Appendix D

RWCmoves

Active Transportation Demand Analysis Methods and Results

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FEHR PEERS

Redwood City California Founded 1867

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Active Transportation Demand Analysis

This report describes the approach used to develop the Active+ walking and bicycling demand scores presented in **Appendix B**. The City will use methods described in this report to evaluate future bicycle and pedestrian improvement projects as part of its Citywide Transportation Plan. The methods are designed such that the City can continue to expand and refine these indices as additional data becomes available.

Approach Methods

Active+ is a general purpose methodology used to assess various geographic areas (i.e. street segments, intersections) in terms of their intrinsic potential to attract walking or bicycling activity. Conceptually, the Active+ methodology produces a bicycling and walking index that is a function of several geographic variables including built environment variables (density), demographics variables (e.g. vehicle ownership rates), and infrastructure variables (e.g. proximity to transit and bike lanes). This methodology is based on research Fehr & Peers conducted for the US Environmental Protection Agency (EPA) on the relationship between the built environment, infrastructure connectivity, and travel patterns. Through this and subsequent studies, several factors have been shown to have a significant effect on the number of people walking and bicycling in a given area.

This analysis used a combination of existing GIS data and newly collected data to develop variables highly correlated with walking and bicycling activity. Variables are weighted based on the results of the EPA research and subsequent studies described above.

The methodology for developing walking and bicycling indices is comprised of the following steps:

- Step 1: Compile data that will be used to create pedestrian and bicycle demand model
- Step 2: Perform GIS analysis and processing
- Step 3: Join attributes for each variable to the City's street centerline file
- Step 4: Summarize walking and bicycling results scores

Description of Methods

Each step of this methodology is described in the following section in more detail.

Step 1: Compile the Data

Pedestrian and bicycle activity is dependent on many different types of variables. Several factors were compiled to forecast pedestrian and bicycle demand. The factors used are outlined in **Table D-1** below.

Table D-1: Bicycle and Pedestrian Demand Factors

Factors	Geography	Date	Source	Variable Used
Built Environment & Street Permeability				
Population Density	Polygon: Block Group	2015	5 Year American Community Survey	Gross population density within census block group
Job Density	Polygon: Block Group	2015	Longitudinal Employer-Household Dynamics	Gross employment density within census block group
Intersection Density	Polyline	2017	Redwood City	Average density of intersections with three or more legs
Demographics				
Low Vehicle Ownership	Polygon: Block Group	2015	5 Year American Community Survey	Proportion of households with one or fewer vehicles
Youth and Senior Population	Polygon: Block Group	2015	5 Year American Community Survey	Proportion of population under 18 and over 65 years old
Poverty Rate	Polygon: Block Group	2015	5 Year American Community Survey	Proportion of population living below poverty line
Proximity Factors				
Connected Sidewalk Proximity	Polyline	2017	Redwood City	Proximity to connected sidewalks
Bike Route Proximity	Polyline	2017	Redwood City	Proximity to bicycle network
School and Public Facilities Proximity	Point	2017	Government of California	Proximity to schools and public facilities (public libraries and senior/community centers) proximity
Parks Proximity	Polygon	2017	OpenStreetMap	Proximity to parks
Caltrain Proximity	Point	2017	General Transit Feed Specification (GTFS)	Proximity to Caltrain station
High Frequency Transit Proximity	Point	2017	GTFS	Proximity to high frequency bus stop
Low Frequency Transit Proximity	Point	2017	GTFS	Proximity to low frequency bus stop

Table D-1: Bicycle and Pedestrian Demand Factors

Factors	Geography	Date	Source	Variable Used
Retail Service Proximity	Polygon	2017	Redwood City	Proximity to commercial & mixed used centers

Source: Fehr & Peers, 2018.

Maps of the variables described in **Table D-1** are shown on the following pages.

