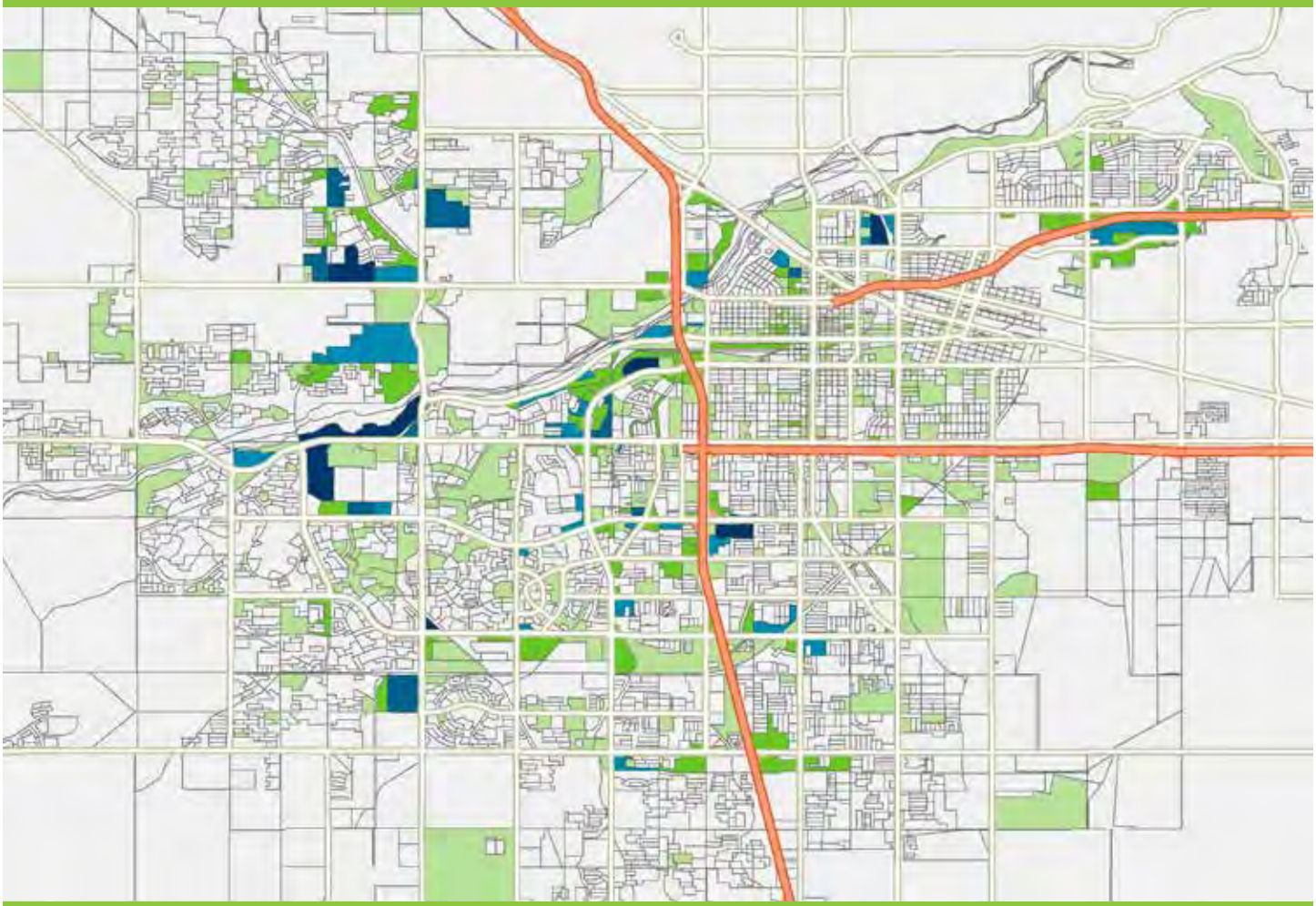
Charging Roadmap:

SITING OPTIMAL LOCATIONS FOR PUBLIC CHARGING STATIONS IN THE SAN JOAQUIN VALLEY

May 2014

Preparing the San Joaquin Valley for Plug-in Electric Vehicles



Center for Sustainable Energy® CALIFORNIA

San Joaquin Valley AIR POLLUTION CONTROL DISTRICT

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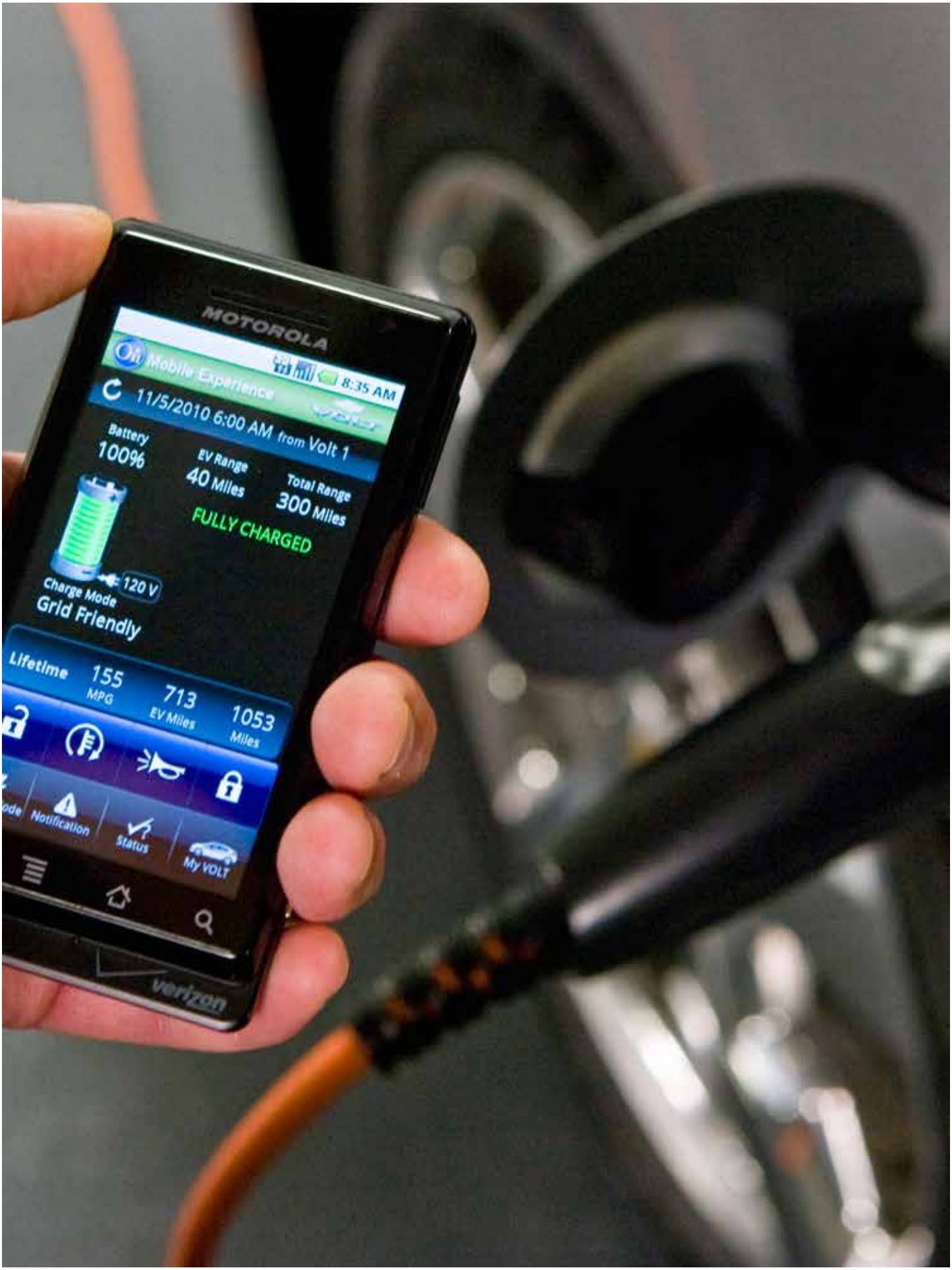
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Mobile Experience
8:35 AM
11/5/2010 6:00 AM from Volt 1
Battery
100%
EV Range
40 Miles
Total Range
300 Miles
FULLY CHARGED
120 V
Charge Mode
Grid Friendly
Lifetime
155
MPG
713
EV Miles
1053
Miles
Notification
Status
My VOLT
verizon

Introduction

The San Joaquin Valley Air Pollution Control District and the San Joaquin Valley Plug-in Electric Vehicle Coordinating Council (PEVCC) have identified optimal locations for public electric vehicle chargers in ten Valley cities and along the Highway 99 corridor. The analysis is based on regional transportation origin and destination data, industry expertise and other demographic information.

The San Joaquin Valley PEVCC is a 28-member advisory group composed of local metropolitan planning organizations, cities, counties, utilities, the San Joaquin Valley Clean Cities Coalition and electric vehicle service providers, as well as local consultants and nonprofit organizations. These stakeholders worked together to develop a methodology at the local level (i.e., census block, travel analysis zone) for identifying optimal charging locations.

This report has three sections: Fast Charging Infrastructure, Public Access Charging and Workplace Charging. Each provides an overview of the type of charging, how charging locations were selected, the data sources used to conduct the siting analysis and, lastly, maps of the optimal locations to place charging stations and infrastructure.

Unique Geographic Challenges in the San Joaquin Valley

The San Joaquin Valley is a very expansive region, stretching across 300 miles. Along Route 99 are some of the Valley's largest cities (e.g., Bakersfield, Fresno, Stockton) along with several suburbs. The Interstate 5 does not offer significant access to urban areas. Urban areas in the Valley are very spread out along the highways and small, rural communities are separated from other cities by vast farmland. Accordingly, access to major transportation corridors is limited. Workers from rural areas drive an average of 47% more miles per day than those from urban areas, according to the National Household Travel Survey. Additionally, rural residents must drive long distances in order to access stores, medical facilities and work.

This geography adds to the challenges of siting public charging infrastructure. It is a priority to make sure PEV drivers can travel from one city to another, but it is also important to make charging available for rural residents making the long drive into a city. Unlike dense regions such as Los Angeles, the Bay Area or San Diego, population density is as low as 71 people per square mile in some Valley counties.[1] Low population density emphasizes the importance of installing enough public infrastructure to allow residents to drive freely within their own city, which is not a problem faced by dense regions. To better accommodate the rural residents, additional analysis on commute patterns and travel flows in the rural areas of the region is necessary to address adequately the charging needs of those communities.

Long drives and commutes in the Valley are important factors when siting chargers. The following regional siting analysis presents a general blueprint for charging infrastructure placement. It does not necessarily address all of the geographical challenges faced by Valley residents; however, it does provide valuable tools for public and private sector stakeholders to better assess the charging needs in their respective areas throughout the Valley.

1 Data from California Department of Finance (2010). Los Angeles County population density is 2,420 people/sq. mile; San Diego County population density is 736 people/sq. mile; San Francisco County population density is 17,179 people/sq. mile.

Fast Charging Infrastructure

As the number of plug-in electric vehicles (PEVs) increases in the San Joaquin Valley, DC fast charging or other fast charging infrastructure will be needed to complement Level 1 and Level 2 charging and serve as a reliable option for drivers to extend their range. Recent studies show that PEV drivers want greater numbers of fast chargers available to use and charge their vehicles. This type of charging equipment, which can provide an 80% charge for a light-duty PEV battery in as few as 30 minutes, will serve the needs of interregional and intraregional travel while also supplying "safety net" charging opportunities for all types of drivers throughout the Valley.

Optimal Locations for Fast Charging in the San Joaquin Valley

For this analysis, DC fast chargers are sited along California State Route 99, or Highway 99. The 99 corridor was chosen because it extends through the most densely populated areas of the San Joaquin Valley and connects the major cities of the Valley to Sacramento.

In order for a site to be considered as an optimal location for hosting fast chargers, it must be within half a mile of a highway exit, easily accessible, well-lit, offer facilities and shelter for drivers while charging and a "destination" point. The types of destinations selected are supermarkets, department stores, shopping malls, restaurants and airports (short-term parking). These locations meet the criteria and likely have adequate power and transformer capacity to support fast chargers and existing parking availability.

Interstate 5 was excluded from this analysis because it predominately passes through rural areas of the San Joaquin Valley and may not have adjacent areas with the existing on-site electrical capacity required for DC fast charging infrastructure.

Type of Charging	Power Levels *(installed circuit rating)*	Where to Install
DC Fast Charging	440 or 480VAC	Public or commercial sites within ½ mile of highway exit

**Refer to vehicle specifications for exact ratings*

Source: Adapted from PEV Collaborative Multi-unit Dwelling Guidelines

In siting optimal fast charge locations, Highway 99 exits were mapped and a half-mile buffer was created around each exit. Within each half-mile buffer, Google's Places API (application programming interface) was used to locate the selected types of destinations. In the following maps, areas with higher

densities of destinations are a darker shade of blue and have greater potential to host fast chargers with adequate electrical capacity. Examining these variables will help determine which proposed areas potentially have the most charging demand.

Data Sources

Data was obtained from the National Household Travel Survey, the California Department of Transportation's data on highway exits, an ESRI-developed layer for highway exits, and Google Places API with analysis support from the UC Davis Plug-in Hybrid Electric Vehicle Research Center.

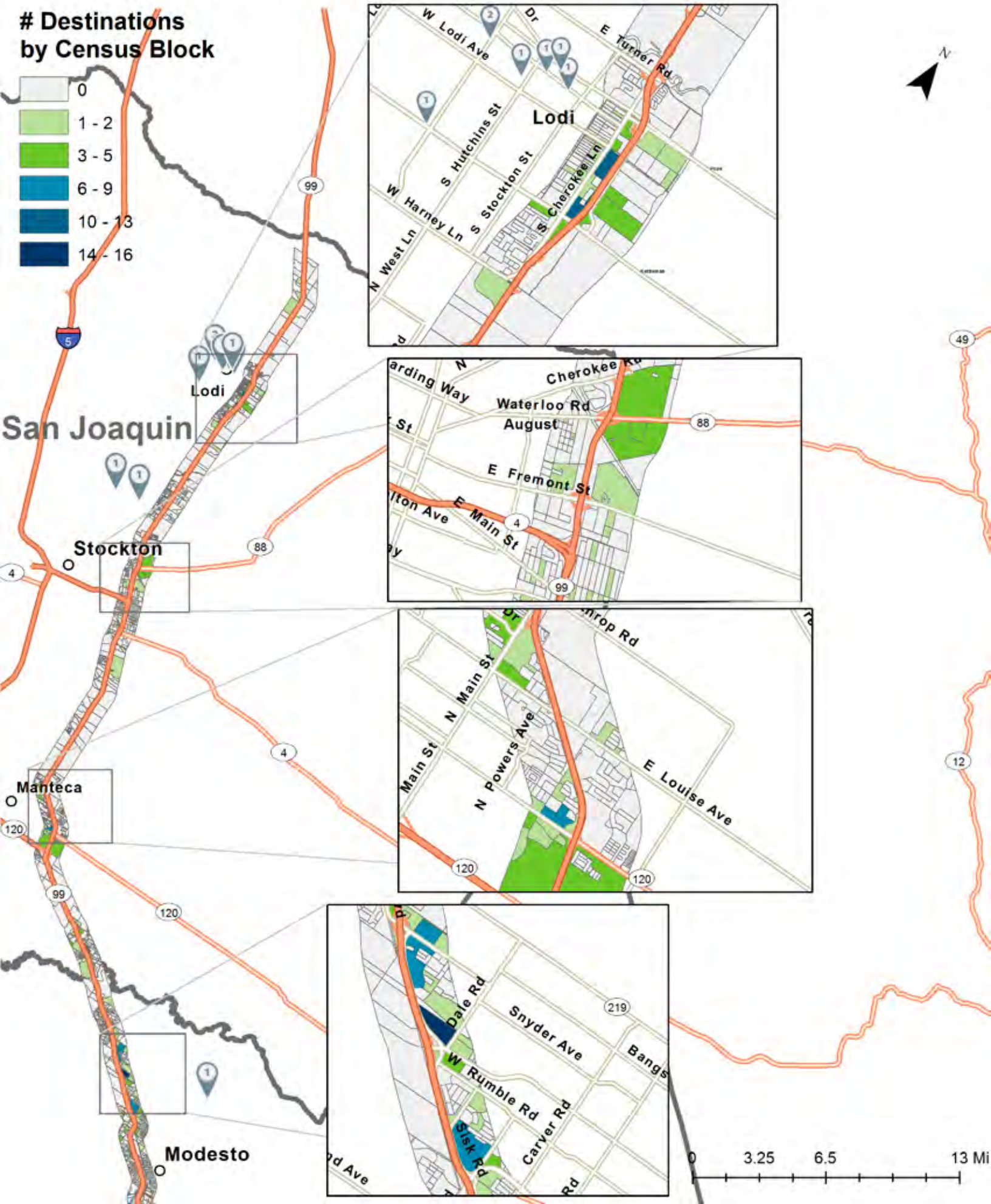
Python computer programming software was used to collect data from the Google Places API. This involved writing code that allows the collection of geocoded coordinates of chosen destinations along Highway 99. This powerful tool removes the need to manually search for each destination online.

