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Tree Opportunity Analysis

MEMORANDUM

To: Rachel Patten, Leslie Mancebo, Charisse Padilla, Jeff Jelsma; City of Sacramento

From: Mauricio Hernandez; Alta Planning + Design

CC: David Wasserman, Grace Young; Alta Planning + Design

Date: May 21, 2024

Re: Streets for People: Sacramento Active Transportation Plan – Tree Opportunity Analysis Results (FINAL)

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Introduction

The *Streets for People: Sacramento Active Transportation Plan* (the Streets for People plan) focuses on improving conditions for people walking, biking, and rolling in the City of Sacramento. This citywide plan is geared towards addressing active transportation needs with a focused approach to three areas of high-need and historical disinvestment: Fruitridge/Broadway, North Sacramento, and South Sacramento.

As part of this Plan, the City is also looking to expand its urban tree canopy and coverage to areas with the greatest need. Expanding urban tree canopy is increasingly being recognized as a means for cities to provide pollution absorption, water quality, and quantity protection, enhanced active travel experience, improved thermal comfort, stormwater management benefits, enhanced mental well-being, and improved urban resilience.[1] These goals are directly aligned with the City's General Plan Goal ERC-3 [2] which states "A well-maintained, resilient, healthy, expansive and equitable urban forest for an environmentally sustainable future."

The findings included in this memo will be used to inform where the highest opportunity for expansion of the City's urban tree canopy can integrate with the development of its active transportation network contained in the final *Streets for People* plan.

Memo Overview

This analysis represents the first of two major phases for understanding the city's tree planting opportunities and has been organized into eight (8) sections:

A complementary Appendix was also included to provide additional details on the methodology.

Summary of Findings

This memo provides findings from a two-phase approach to the prioritization of tree planting investments along corridors with active transportation recommendations to benefit residents of all ages and abilities. The phases have been defined as:

- *Phase 1 - Tree Opportunity Index:* development of a Tree Opportunity Index (TOI) to understand the existing need for additional tree shade and the feasibility of tree canopy expansion.

[1] Pataki et al. (2021). The Benefits and Limits of Urban Tree Planting for Environmental and Human Health. Frontiers in Ecology and Evolution, 9. https://doi.org/10.3389/fevo.2021.603757

[2] City of Sacramento 2040 General Plan. (2024) https://www.cityofsacramento.gov/community-development/planning/major-projects/general-plan

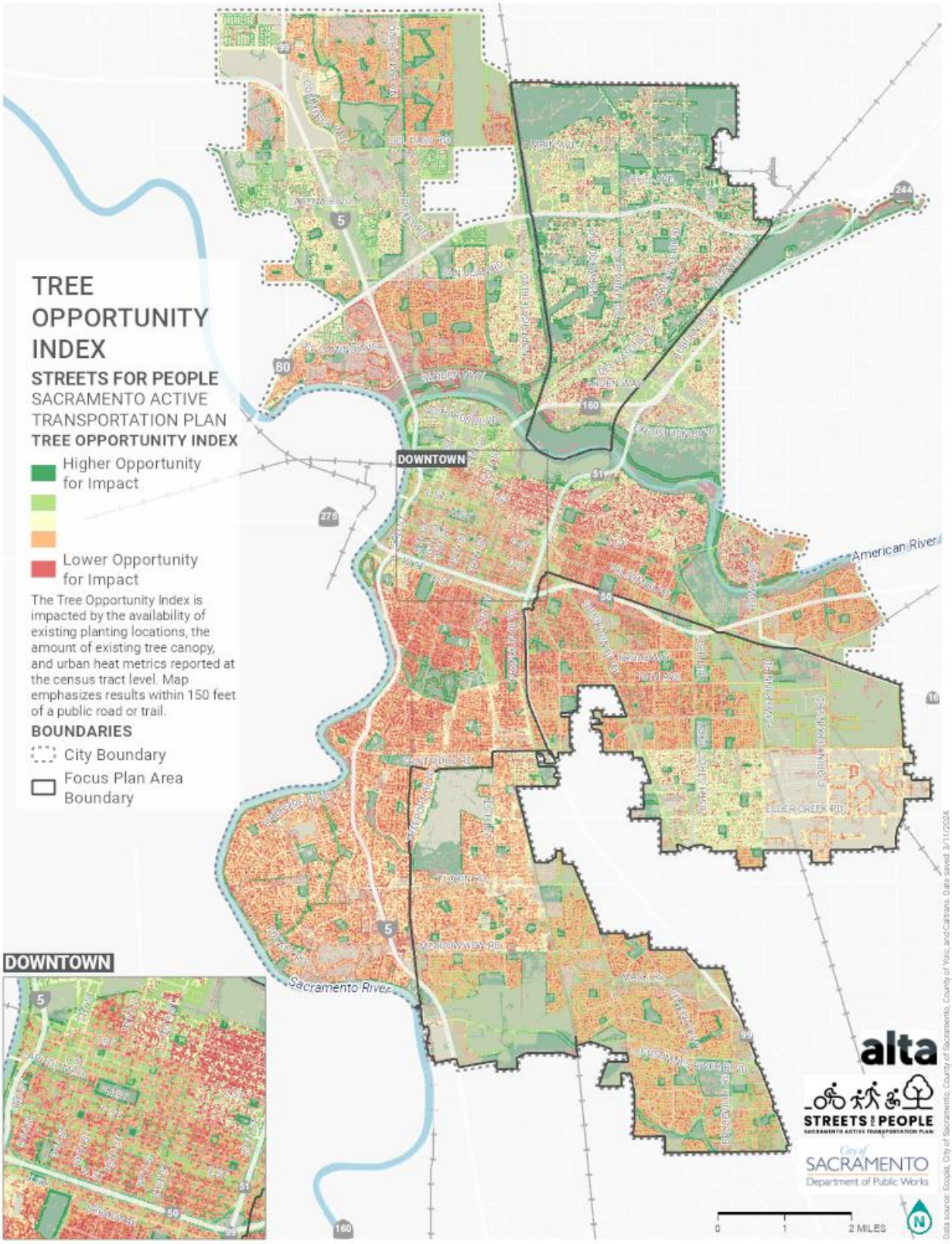
- *Phase 2 – Implementation and Plan Integration Recommendations:* this phase will integrate the results of the TOI analysis and the recommended active transportation network, to determine which roadways the city should prioritize for additional tree plantings to help improve conditions for people walking, biking, and rolling throughout the city.

This analysis developed a Tree Opportunity Index (TOI) that highlighted areas within Sacramento that have both a high need for new tree plantings (based on heat exposure) and open planting locations in the public right-of-way and/or on publicly-owned parcels[3] that may support new tree planting. For this analysis, need was determined by areas with a lack of trees (low tree canopy density), high levels of radiant heat (intense urban heat island effect), and projected increases in heat exposure. The results, shown in Figure 1, highlight corridors and areas of the city that have higher opportunities for new tree plantings (noted in green) to help mitigate the effects of urban heating in readily available planting locations. This was based on the availability of right-of-way (in the form of available tree planting locations) and existing tree canopy density.

Generally, the TOI is highest in the North Sacramento focus area, which tends to be the area within the city most exposed to heat effects. Locations with the highest TOI (shown in dark green) are commonly located at the perimeter of parks and other publicly-owned parcels including public school campuses, and along trails. Major roadways including Commerce Way, Meadowview Road, and Riverside Boulevard tend to have open planting locations available via sidewalk planting boxes or vegetated medians. However, most local roadways with a complete sidewalk do not exhibit any available space for planting opportunities within the City right-of-way.

[3] Publicly-owned parcels include those with land use designated as open space, parks and recreation, or public/quasi-public in the 2030 General Plan.

Figure 1. Tree Opportunity Index



Methodology

The Tree Opportunity Index (TOI) highlights areas of the City which have the greatest potential impact in terms of the tree canopy. While resources for tree canopy repair and improvement projects are limited, it is important to identify synergistic opportunities for such projects to be incorporated with other public works initiatives and projects where feasible. To that end, the TOI combined four (4) metrics into a single score that speak to the local need for additional tree canopy as well as the availability of feasible tree planting locations. These metrics also highlight areas that have a high urban heat exposure, greater urban heat island effects, low density of existing tree canopy, and also include existing planting opportunities. These metrics and related analysis inputs are summarized in **Table 1** and are further detailed in the sections below.

Table 1. Tree Opportunity Index Weighting Summary

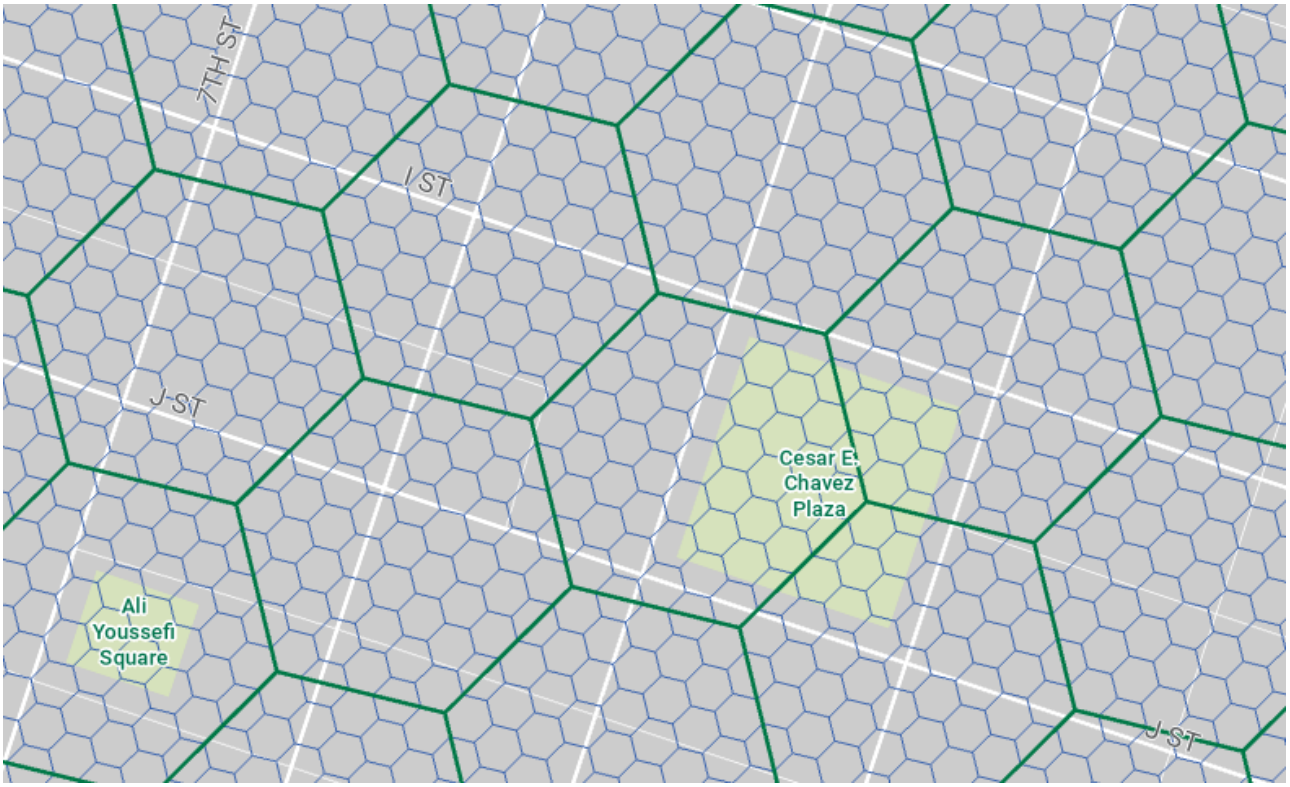
Criteria	Measures	Data Source	Hexagon Metric	Weight
Existing Tree Canopy Density	Identify areas with low existing tree canopy density.	AI-Derived	Hexagons are scored based the existing coverage of tree canopy. Areas with no tree canopy score 10 points, up to 25% coverage scores 7 points, up to 50% coverage scores 5 points, up to 75% coverage scores 3 points, and more than 75% coverage scores 1 point.	40%
Urban Heat Exposure	Identify areas with high counts of future heat health events 2020-2100.	California Heat Assessment Tool (CHAT)	A hexagon's proportional average of census tract level CHAT data estimates of average annual heat events in 2040. Results are percentile ranked and linearly scaled to 10 points.	5%
Urban Heat Island Effect	Identify areas with high differences in temperatures relative to rural areas.	California Heat Assessment Tool (CHAT)	A hexagon's proportional average of census tract level CHAT data on the difference in temperature relative to rural areas. Results are percentile ranked and linearly scaled to 10 points.	5%
New Planting Suitability	Areas identified with available pervious area for tree planting.	AI-Derived, City of Sacramento Public Works (LIDAR Classifications)	Hexagons are scored based on the area available for planting and their quality. On-street planting areas that have widths of at least 3 feet for sidewalk planting areas or 4 feet for vegetated medians will be given a bonus of 2 points.	50%

The TOI and all underlying analyses were tabulated using a hexagon grid scale[4], assessing the entire city of Sacramento with a *whole area prioritization*. Each hex grid cell was generally 75 feet across to capture street level variations in potential planting opportunities. This robust method enabled the scoring and evaluation of multiple planting alignments with potential new projects.

[4] This hex grid is based on H3 which are pulled from a global repository of hexagons at different scales. These hexagons have unique IDs and are popular for spatial analysis because they join easily to other H3-based grids because of the consistent spatial reference. Our gap analysis grid is a resolution 10 grid and our tree opportunity analysis is at resolution 12 grid.

The benefit of using this unit of analysis is that each hexagonal area is uniform in size and shape and works well for spatial sampling. Alta used a smaller hexagon grid for the TOI compared to the Gap Analysis. This smaller grid is complimentary to the Gap Analysis and allows for easy conflation between the TOI results and Gap Analysis results during Phase 2. The TOI is designed to support Phase 2 through an easy application of TOI scores to proposed on-street and off-street facilities for people walking and biking.

Figure 2. TOI Hexagon Grid (Blue) Nested Within the Hexagon Grid Used in Gap Analysis (Green).



Limitations

The TOI provides city scale level of insights into where there is a need for tree canopy and where possible open sites for tree planting may be located based on AI-derived data and LIDAR land cover data. However, there are a few limitations to consider for this analysis:

Data

As documented in Appendix A, AI-derived data at times has trouble reliably identifying median and sidewalk planter boxes, particularly when they are obstructed in aerial imagery by existing trees. Because of how the analysis approach was designed to only consider open planting locations, this should have had minimal effect on the analysis results but may have under-identified available planting areas.