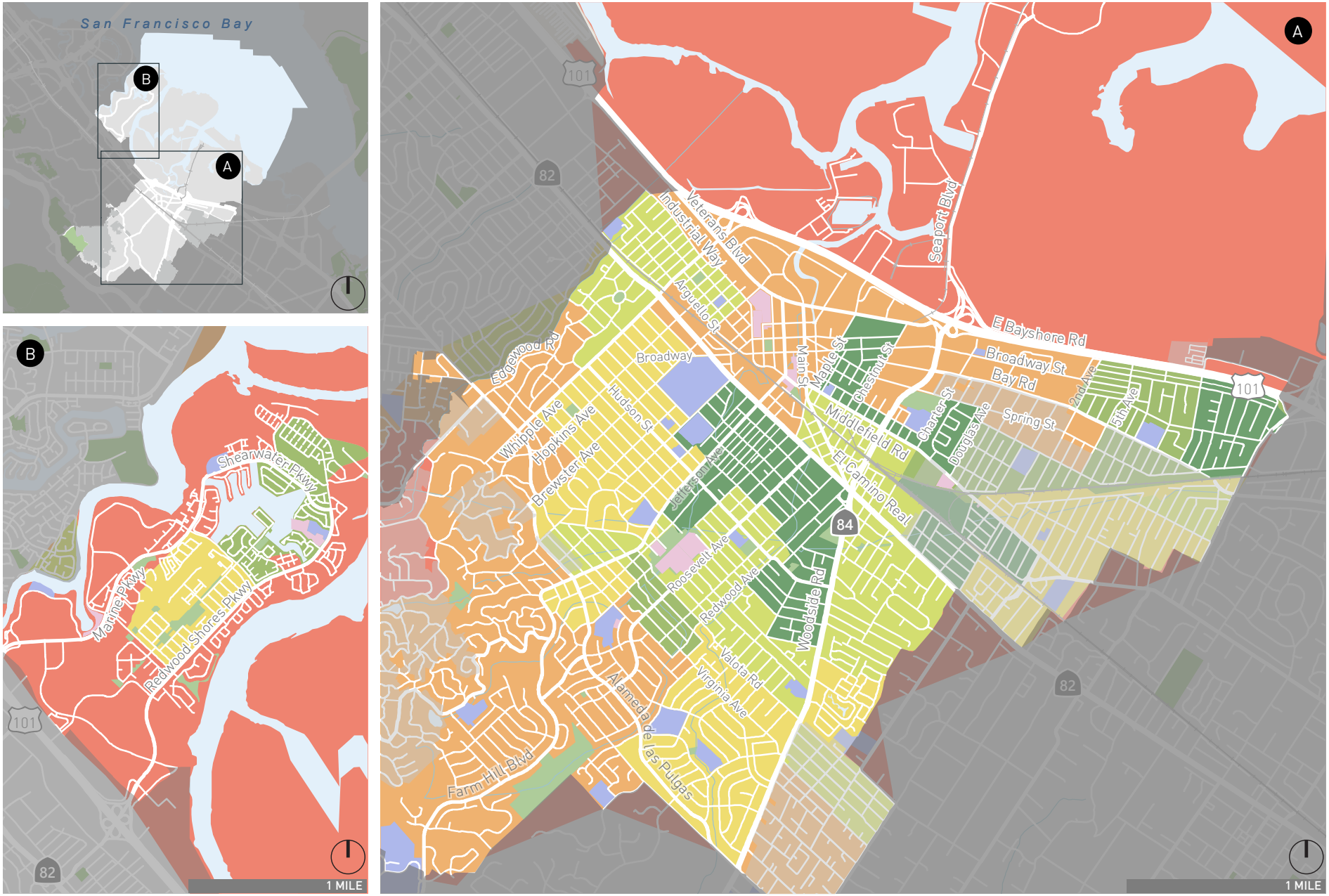


Figure D-1

Redwood City
Population Density Score

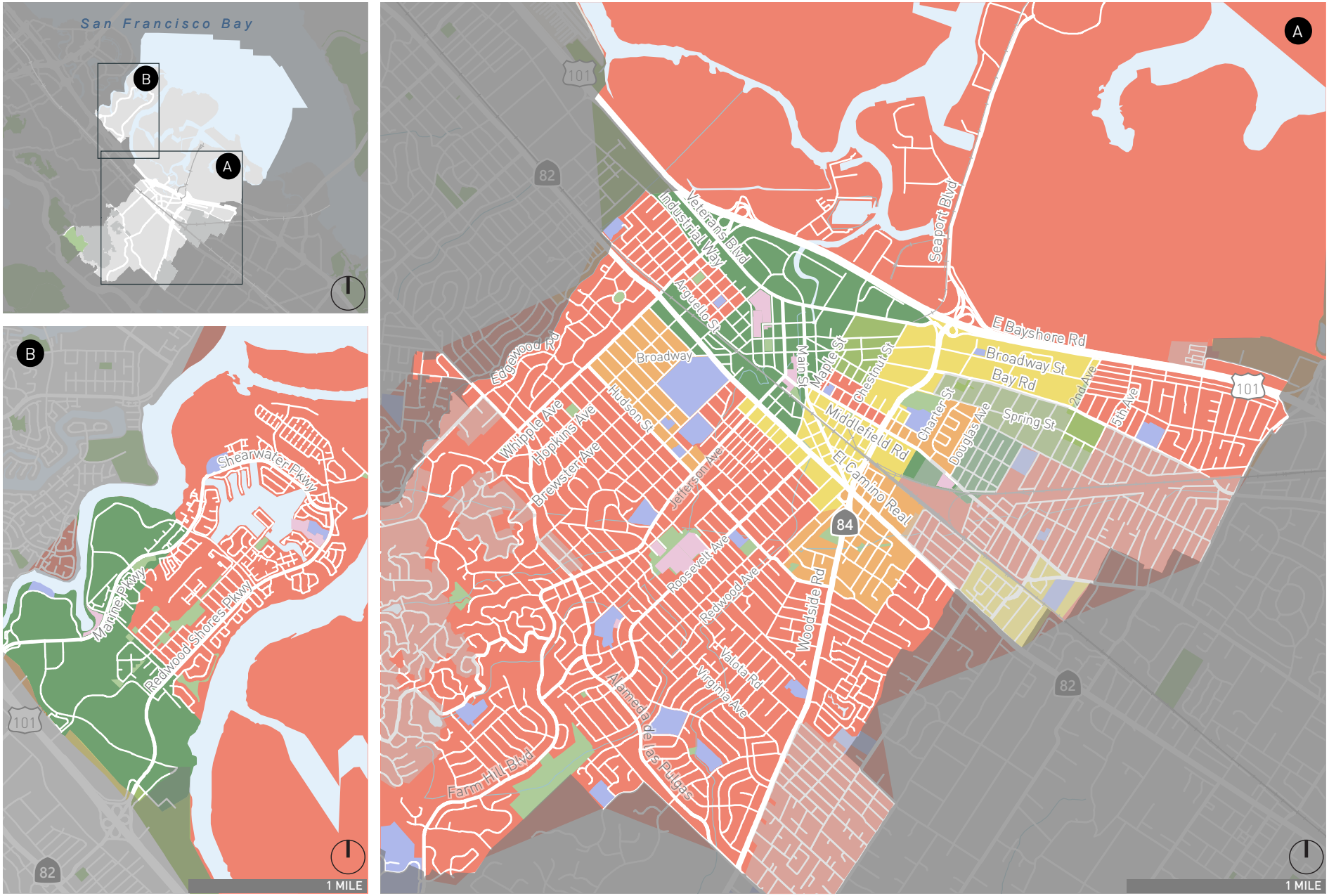


