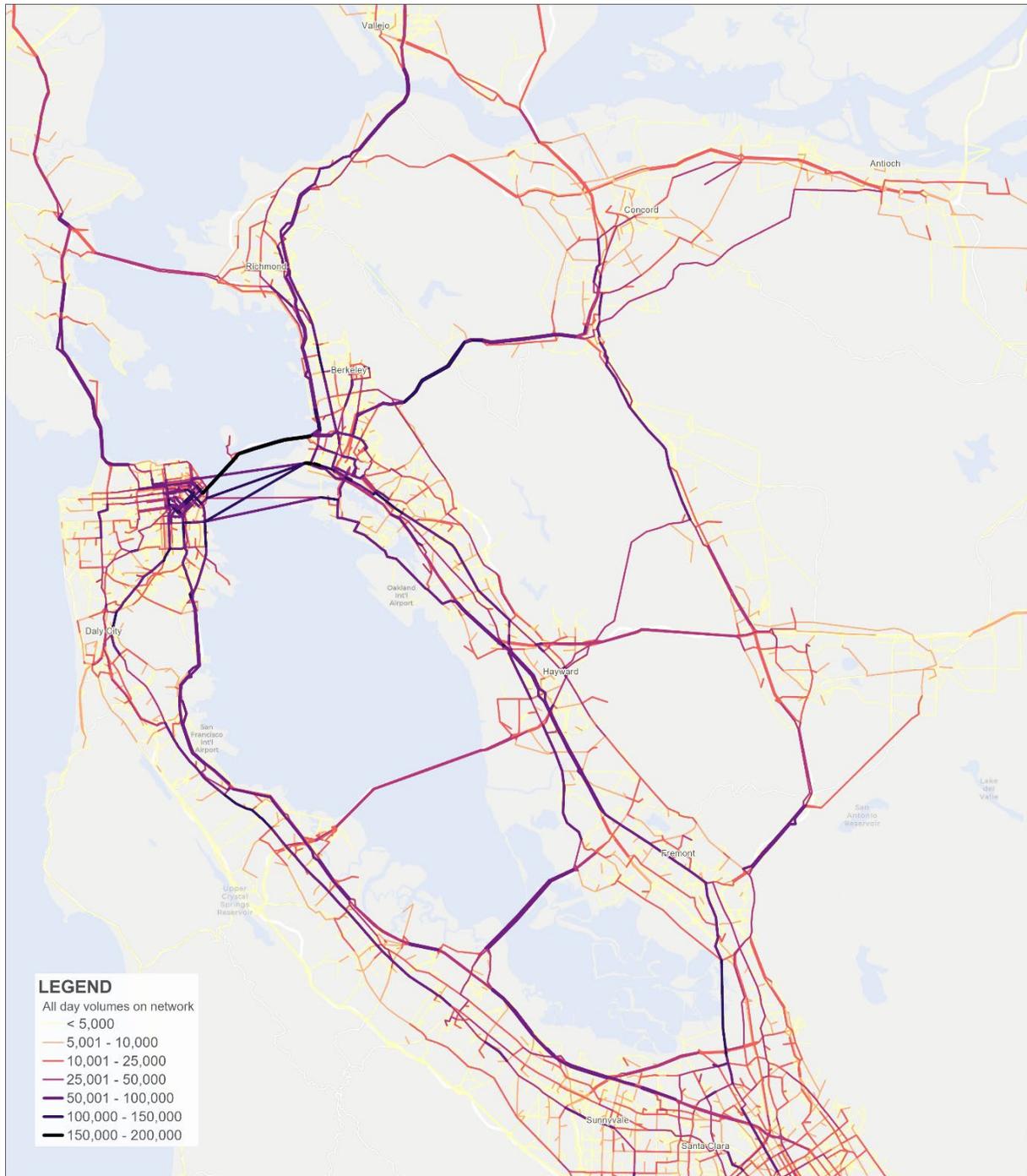
MARKET ANALYSIS
All Day Volumes on Network



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Figure 25. Weekday Daily Transit Ridership – Bay Crossings Detail