Additionally, the tree canopy data captures only the current conditions as of Fall 2023. Young trees may appear small in the tree canopy data and result in identifying an open tree planting opportunity that will be covered in the years to come as the tree grows and matures. When identifying new planting locations, the analysis assumes any sidewalk or median planting box can support additional trees that are properly spaced from existing trees. However, a detailed site review will be required to verify existing spacing requirements/needs and to document any potential utility conflicts, soil depth, and type considerations, as well as other site-specific characteristics that may impact the health and viability of a tree planted in that location.[5,6]

Finally, this analysis does not consider possible tree canopy loss from climate induced stress of existing tree species in Sacramento as a result of tree species ranges changing over time. Recent reports indicate changes in precipation, average temperatures, and other climate conditions will affect the viable range of tree species across the the United States, and there are risks that it is outpacing the natural rate of plant migration[7]. Agencies charged with tree care will need to consider possibly different species or strategies to improve tree resilience. The City may use findings from recent reports to identify how changes in climate may affect the projected habitat suitability[8]. While this report was focused on the Northeast US, it can be used identify more detailed tree species and classifications that will be less suitable in Sacramentos's emerging climate context. Sacramento could consider an analysis of areas have trees that are likely to be impacted by climate change and then identify possible actions to take to help protect and enhance existing tree canopy facing climate stress.[9]

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[5] Macie et al. (2019, July 25). Urban tree planting (part 1): Site selection. Community Planning and Zoning. https://community-planning.extension.org/urban-tree-planting-part-1-site-selection/

[6] US Forest Service. (2023). California Tree Canopy Inventory. https://www.fs.usda.gov/detailfull/r5/communityforests/?cid=fseprd647442&width=full

[7] US Forest Service. (2024). Experimental network for assisted migration and establishment silviculture (ENAMES). US Forest Service Research and Development. https://www.fs.usda.gov/research/pnw/projects/enames

[8] Shannon, P.D.; Toot, R.; Rutledge, A.; Butler-Leopold, P.R.; Baroli, M. 2023. Considering climate change in tree planting. White Paper. Houghton, MI: U.S. Department of Agriculture, Northern Forests Climate Hub. 11 p. https://doi.org/10.32747/2023.8054015.ch

[9] Janowiak, Maria K.; Brandt, Leslie A.; Wolf, Kathleen L.; Brady, Mattison; Darling, Lindsay; Lewis, Abigail Derby; Fahey, Robert T.; Giesting, Kristen; Hall, Eboni; Henry, Molly; Hughes, Maise; Miesbauer, Jason W.; Marcinkowski, Kailey; Ontl, Todd; Rutledge, Annamarie; Scott, Lydia; Swanston, Christopher W. 2021. Climate adaptation actions for urban forests and human health. Gen. Tech. Rep. NRS-203. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 115 p. https://doi.org/10.2737/NRS-GTR-203

Approach

This analysis did not account for sight distance considerations when identifying possible planting locations. While there is a diversity of approaches to accommodate this in a GIS-focused analysis, it would involve detailed speed limit and intersection geometry information to estimate potential conflicts of sight triangles at approaches and fixed objects added from tree planting. Additionally, sight triangles are not static quantities but can be addressed through more compact intersection design and traffic calming measures as NACTO's Urban Street Design Guide outlines and illustrates (see

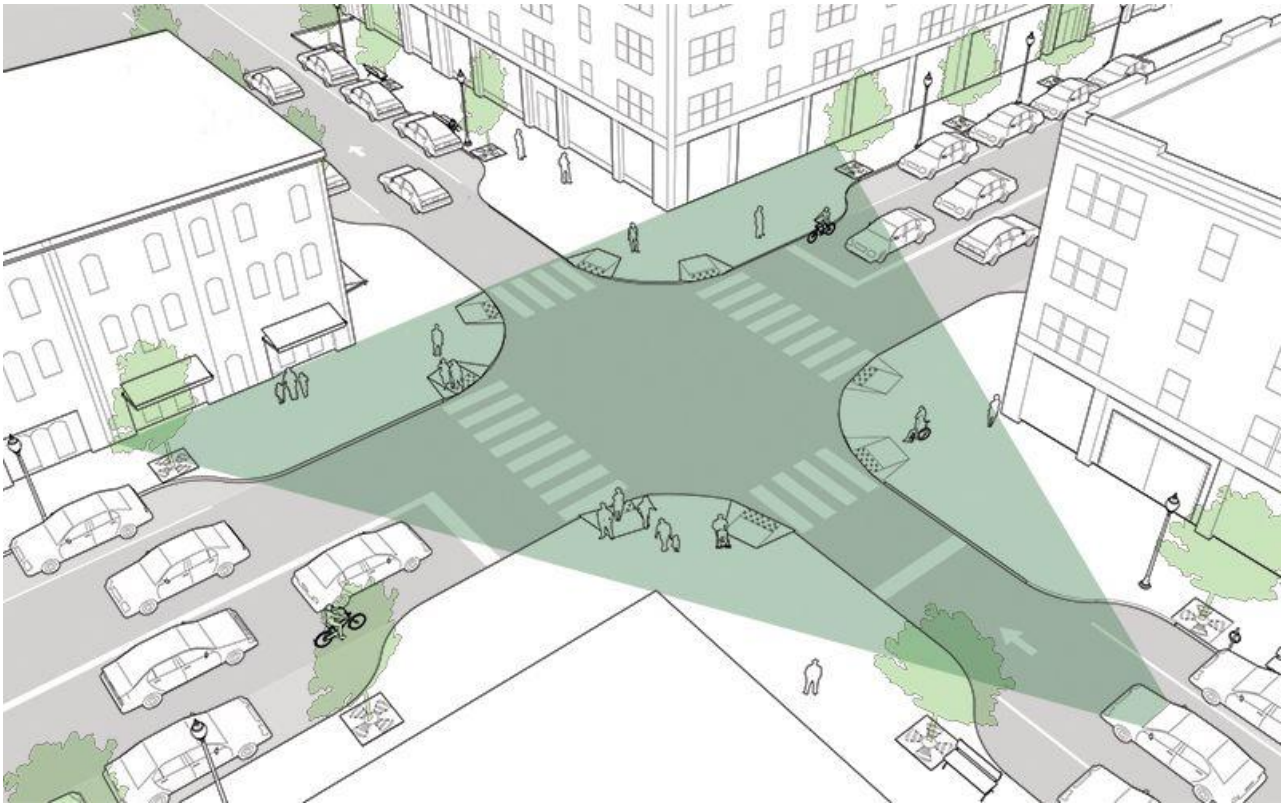


Figure 3). For these reasons, Alta elected to not address this concern explicitly in the analysis.

Finally, it is important to highlight that the existence of overhead tree canopy, may not necessarily guarantee shading for people walking or biking underneath the canopy. This may be attributed to different factors including the angle of the sun, time of day, as well as tree size and foliage shape. Furthermore, adjacent buildings may offer street level shade depending of the time of day.

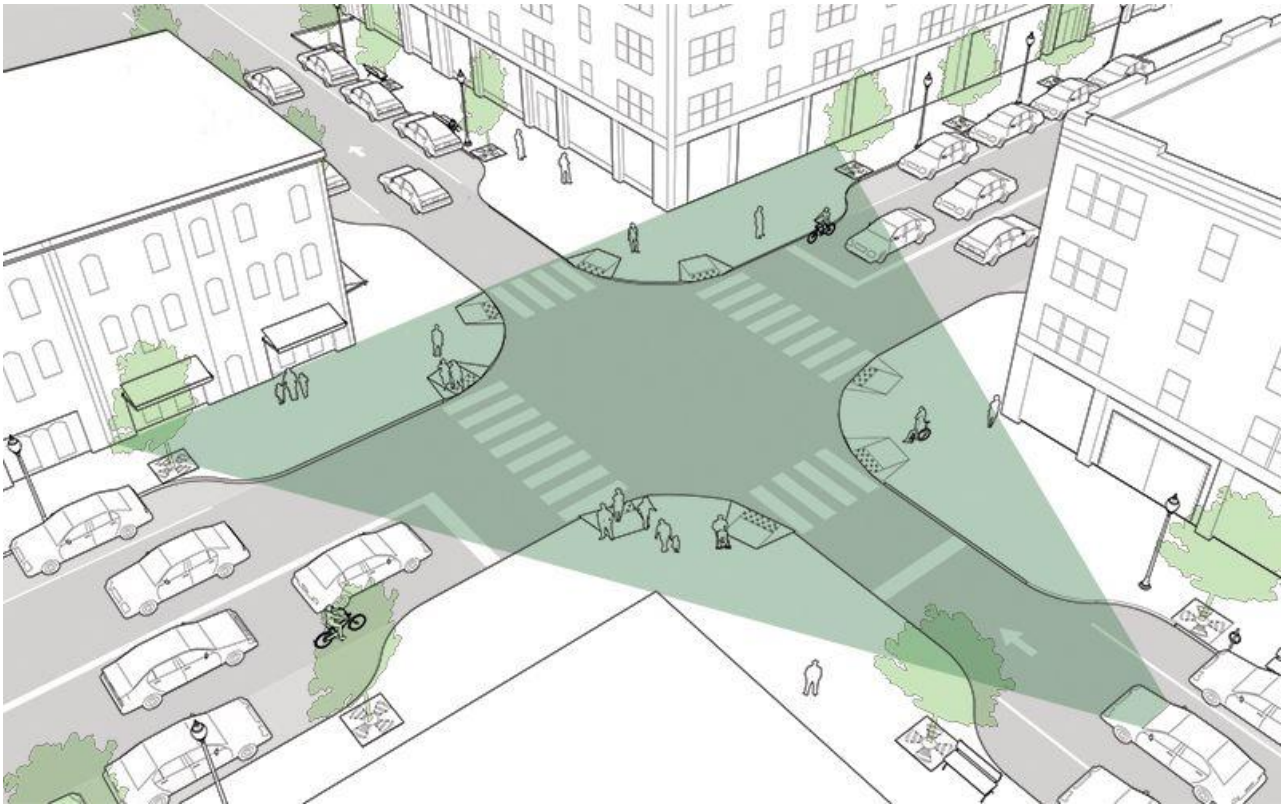


Figure 3. NACTO's Urban Street Design Guide documents different strategies to deal with sight distance concerns beyond removal of fixed objects such as trees such as reducing speeds or changing the geometric design with curb extensions.

Urban Heat Exposure

Sacramento's 2040 General Plan includes a goal (ERC-8) to improve resilience to the effects of heat, and the plan notes that studies have shown that 25% tree canopy cover in urban areas can dreduce temperature by as much as eight (8) degrees Farenheight when compared with bare, unplanted areas.[10] Alta used data from the California Heat Assessment Tool (CHAT) to understand the potential future exposure to heat severe enough to pose a possible risk to human health.[11] By combining historical heat events data with climatic projections, the CHAT database provides projections for the annual average number of Heat-related Health Events (HHE) expected to occur in 2040. A HHE is defined as any heat event that results in public health impacts. Within a city experiencing the same heat event, public health outcomes may vary based on local socioeconomic inequities like household income that dictate what actions are available to an individual to mediate the effects of the HHE. The scores for this criterion were determined based on the coverage with census tract level CHAT estimates of the average annual number of HHEs in 2040. This score was percentile ranked and then scaled to form a 10-point score.

Citywide Findings

Data indicated that the average estimated number of heat-related health events was three (3) per year. However, the most affected areas of the city (northeastern portions of the city) may experience an estimated 8.5 HHEs per year by 2040. Figure 4 shows the results from the analysis using disaggregated census tract level CHAT data. According to the data, North Sacramento, the Natomas Crossing neighborhood bisected by I-80, and Shasta in the southernmost portion of South Sacramento have the highest number of predicted HHE's per year, followed by Valley Hi/North Laguna in South Sacramento and the southwestern portion of Fruitridge/Broadway.

Focus Area Findings

Fruitridge / Broadway

Most of the Fruitridge / Broadway focus area is projected to experience about two (2) HHEs per year by 2040, which is below the citywide average. The area south of Fruitridge Road and west of Power Inn Road has a slightly higher projected urban heat exposure at 2.5 HHEs per year.

North Sacramento

The North Sacramento focus area is projected to experience some of the highest urban heat exposure within the city, with an estimated 7.6 HHEs per year by 2040, or over double the citywide average.

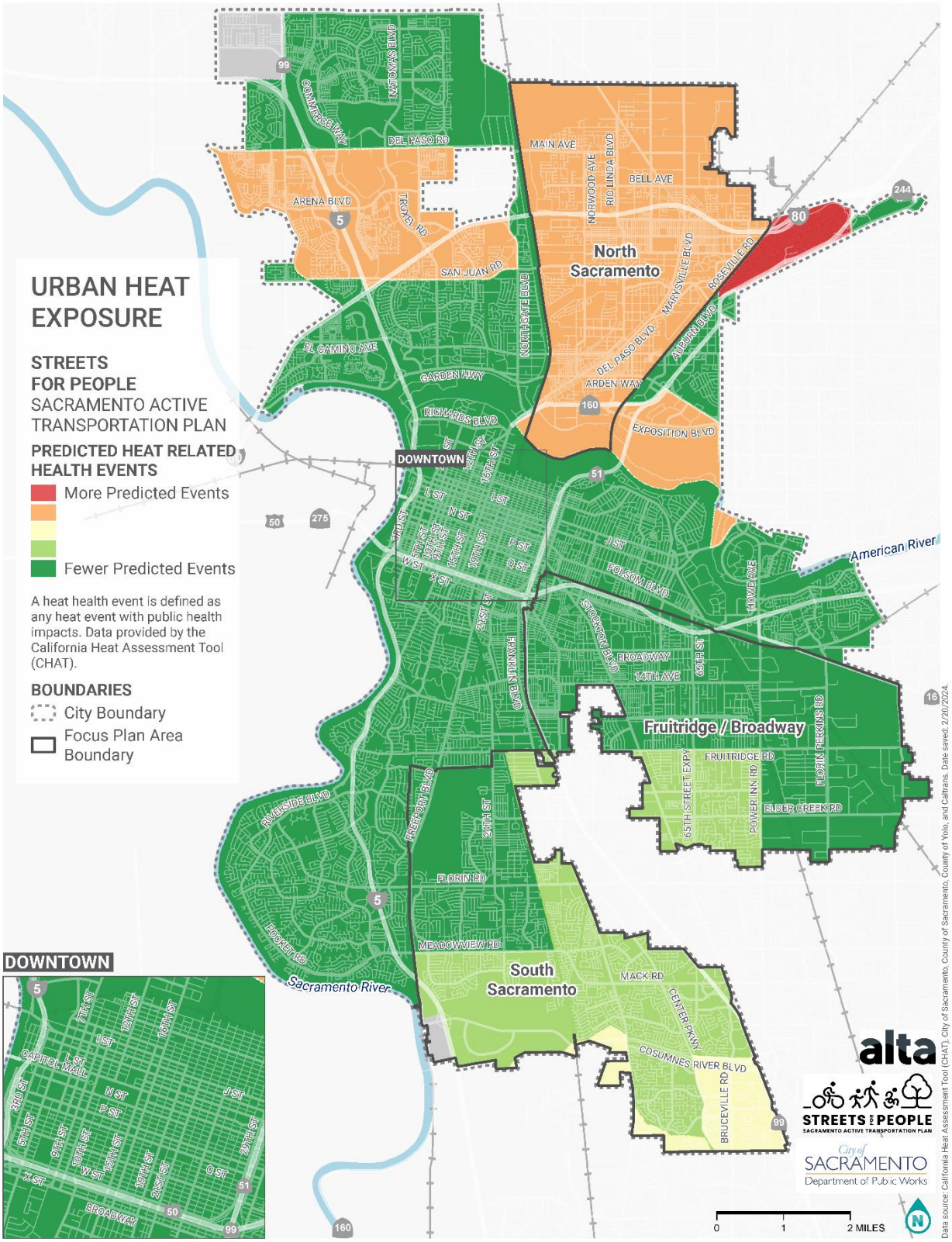
South Sacramento

The projected urban heat exposure increases from the north to the south within the South Sacramento focus area, with the highest values (7.3 HHEs per year) south of Consumnes River Boulevard. The area north of Meadowview Road and west of the light rail tracks is projected to have about two (2) HHEs per year in 2040.