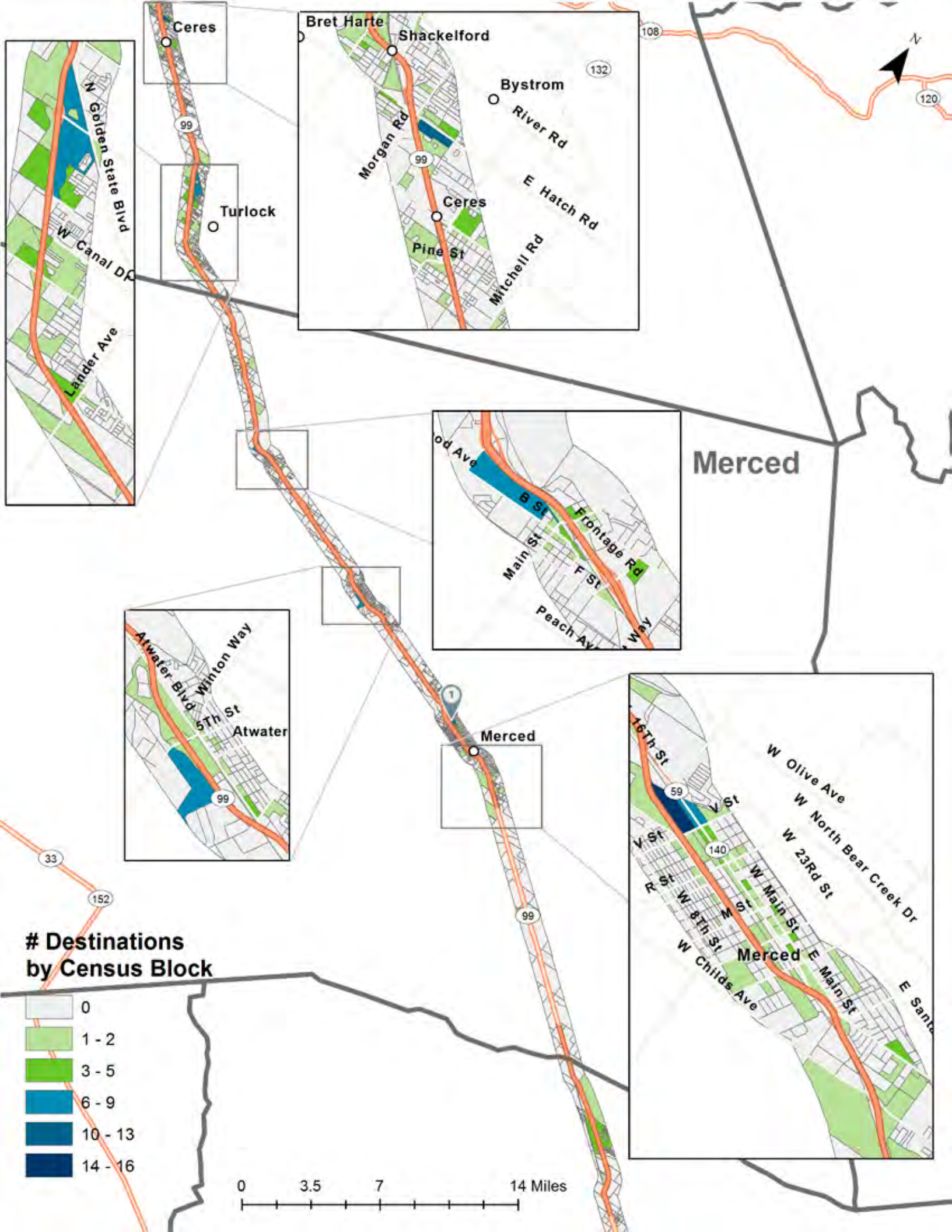
Maps

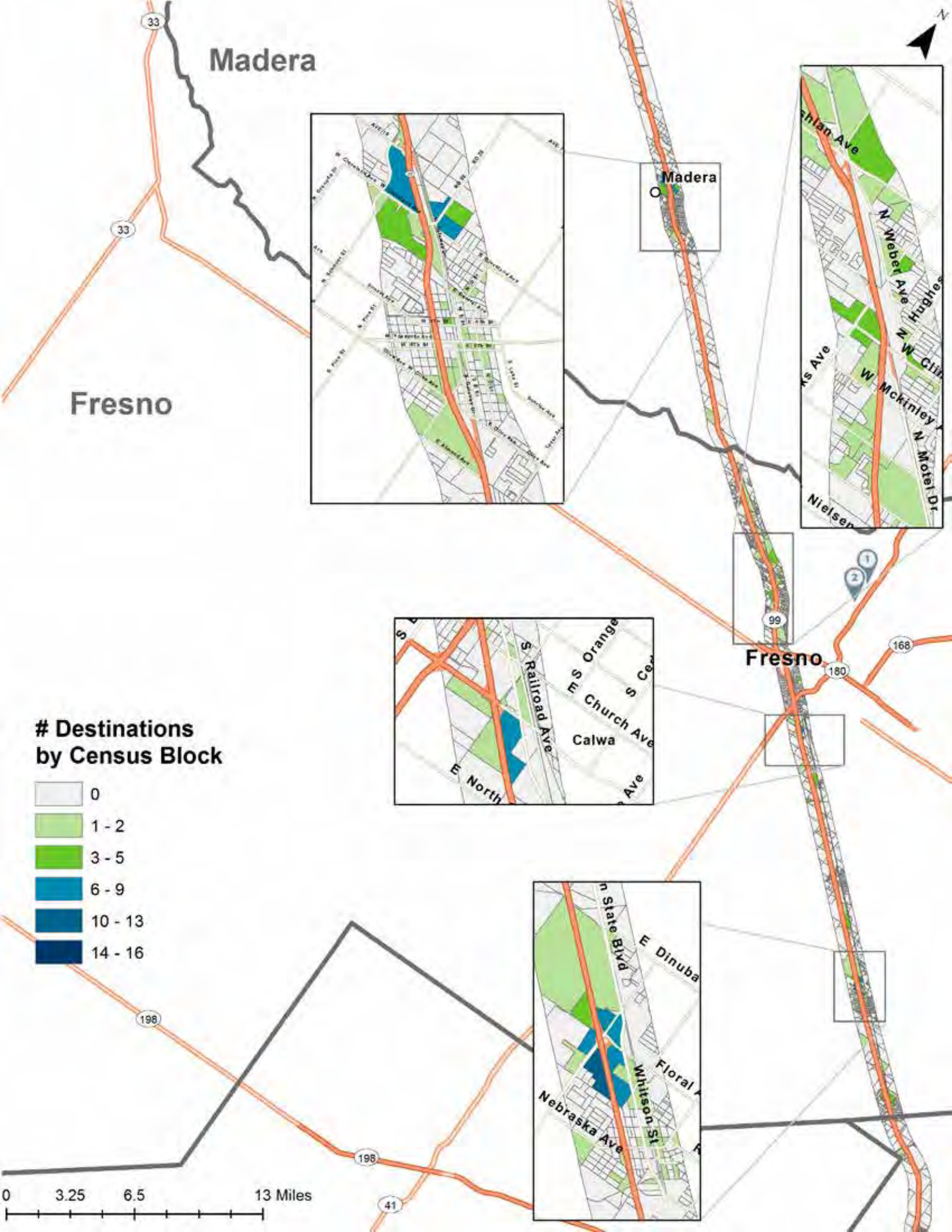
The following is a continuous map of the Highway 99 corridor from San Joaquin County to Kern County. Areas with a higher density of destinations are a darker shade of blue whereas areas with lower density of destinations are shades of green or gray.

This symbol represents the number of existing Level 2 charging stations throughout the maps

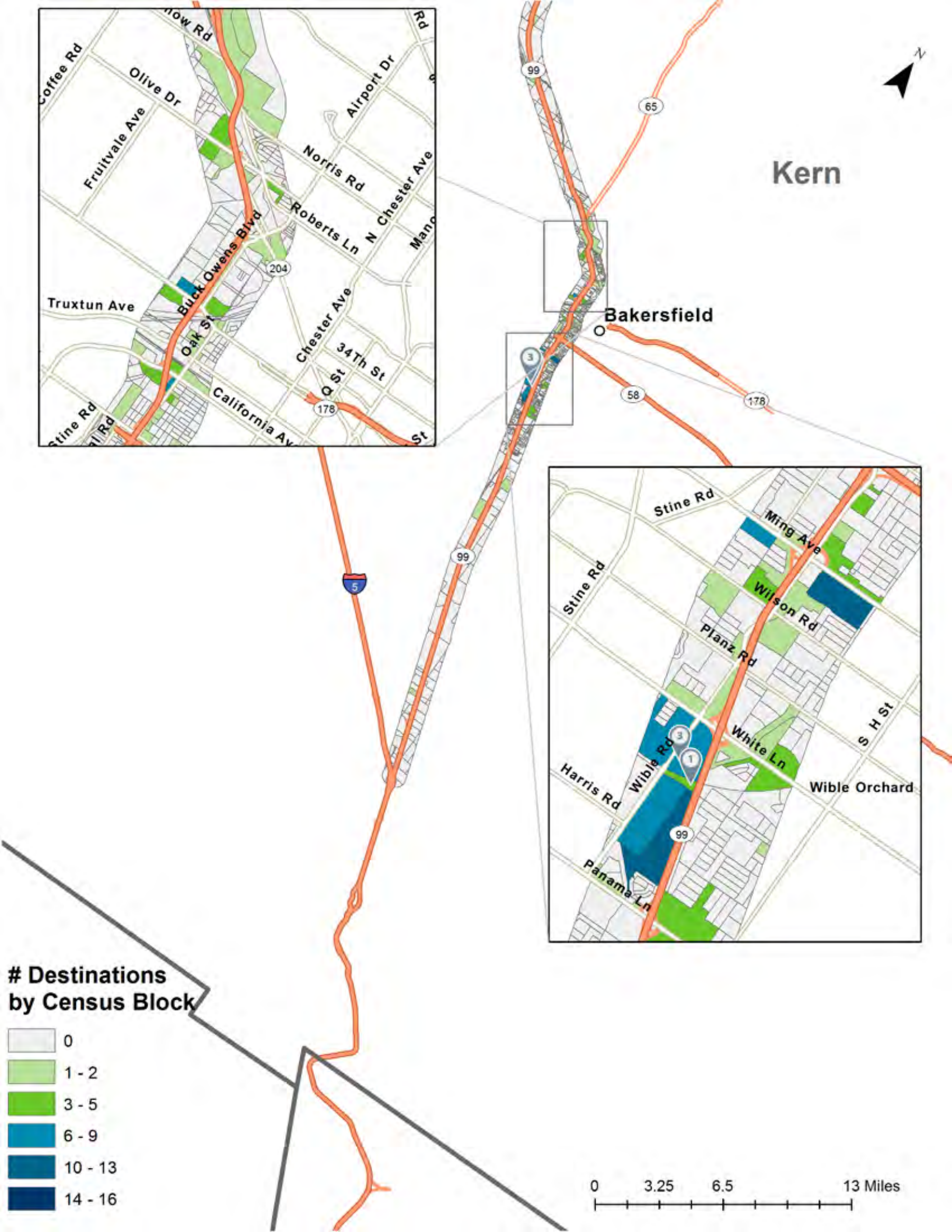
Optimal DC Fast Charging Locations




Ceres
Bret Harte
Shackelford
Bystrom
River Rd
Morgan Rd
E Hatch Rd
Ceres
Pine St
Mitchell Rd
Turlock
N Golden State Blvd
W Canal Dr
Lander Ave
Merced
B St
Main St
F St
Frontage Rd
Peach Ave
Atwater Blvd
Winton Way
5Th St
Atwater
Merced
16Th St
W Olive Ave
W North Bear Creek Dr
W 23Rd St
W Main St
W 8Th St
W Childs Ave
E Main St
V St
R St
99
59
140
108
132
120
33
152
1
Destinations
by Census Block
0
1 - 2
3 - 5
6 - 9
10 - 13
14 - 16
0
3.5
7
14 Miles


Madera
Fresno
Madera
Fresno
S Railroad Ave
E S Orange
E Church Ave
Calwa
E North
N Webert Ave
W Mckinley
N Motel Dr
Nielsen
E Dinuba
State Blvd
Whitson St
Nebraska Ave
Floral
99
168
180
198
198
41
33
33
Destinations by Census Block
0
1 - 2
3 - 5
6 - 9
10 - 13
14 - 16
0
3.25
6.5
13 Miles


Hanford
Kings
Tulare
Delano
W Tulare Ave
E Cross Ave
E Kern Ave
E Bardsley Ave
E Paige Ave
S K St
Turner Dr
Cecil Ave
Fremont St
High St
41
5
46
99
65
N
Destinations by Census Block
0
1 - 2
3 - 5
6 - 9
10 - 13
14 - 16
0
3.25
6.5
13 Miles


Kern
Bakersfield
Coffee Rd
Olive Dr
Fruitvale Ave
Airport Dr
Norris Rd
Roberts Ln
N Chester Ave
Buck Owens Blvd
Truxtun Ave
Oak St
Chester Ave
34Th St
Q St
California Ave
Stine Rd
Ming Ave
Wilson Rd
Planz Rd
White Ln
S H St
Wible Rd
Harris Rd
Wible Orchard
Panama Ln
99
65
204
178
58
5
Destinations by Census Block
0
1 - 2
3 - 5
6 - 9
10 - 13
14 - 16
0
3.25
6.5
13 Miles


UNAUTHORIZED VEHICLES NOT
CONNECTED FOR ELECTRIC
CHARGING PURPOSES
WILL BE TOWED AWAY
AT THE OWNER'S EXPENSE
L.M.C. 1044.125 V.C. 22511
EXCEPT FOR
ELECTRIC
VEHICLE
ACTIVELY
CHARGING
MAX CHARGE
TIME
4 HOURS

Public Access Charging

A robust network of publically available Level 2 charging stations is needed to encourage greater PEV adoption in the San Joaquin Valley. Destination charging sites should be located in urban areas and destinations where drivers will park their vehicle for more than an hour. This includes places that attract out-of-town visitors (i.e., art galleries, zoos, museums and amusement parks) and places where community members frequent (such as libraries, universities and parks).

City Level

Ten cities in the San Joaquin Valley were used in the siting analysis for Level 2 chargers. Maps have been created for each of the following cities.

- Bakersfield
- Clovis
- Fresno
- Hanford
- Madera
- Merced
- Modesto
- Stockton
- Tracy
- Visalia

These ten cities include the top four PEV-adopting cities in the Valley (Bakersfield, Clovis, Fresno and Tracy) and the county seats of each San Joaquin Valley county. Top PEV-adopting cities were chosen because local government officials can benefit from understanding what areas in their community are likely to experience the most demand for public charging. The county seats were chosen because they tend to be more populated and doing so is an impartial way to give representation to all counties in the Valley.

Best Locations for Public Access Charging

Data was obtained from the National Household Travel Survey to understand where drivers tend to be parked for longer periods. The following places may attract drivers to travel "medium-to-long" distances from their home and tend to stay parked at these places for at least one hour, generally enough time to charge their vehicle sufficiently with a Level 2 charger to complete the trip home.

- Airport
- Amusement park
- Aquarium
- Art gallery
- Campground
- Casino
- Dentist's office
- Department or big-box store
- Doctor's office
- Grocery store or supermarket

- Hospital
- Library
- Local government office
- Lodging
- Movie theater
- Museum
- Park
- Restaurant
- Shopping mall
- Stadium
- Train station
- University
- Zoo

How Local Government Officials can use the Maps

Each map displays the population density of selected "destinations" by census block, the smallest geographic unit used for tabulation by the U.S. Census Bureau. Mapping the destination points of a city within each census block will allow local transportation and city planners to assess the relative number of charger hosting opportunities located in a block. From there, planners can assess the potential parking availability for charging stations within each high-density block and prioritize upcoming planning reforms. In addition, planners may be able to take inventory of the blocks with high density of destinations and identify the building types that offer cost-effective charging opportunities.

Data Sources

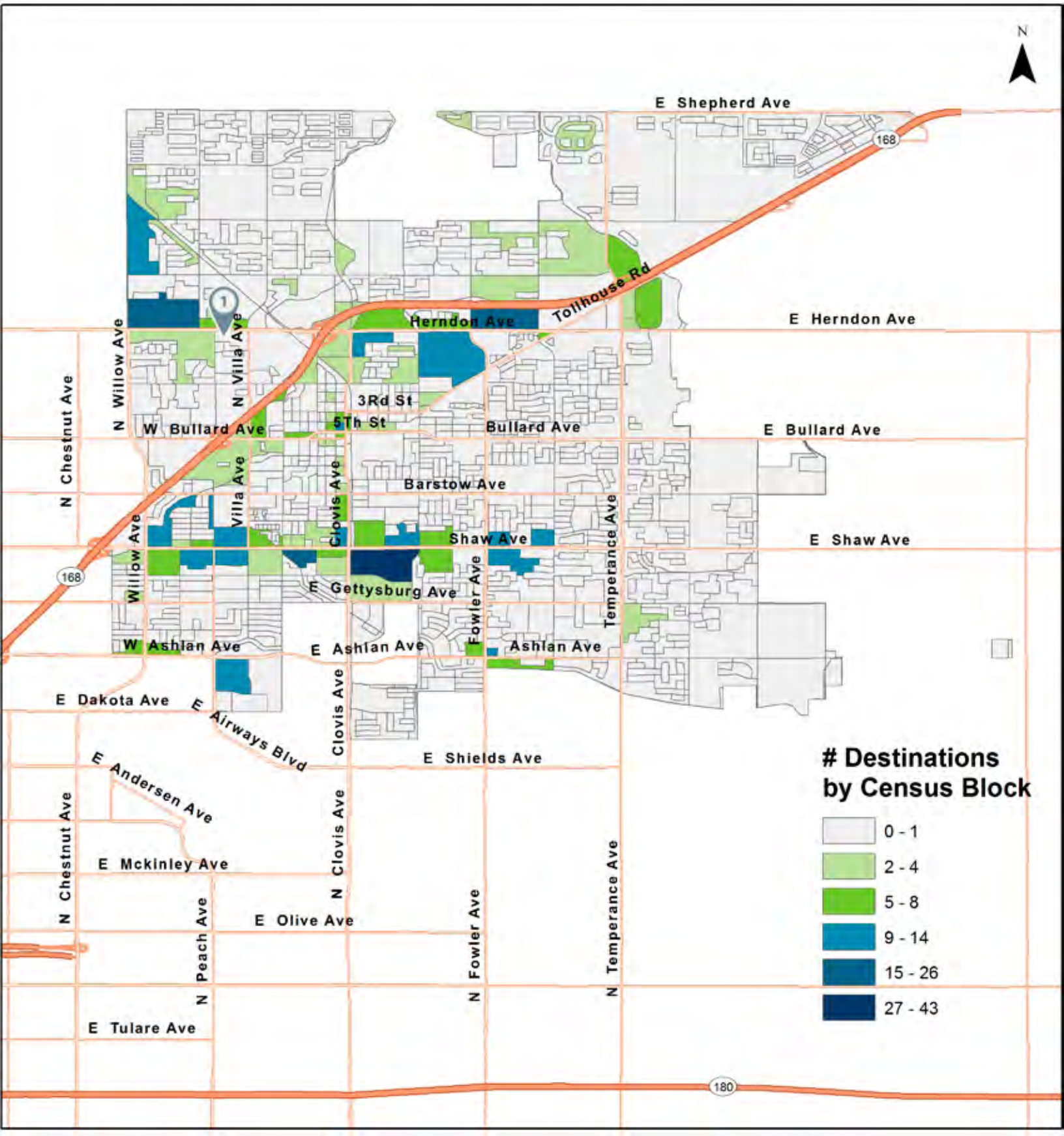
Data was gathered from Google Places API using Python. The data for existing public charging stations was accessed from the Department of Energy's Alternative Fuels Data Center (as of October 2013).