Figure D-2

Redwood City
Job Density Score

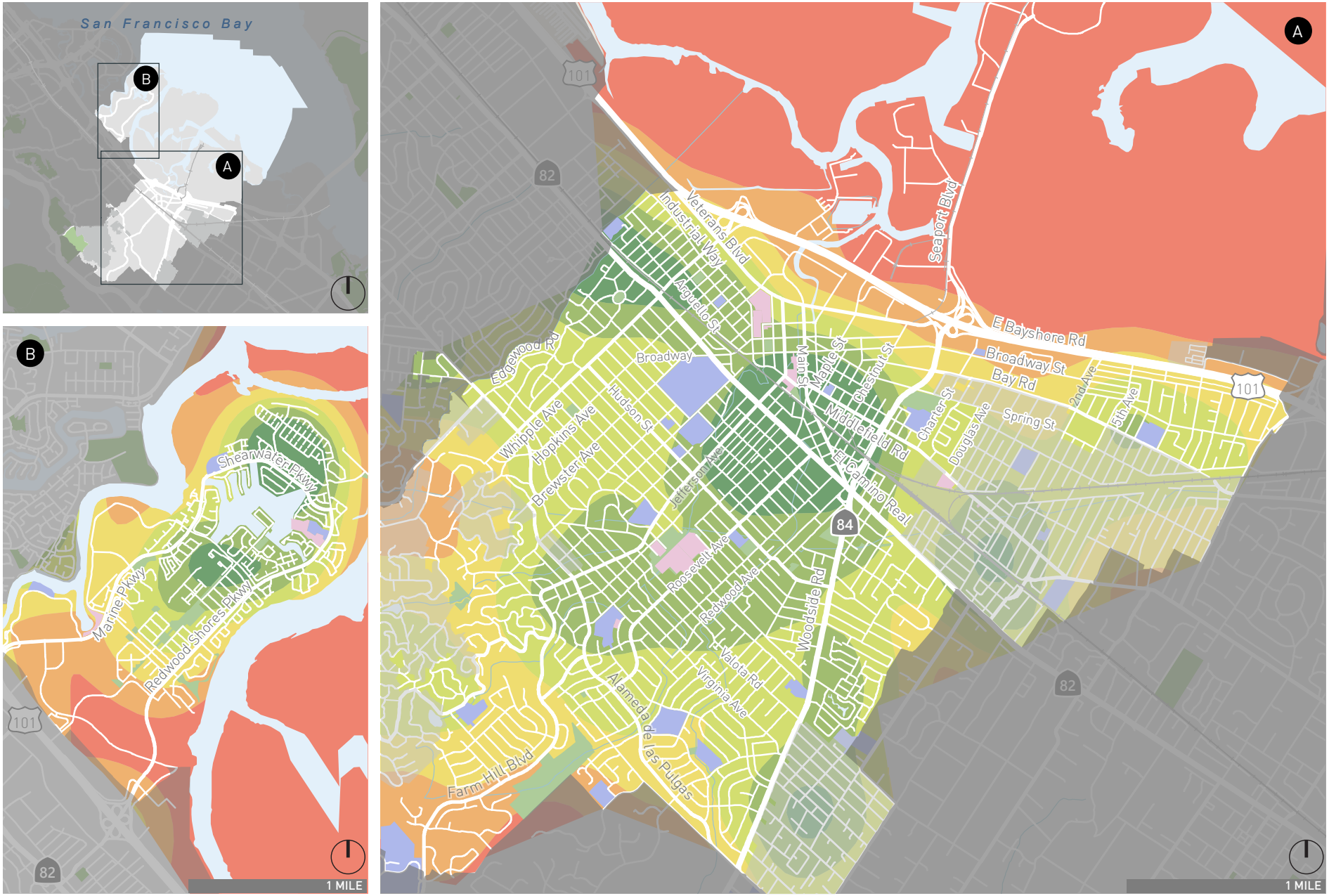
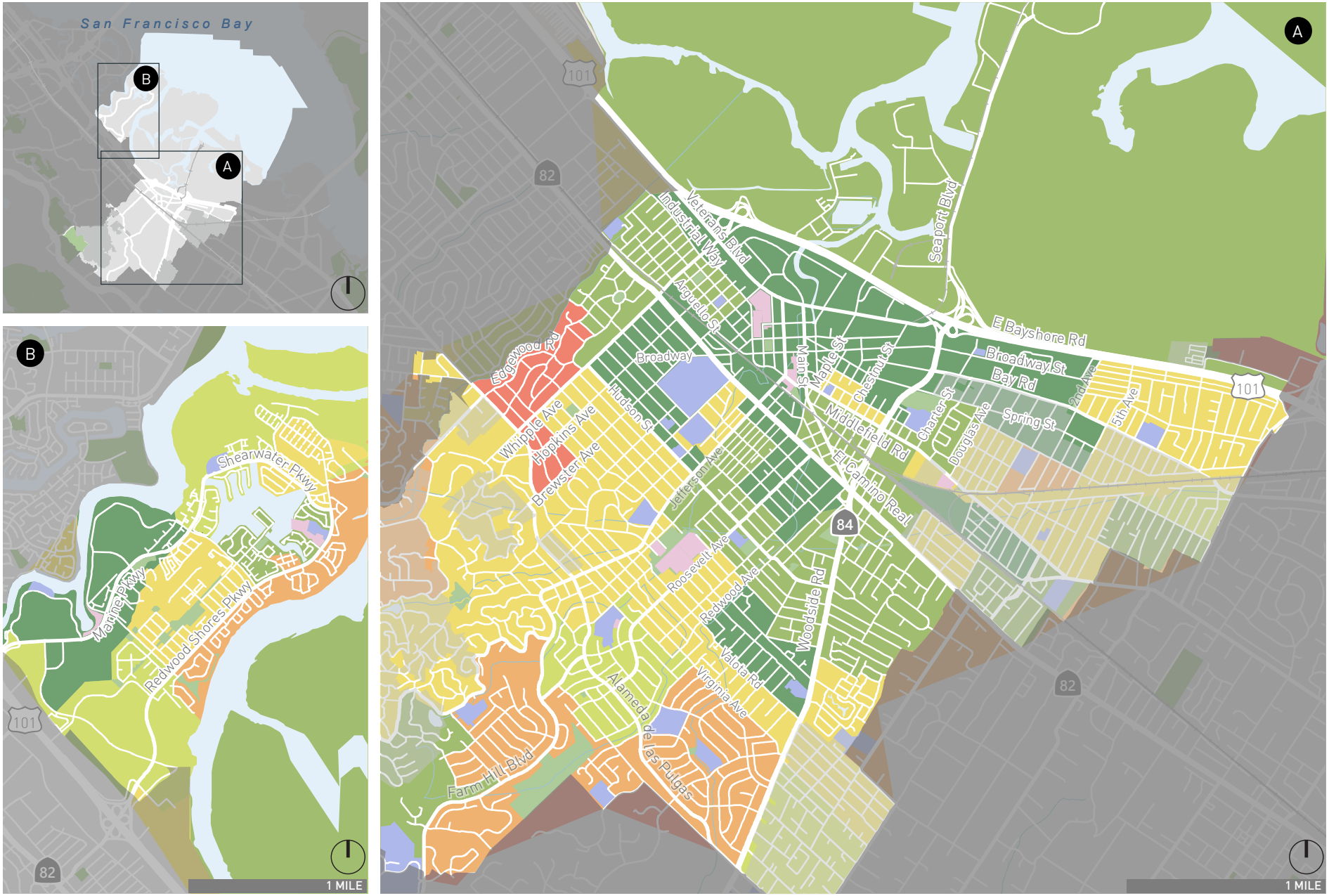