MARKET ANALYSIS
All Day Volumes on Network

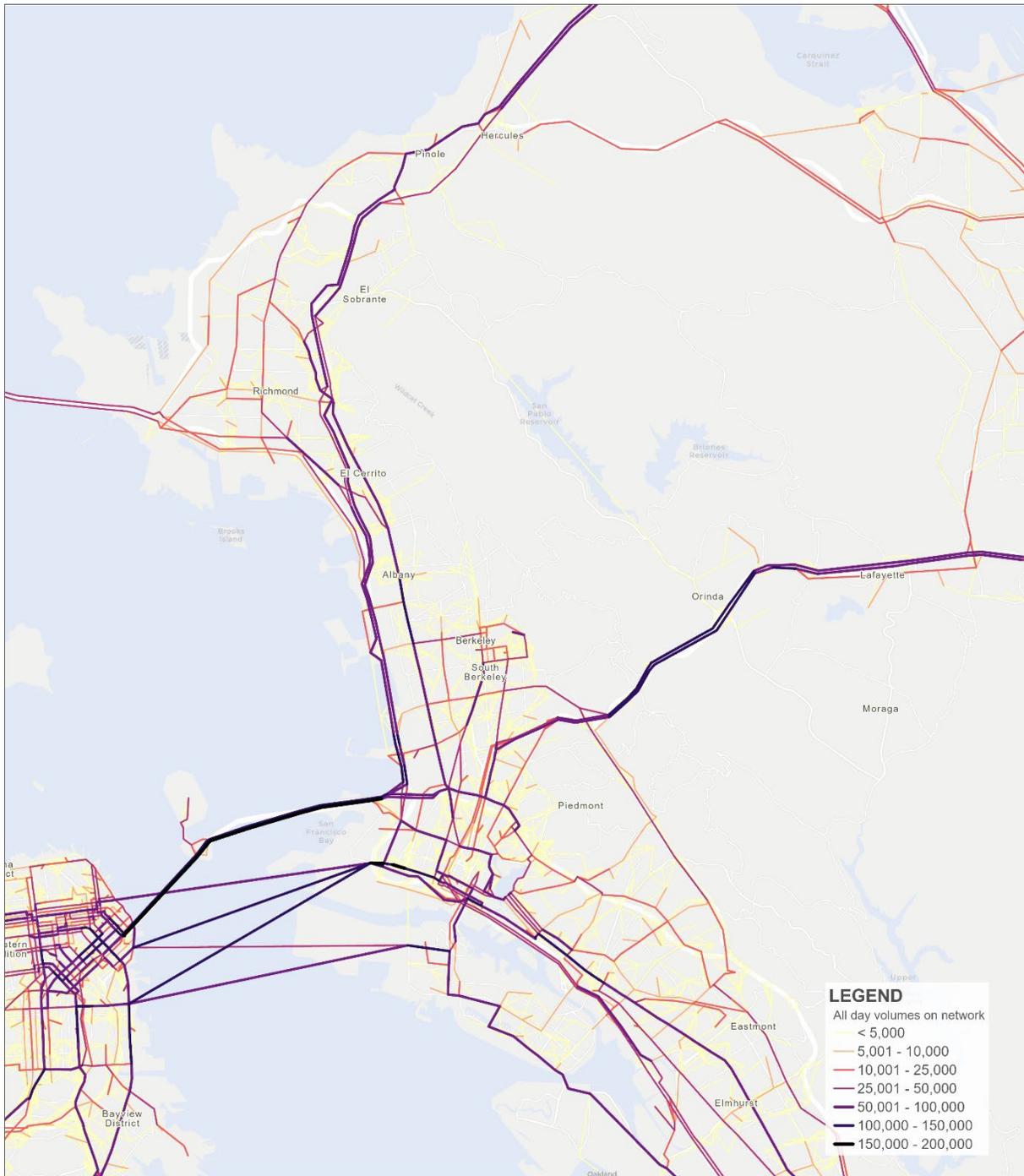


0 5.5 11 Miles

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Figure 26. Weekday Daily Transit Ridership – Alameda/Contra Costa County Detail