Maps

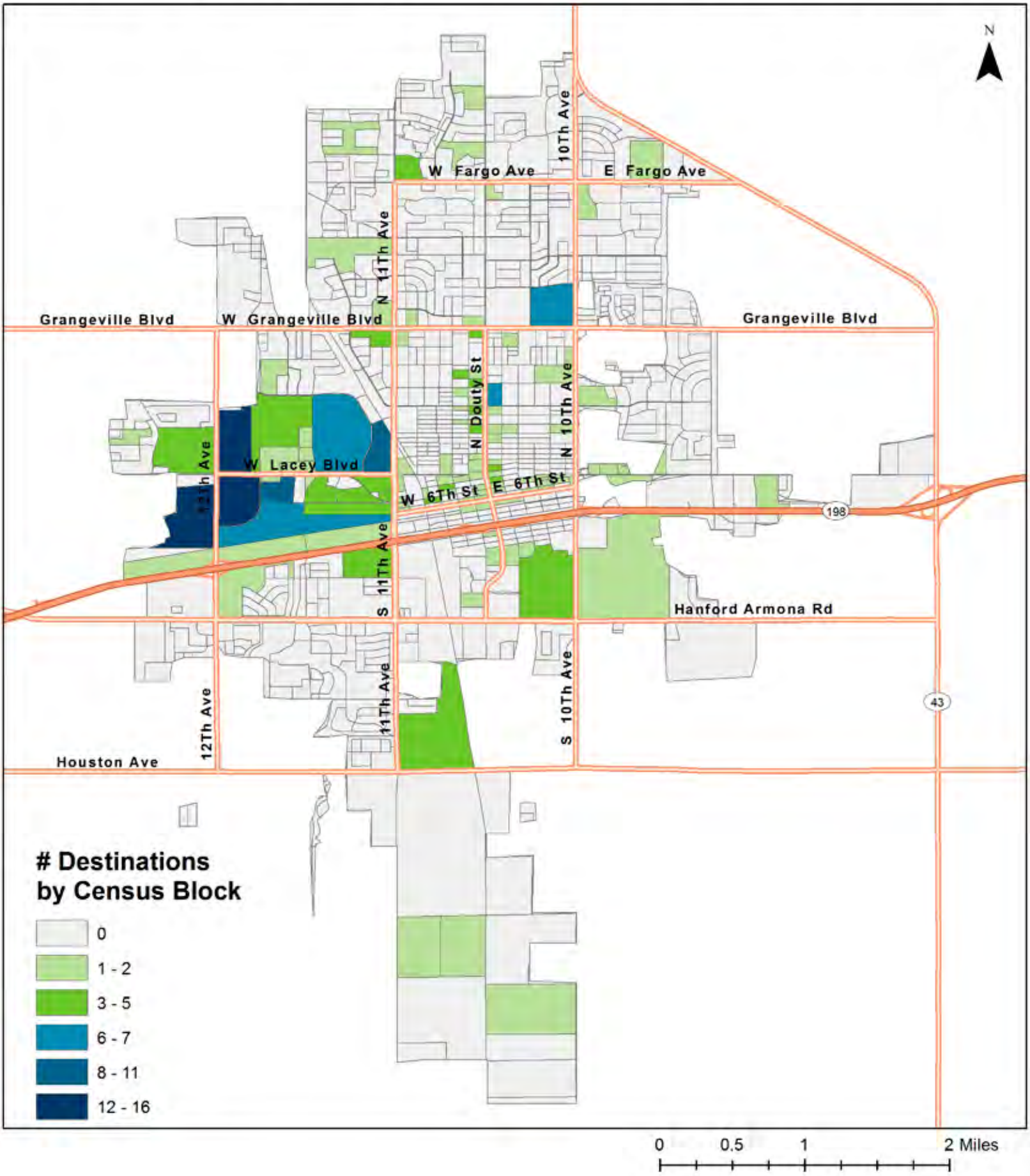
Each map identifies optimal locations for public access charging by census block. Census blocks with high densities of the selected destinations are dark blue, whereas those with low density are green and gray. Due to the size of Bakersfield and Fresno, maps for these cities are divided into council wards and districts, respectively. The maps are presented alphabetically; however, Bakersfield and Fresno are at the end because of their size.

This symbol represents the number of existing Level 2 charging stations throughout the maps

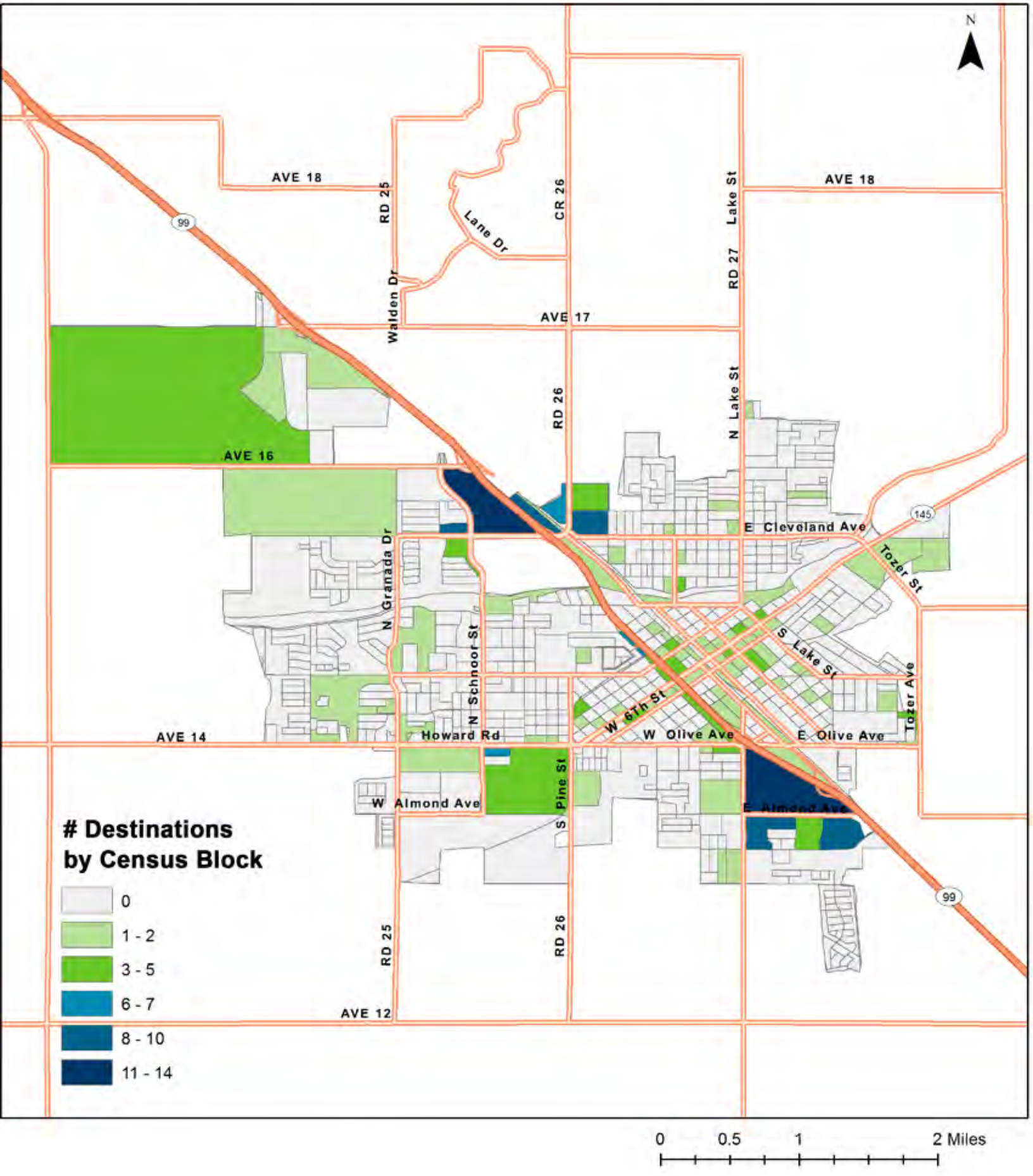
Optimal Public Access Charging Locations - City of Clovis



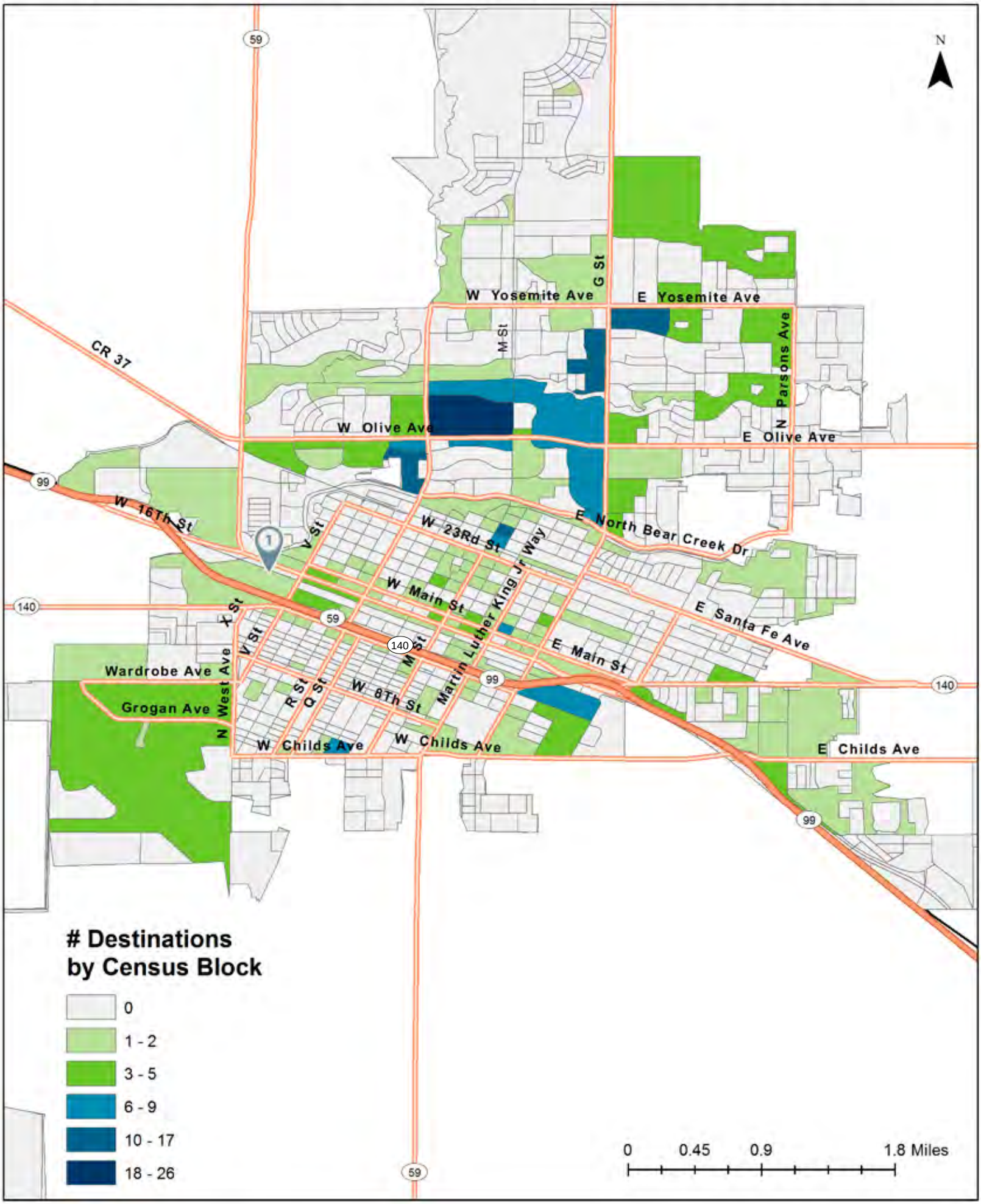
Optimal Public Access Charging Locations - City of Hanford



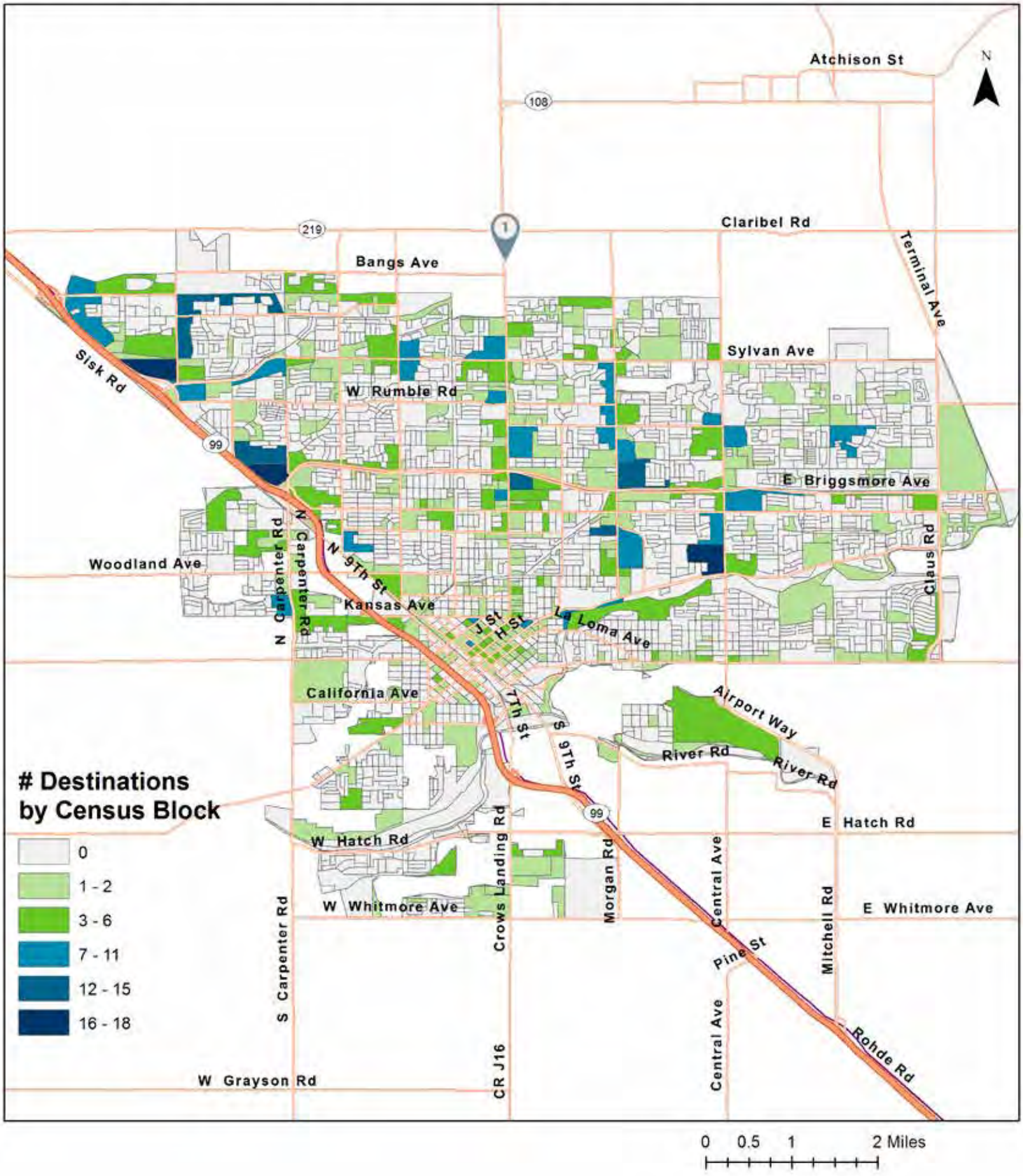
Optimal Public Access Charging Locations - City of Madera



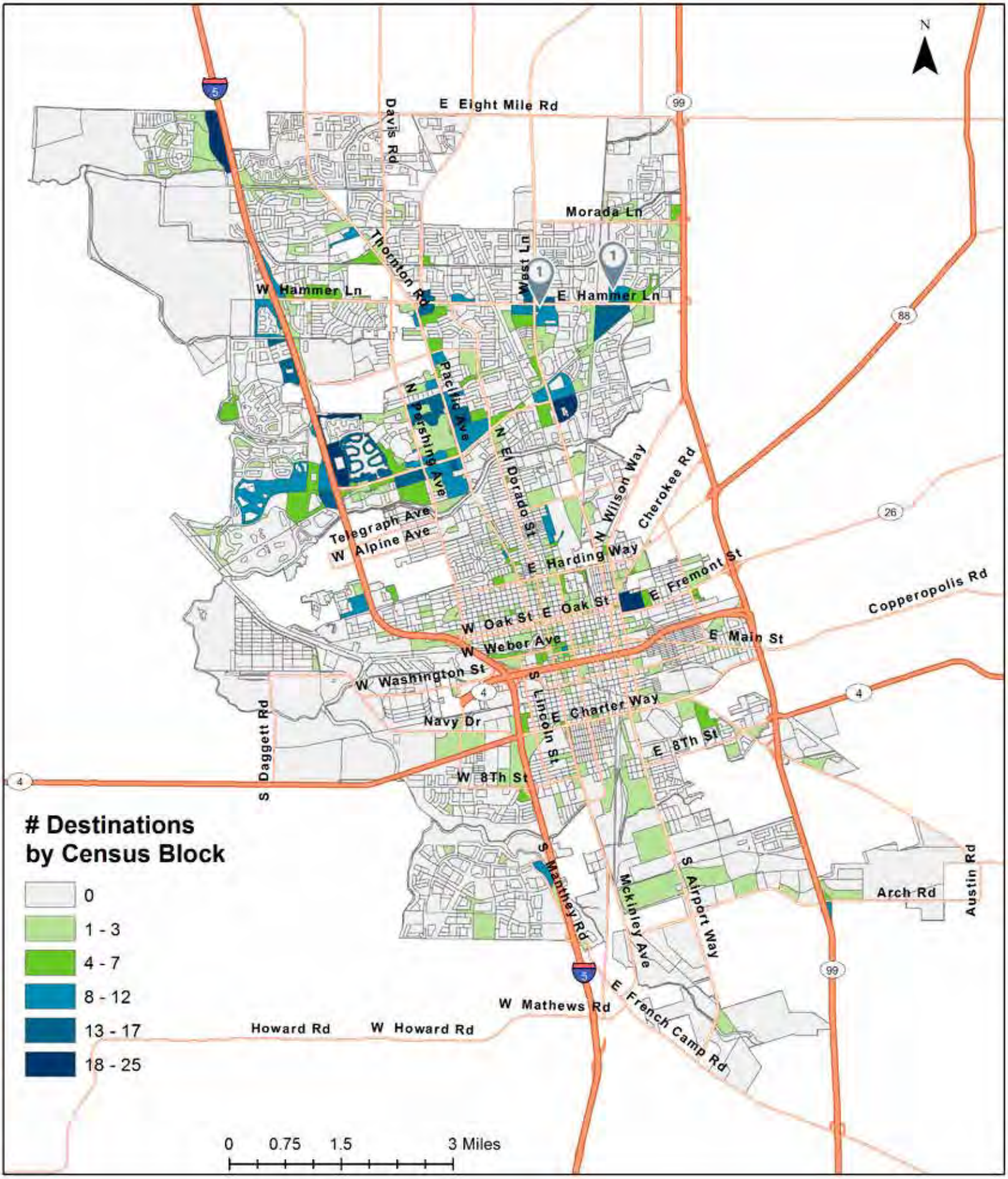
Optimal Public Access Charging Locations - City of Merced