Figure D-3

Redwood City
Intersection Density Score



Redwood City Limits
Sphere of Influence
Railroad
Parks
Schools
Public Facilities

Low Vehicle Ownership Score

0
20
40
60
80
100

Figure D-4

Redwood City
Low Vehicle Ownership Score

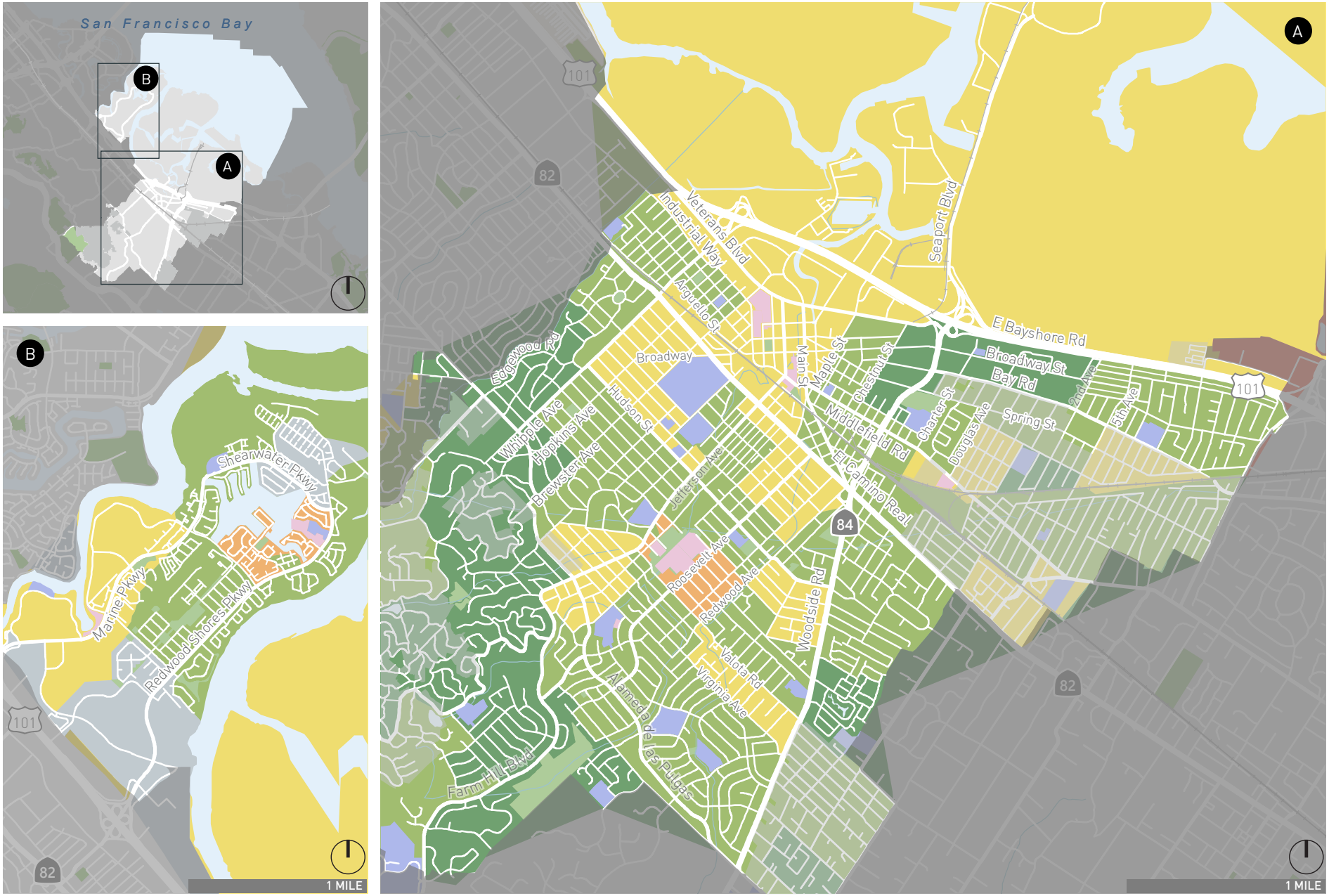


Figure D-5

Redwood City
Youth and Senior Population Score

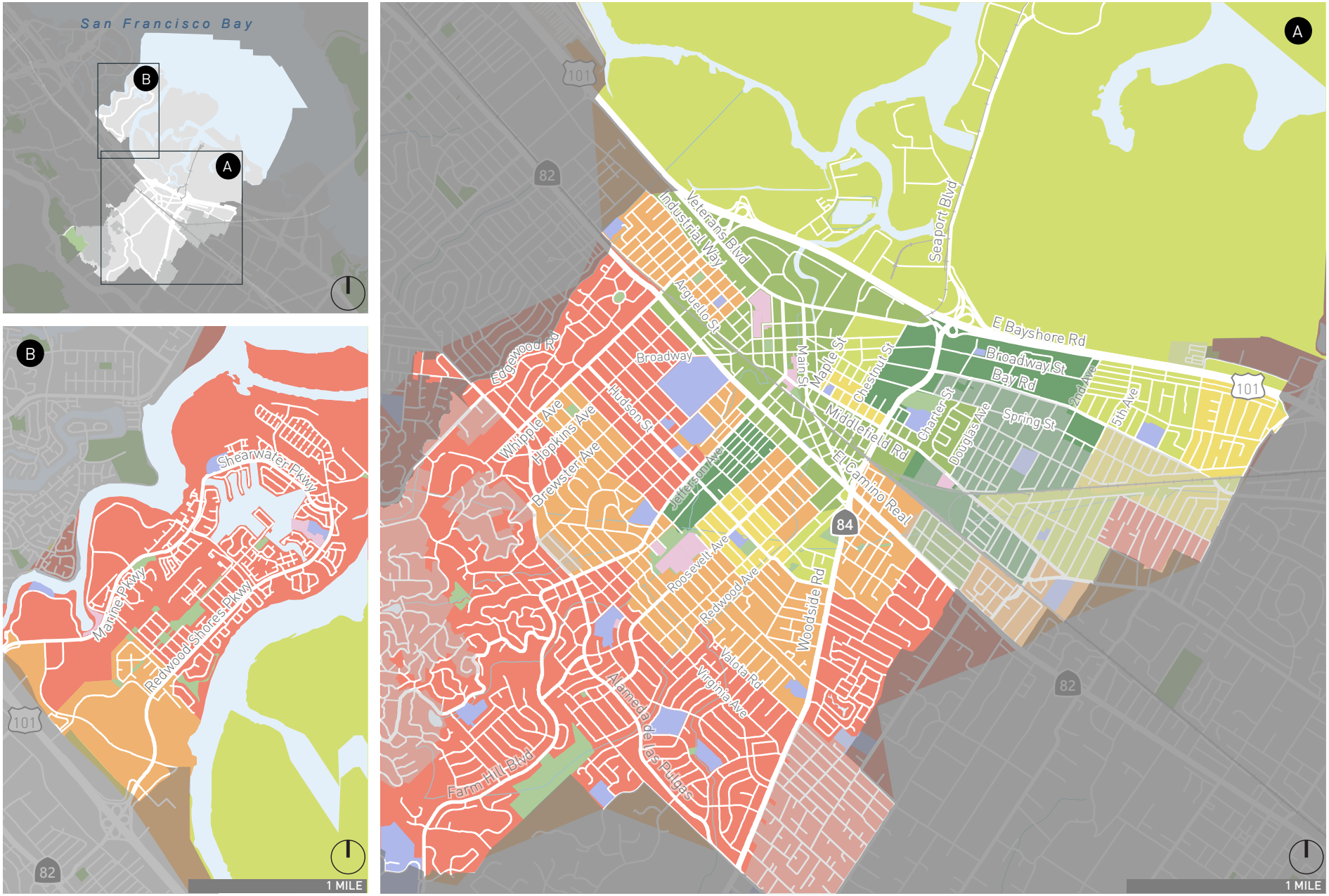


Figure D-6

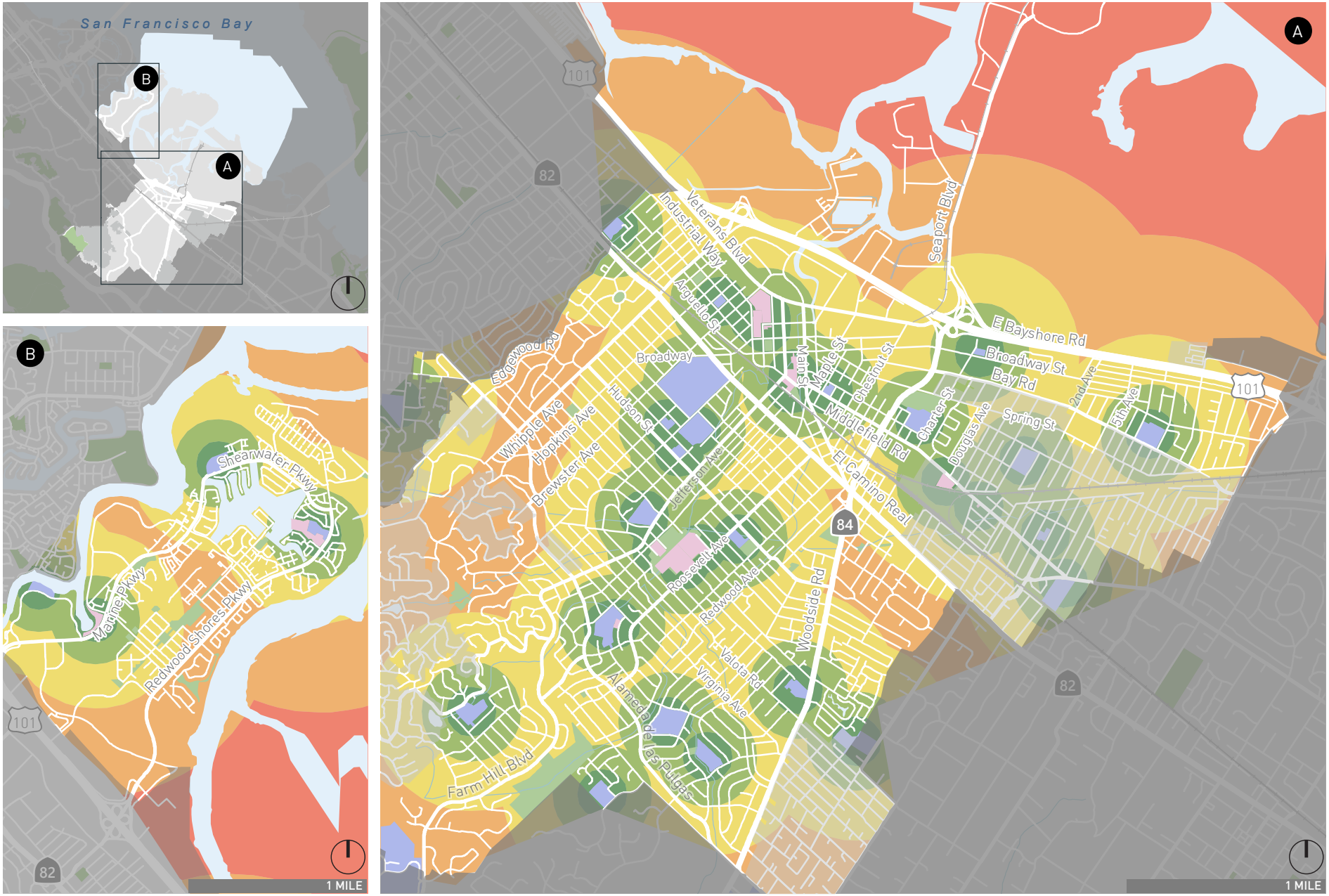
Redwood City
Poverty Rate Score

Figure D-7