[10] City of Sacramento 2040 General Plan. (2024) https://www.cityofsacramento.gov/community-development/planning/major-projects/general-plan

[11] California Heat Assessment Tool (CHAT). https://www.cal-heat.org/

Figure 4. Urban Heat Exposure



Urban Heat Island Effect

Urban heat islands occur when impervious surfaces such as pavement absorb heat during the day and then radiate that heat at night. Figure 5 illustrates the relationship between urbanization and surface temperatures.[12] This release of heat limits nighttime cooling and amplifies daytime high temperatures. The urban heat island effect has substantial implications for public health beyond excess heat concerns because air quality deteriorates in these areas as cooling energy demand increases, emissions of pollutants increase, and ozone formation accelerates. The scores for this criterion were determined based on a hexagon's coverage with census tract level CHAT summaries of the difference in urban temperatures relative to rural areas, per data reported by the California Environmental Protection Agency in 2015. This score was percentile ranked and then scaled to form a 10-point score.

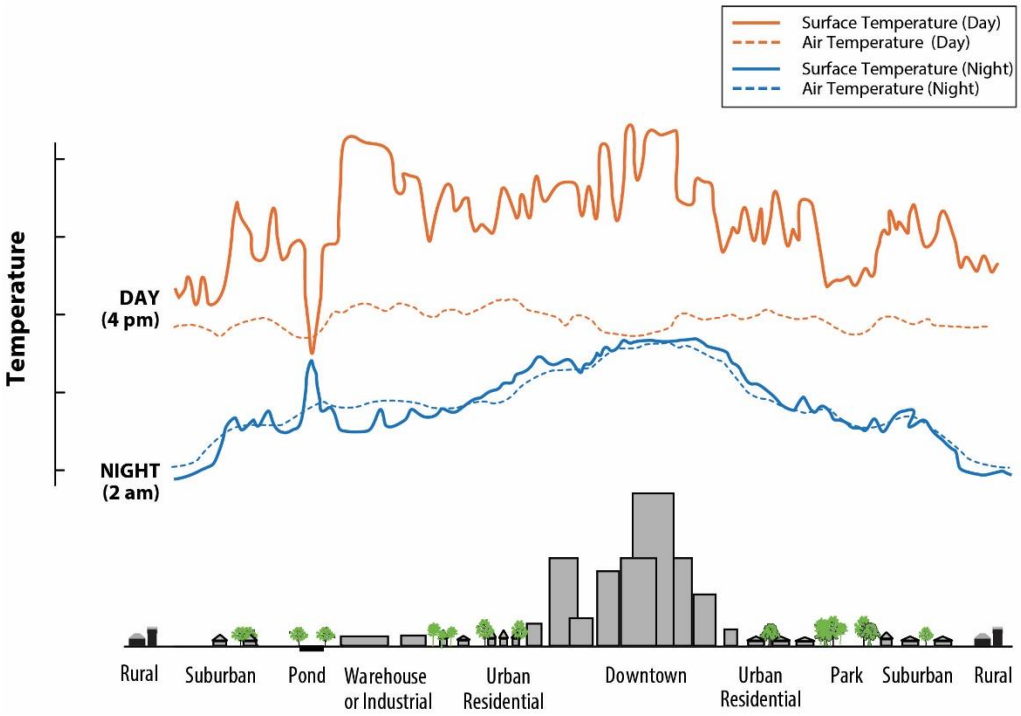


Figure 5. Surface temperatures vary more than atmospheric air temperatures during the day, but are generally similar at night.

Citywide Findings

On average, Sacramento is about 1.2°C (2.1°F) warmer than the baseline surrounding rural areas, but the hottest areas (northeastern portions) of the city are as much as 2.4°C (4.3°F) warmer. Figure 6 shows the census tract level CHAT data on urban heat island intensity, disaggregated to the hex grid level. In general, the urban heat island effect decreases moving to the south and west. Downtown Sacramento, the northwest part of the Fruitridge/Broadway focus area, and the Natomas Park neighborhoods also exhibit higher heat island intensities.

[12] Characteristics of Heat Islands. EPA. https://www.epa.gov/heatislands/learn-about-heat-islands

Focus Area Findings

Fruitridge / Broadway

Generally, the urban heat island effect decreases when moving from the north to the south within the Fruitridge / Broadway focus area. The greatest temperature differences of about 1.5°C (2.7°F) occur north of Broadway and decrease to about 1°C (1.8°F) south of Fruitridge Road.

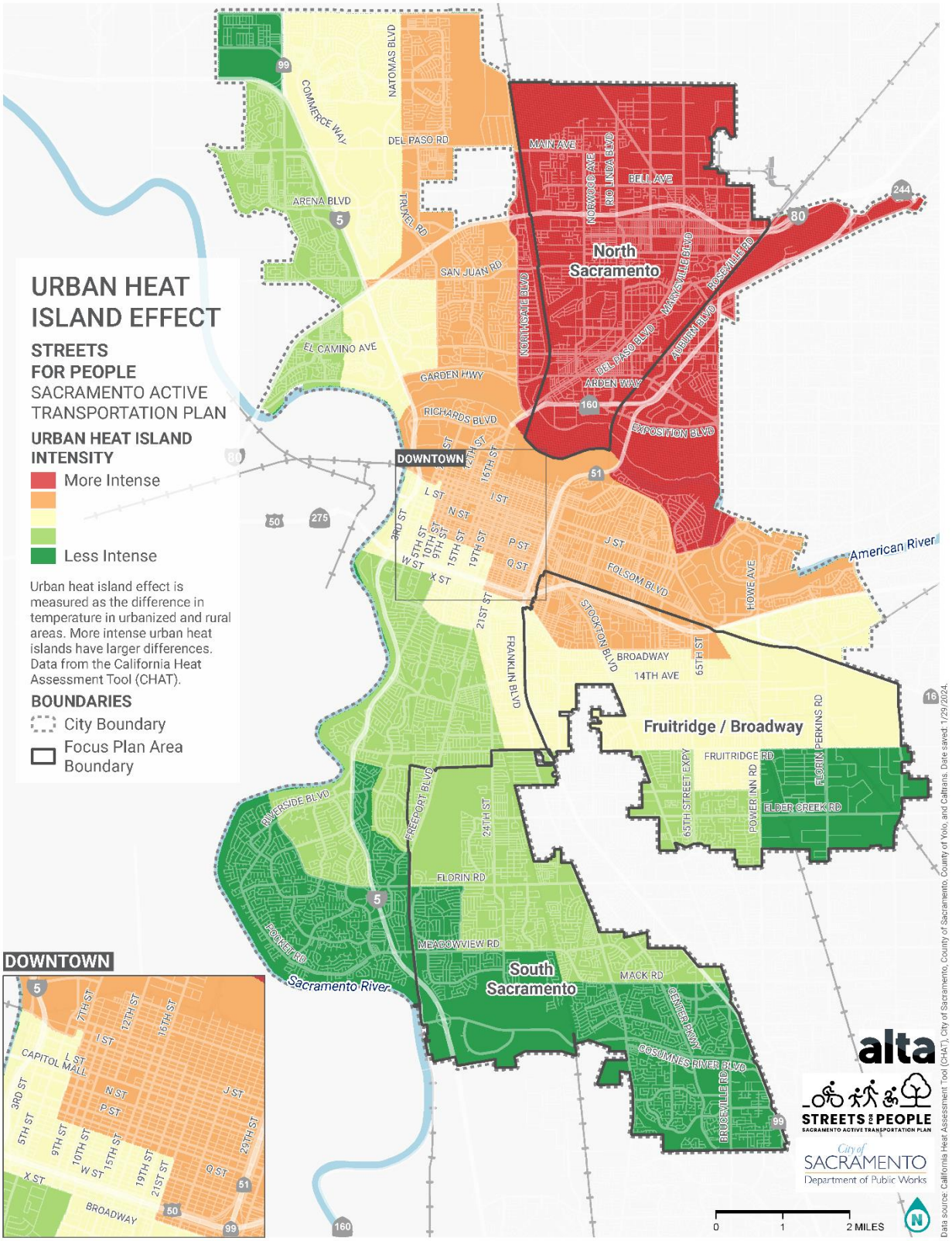
North Sacramento

North Sacramento has some of the most intense urban heat island effect in the city, marked by the greatest difference in temperature compared to nearby rural areas. The maximum temperature difference within the focus area is about 2.2°C (3.9°F).

South Sacramento

South Sacramento has among the least intense heat island effect in the city, particularly south of Meadowview Road and Mack Road, where the temperature difference compared to the rural baseline is about 0.4°C (0.7°F). The urban heat island effect in entire focus area is below the citywide average.

Figure 6. Urban Heat Island Effect



Existing Tree Canopy Density

Urban greening, such as parks and trees, will often have a local cooling effect through shade and evapotranspiration.[13] A systematic review of evidence linking urban greening and the air temperature of urban areas has shown that green sites are generally cooler than non-green sites.[14] Evidence links tree canopy coverage to positive health outcomes from reduced exposure to ultraviolet radiation, reduced urban heat islands, and mitigation of air pollution.[15] The Existing Tree Canopy Density metric identifies locations that currently lack high density tree canopy and assigns hexagons the minimum point value specified in Table 2. Existing tree canopy data is provided by an AI-derived data company.

Table 2. Existing Tree Canopy Density Scoring Points

Criteria	Data Source[16]	Threshold	Points
Existing Tree Canopy (High Density)	AI-Derived	Hexagons with more than 75% of their area with tree canopy.	1 Point
Existing Tree Canopy (Moderate Density)	AI-Derived	Hexagons with 50% to 75% of their area with tree canopy.	3 Points
Existing Tree Canopy (Low Density)	AI-Derived	Hexagons with 25% to 50% of their area with tree canopy.	5 Points
Existing Tree Canopy (Very Low Density)	AI-Derived	Hexagons with less than 25% of their area with tree canopy.	7 Points
All Other Lands	AI-Derived	All hexagons without tree canopy.	10 Points

Citywide Findings

Figure 7 shows the hex grid scored based on the existing tree canopy density criteria. Generally, neighborhoods located further away from downtown tend to have lower tree canopy density. This is particularly the case for areas of the city north of I-80 and most of South Sacramento. On a smaller scale, tree canopy is particularly sparse in commercial or professional areas with large buildings and paved parking lots, including around the Valley Hi Village and Southgate Plaza in South Sacramento, the UC Davis Campus along Stockton Boulevard in Fruitridge/Broadway, and along Del Paso Boulevard through Old North Sacramento. Tree canopy density tends to be higher along existing trails (ex. Jedediah Smith Memorial Trail) and in residential areas. According to the data, residential neighborhoods like Land Park, East Sacramento, Curtis Park, and Boulevard Park have some of the highest tree canopy densities in the city, along with natural areas like the American River Parkway. It is important to note that many parks across the City are shown as having low tree canopy density due to their typically large areas of open grass.

[13] Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.
[14] Pataki, D. E., Alberti, M., Cadenasso, M. L., Felson, A. J., McDonnell, M. J., Pincetl, S., Pouyat, R. V., Setälä, H., & Whitlow, T. H. (2021). The Benefits and Limits of Urban Tree Planting for Environmental and Human Health. Frontiers in Ecology and Evolution, 9. https://doi.org/10.3389/fevo.2021.603757
[15] i-Tree Canopy. (2023) i-Tree Software Suite v5.x. http://www.itreetools.org
[16] Ecopia https://www.ecopiatech.com/

Focus Area Findings

Fruitridge / Broadway

Tree canopy density is generally highest in the northwest portion of the Fruitridge / Broadway focus area. Particularly the areas between V Street and Highway 50, between Stockton Boulevard and Golden State Highway north of 12th Avenue, and between 14th Avenue and 21st Avenue west of 65th Street Expressway show the highest tree coverage in the area. The neighborhoods south of Fruitridge Road and west of Power Inn Road tend to have lower tree canopy density than the neighborhoods north of 21st Avenue. Tree canopy coverage is particularly low in the industrial area east of Power Inn Road and within the UC Davis campus.