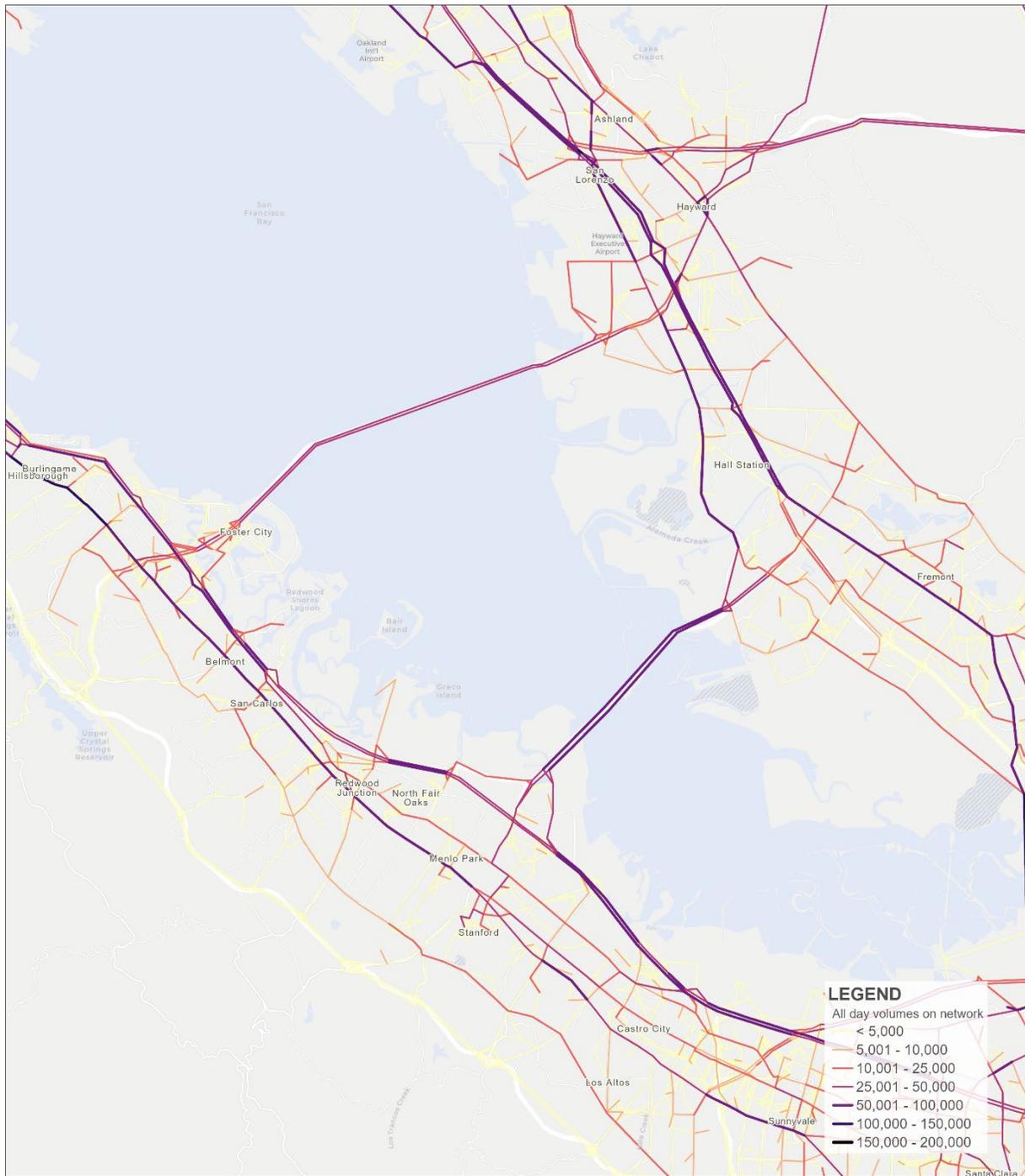
MARKET ANALYSIS
All Day Volumes on Network



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Figure 27. Weekday Daily Transit Ridership – San Mateo-Hayward/Dumbarton Bridges Detail