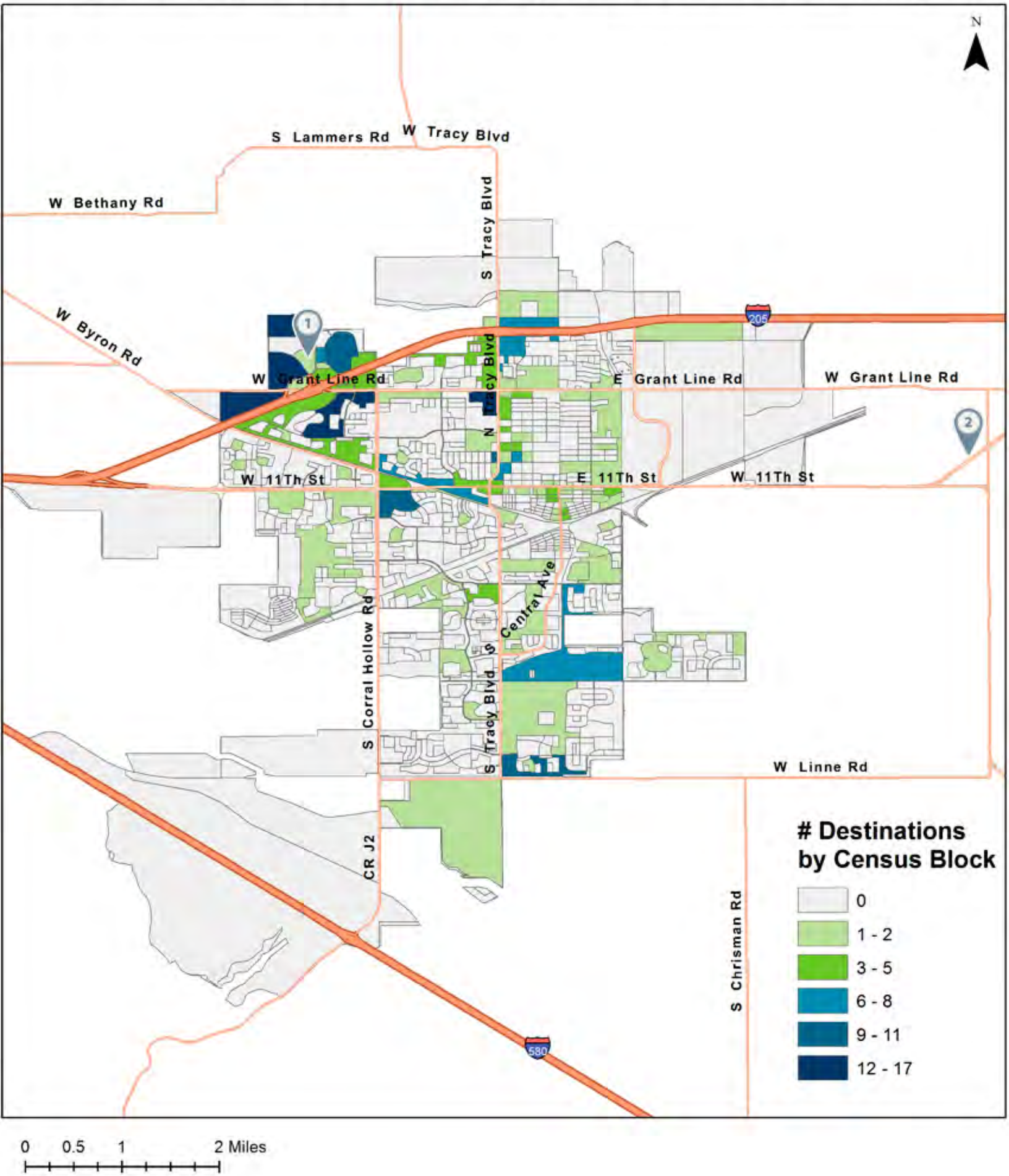
Optimal Public Access Charging Locations - City of Modesto



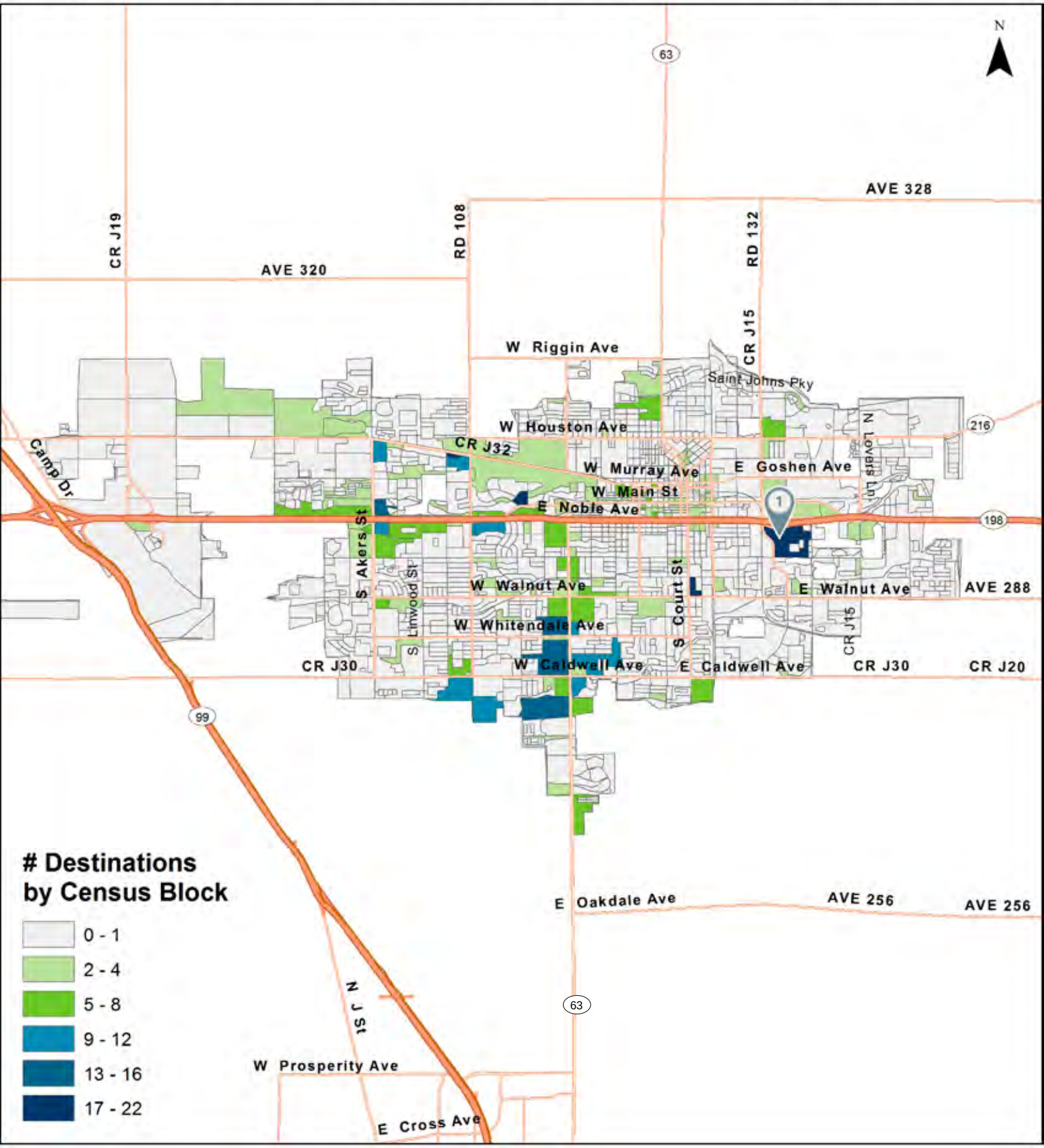
Optimal Public Access Charging Locations - City of Stockton



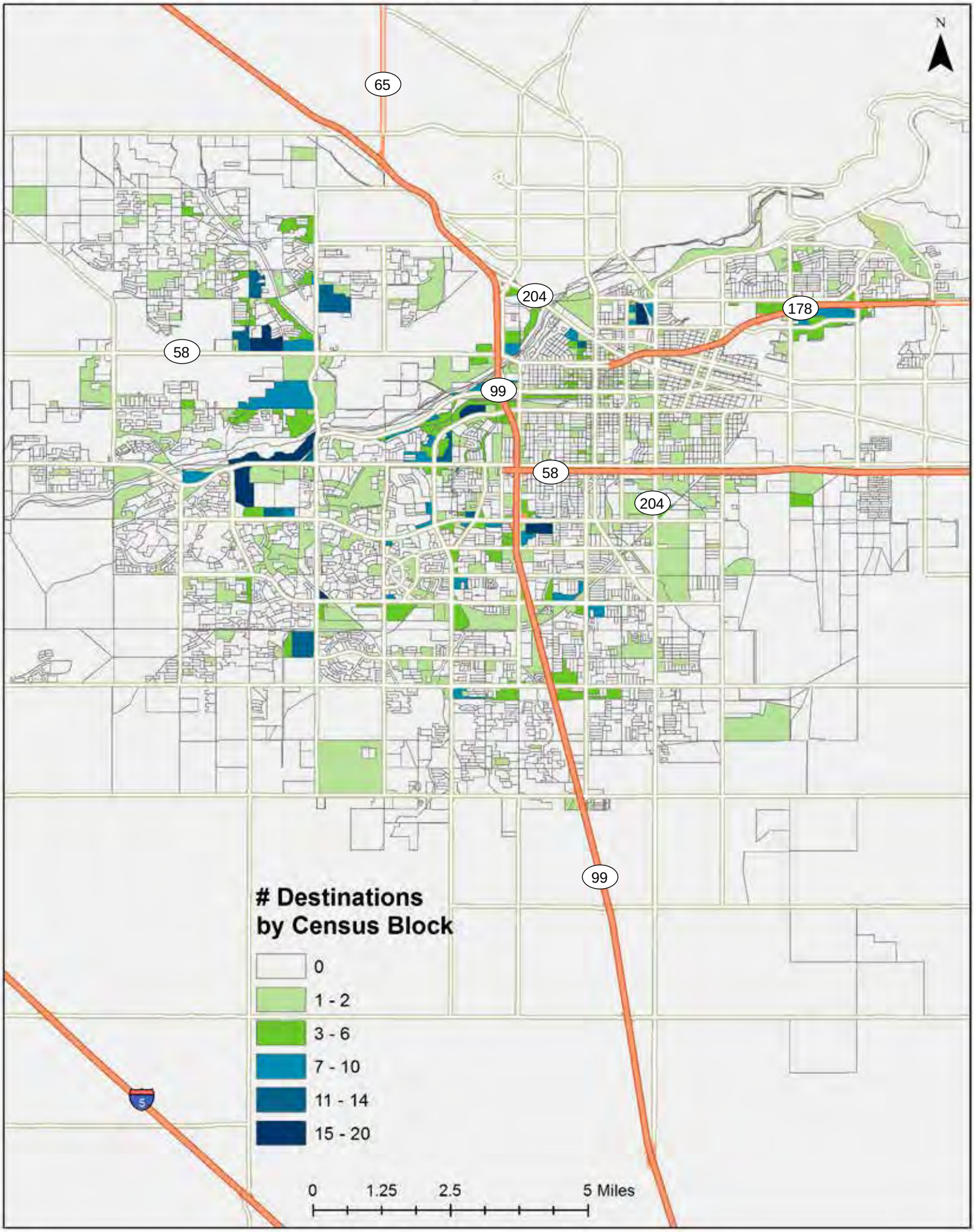
Optimal Public Access Charging Locations - City of Tracy



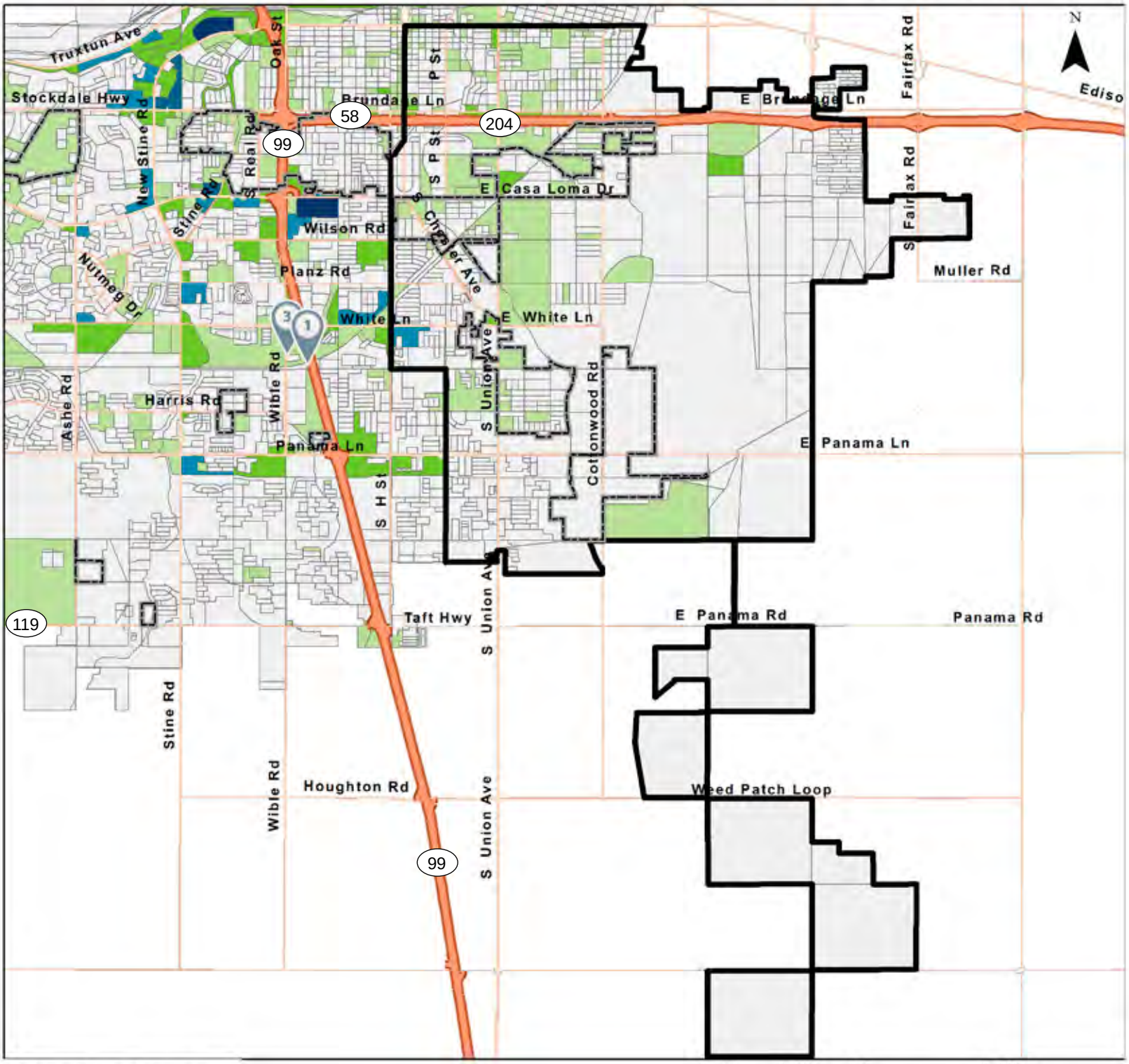
Optimal Public Access Charging Locations - City of Visalia



Optimal Public Access Charging Locations - City of Bakersfield



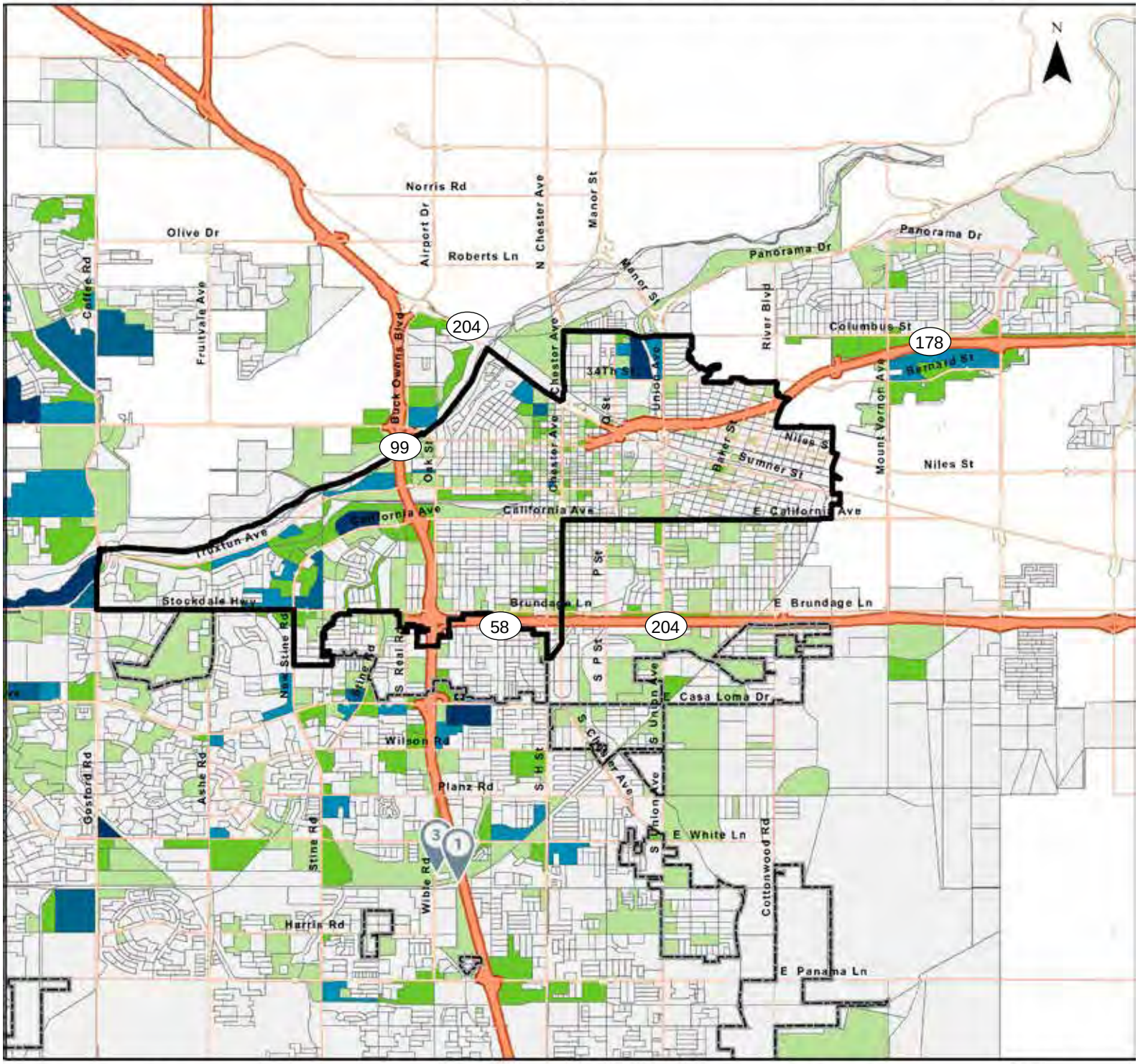
Optimal Public Access Charging Locations - Bakersfield Ward 1



Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

Optimal Public Access Charging Locations - Bakersfield Ward 2

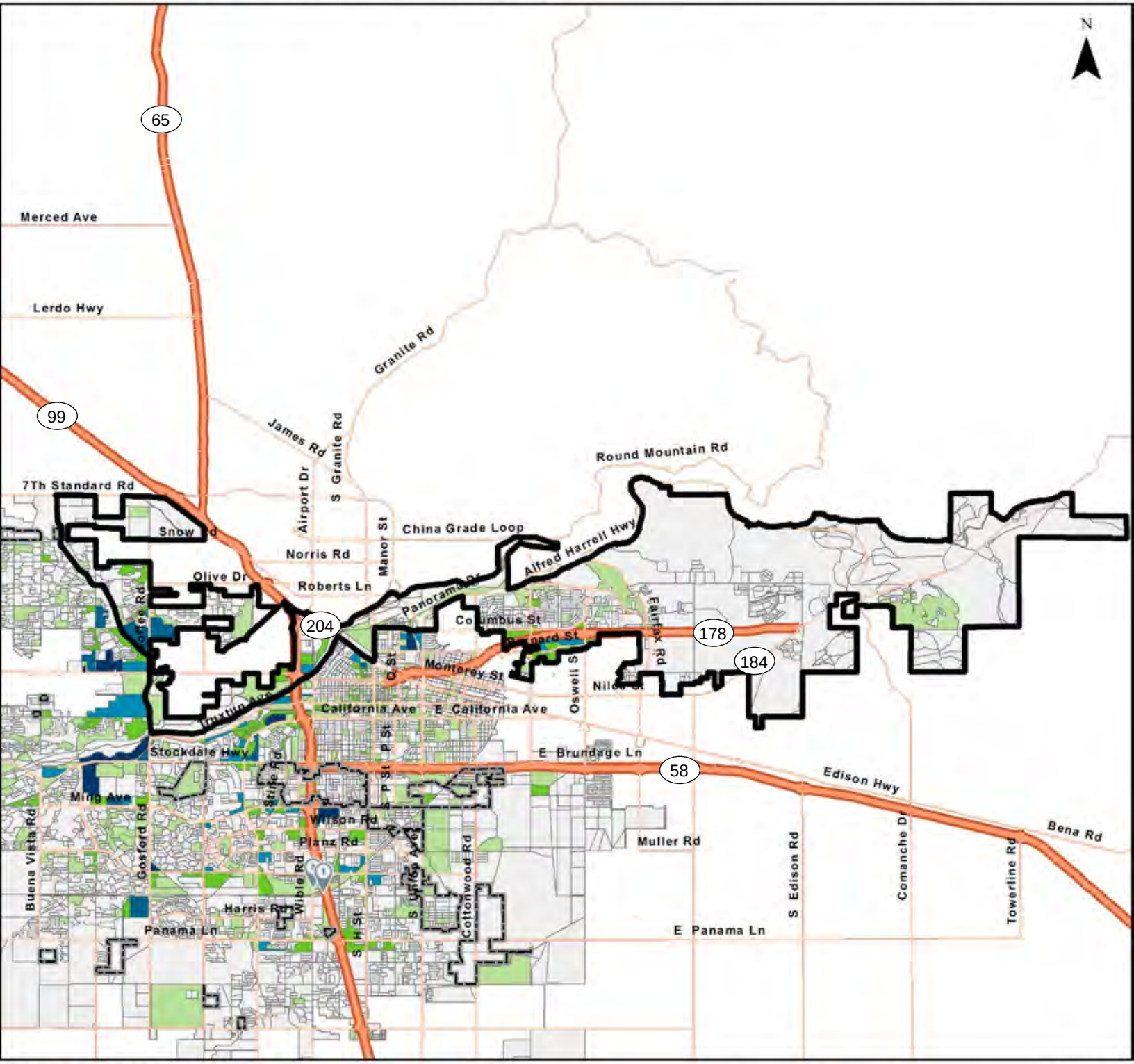


 # Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

0 0.75 1.5 3 Miles

Optimal Public Access Charging Locations - Bakersfield Ward 3

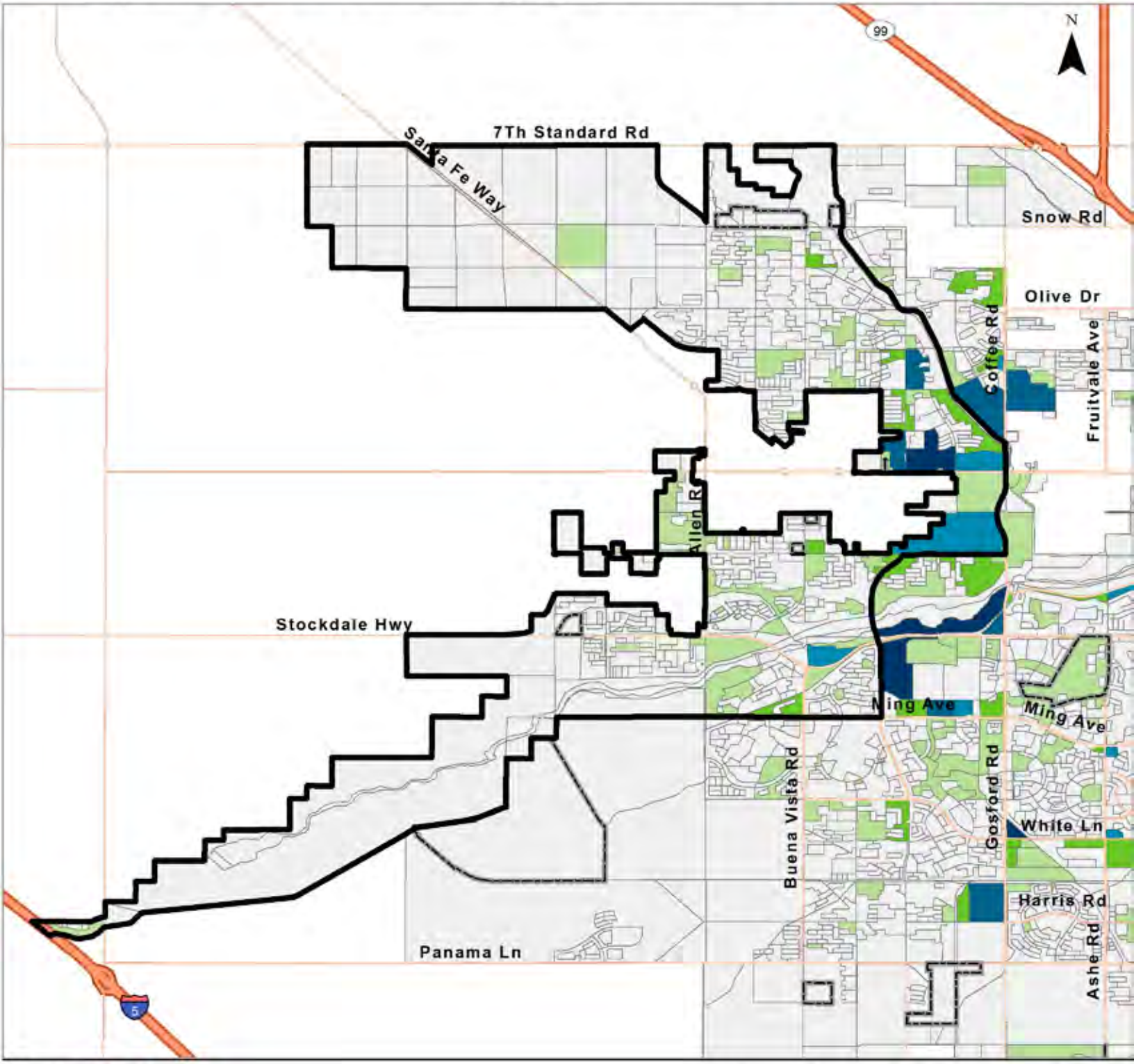


 # Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

0 1.75 3.5 7 Miles

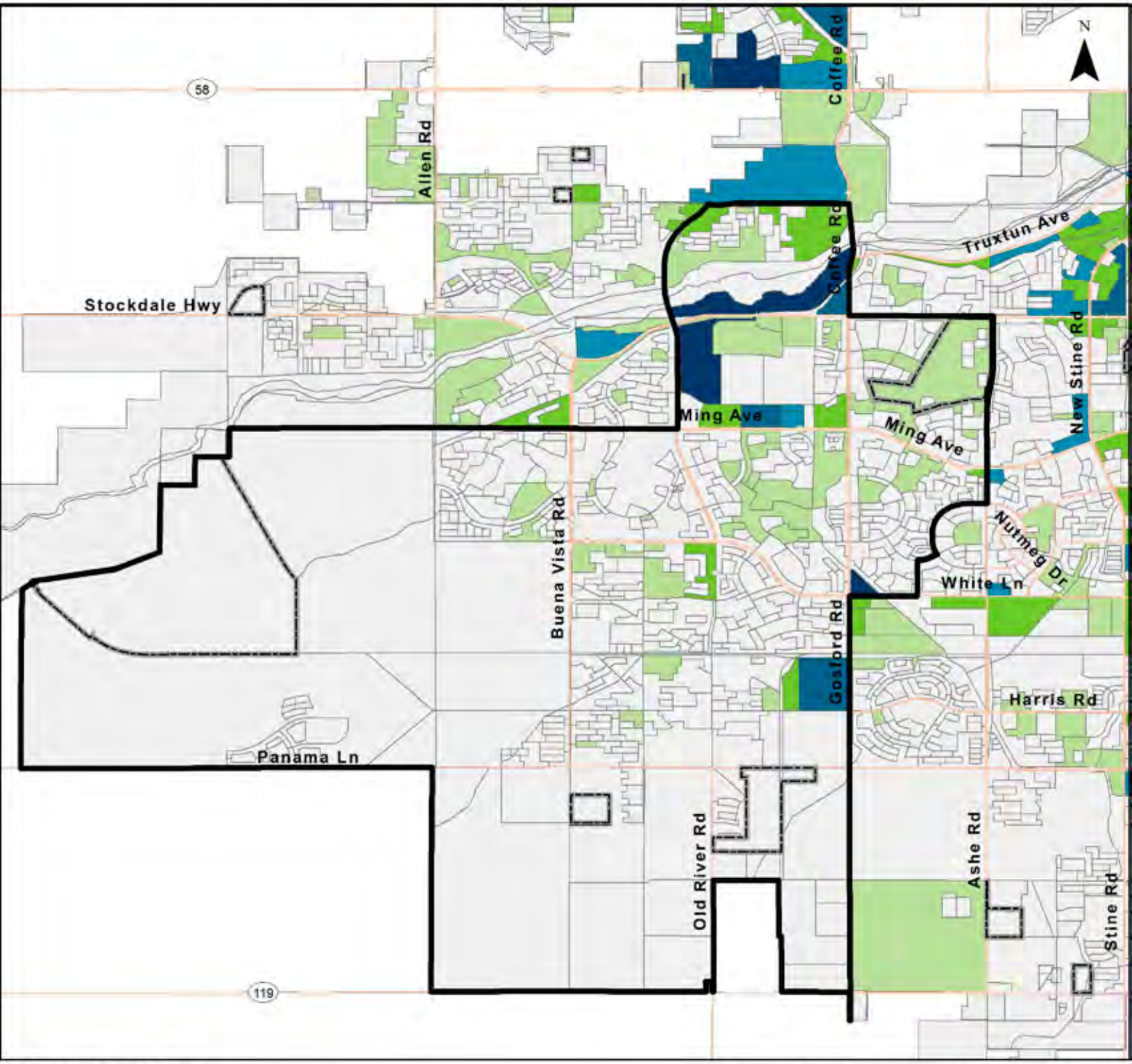
Optimal Public Access Charging Locations - Bakersfield Ward 4



 # Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

Optimal Public Access Charging Locations - Bakersfield Ward 5

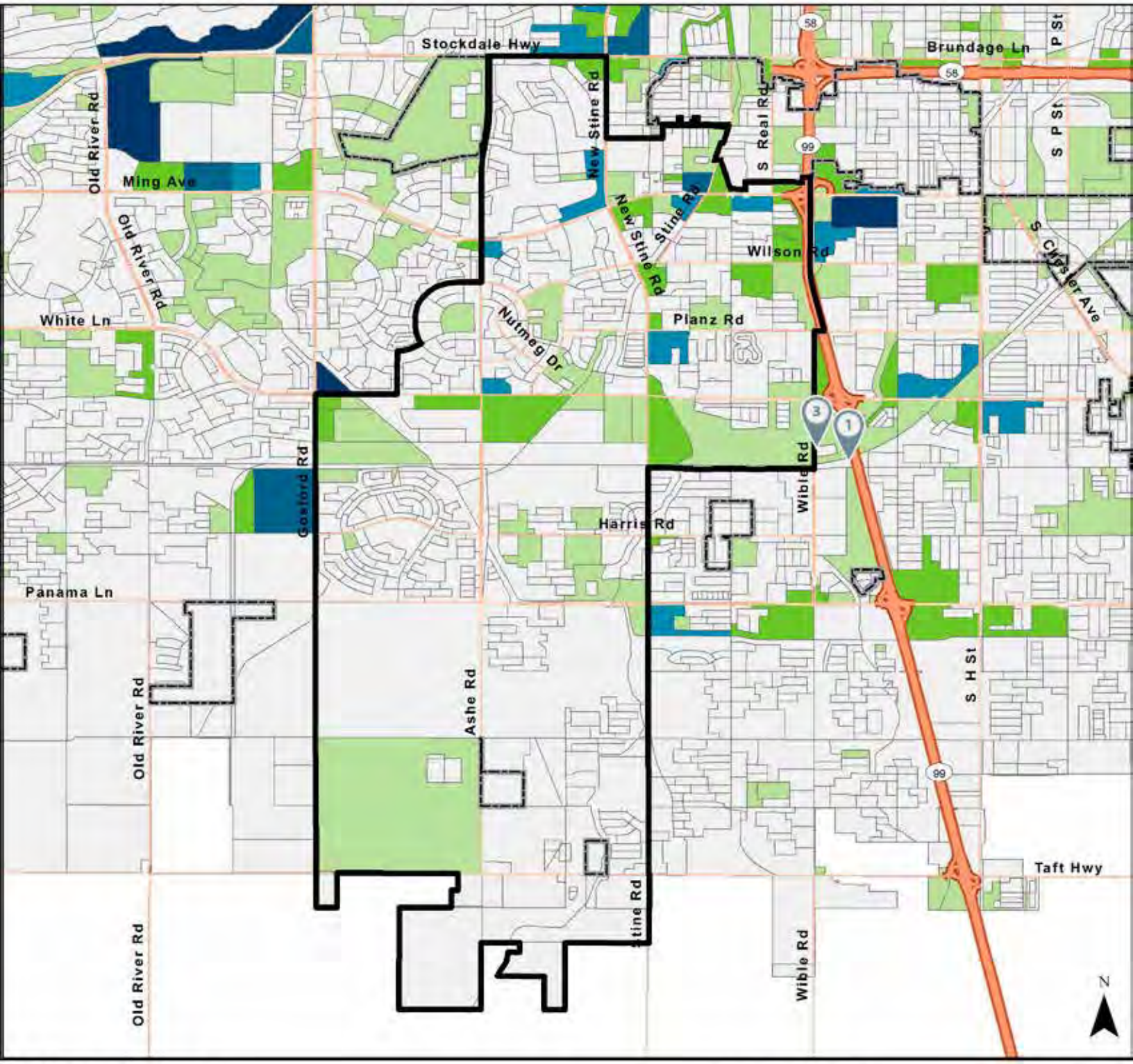


 # Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

0 0.5 1 2 Miles

Optimal Public Access Charging Locations - Bakersfield Ward 6

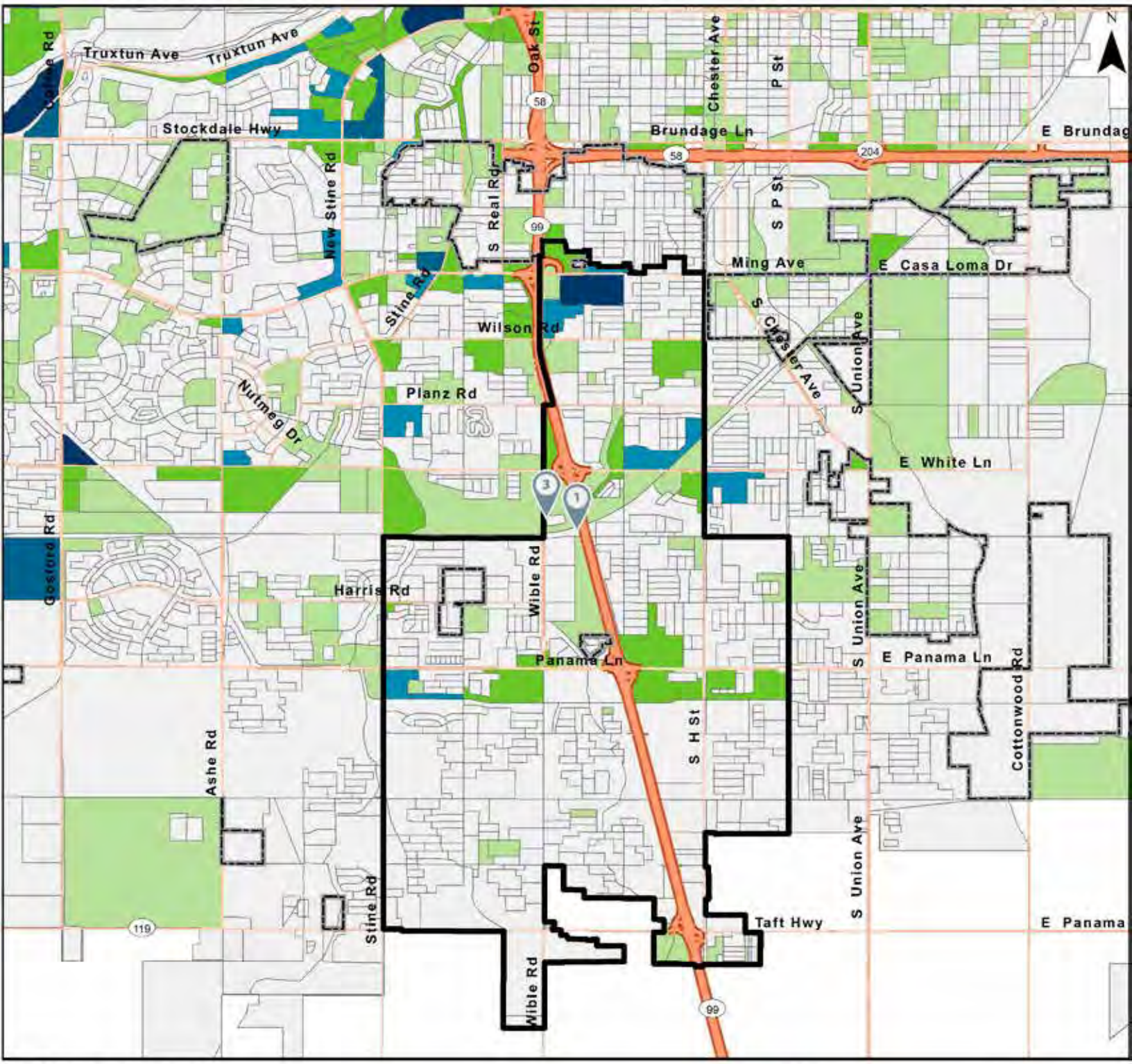


 # Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

0 0.5 1 2 Miles

Optimal Public Access Charging Locations - Bakersfield Ward 7

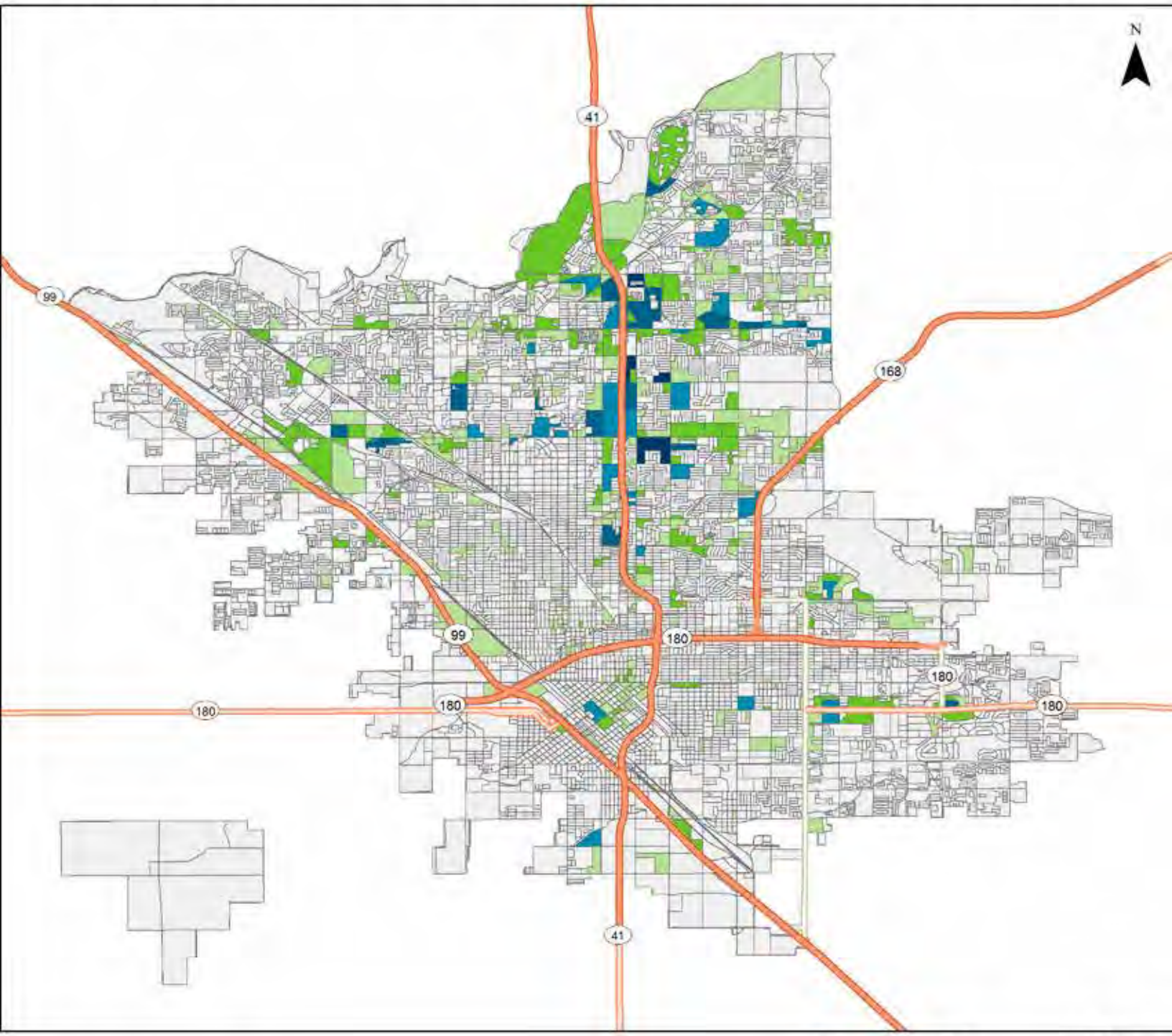


 # Destinations by Census Block

- Unincorporated
- 0
- 1 - 2
- 3 - 6
- 7 - 10
- 11 - 14
- 15 - 20

0 0.5 1 2 Miles

Optimal Public Access Charging Locations - City of Fresno

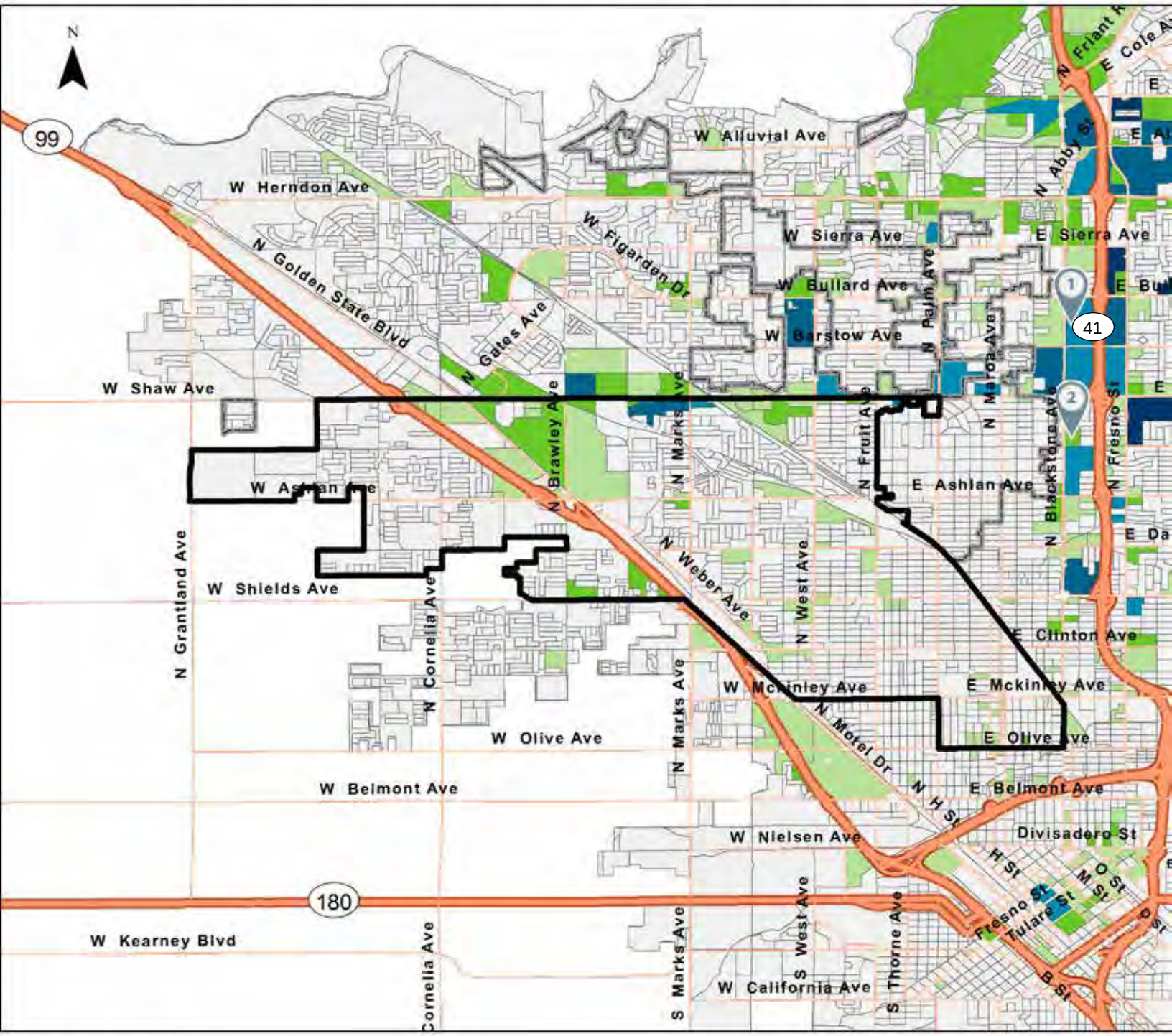


0 1.25 2.5 5 Miles

 # Destinations by Census Block

- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

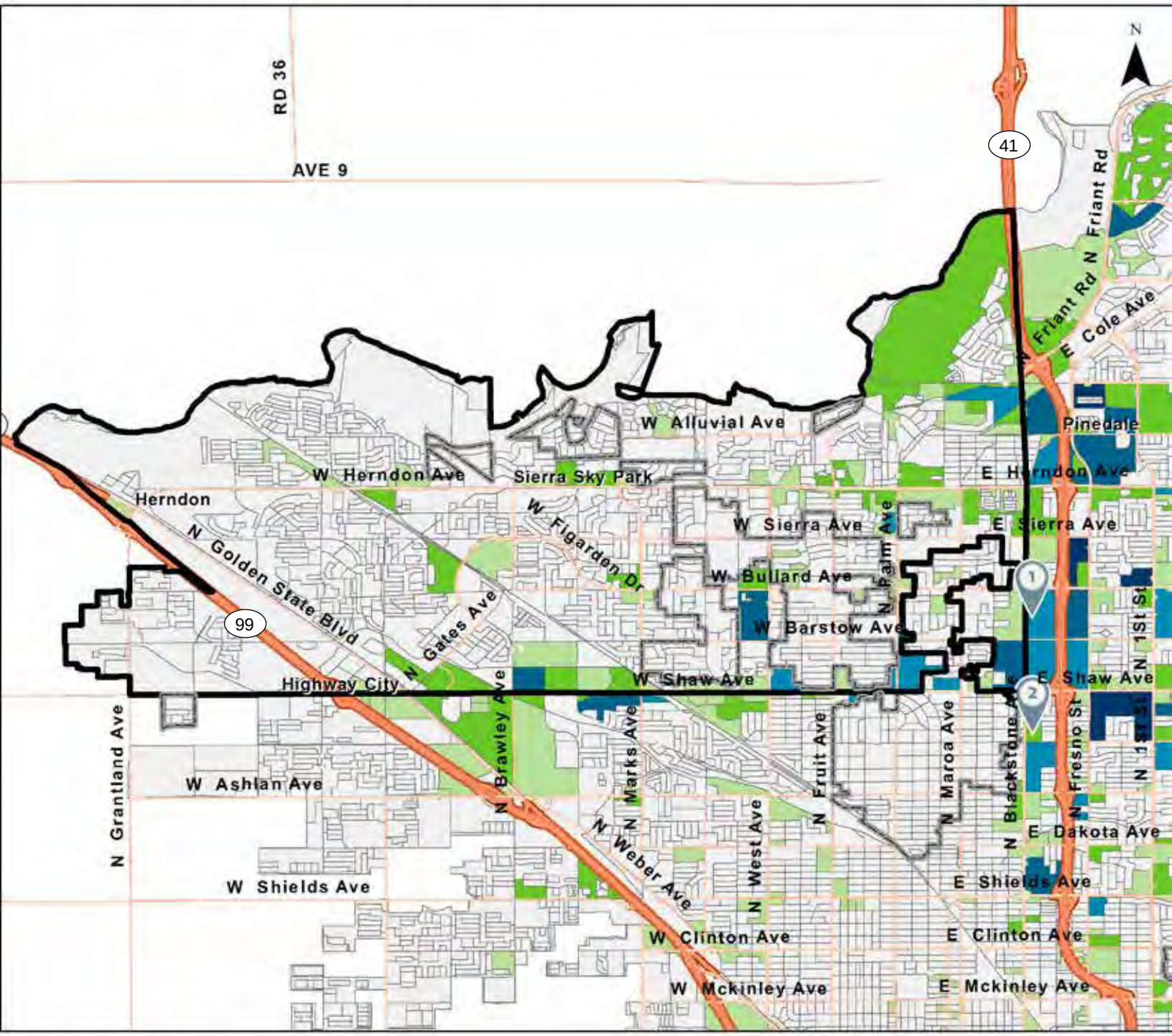
Optimal Public Access Charging Locations - Fresno District 1



Destinations by Census Block

- Unincorporated
- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

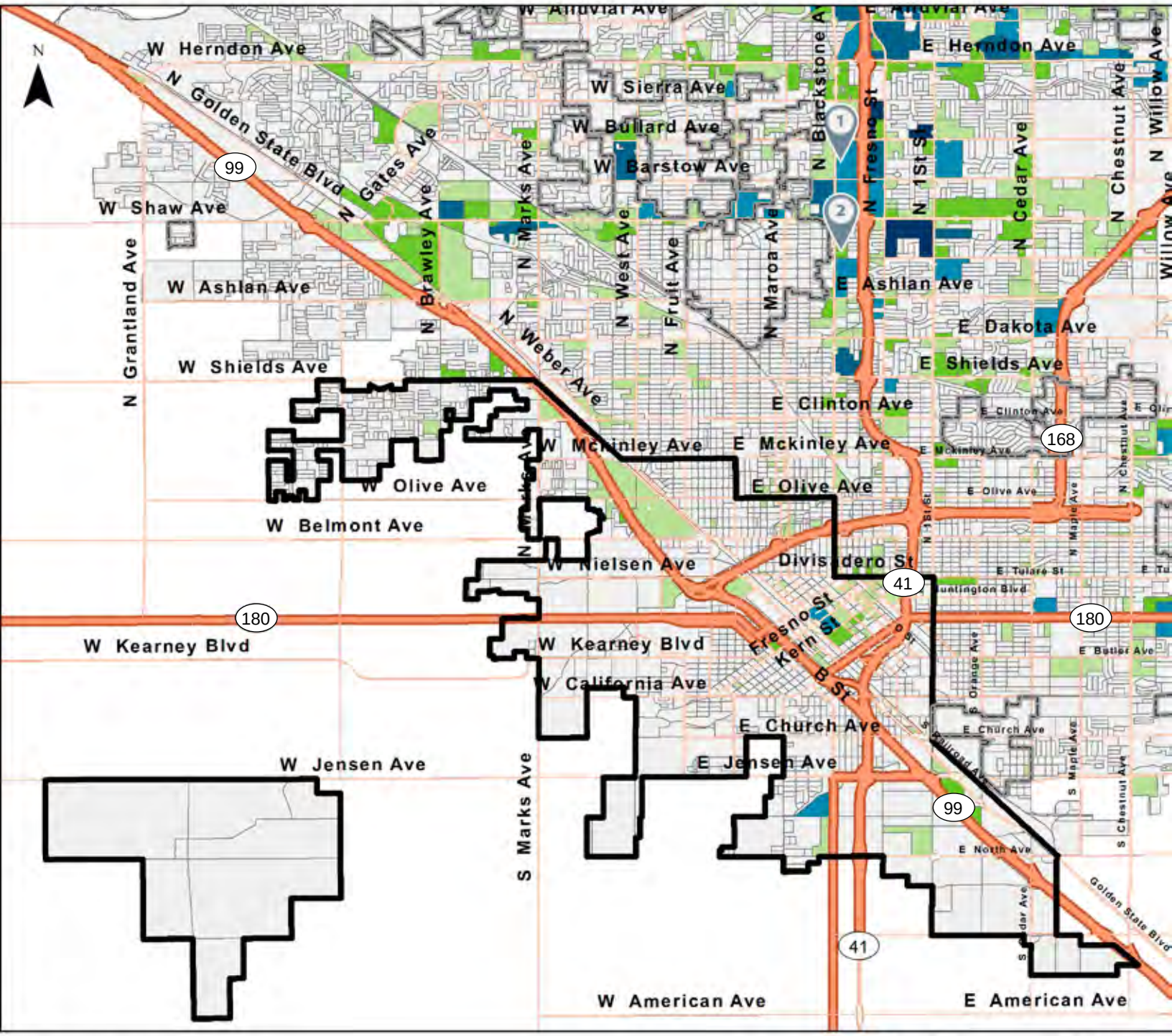
Optimal Public Access Charging Locations - Fresno District 2