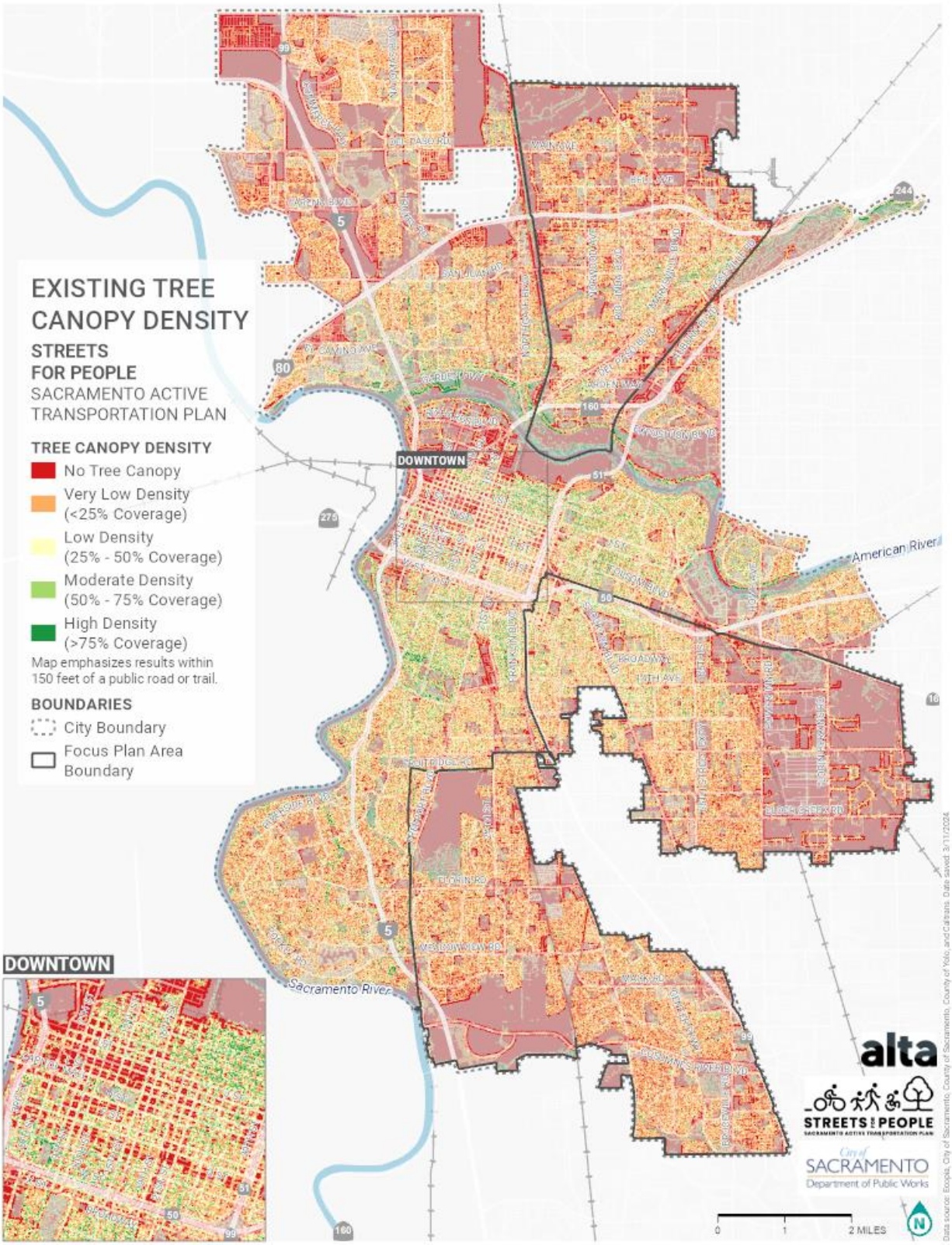
North Sacramento

Tree canopy density in North Sacramento is generally low except for the Hagginwood and Woodlake neighborhoods. Tree canopy density is lowest within the Erickson Industrial Park, along the rail corridor paralleling Auburn Boulevard, in the northeast corner of the focus area, and near Steelhead Creek between Silver Eagle Road and I-80.

South Sacramento

Tree canopy density in South Sacramento is generally low, driven by low canopy density along many major roads like Florin Road and Meadowview Road east of 24th Street, Consumnes River Boulevard and Franklin Boulevard, as well as around major commercial or business centers like Southgate Plaza, Valley Hi Village and the Kaiser Permanente Medical Center, and the Florin Square Shopping Center. Pockets of some neighborhoods have high tree canopy density, like near Mack Elementary School north of Mack Road and east of Franklin Boulevard, in the residential neighborhood bordering Valley Hi Village, and along the eastern side of the Sacramento Executive Airport.

Figure 7. Existing Tree Canopy Density



New Planting Suitability

Key locations for tree planting are in pervious or low-height vegetation areas like sidewalk planting strips, medians, or along off-street paths. These locations may demand fewer resources to support and maintain new tree canopy. This analysis refers to sidewalk planting strips and medians as on-street and along paths as off-street opportunities. Alta used AI-derived extractions of vegetated locations to identify on-street planting locations, excluding those on private roadways. As noted in **Table 3**, sidewalk planting areas must be at least 3 feet wide, which are best practice widths identified for urban forestry[7], and medians must be at least 4 feet wide, which is consistent with the Sacramento Public Works standard. To maintain proper spacing between trees, planting areas within 10 feet of the existing tree canopy were removed from consideration.

Alta used Sacramento's LIDAR data to identify off-street planting areas through the pervious land classification. These areas were further filtered using land use data to identify pervious areas located on publicly owned land. Hexagons with no current planting opportunities were assigned 0 points for this criterion. For hexagons with more than one (1) type of planting location present, the maximum score was applied. The criteria and point allocation for documenting planting areas is summarized in **Table 3**.

Table 3. New Planting Suitability Points Criteria

Criteria	Data Source[17]	Methods	Points
On-Street Vegetated Buffers	AI-Derived	Sidewalk vegetated buffers in the public right-of-way whose width is greater than or equal to 3 feet.	10 Points
Off-Street Vegetated Locations	City of Sacramento LIDAR	All pervious land cover locations on publicly owned lands or areas reserved for parks, recreation, or open space as specified in the General Plan.	8 Points
On-Street Pervious Medians	AI-Derived	Medians in the public right-of-way whose maximum width is greater than or equal to 4 feet.	5 Points

Citywide Findings

Sidewalk planter boxes that are at least three feet wide are the most suitable planting locations to provide tree canopy for active transportation users, followed by off-street vegetated locations, then pervious medians that are at least four feet wide. **Figure 8** shows locations by new planting suitability, with more suitable locations in dark green and less suitable locations in red. There are suitable planting opportunities throughout the city, with the highest concentrations in northwest Sacramento, the southern half of downtown, the northwest area of the Fruitridge/Broadway focus area, and in the immediate vicinity of Old North Sacramento. Generally, these existing planting opportunities are located along major roads like Commerce Way, Natomas Blvd, Stockton Blvd, Freeport Blvd, Mack Rd, and Pocket Rd.

[17] Ecopia https://www.ecopiatech.com/

The map emphasizes hexagons within 150 feet of an existing road or trail, which are shown as less transparent. By area, however, most of the city lacks suitable planting locations. In South Sacramento, for example, most of the area is neighborhoods with low planting suitability on the smaller local streets and suitable planting areas only exist on some major roads like Mack Rd and parts of Florin Rd. Efforts to improve city-owned and maintained tree canopy coverage in these areas will require creating additional planting opportunities.

Focus Area Findings

Fruitridge / Broadway

The most suitable locations for new tree plantings in Fruitridge / Broadway are in sidewalk vegetated buffers in the neighborhoods in the northwest corner of the focus area, on the east side of Stockton Boulevard between 21st Avenue and 8th Avenue, and within the vegetated medians on 21st Avenue, Power Inn Road north of 14th Avenue, and 65th Street Expressway south of Fruitridge Road. Additionally, several city-owned parks like Tahoe Park, Greenfair Park, and McClatchy Park or public school campuses like Kenny Elementary, Warren Elementary, and Camellia Elementary offer suitable planting locations in neighborhoods.

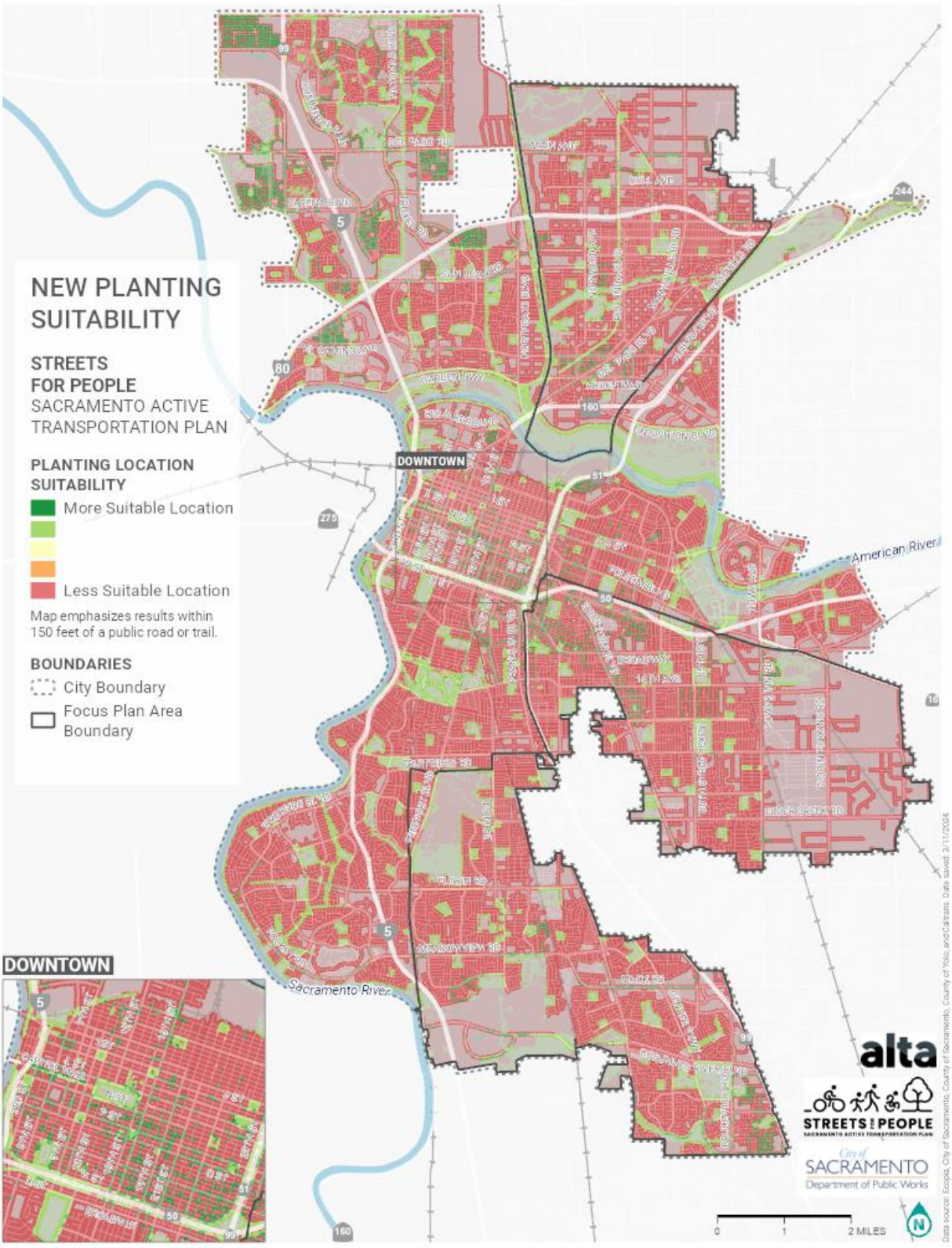
North Sacramento

The most suitable locations for new tree plantings in the North Sacramento focus area are in sidewalk vegetated buffers in the neighborhoods surrounding Del Paso Boulevard in Old North Sacramento, in the neighborhood surrounding Brookins Park, and along segments of streets like Main Avenue west of Norwood Avenue and east of Marysville Boulevard, North Avenue east of I-80, and Pinell Street north of I-80. Marysville Boulevard and Del Paso Boulevard have suitable planting opportunities in vegetated medians along several stretches. The greenspace corridor along the Sacramento Northern Bike Trail, as well as parks like Robla Community Park, Robertson Park, and Del Paso Park, and public school campuses like Grant Union and Grant West High School, Castori Elementary, Hagginwood Elementary, and Vista Nueva High School offer other suitable planting locations on publicly owned land.

South Sacramento

The most suitable locations for new tree plantings in the South Sacramento focus area are in sidewalk vegetated buffers in the Shasta neighborhood south of Cosumnes River Boulevard and east of Bruceville Road, along Mack Road and parts of Meadowview Road. Center Parkway has suitable sidewalk vegetated buffers south of Calvine Road and vegetated median planting opportunities throughout the focus area. Florin Road and Freeport Boulevard also have vegetated medians suitable for new plantings. Additional opportunities are in parks like Pollack Ranch Park, Mesa Grande Park, and Wood Park, and on public school campuses like Bidwell Elementary, Harkness Elementary, and Reith Elementary.

Figure 8. New Planting Suitability



Tree Opportunity Index Results

This section presents the results of the Tree Opportunity Index and discusses findings across the city and within each focus area. The section concludes with a discussion of analyses that focus on the intersection between active transportation facilities, tree planting feasibility, open planting locations, and areas that have a high opportunity for impactful tree plantings. These will help inform the Phase II analysis and integration with identified active transportation recommendations from the *Streets for People Plan*.

Figure 9 shows the results from the Tree Opportunity Index with areas identified by their opportunity for impact. Areas with higher opportunity for impact (shown in green) indicate that there is a higher need for additional tree canopy coverage, greater urban heat impacts, and available existing planting locations. Conversely, areas with lower opportunity for impact (shown in red) may already have high tree canopy coverage and a lesser need to mitigate urban heat impacts, and/or may not have suitable areas to plant new trees. These areas are shown in red on the map. The map emphasizes hexagons within 150 feet of an existing road or trail, which are shown as less transparent.

Citywide Findings

The results indicate that North Sacramento and the Natomas neighborhoods to the west have the highest opportunity for impact. Smaller pockets with higher opportunity exist near the California State University and Sacramento City College campuses as well as along the perimeter of parks. Co-locating new tree plantings with existing trails also has a high opportunity for impact, particularly for the active transportation users on those facilities. These include shared-use paths in the American River Parkway, the Sacramento Northern Bike Trail, the Natomas Bike Path, and the paths in North Laguna Creek Park. Finally, there are some pockets and corridors of opportunity for planting within Sacramento's Downtown.

Focus Area Findings

Fruitridge / Broadway

Streets with the highest opportunity for impact include neighborhood streets in the northwest portion of the Fruitridge / Broadway focus area, particularly in the North Oak Park and Elmhurst neighborhoods and to a lesser extent the Colonial Heights and Colonial Manor neighborhoods. Much of the area with high opportunity for impact is within publicly owned lands like parks and public school campuses. These include Sacramento High School, McClatchy Park, Tahoe Park & Elementary School, Warren Elementary, and Wood Middle School.