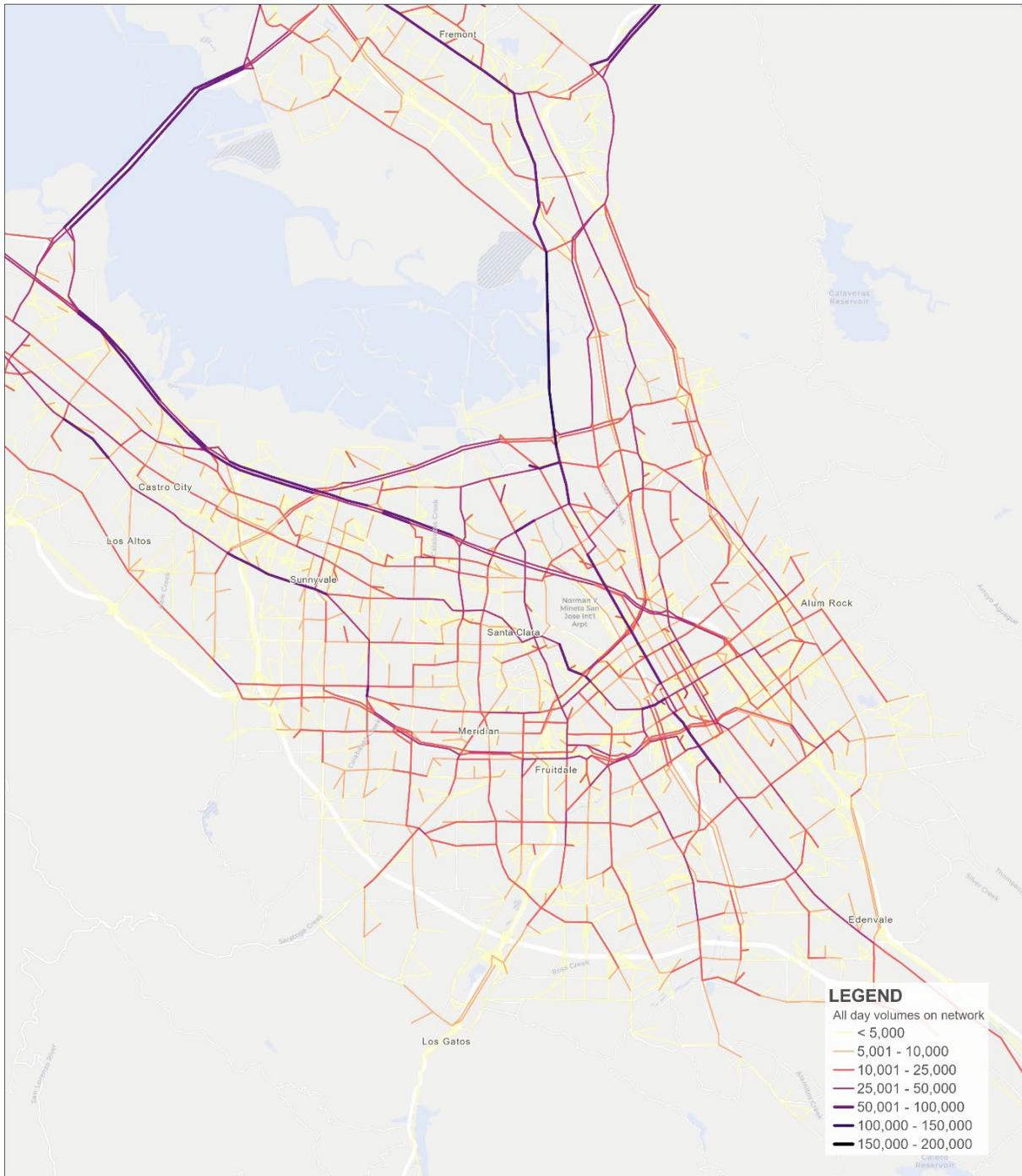
MARKET ANALYSIS
All Day Volumes on Network