Destinations by Census Block

- Unincorporated
- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

Optimal Public Access Charging Locations - Fresno District 3

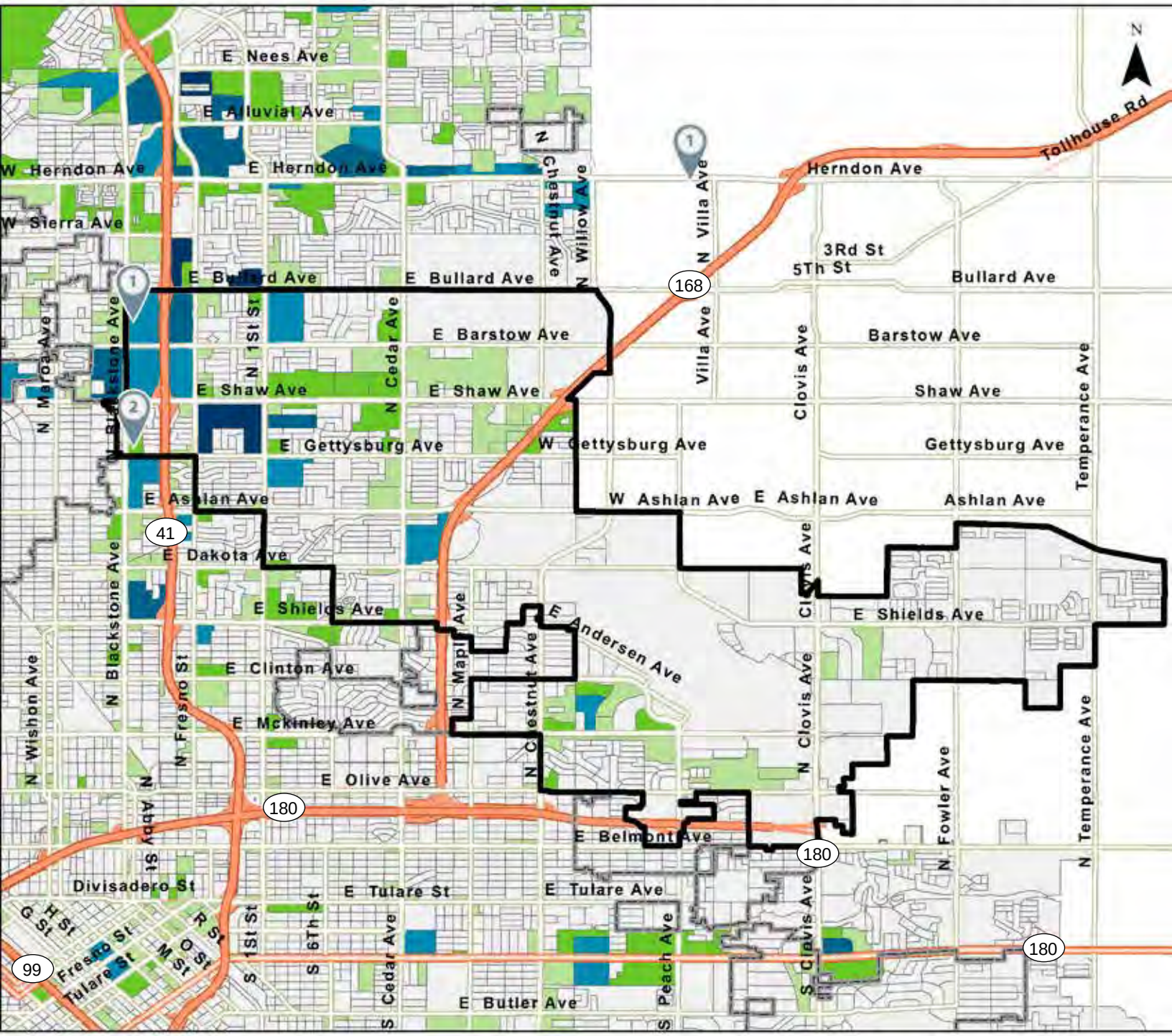


0 0.75 1.5 3 Miles

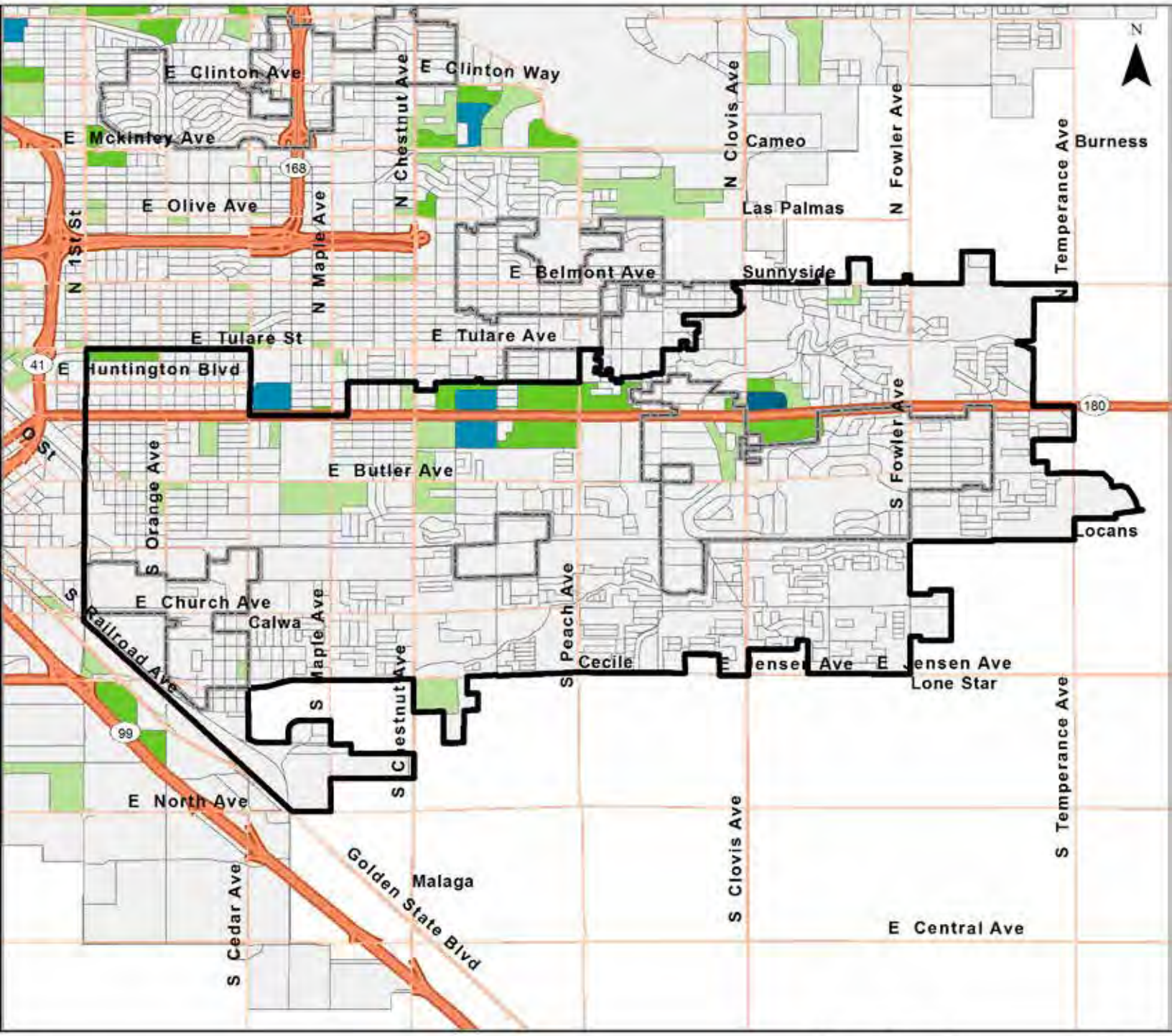
Destinations by Census Block

- Unincorporated
- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

Optimal Public Access Charging Locations - Fresno District 4



Optimal Public Access Charging Locations - Fresno District 5

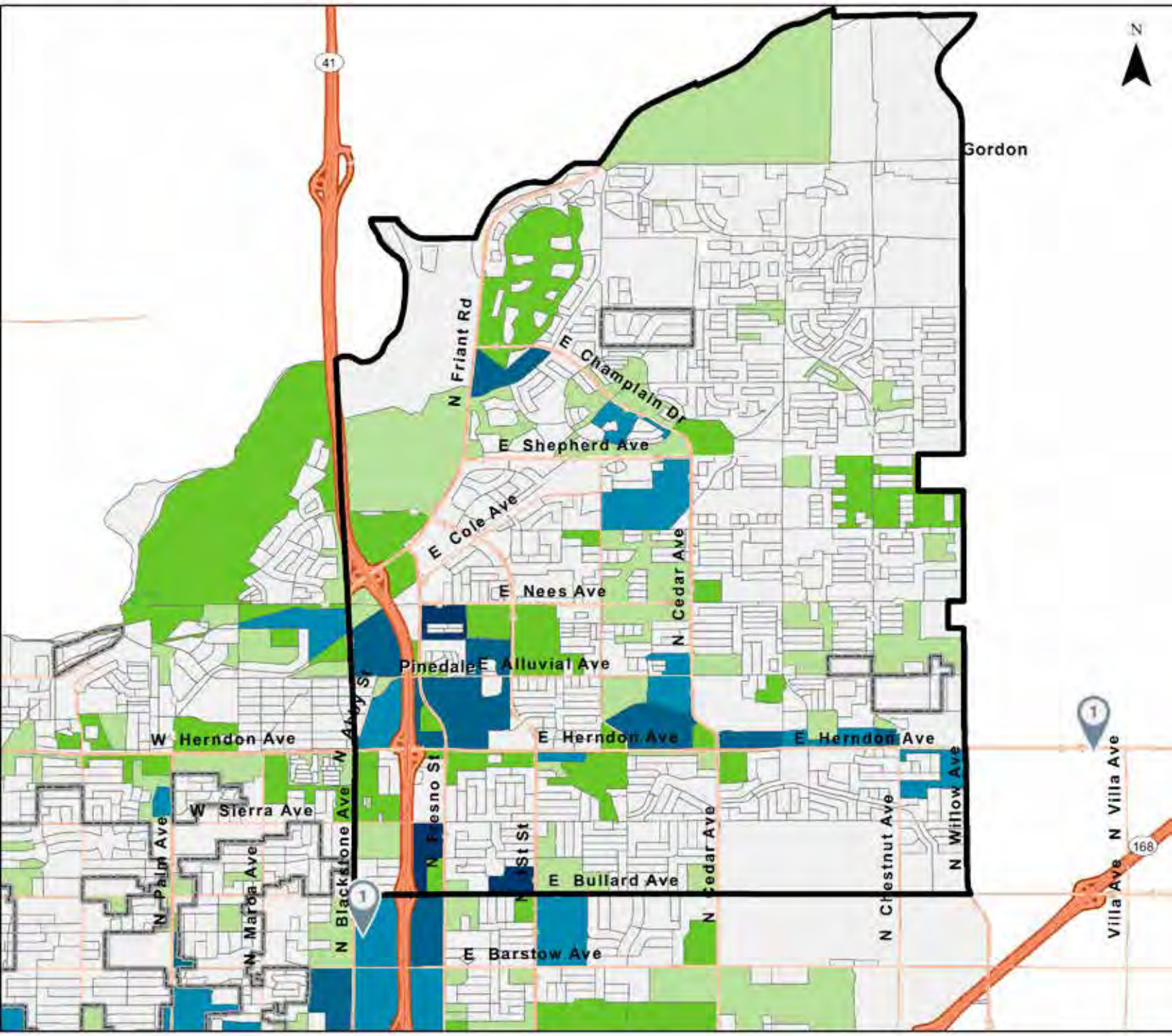


0 0.5 1 2 Miles

 # Destinations by Census Block

- Unincorporated
- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

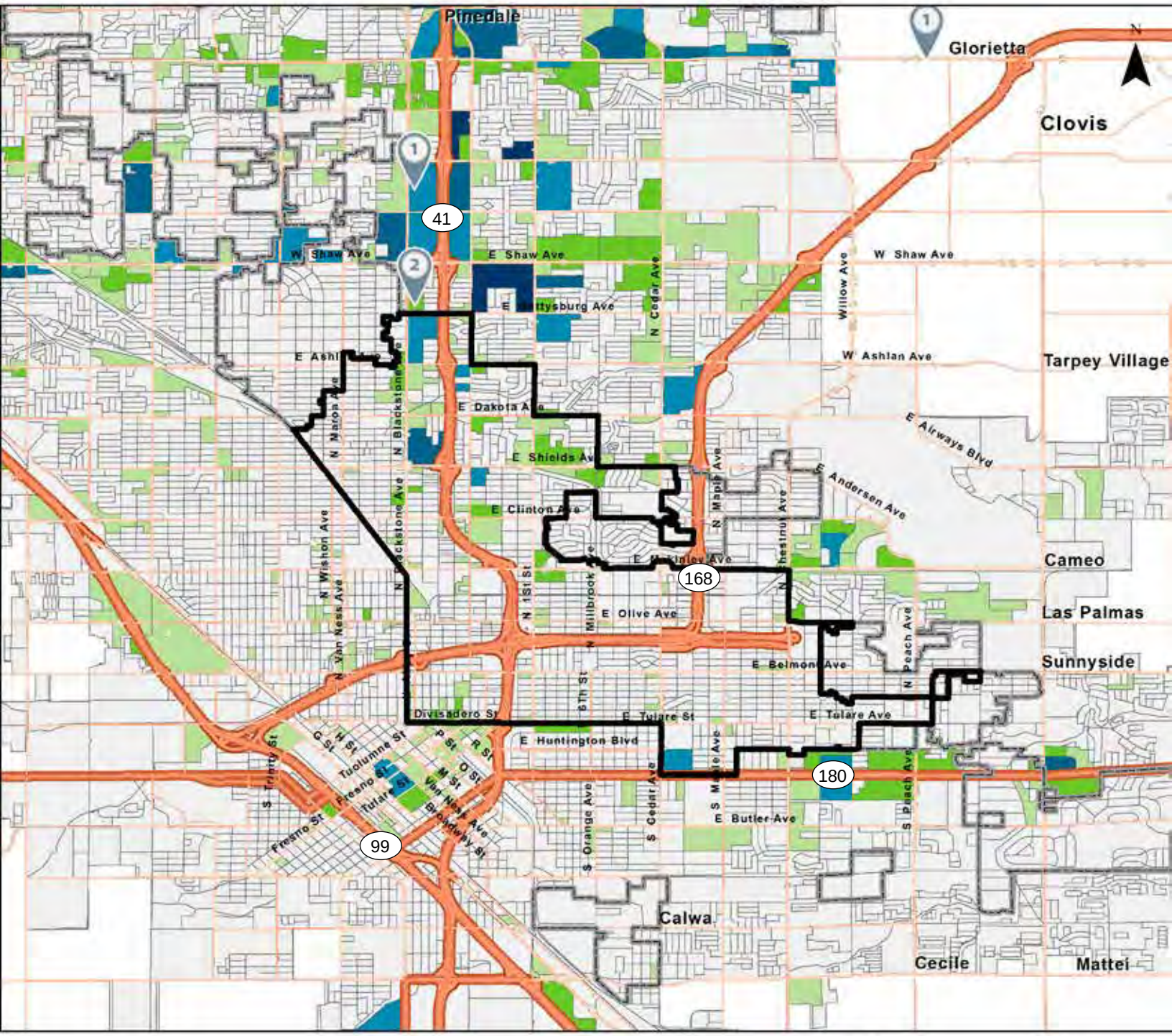
Optimal Public Access Charging Locations - Fresno District 6



Destinations by Census Block

- Unincorporated
- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

Optimal Public Access Charging Locations - Fresno District 7



Destinations by Census Block

- Unincorporated
- 0 - 1
- 2 - 4
- 5 - 8
- 9 - 13
- 14 - 18
- 19 - 26

Workplace Charging

According to the Electric Power Research Institute, the workplace is the second-most frequented location for charging following charging at home. This is because vehicles tend to stay parked at a workplace on average 8 to 9 hours, providing sufficient time for PEV drivers to "top off" and fully complete their commute or take side trips. Workplace charging also serves as an alternative for PEV drivers who may not have available residential charging.

Best Locations for Workplace Charging

To understand which locations would benefit from workplace charging, land use data were obtained to understand the total numbers of employees located in a travel analysis zone (TAZ). A TAZ serves as the geographic basis for travel demand model forecasting systems and is used in transportation models to provide socio-economic data within these zones. A TAZ also may be referred to as a travel analysis zone, transportation analysis zone or a traffic analysis zone. The boundary of a zone typically varies, ranging from very large zones in rural areas to as small as a city block or building in central business districts. For this project, TAZs provided data on employee numbers and land use.

Employee data in each TAZ helped to located dense workplace zones, which may inform planners and business owners on where to focus workplace charging initiatives. The analysis assumes that zones with more employees will likely contain higher numbers of PEV drivers.

Data Sources

Some regional agencies provided thorough land use data for the siting analysis. These include Madera County Transportation Commission, Fresno Council of Governments (COG), Kern COG and Tulare COG. The data were given to the project as Geographic Information System shapefiles.

Maps

Employment density maps are provided for the cities of Bakersfield, Clovis, Fresno and Visalia and the counties of Fresno, Kern and Tulare. Areas with higher density of workplaces are dark blue, and areas with low density of workplaces are light green or gray.

Optimal Workplace Charging Locations - Bakersfield

# of Employees by Travel Analysis Zone

- 0
- 1 - 430
- 431 - 976
- 977 - 2069
- 20701 - 5865
- 5866 - 16158

0 2.5 5 10 Miles

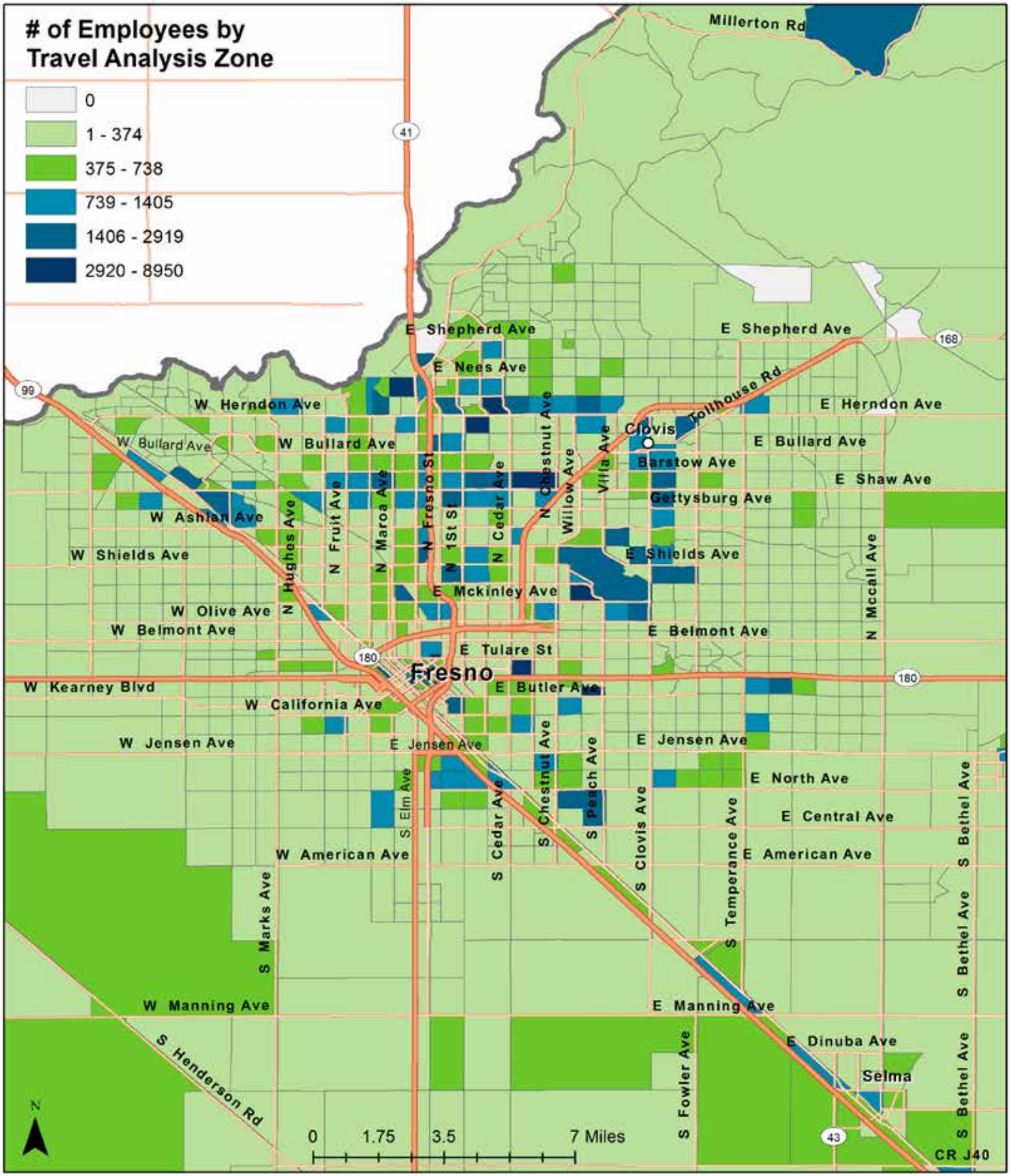
Optimal Workplace Charging Locations - Clovis