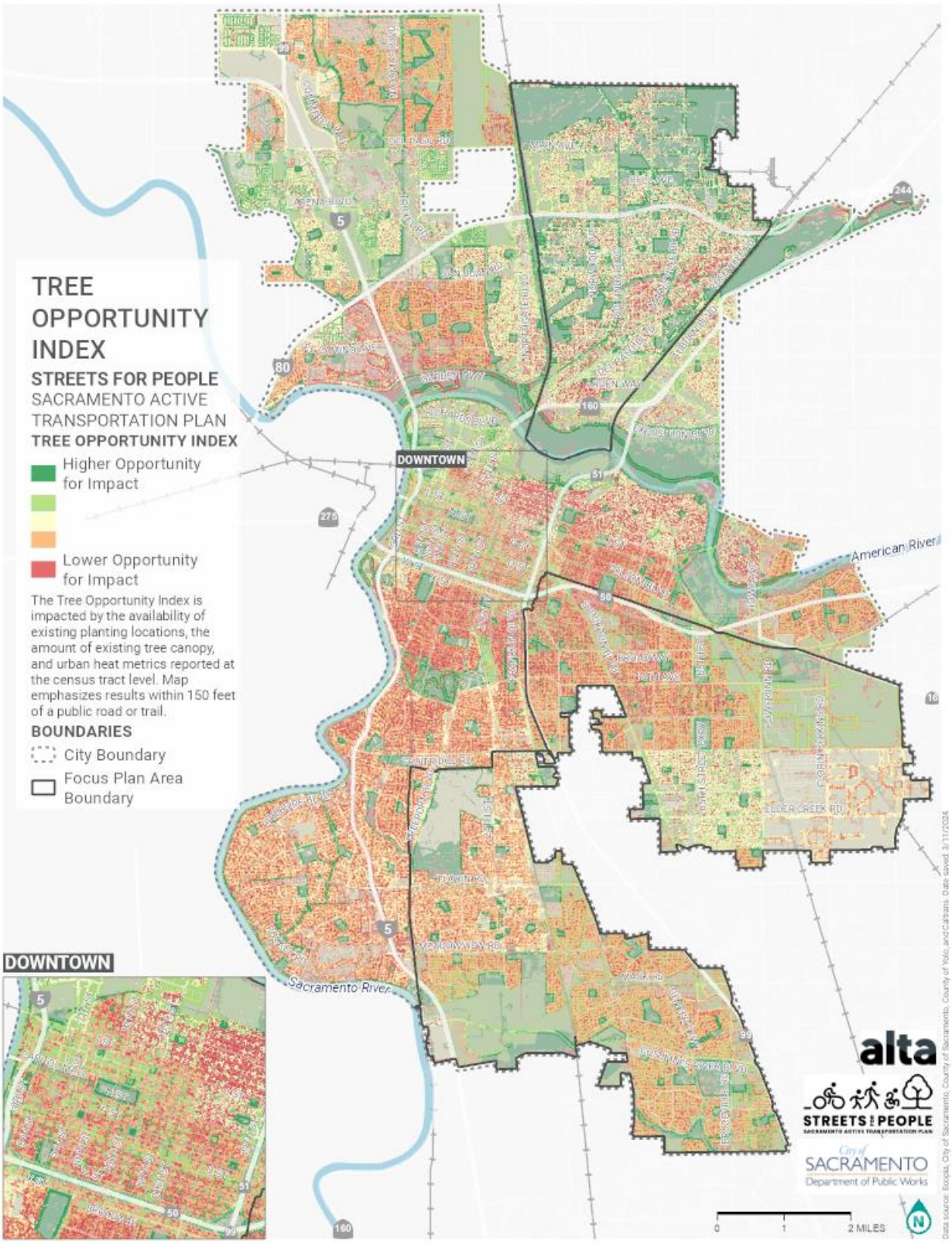
North Sacramento

In general, the North Sacramento focus area tends to have a higher opportunity for impact, driven by the greater magnitude of the urban heat island effect and more projected future HHEs. Most locations within North Sacramento with the highest opportunity for impact are within publicly owned green spaces like along the Sacramento Northern Bike Trail and American River Bike Trail, within parks like North Del Rio School Park, Robla Community Park and Hagginwood Park, and on school property surrounding Grant Union and Grant West High School, Del Paso Heights Elementary School, and Castori Elementary School. Additionally, some neighborhood streets in surrounding Old North Sacramento offer areas with the highest opportunity for impact.

South Sacramento

Generally, the South Sacramento focus area tends to have lower opportunity for impact, but key opportunities exist along Florin Road between Freeport Boulevard and 24th Street, Meadowview Road between 24th Street and the light rail tracks, and Freeport Boulevard between Fruitridge Road and Florin Road. The majority of high-opportunity areas, however, are in public greenspaces like Laguna Park, Hopkins Park, and Steve Jones Park, and on public school property by Prairie Elementary School, Bidwell Elementary School, and Harkness Elementary School.

Figure 9. Tree Opportunity Index

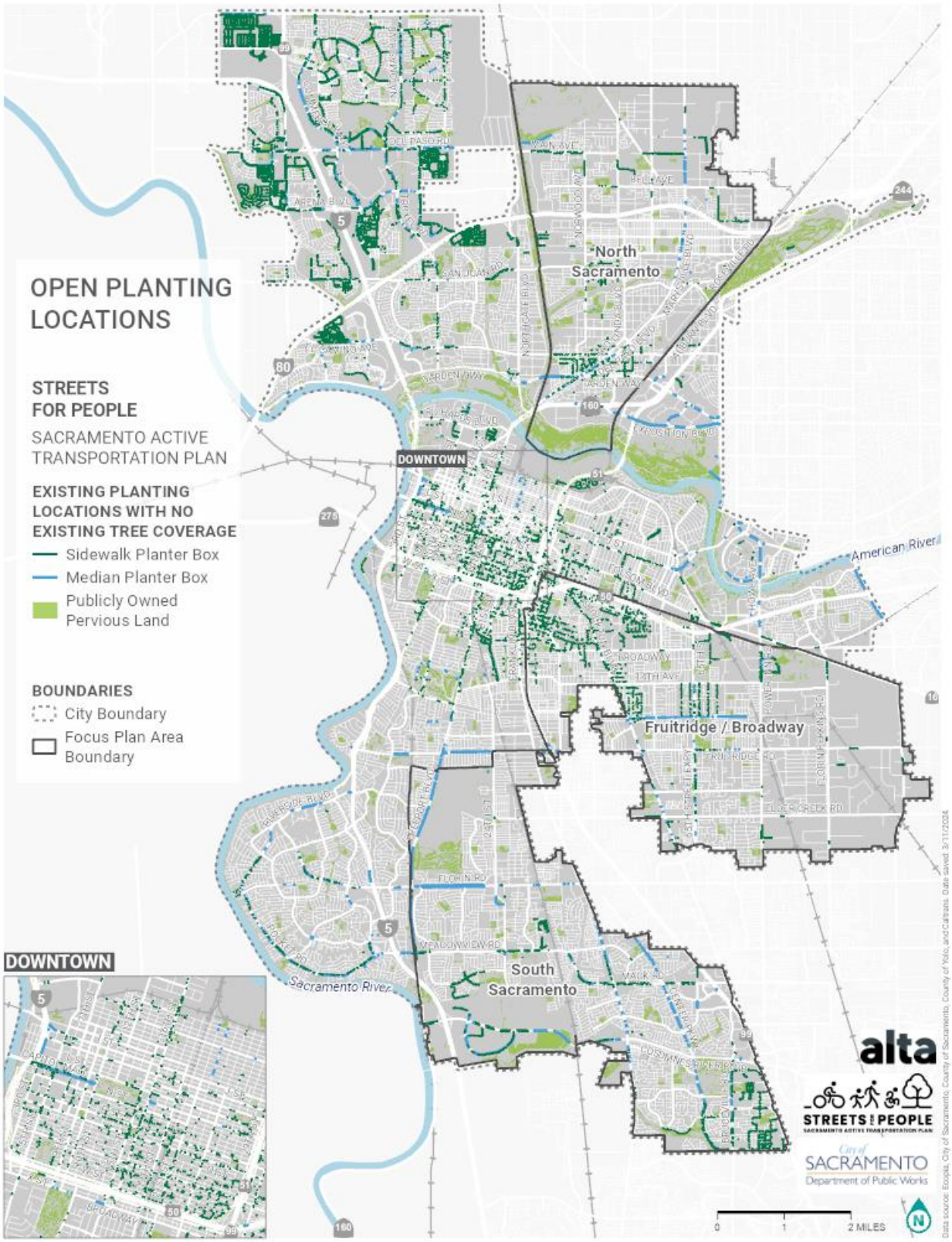


Open Planting Locations

Based on the parameters identified by the City for areas that would be suitable for new tree plantings (sidewalk planting boxes, median planting boxes, and pervious surface), just 5% of the 1,500 miles of sidewalk in the City that have no coverage from an overhead tree canopy could be addressed by the open planting locations identified through this analysis. Figure 10 shows the existing planting locations in the city that are not already supporting a tree, categorized by sidewalk planting boxes, median planting boxes, and pervious surfaces. Citywide, there are an estimated 76 miles of existing sidewalk planter boxes in the public right-of-way that are not currently occupied by trees. The neighborhoods in northwest Sacramento have the most open planting locations, followed by southern Downtown and the northwest part of the Fruitridge/Broadway focus area.

It is important to note that just because a planting area may not currently be occupied by a tree, it does not necessarily mean it can support a new tree. Sites may be disqualified for other reasons including proximity to buildings or utilities, poor soil quality, or existing vegetation.

Figure 10. Open Planting Locations



Tree Canopy Coverage and Existing Active Transportation Facilities

The main goal of this analysis is to focus tree planting efforts on providing tree canopy coverage for people walking and biking on active transportation infrastructure in Sacramento. There are about 2,100 miles of existing sidewalks in Sacramento, about 30% of which have existing overhead tree canopy as shown in Figure 11 and detailed in Table 4. Some areas of the city have higher tree coverage on existing sidewalks, like downtown Sacramento, East Sacramento, and Land Park, where approximately half of the sidewalks have overhead tree canopy. The three focus areas have sidewalk tree canopy coverage below the citywide ratio; only 22% of sidewalks in North Sacramento and 19% of sidewalks in South Sacramento have overhead tree canopy, and 28% of sidewalks in the Fruitridge/Broadway focus area have overhead canopy but coverage is unevenly distributed and favors the northwest corner of the focus area.

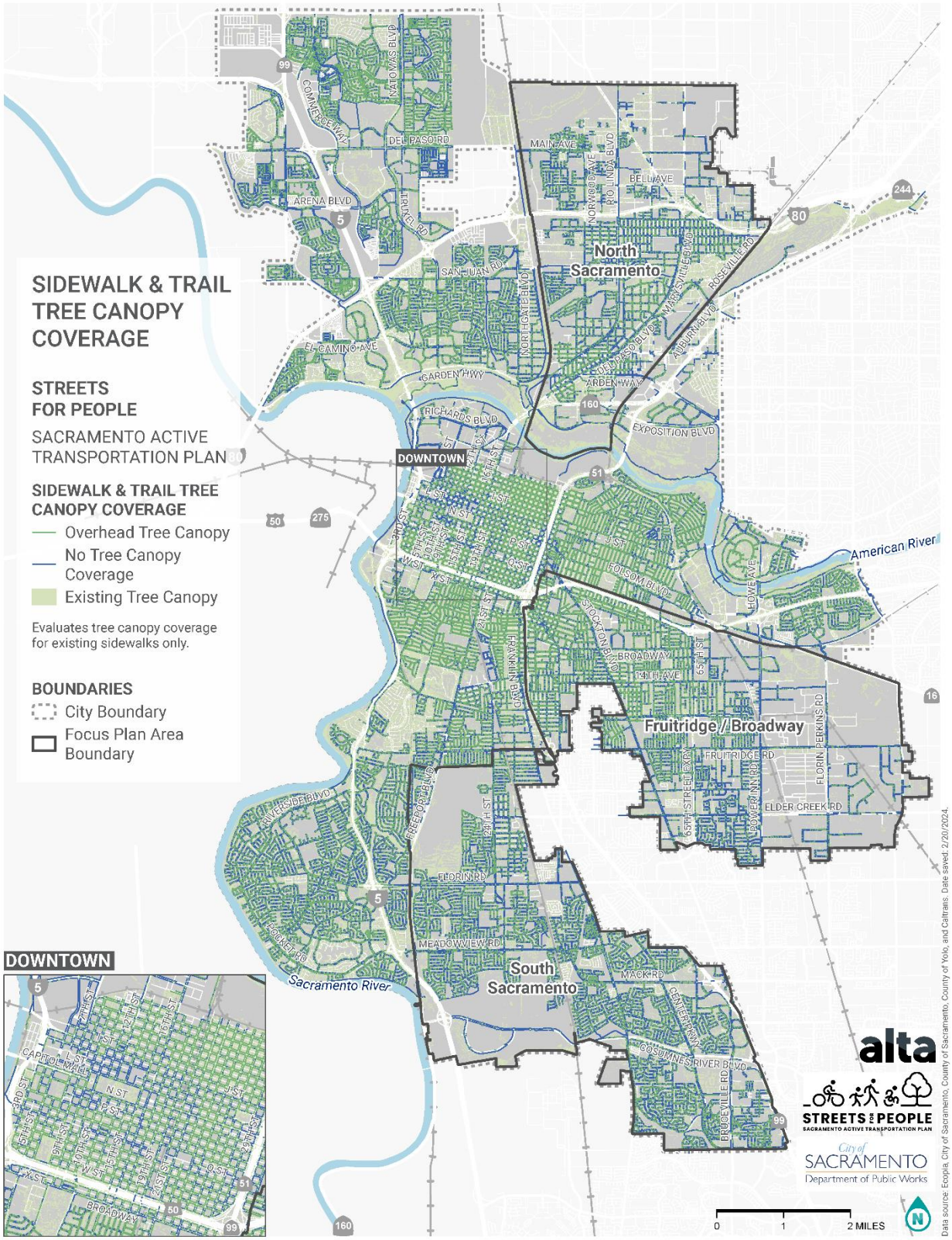
Citywide, 19% of shared-use paths have existing tree canopy coverage. Among the focus areas, Fruitridge/Broadway has the lowest percentage and length of tree canopy coverage at just 6% or 0.1 miles (see Table 4). Shared-use paths often pass through parks or other green spaces that may have opportunities to plant trees alongside the facility.

Tree canopy coverage along on-street bike facilities (ex. bike lanes, separated bikeways) is consistently lower than sidewalk coverage. On-street facilities are often further from the planting areas and require larger trees to provide canopy coverage. This is likely the result of parking, turnlanes, or frontage placement of trees can reduce canopy for on-street facilities. Citywide, only 12% of on-street bike facilities have overhead tree canopy, and all focus areas are below the city average.