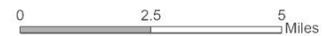
DRAFT - DELIBERATIVE



Figure 28. Weekday Daily Transit Ridership – Santa Clara County Detail



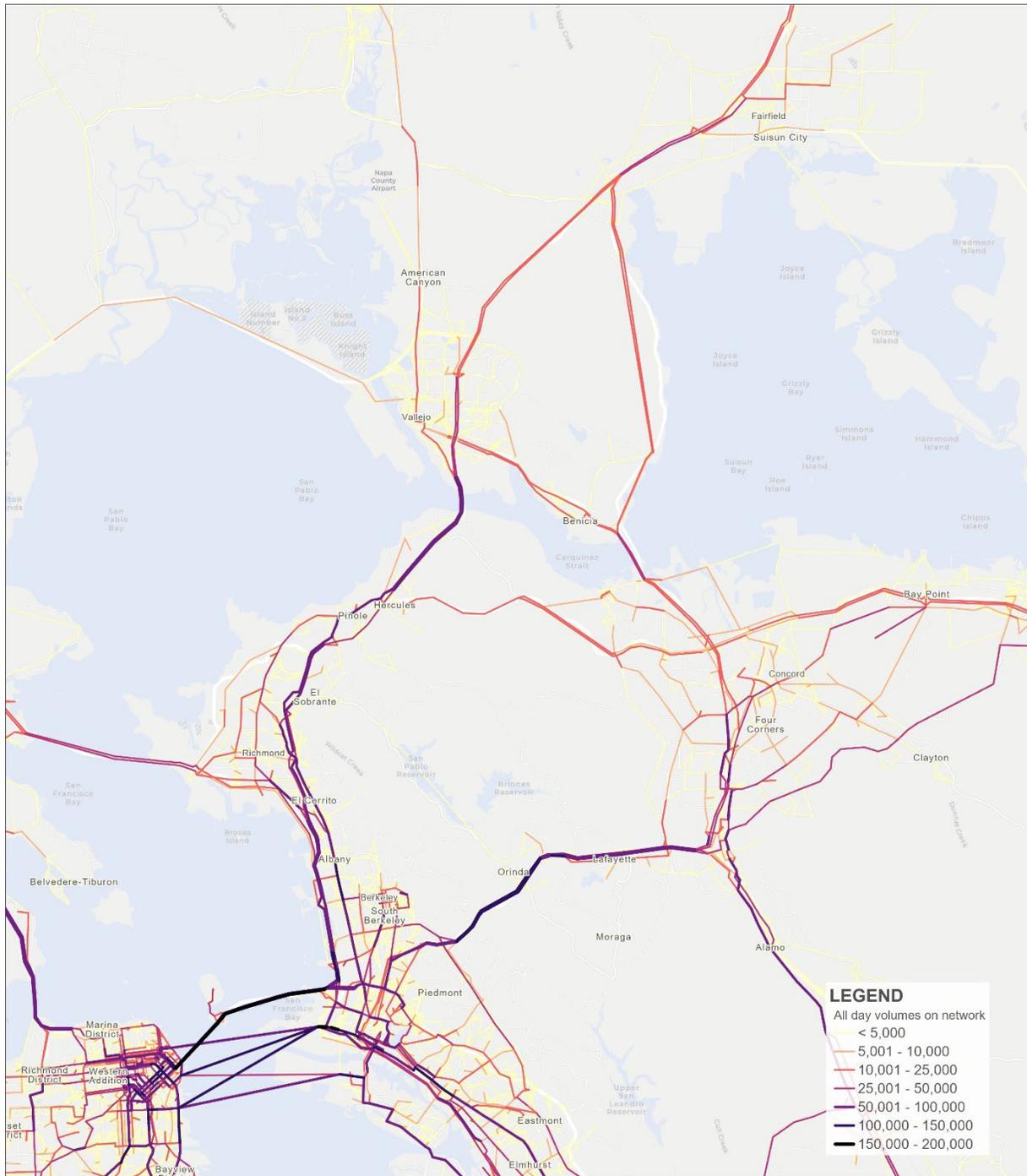
MARKET ANALYSIS
All Day Volumes on Network



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Figure 29. Weekday Daily Transit Ridership – Contra Costa/Solano County Detail



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MARKET ANALYSIS
All Day Volumes on Network