# of Employees by Travel Analysis Zone

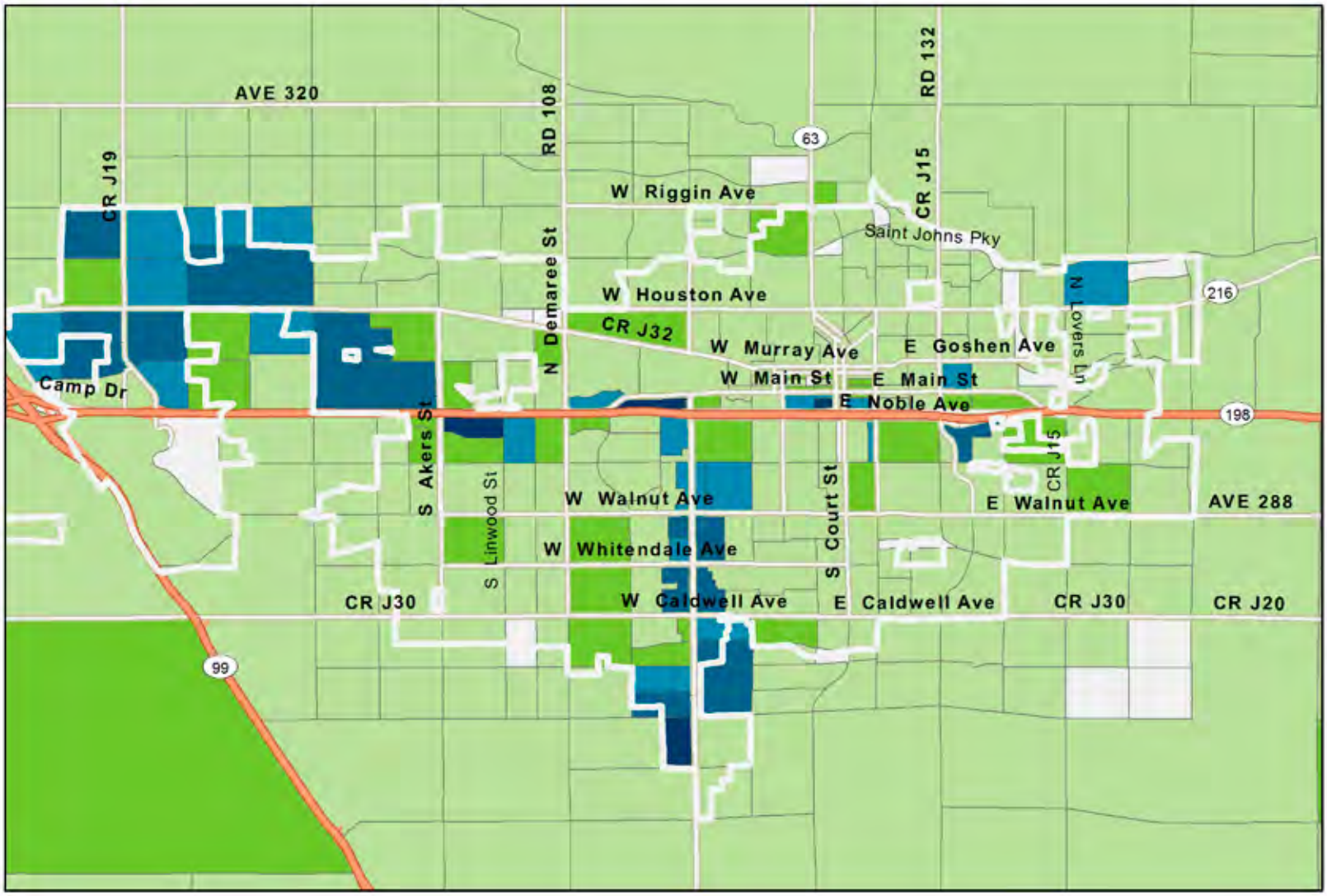
- 0
- 1 - 374
- 375 - 738
- 739 - 1405
- 1406 - 2919
- 2920 - 8950

0 0.5 1 2 Miles

Optimal Workplace Charging Locations - Fresno



Optimal Workplace Charging Locations - Visalia

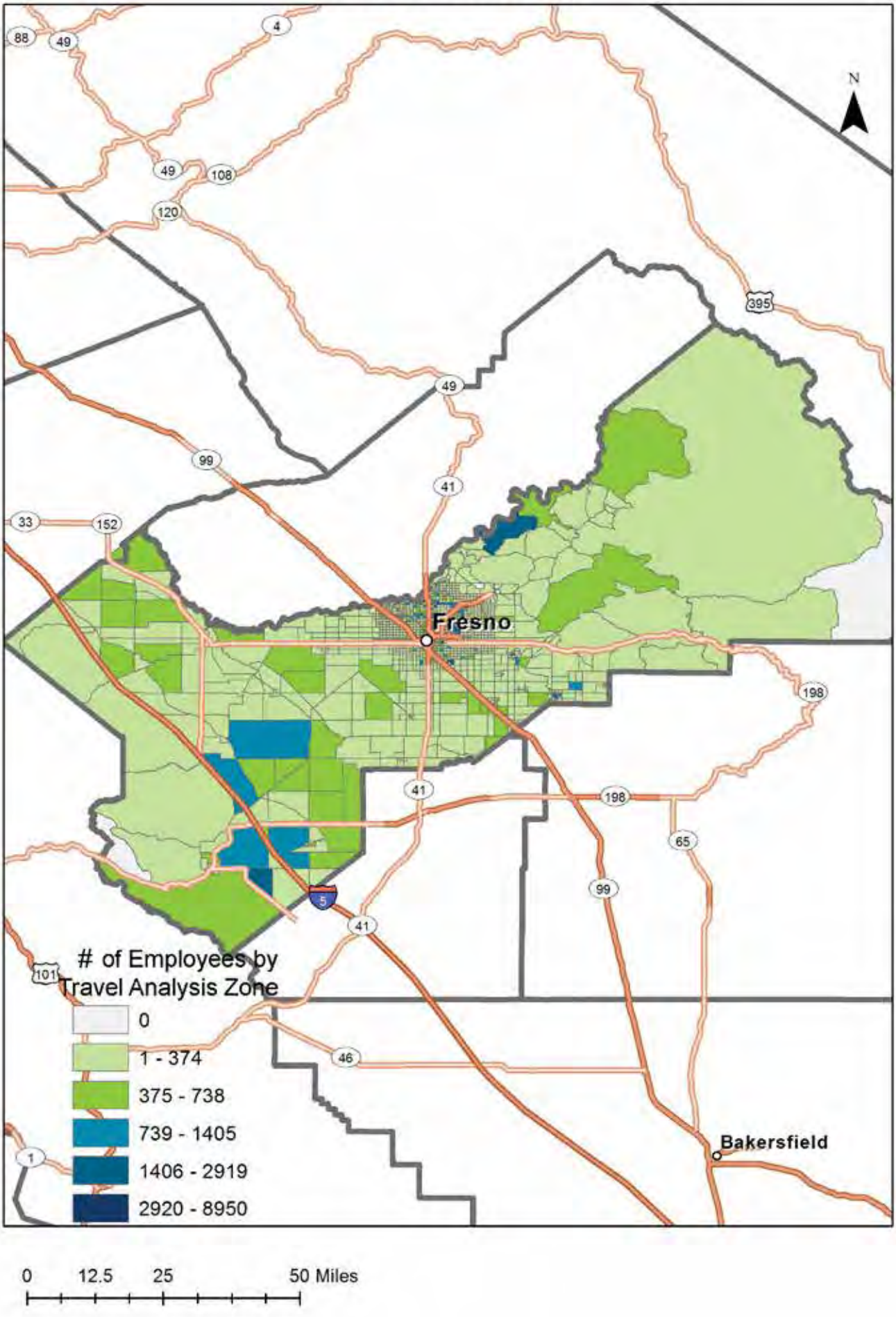


# of Employees by Travel Analysis Zone

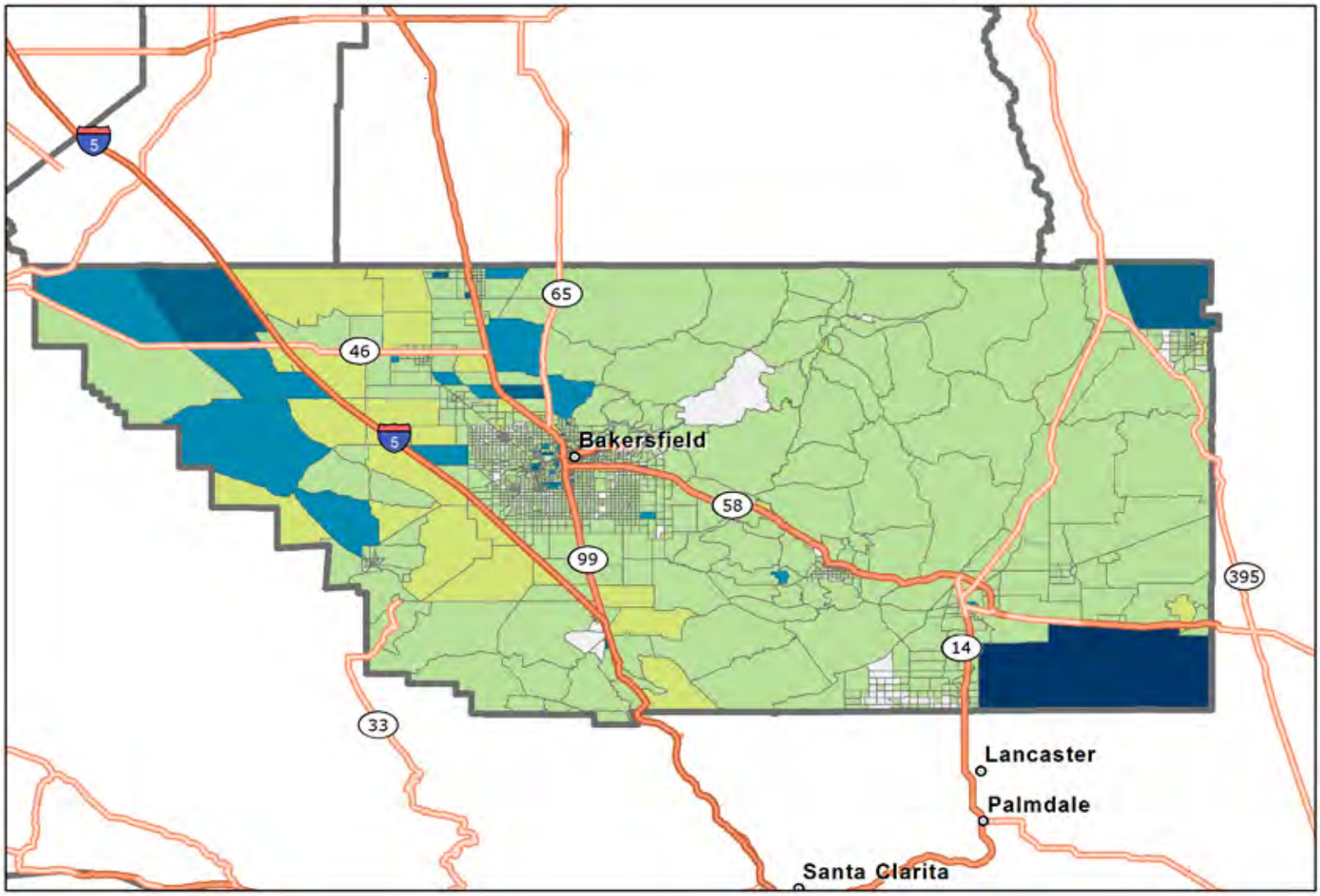
- 0
- 1 - 266
- 267 - 508
- 509 - 861
- 862 - 1576
- 1577 - 3136

0 0.75 1.5 3 Miles

Optimal Workplace Charging Locations
Fresno County



Optimal Workplace Charging Locations
Kern County

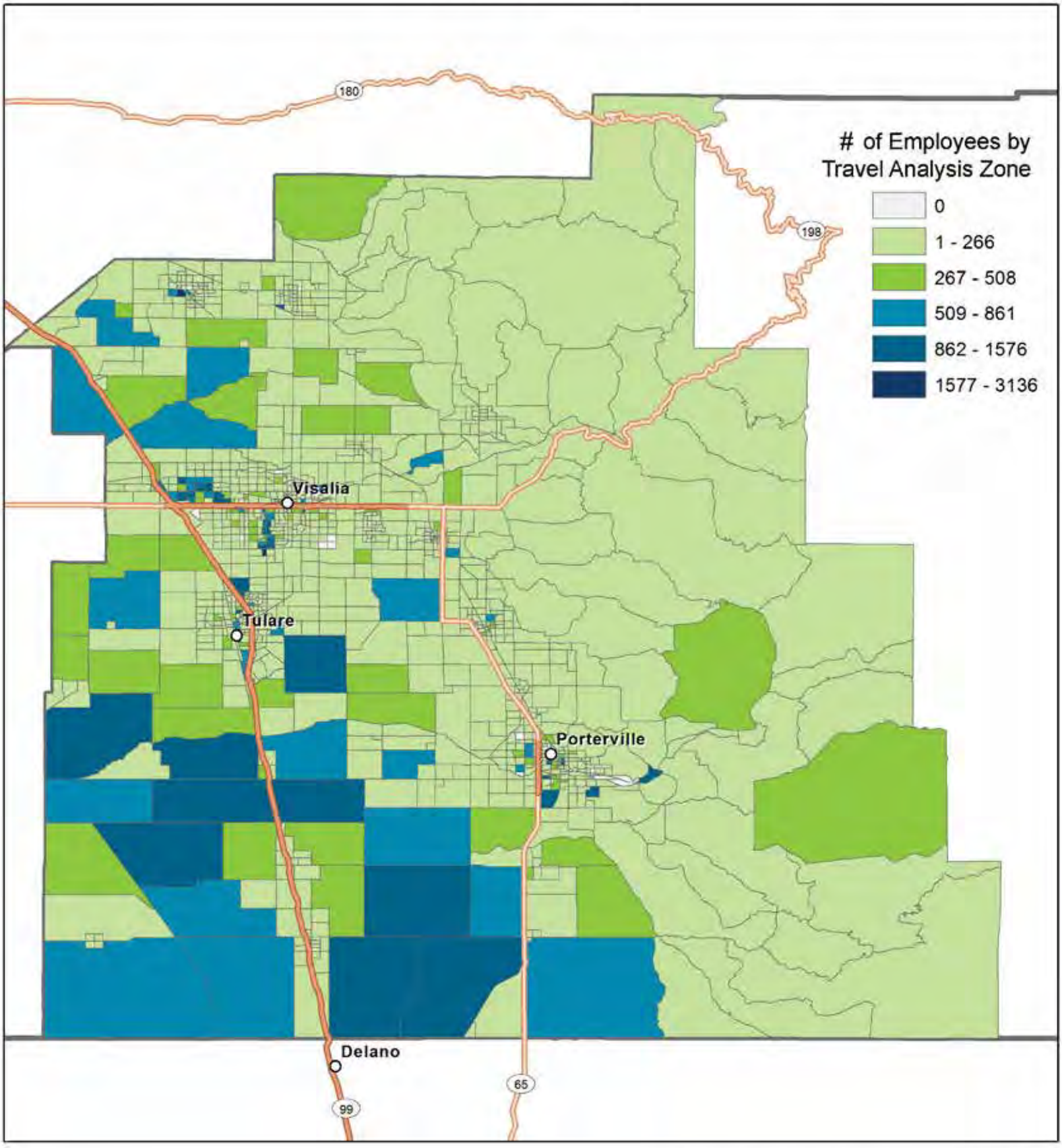


# of Employees by Travel Analysis Zone

- 0
- 1 - 430
- 431 - 976
- 977 - 2069
- 20701 - 5865
- 5866 - 16158

0 12.5 25 50 Miles

Optimal Workplace Charging Locations
Tulare County



Data Limitations

A major limitation in the analysis was the lack of consistency among TAZ data provided by regional COGs. The original goal was to obtain TAZ data with information about vehicle trips per day along with land use information to identify where commercial and workplaces clustered. Mapping vehicle trips per day reveals information about how often destinations are visited, which may indicate specific areas that may experience more charging demand from regional PEV drivers. Some COGs were able to provide land use or trip destination data, but rarely could they offer both.

To address this inconsistency, Google Places API was used as a proxy for acquiring vehicle trip and destination data. The API was used to gather information on the location of destinations in ten Valley cities. It was assumed that areas with a higher density of destinations also experience a high volume of visitations and that PEV drivers will benefit from charging at these locations. The analysis does not take into consideration the designated land use, ownership or on-site electrical capacity for public access charging to host chargers at each location. Despite the benefits of Google's API, the dataset of destinations for each city has not been verified by another source and is not exhaustive.

The data for the maps' streets and highways were from ESRI, an international supplier of GIS software. An effort was made to ensure the integrity of the maps, which included data comparison with Google Maps and distributing the maps to local planning organizations for verification. Despite this, the maps may include discrepancies.

Each map is intended for informational purposes only. It is recommended that local stakeholders use these maps as a resource when planning for PEV infrastructure deployment. Ultimately, it is up to individual stakeholders to decide whether these suggested locations are feasible for EVSE installations.


ELECTRIC VEHICLE
CHARGING STATION
UPPERCREEK

List of Optimal Charging Sites

The following chart lists the "most optimal" sites for charging stations. The locations with the densest number of destinations in each city are listed for DC fast charging and public access charging; their corresponding census tract and census blocks are identified.

DC Fast Charging			
City	# of Destinations	Census Tract	Census Block
Merced City	15	001301	3032
Modesto City	16	000503	3020

Public Access Charging			
City	# of Destinations	Census Tract	Census Block
Bakersfield			
Ward 5	16	002819	1019
Ward 5	17	002806	1015
Ward 2	17	001802	1029
Ward 7	17	002900	4002
Ward 5	18	002806	1001
Ward 2	18	000600	1024
Ward 4	20	003808	1007
Clovis	43	005801	1003
Fresno			
District 6	21	005405	1016
District 6	21	004406	1002
District 6	26	004504	1013
District 4	26	005302	2003
Hanford	13	001001	2042
	13	001001	2066
	16	001001	1014

City	# of Destinations	Census Tract	Census Block
Madera	11	000503	2025
	14	000503	4001
Merced	26	001004	1002
Modesto	16	001001	2000
	18	000503	3020
	18	000503	1008
Stockton	20	003112	1000
	20	001600	2004
	25	003409	3002
	25	004002	1070
Tracy	13	005206	5012
	14	005206	2015
	14	005206	2003
	16	005206	5021
	17	005206	2002
Visalia	18	001703	1000
	20	001006	2010
	21	001006	3001
	22	001701	4014

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