Table 4. Existing Tree Canopy Coverage on Active Infrastructure

Area	Facility Class	Total Mileage	Mileage Covered	Percent Covered
Citywide	Sidewalk	2,136	641	30%
	Shared-Use Path	78	14.9	19%
	On-Street Bike Facilities	425	51.0	12%
North Sacramento	Sidewalk	235	51.6	22%
	Shared-Use Path	8	1.1	14%
	On-Street Bike Facilities	29	2.9	10%
Fruitridge/Broadway	Sidewalk	324	90.6	28%
	Shared-Use Path	2	0.1	6%
	On-Street Bike Facilities	52	3.1	6%
South Sacramento	Sidewalk	420	79.8	19%
	Shared-Use Path	6	1.2	21%
	On-Street Bike Facilities	63	4.4	7%

Figure 11. Tree Canopy Coverage on Existing Sidewalks and Trails



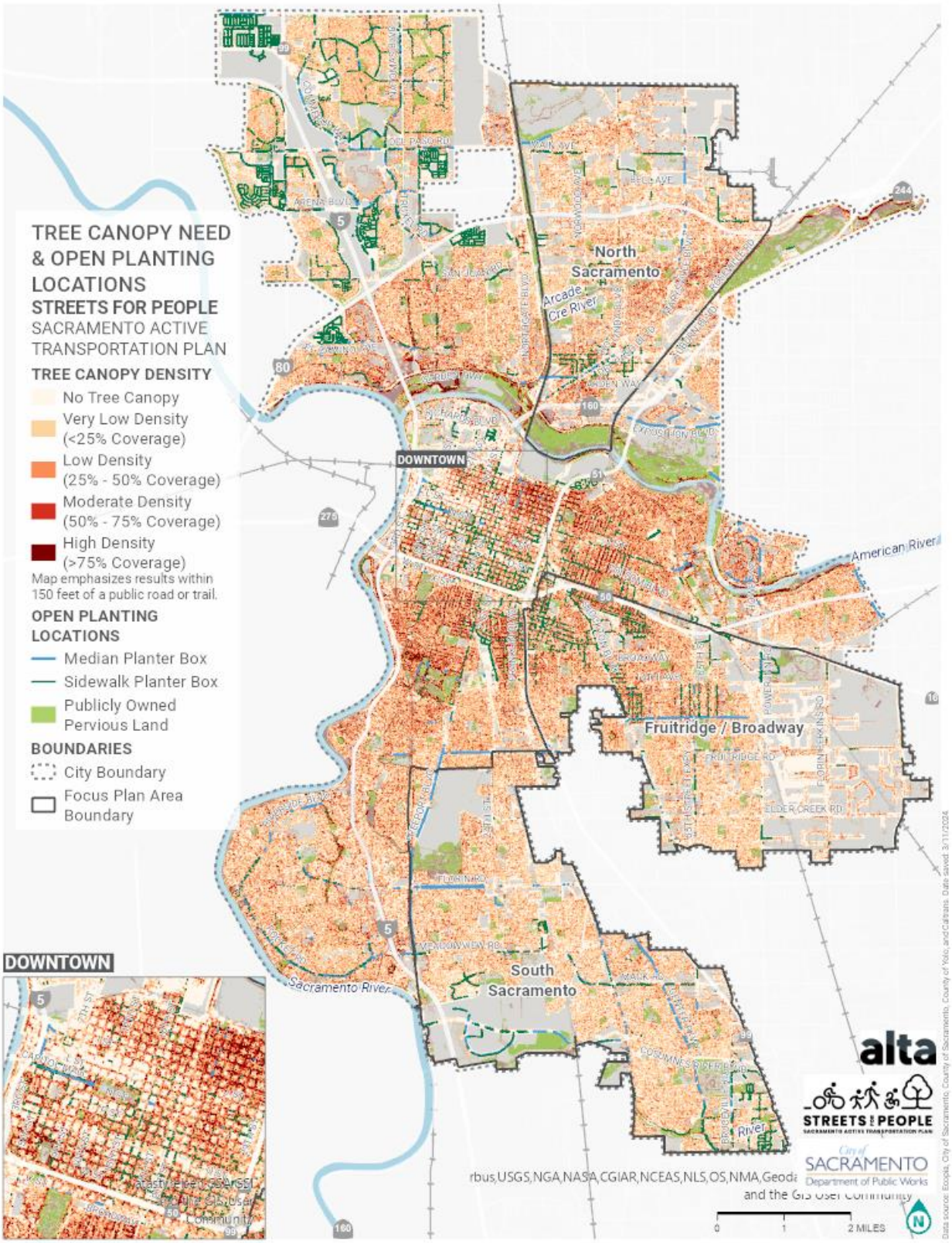
Tree Canopy Need and Planting Feasibility

One of the key challenges that Sacramento faces in increasing citywide tree canopy density is a lack of open planting locations in city-owned right-of-way, as shown in Figure 12. Red hues on the map indicate the tree canopy density while open planting locations are overlaid in green and blue.

As noted in the map, areas with lower tree canopy density are shown in lighter colors and expand to much of the residential neighborhood areas of the city. Most of these neighborhood locations that lack tree canopy and sidewalk planter boxes typically have sidewalks on one or more sides of the street. These sidewalks generally provide low-stress environments for people walking because of the low volume, and low-speed nature of the residential areas, and thus are unlikely to be prioritized for reconstruction without a major pavement quality or maintenance issue. Because of this, creative solutions are required to create additional planting opportunities in these neighborhoods. To this end, the city may consider widening sidewalks by adding a planting box on one side of the existing right-of-way and narrowing the street, daylighting crossings at intersections with curb extensions, or adding chicanes to the street to create smaller planting areas that may require less construction but result in fewer open planting locations. These solutions would have the added benefit of traffic calming, by narrowing the street requiring additional vehicle maneuvering, and slowing traffic speeds.

On higher volume roads like collectors and arterials, chicanes are not a viable solution, and adding planting locations requires implementing sidewalk planter boxes through sidewalk widening or reconstruction or constructing a vegetated median. In these locations, while there is sufficient right of way to accommodate some type of reconfiguration, consideration of tradeoffs (ex. Planter/sidewalk widening vs provision of on-street parking) may be required. Many of these locations are along commercial corridors in Sacramento and it is land outside of the right-of-way but close to the street could be an opportunity for tree planting. This would require appropriate coordination with landowners to plant trees in pervious areas not in public right of way of the City of Sacramento.

Figure 12. Tree Canopy Need and Open Planting Locations



Opportunity for New Trees Along Existing Facilities and High Stress Streets

The following maps show areas where new trees could be planted to best serve existing active transportation infrastructure, as well as locations where new tree plantings could be paired with infrastructure improvements to reduce the Level of Traffic Stress (LTS) for people walking or biking. High stress streets are defined as those with a LTS score of 3 or 4, as calculated in a prior analysis completed for the *Streets for People* projectd under its Gap Analysis.[18]

Infrastructure for People Walking

Figure 13 through Figure 19 show the top scoring hexagons on the Tree Opportunity Index overlaid with existing infrastructure and high-stress streets for people walking. Citywide, about 80% of streets with high-stress environments for people walking are in areas that showcase high impact opportunity for new tree plantings. This includes 93% (47 miles) of high stress streets for walking in the North Sacramento focus area, 87% (76 miles) of high stress streets for walking in the South Sacramento focus area, and 84% (55 miles) of high stress streets for walking in the Fruitridge/Broadway focus areas are in area.

Citywide, 42% (about 945 miles) of existing sidewalks and shared-use paths are in areas with a high impact opportunity for new tree plantings that would increase tree canopy coverage on facilities that are currently not covered. This includes 60% (145 miles) of existing walking infrastructure in the North Sacramento focus area, 42% (174 miles) of walking infrastructure in the South Sacramento focus area, and 54% (177 miles) of walking infrastructure in the Fruitridge/Broadway focus area.

Infrastructure for People Biking

Figure 14 Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (Northwest Sacramento)

[18] The Gap Analysis was developed to support the *Streets for People: Sacramento Active Transportation Plan* and identifies roadway corridors that are the biggest barriers or gaps in infrastructure for people walking, biking, or rolling. One factor for identifying gaps is the Level of Traffic Stress (LTS). LTS is determined based on road characteristics like number of travel lanes and posted speed limit, and characteristics of the active transportation infrastructure present, like facility width, buffer width, and buffer type.

Figure 20 through Figure 26 show the top scoring hexagons on the Tree Opportunity Index overlaid with existing infrastructure and high stress streets for people biking. Citywide, 85% (333 miles) of streets with high stress environments for people biking are in areas that showcase high impact opportunity for new tree plantings. This includes 94% (41 miles) of high stress street for biking in the North Sacramento focus area, 92% (71 miles) of high-stress streets for biking in the South Sacramento focus area, and 83% (46 miles) of high-stress streets for biking in the Fruitridge/Broadway focus areas.

Citywide, 87% (55 miles) of existing bike facilities are in areas with a high impact opportunity for new tree plantings that would increase tree canopy coverage on facilities that are currently not covered. This includes 97% (28 miles) of existing bike facilities in North Sacramento, 85% (50 miles) of existing bike facilities in the South Sacramento focus area, and 87% (43 miles) of existing bike facilities in the Fruitridge/Broadway focus area.

Figure 13. Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets

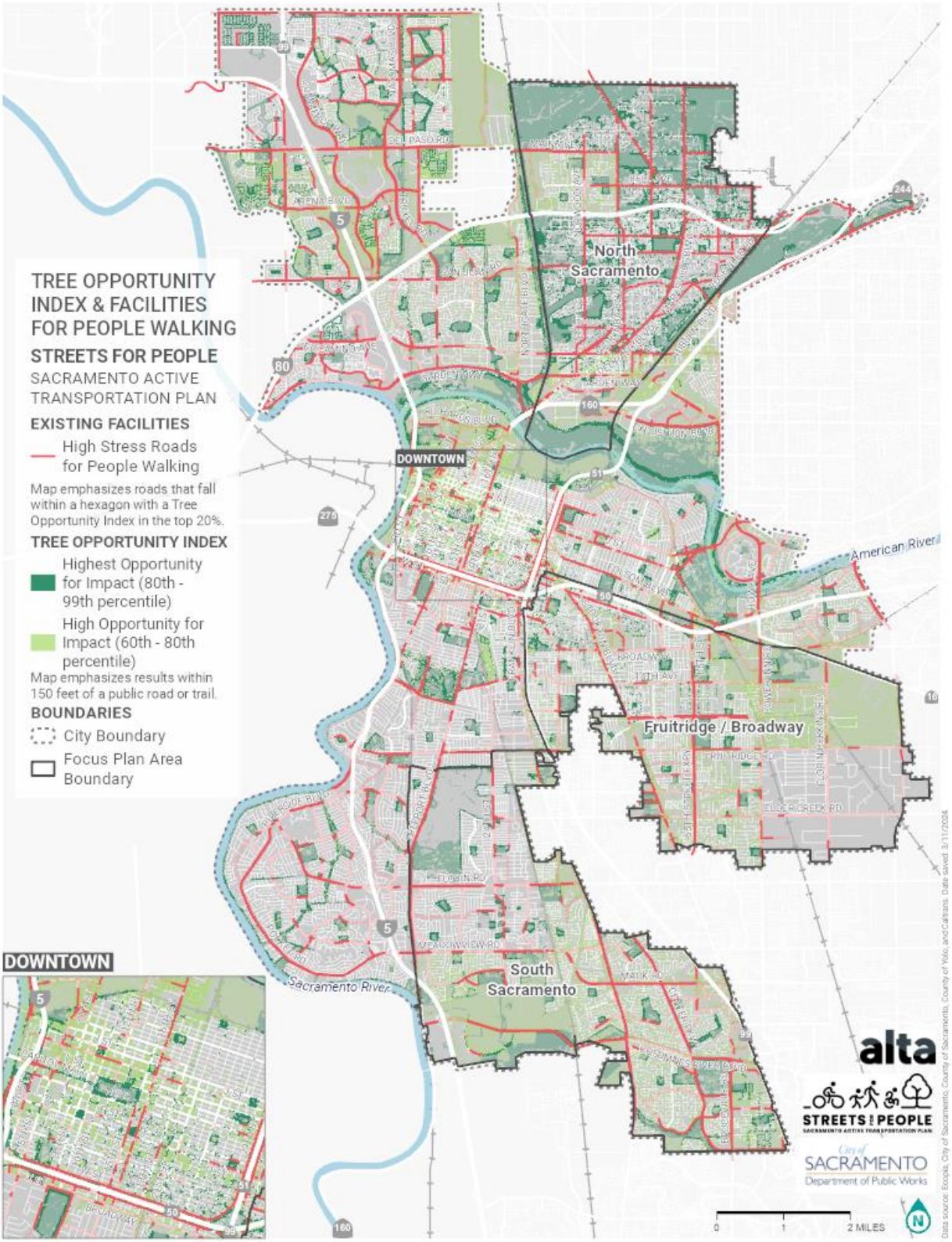


Figure 14 Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (Northwest Sacramento)

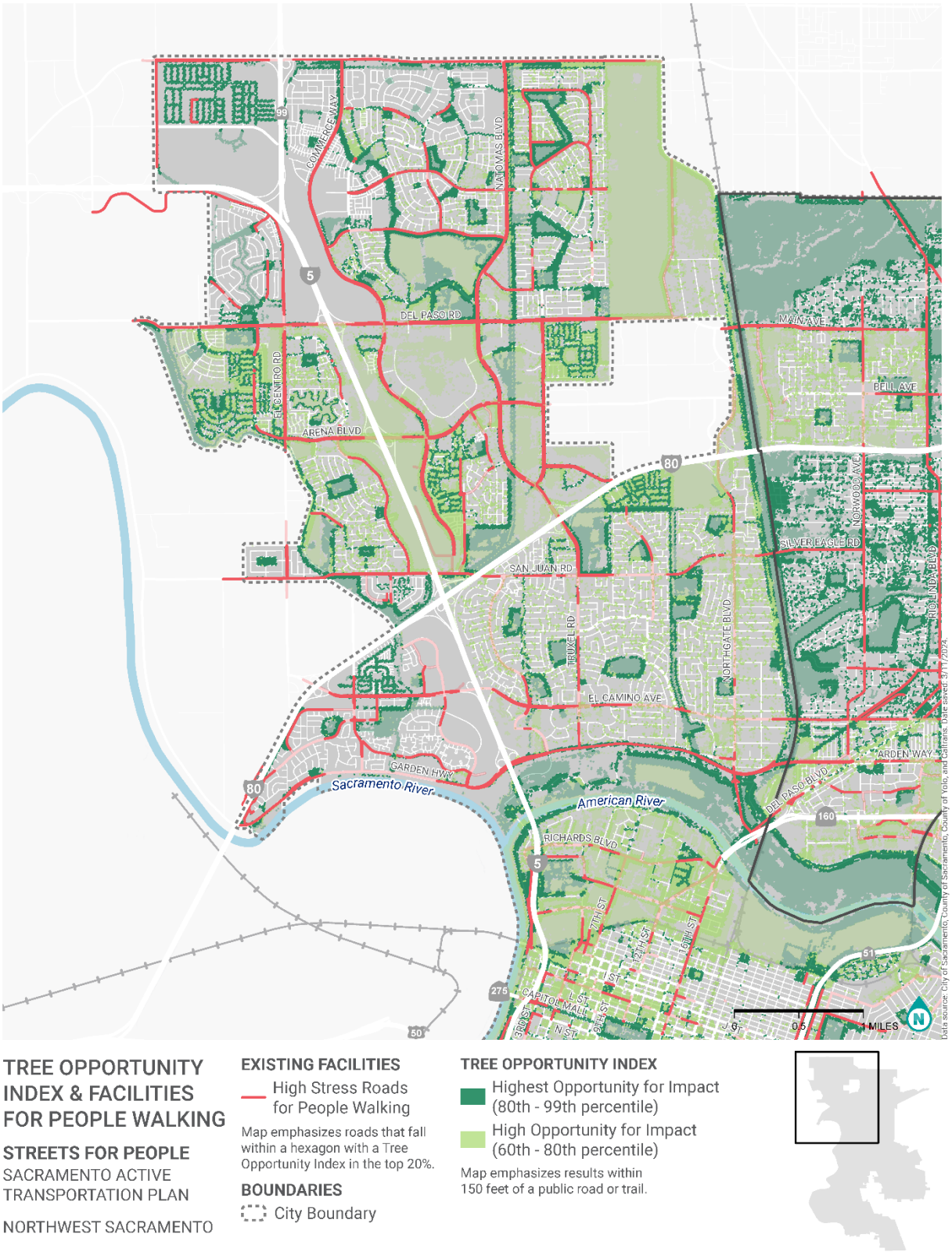


Figure 15. Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (North Sacramento)