Redwood City
Connected Sidewalk Proximity Score

Figure D-8

Redwood City
Bike Route Proximity Score



Redwood City Limits
Sphere of Influence
Railroad
Parks
Schools
Public Facilities

School & Public Facilities Proximity Score

0
25
50
75
100

Figure D-9

Redwood City
School and Public Facilities Proximity Score

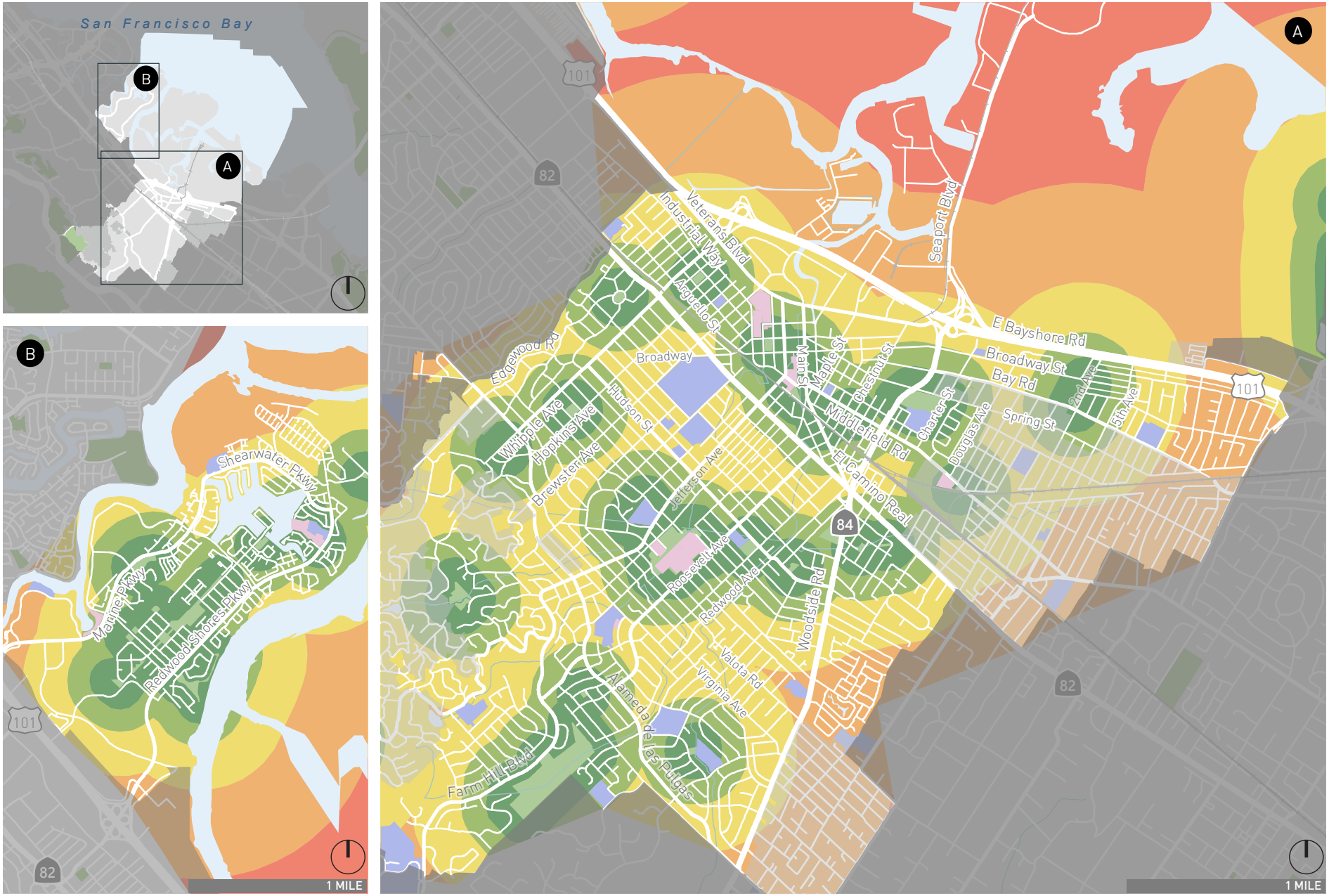


Figure D-10

Redwood City
Parks Proximity Score

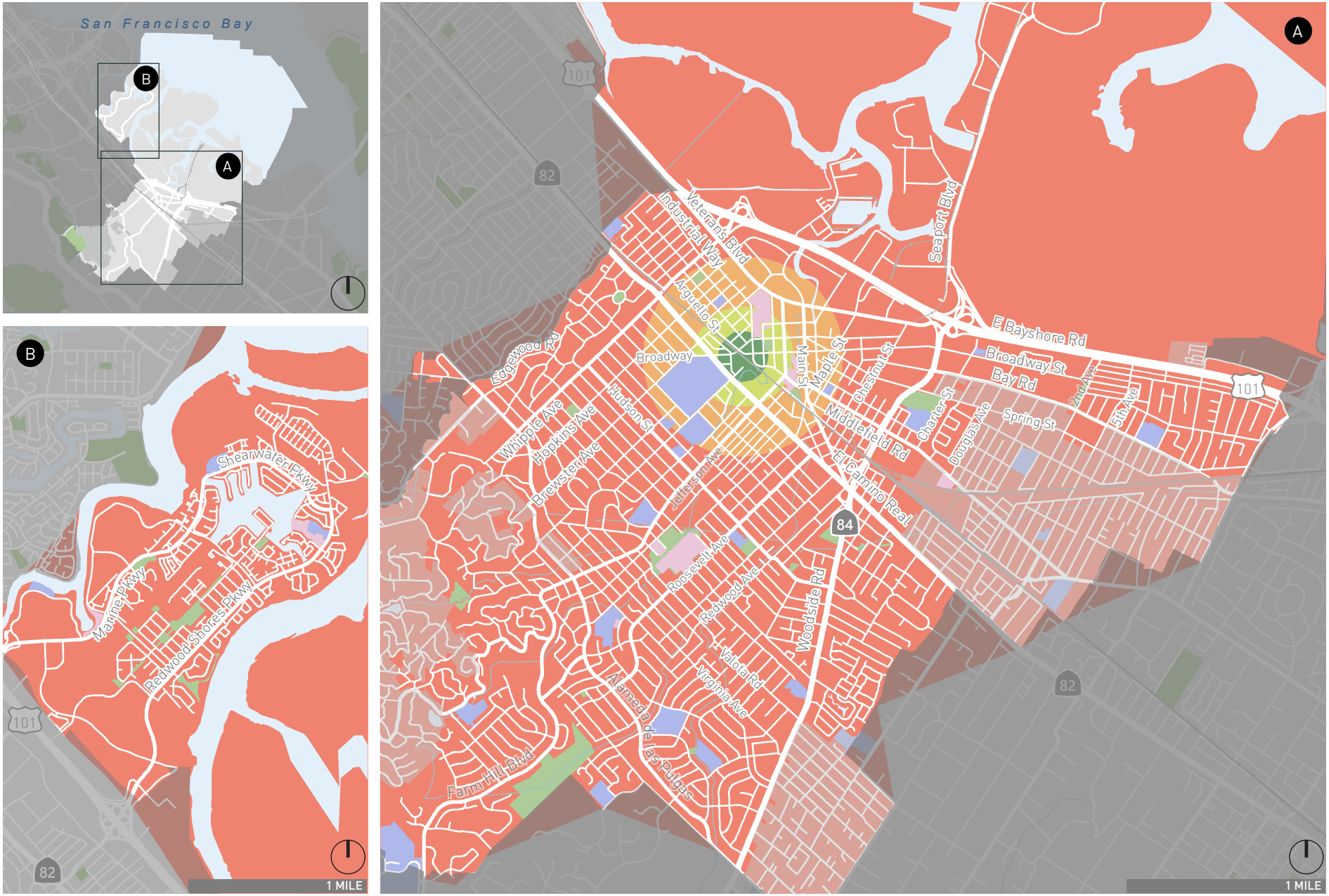


Figure D-11

Redwood City
Caltrain Proximity Score