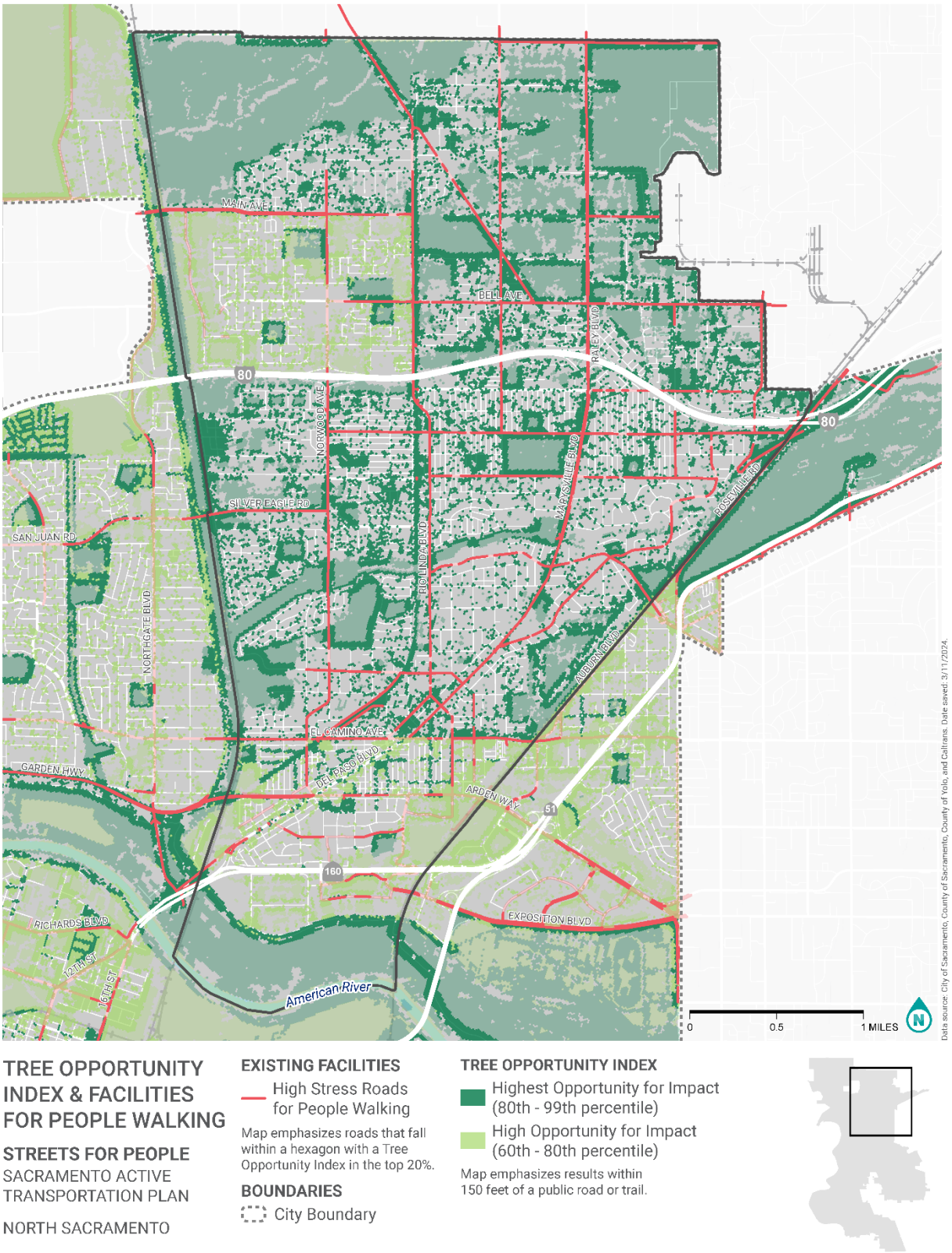
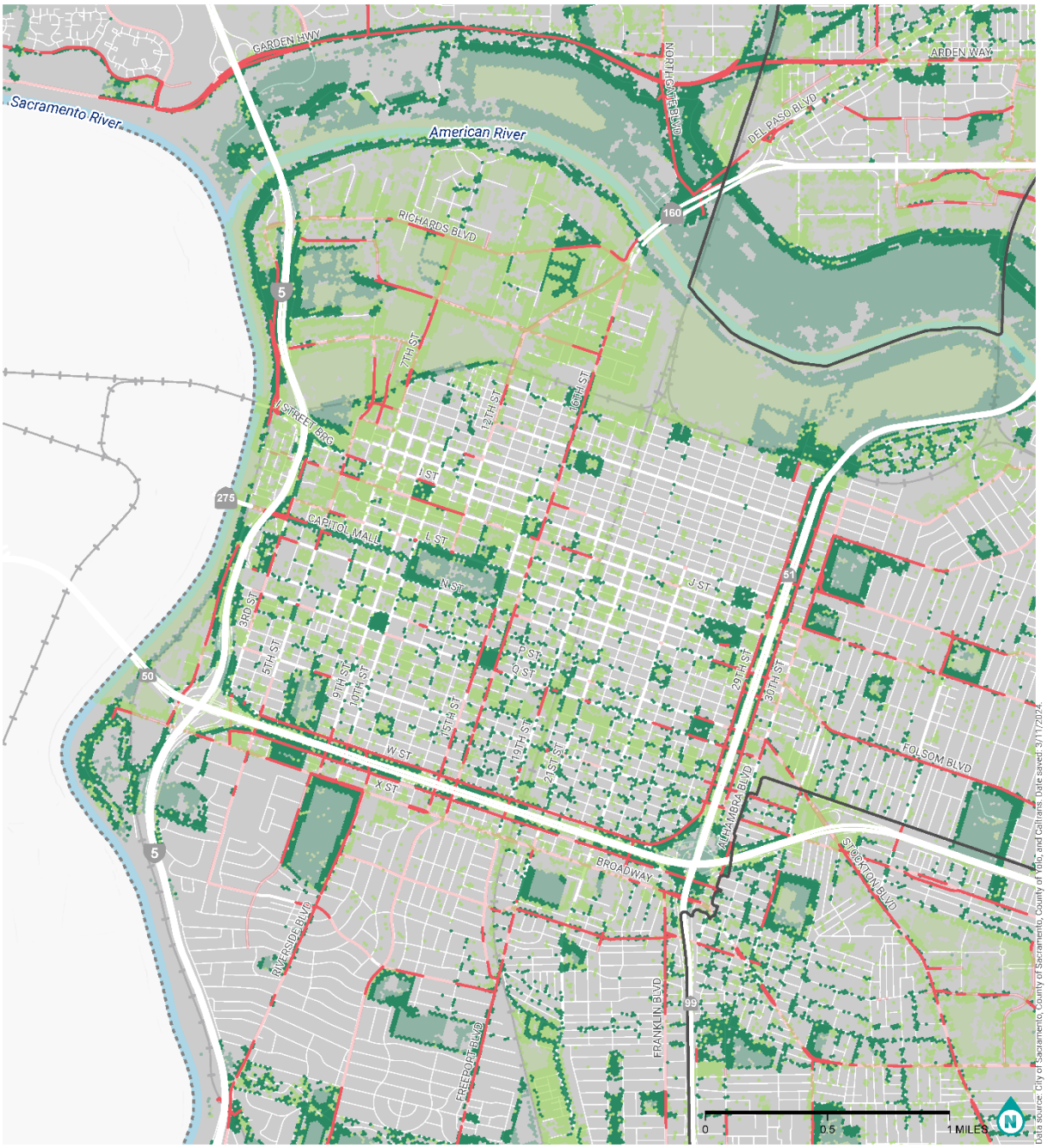


Figure 16 Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (Downtown)



TREE OPPORTUNITY INDEX & FACILITIES FOR PEOPLE WALKING

STREETS FOR PEOPLE
SACRAMENTO ACTIVE TRANSPORTATION PLAN

DOWNTOWN

EXISTING FACILITIES

High Stress Roads for People Walking

Map emphasizes roads that fall within a hexagon with a Tree Opportunity Index in the top 20%.

BOUNDARIES

City Boundary

TREE OPPORTUNITY INDEX

Highest Opportunity for Impact (80th - 99th percentile)

High Opportunity for Impact (60th - 80th percentile)

Map emphasizes results within 150 feet of a public road or trail.

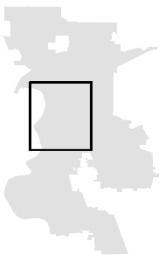
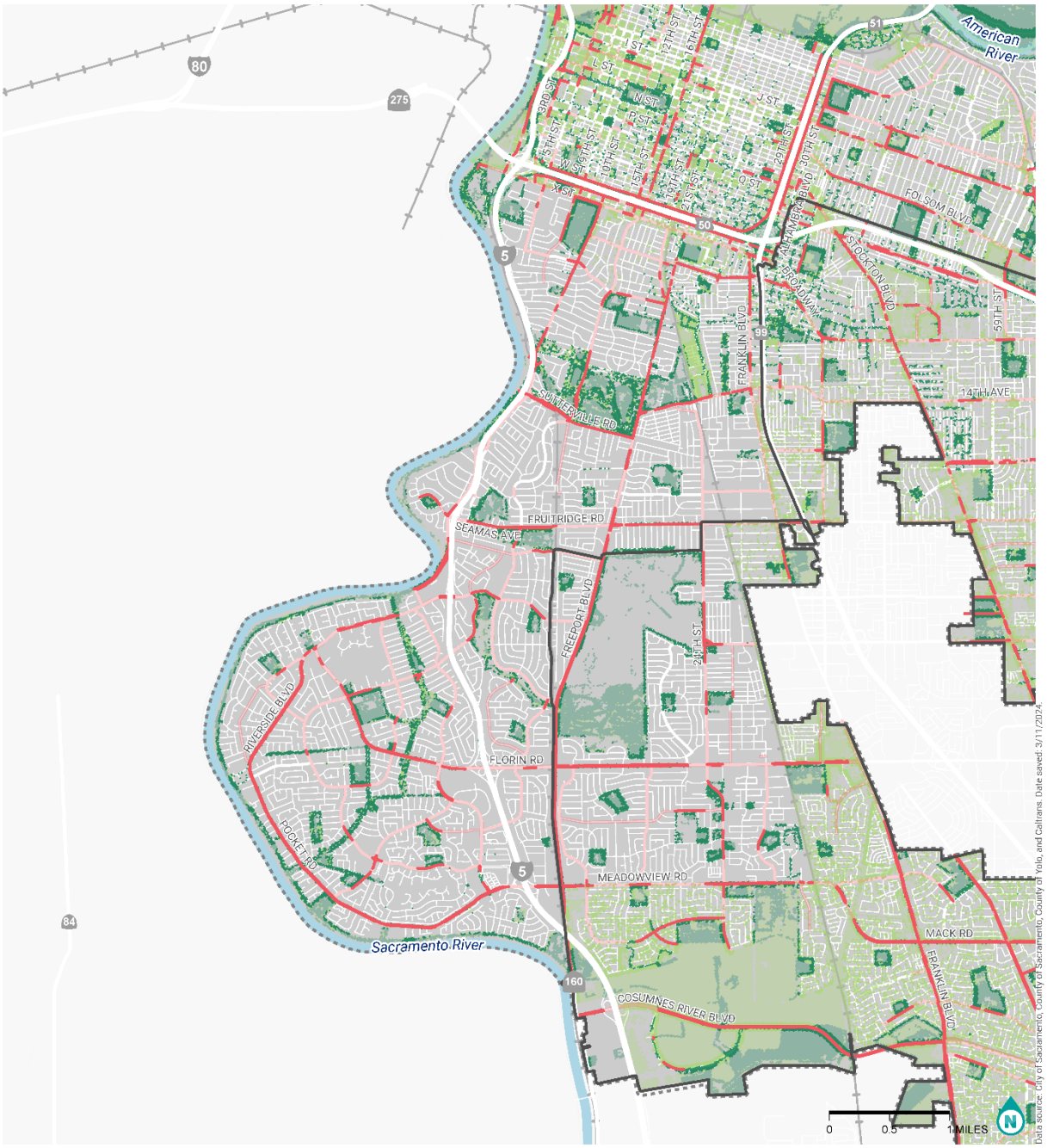


Figure 17. Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (Southwest Sacramento)



TREE OPPORTUNITY INDEX & FACILITIES FOR PEOPLE WALKING

STREETS FOR PEOPLE
SACRAMENTO ACTIVE TRANSPORTATION PLAN

SOUTHWEST SACRAMENTO

EXISTING FACILITIES
- High Stress Roads for People Walking

Map emphasizes roads that fall within a hexagon with a Tree Opportunity Index in the top 20%.

BOUNDARIES
- City Boundary

TREE OPPORTUNITY INDEX
- Highest Opportunity for Impact (80th - 99th percentile)
- High Opportunity for Impact (60th - 80th percentile)

Map emphasizes results within 150 feet of a public road or trail.