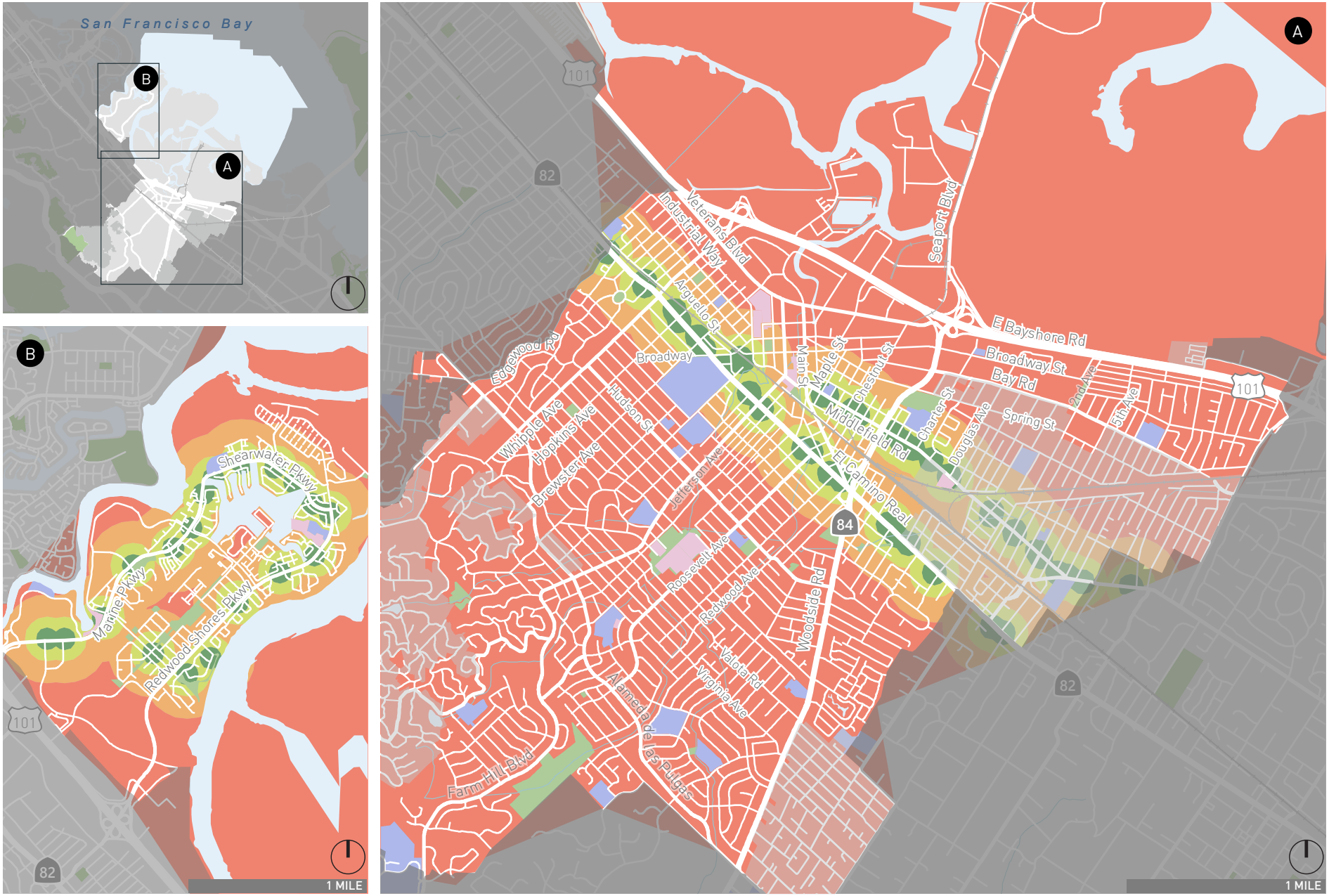


Figure D-12

Redwood City
High Frequency Transit Score

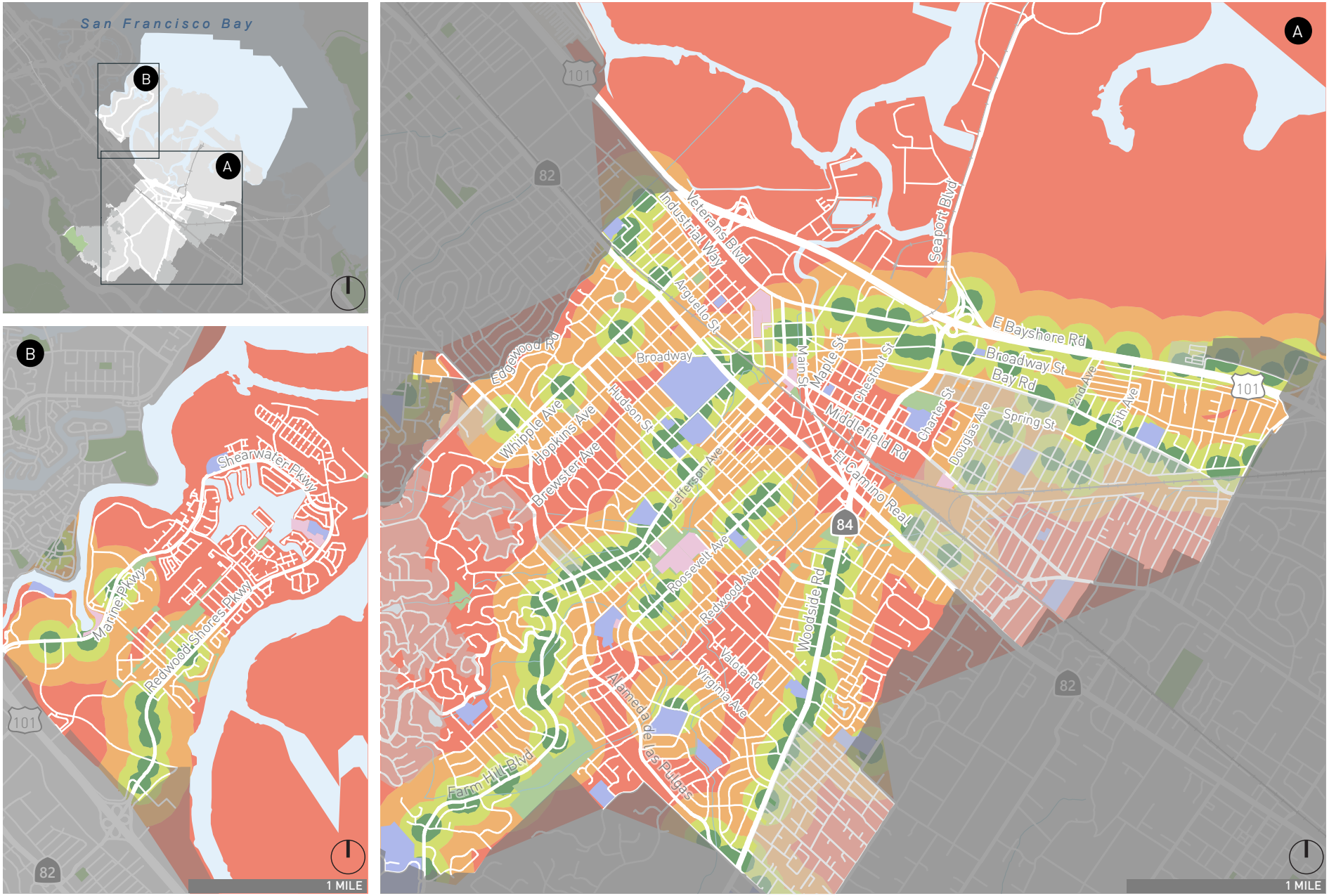
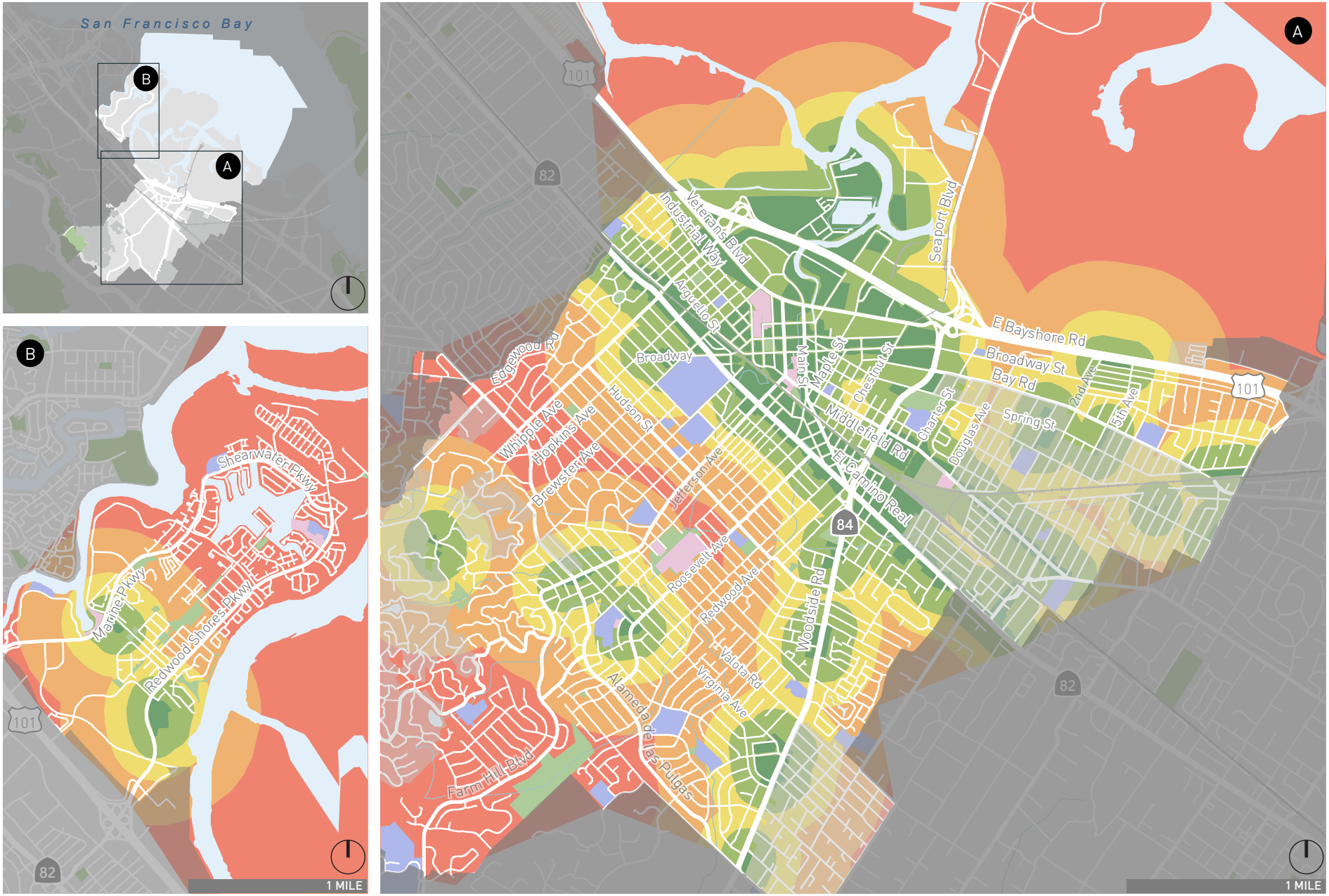


Figure D-13

Redwood City
Low Frequency Transit Score



FigureD-14

Redwood City
Retail Service Proximity Score

Step 2: GIS Data Processing

Pedestrian and bicycle demand was estimated using factors that describe land use characteristics, proximities to key destinations for walking and bicycling trips, socio-economic attributes, and accessibility of streets in Redwood City. Using GIS, all the variables were rasterized (transformed into a grid of cells representation) and reclassified into their associated scores. The final pedestrian and bicycle indices were determined by a weighted overlay analysis. Both the data processing steps and the final weights of the weighted overlay analysis for the bicycle and pedestrian demand analysis are outlined in **Table D-2** below.

Table D-2: Bicycle and Pedestrian Demand Overlay Analysis Considerations

Variable	Variable Values	Score	Processing Steps	Demand Weighting	
				Pedestrian	Bicycle
Built Environment & Street Permeability					
Population Density	0 -5 persons per acre	0	• Population density reflects how many people are living near one another and serves as a surrogate for the compactness of the built environment. • Values of computed gross population density in units of persons per acre based on census block group geography.	7.50%	7.50%
	5-10 persons per acre	20			
	10-15 persons per acre	40			
	15-20 persons per acre	60			
	20-25 persons per acre	80			
	>25 persons per acre	100			
Job Density	0-4 jobs per acre	0	• Job density reflects where clustered employment opportunities are within the study areas and serves as a surrogate for the compactness of the built environment. • Values of computed gross job density in units of jobs per acre based on census block group geography.	7.50%	7.50%
	4-8 jobs per acre	20			
	8-12 jobs per acre	40			
	12-16 jobs per acre	60			
	16-20 jobs per acre	80			
	>20 jobs per acre	100			

Table D-2: Bicycle and Pedestrian Demand Overlay Analysis Considerations

Variable	Variable Values	Score	Processing Steps	Demand Weighting	
				Pedestrian	Bicycle
Intersection Density	0-40 intersections per square mile	0	• Intersection density reflects intersection proximity and serves as a surrogate for pedestrian connectivity and block size. • This variable was derived from the Redwood City centerline network. Intersections with three or more legs were used to create a heat map. The heat map is based on the average number of intersections within ½ mile.	10%	7.50%
	40-80 intersections per square mile	20			
	80-120 intersections per square mile	40			
	120-160 intersections per square mile	60			
	160-200 intersections per square mile	80			
	>200 intersections per square mile	100			
Demographics					
Low Vehicle Ownership	50-100% of households	100	• Calculated the proportion of households that have a low rate (0 or 1) of vehicle ownership and is likely to have household members that use transit or active modes of transportation.	12.50%	12.50%
	30-50% of households	80			
	15-30% of households	60			
	10-15% of households	40			
	5-10% of households	20			
	0-5% of households	0			
Youth and Senior Population	40-100% of the population	100	• Calculated the proportion of the population under 18 or over 65 reflects the proportion of the population that is less likely to have a vehicle and more demand for active travel options.	7.50%	5%
	32.5-40% of the population	80			
	25-32.5% of the population	60			
	17.5-25% of the population	40			
	10-17.5% of the population	20			

Table D-2: Bicycle and Pedestrian Demand Overlay Analysis Considerations

Variable	Variable Values	Score	Processing Steps	Demand Weighting	
				Pedestrian	Bicycle
	0-10% of the population	0			
Poverty Rate	25-100% of the population	100	• Calculated the proportion of the population living below the poverty line reflects the proportion of the population that is likely not to have a vehicle and use low cost transportation options.	5%	5%
	20-25% of the population	80			
	15-20% of the population	60			
	10-15% of the population	40			
	5-10% of the population	20			
	0-5% of the population	0			
Proximity Factors					
Connected Sidewalk Proximity	0-100 ft.	100	• Sidewalk proximity represents the general support an area provides to walking trips between destinations. This variable was derived from sidewalk data provided by Redwood City. • As part of this analysis we removed sidewalks that were not connected to the rest of the sidewalk network. • After the data was filtered to connected sidewalks, a proximity surface was created where every point in Redwood City was assigned a value that represented the distance to sidewalks.	10%	0%
	100-330 ft.	80			
	330-660 ft.	60			
	660-990 ft.	40			
	990-1320 ft.	20			
	>1320 ft.	0			
Bike Route Proximity	0-330 ft.	100	• Bicycle facility proximity represents the general support an area provides for low stress cycling to destinations. • As part of this analysis we wanted the bicycle facilities that provide some separation from traffic, so any facility that was a shared route (Class III) was filtered out of the analysis.	0%	20%
	330-660 ft.	80			
	660-990 ft.	60			
	990-1320 ft.	40			

Table D-2: Bicycle and Pedestrian Demand Overlay Analysis Considerations

Variable	Variable Values	Score	Processing Steps	Demand Weighting	
				Pedestrian	Bicycle
	1320-2640 ft.	20	• After shared routes were filtered from the analysis, a proximity surface was created where every point in Redwood City was assigned a value that represented the distance to bicycle facilities.		
	>2640 ft.	0			
School and Public Facilities Proximity	0-660 ft.	100	• School and public facilities proximity reflects how close locations are to schools and public facilities, with those being closer more likely to have people walking or biking to them. • A proximity surface was created where every point in Redwood City was assigned a value that represented the distance to schools and public facilities.	7.50%	5%
	660-1320 ft.	75			
	1320-2640 ft.	50			
	2640-5280 ft.	25			
	>5280 ft.	0			
Park Proximity	0-660 ft.	100	• Parks/recreational facility proximity reflects how close locations are to neighborhood parks that are likely to serve local populations who might access the parks via walking or biking. • A proximity surface was created where every polygon in Redwood City was assigned a value that represented distance to the nearest park.	5%	5%
	660-1320 ft.	75			
	1320-2640 ft.	50			
	2640-5280 ft.	25			
	>5280 ft.	0			
Caltrain Proximity	0-660 ft.	100	• Caltrain proximity reflects how well an area is served by the region's transit network, Caltrain. • The resulting stops from GTFS data were filtered to only Caltrain stations as they are the only regional rail service provided. • After the GTFS data was filtered, a proximity surface was created where every point in Redwood City was assigned a value that represented the distance to stops.	10%	15%
	660-1320 ft.	60			
	1320-2640 ft.	30			
	> 2640 ft.	0			

Table D-2: Bicycle and Pedestrian Demand Overlay Analysis Considerations

Variable	Variable Values	Score	Processing Steps	Demand Weighting	
				Pedestrian	Bicycle
High Frequency Transit Proximity	0-330 ft.	100	• High frequency transit proximity reflects how well an area is served by high quality transit routes. • The resulting stops from GTFS data were filtered to routes with weekday morning headways of 15 minutes or better (excluding Caltrain). • After the GTFS data was filtered, a proximity surface was created where every point in Redwood City was assigned a value that represented the distance to the closest stops.	5%	2.50%
	330-660 ft.	60			
	660-1320 ft.	30			
	> 1320 ft.	0			
Low Frequency Transit Proximity	0-330 ft.	100	• Low frequency transit stop proximity reflects how well an area is served by low frequency transit routes. • The resulting stops from GTFS data were filtered to routes with weekday morning headways of higher than 15 minutes. • After the GTFS data was filtered, a proximity surface was created where every point in Redwood City was assigned a value that represented the distance to the nearest stops.	2.50%	9%
	330-660 ft.	60			
	660-1320 ft.	30			
	> 1320 ft.	0			
Retail Service Proximity	0 ft.	100	• Commercial district proximity reflects how close opportunities to access retail or service destinations are. • The layer was constructed from General Plan Zoning polygons that were classified as commercial or mixed use. • After the data was filtered to commercial/mixed use areas, a proximity surface was created where every point in Redwood City was assigned a value that represented the distance to the nearest districts.	10%	7.50%
	0-660 ft.	75			
	660-1320 ft.	50			
	1320-2640 ft.	25			
	>2650 ft.	0			

Source: Fehr & Peers, 2018.

Step 3: Develop Final Database and Join Attributes to Street Centerline File

After GIS processing, a centerline database was used to derive the pedestrian and bicycling model. After calculating scores for each input variable, the overall pedestrian and bike demand score was calculated for each street segment using the weights outlined in the table above.

Walking and bicycling demand scores were calculated for all street segments within Redwood City.

Step 4: Summarize Walking and Bicycling Results Scores

The walking and bicycling demand model results, shown in **Figure B-1** and **Figure B-2** of **Appendix B**, indicate many streets near Downtown Redwood City are attractive for walking and biking. Streets that serve as a link to a variety of uses and destinations score particularly well, including parts of El Camino Real, Brewster, Main Street, and Maple Street.