Figure 18. Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (Fruitridge/Broadway)

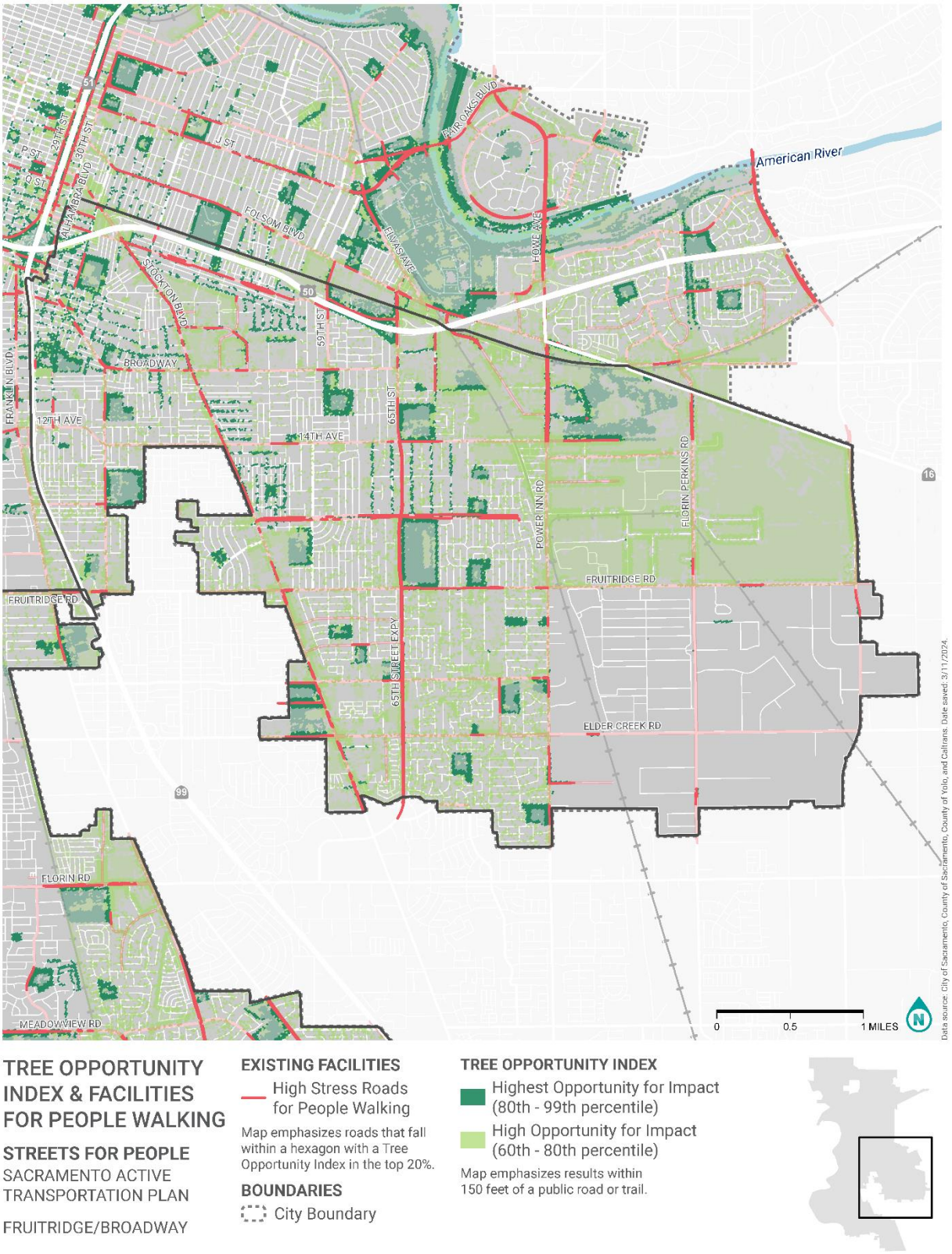


Figure 19. Areas of High Tree Opportunity with Existing Facilities for People Walking and High-Stress Streets (South Sacramento)

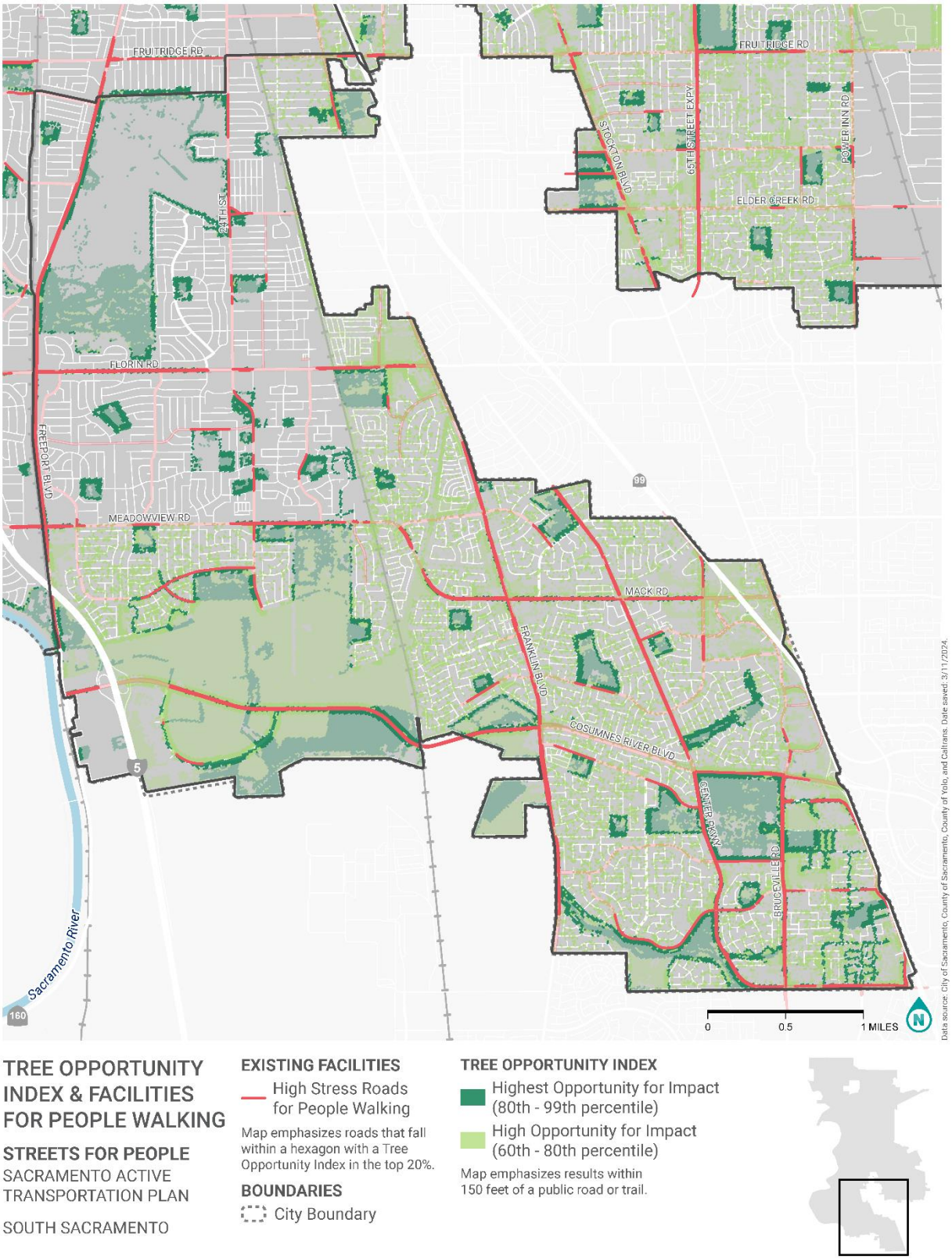


Figure 20. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets

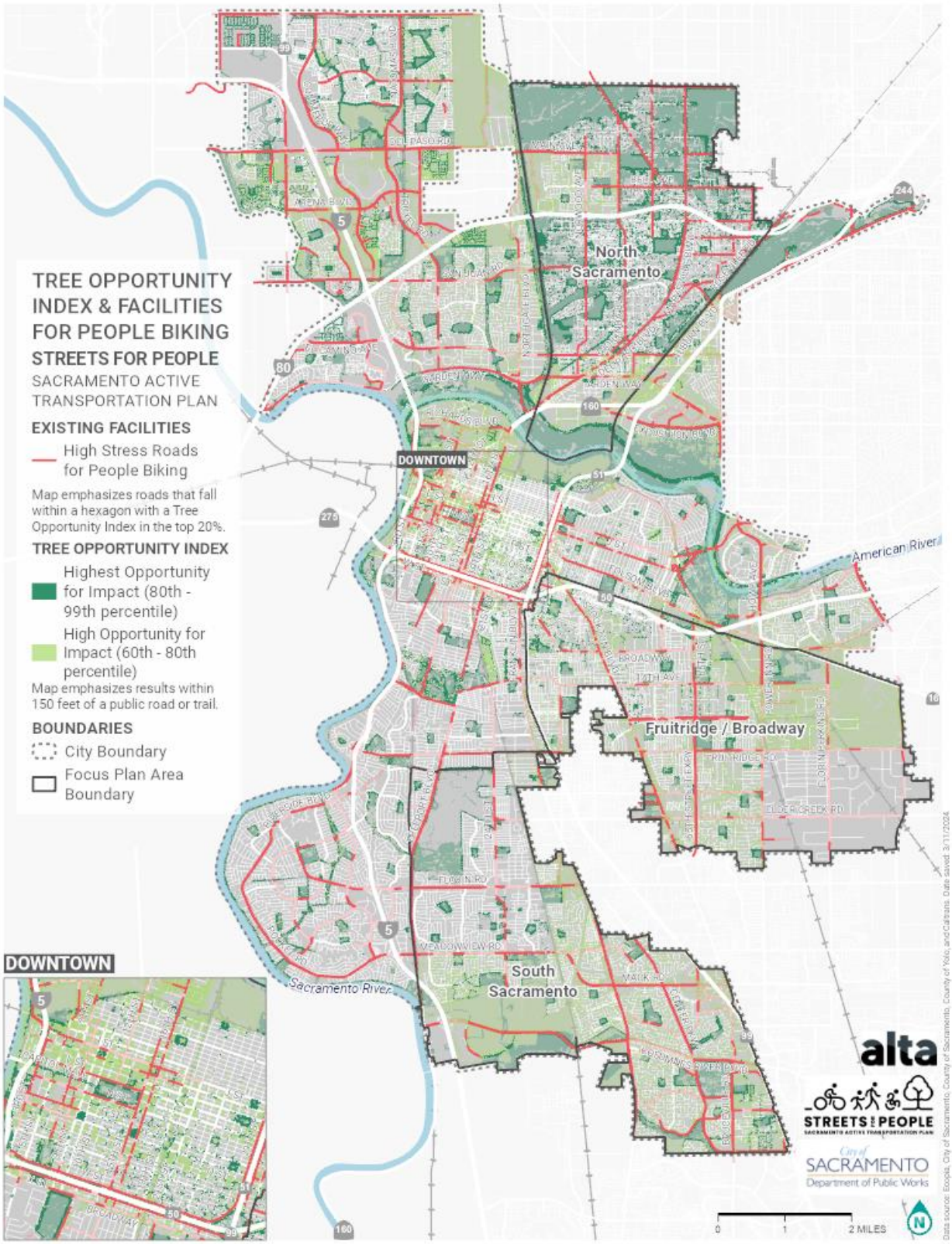


Figure 21. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets (Northwest Sacramento)

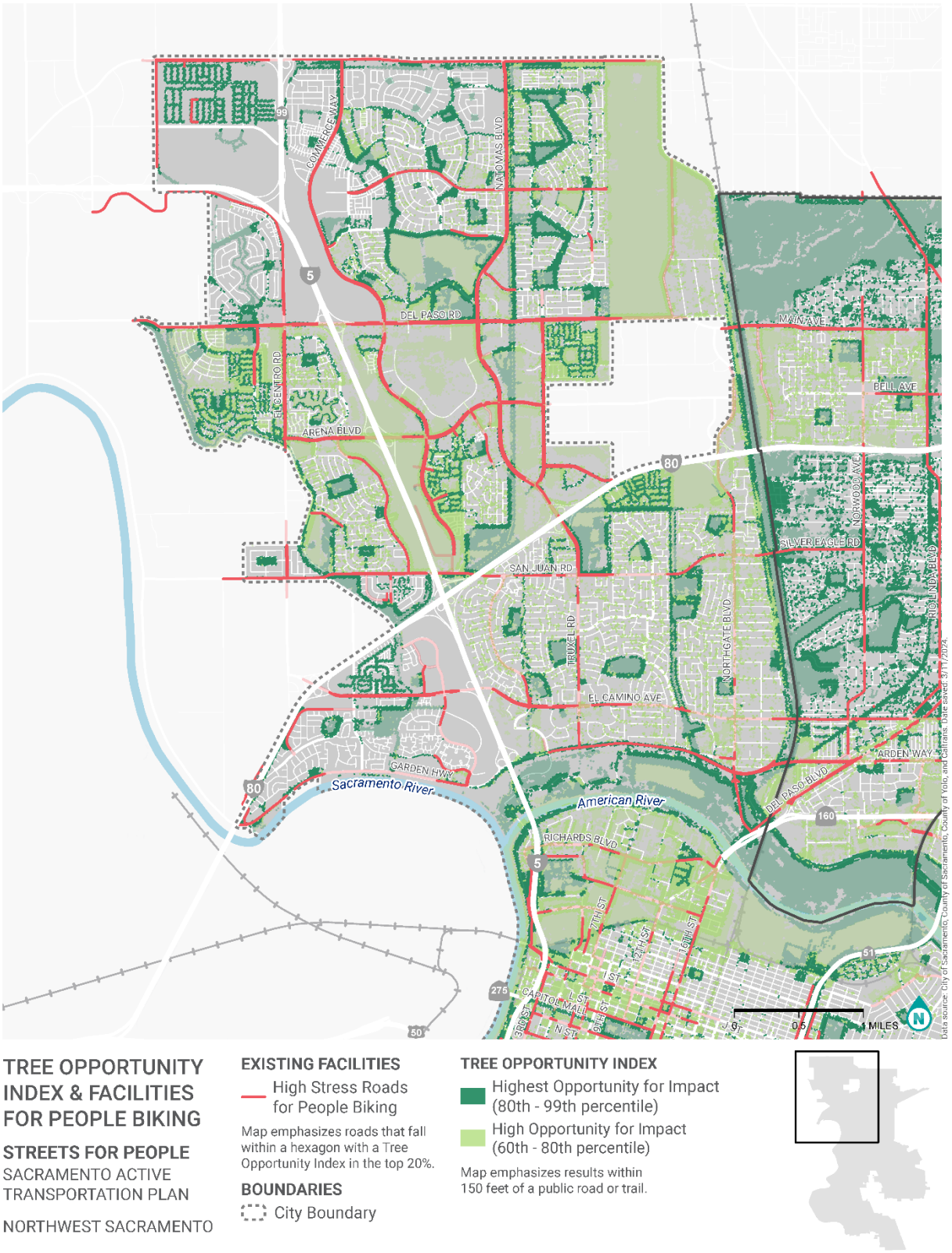


Figure 22. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets (North Sacramento)

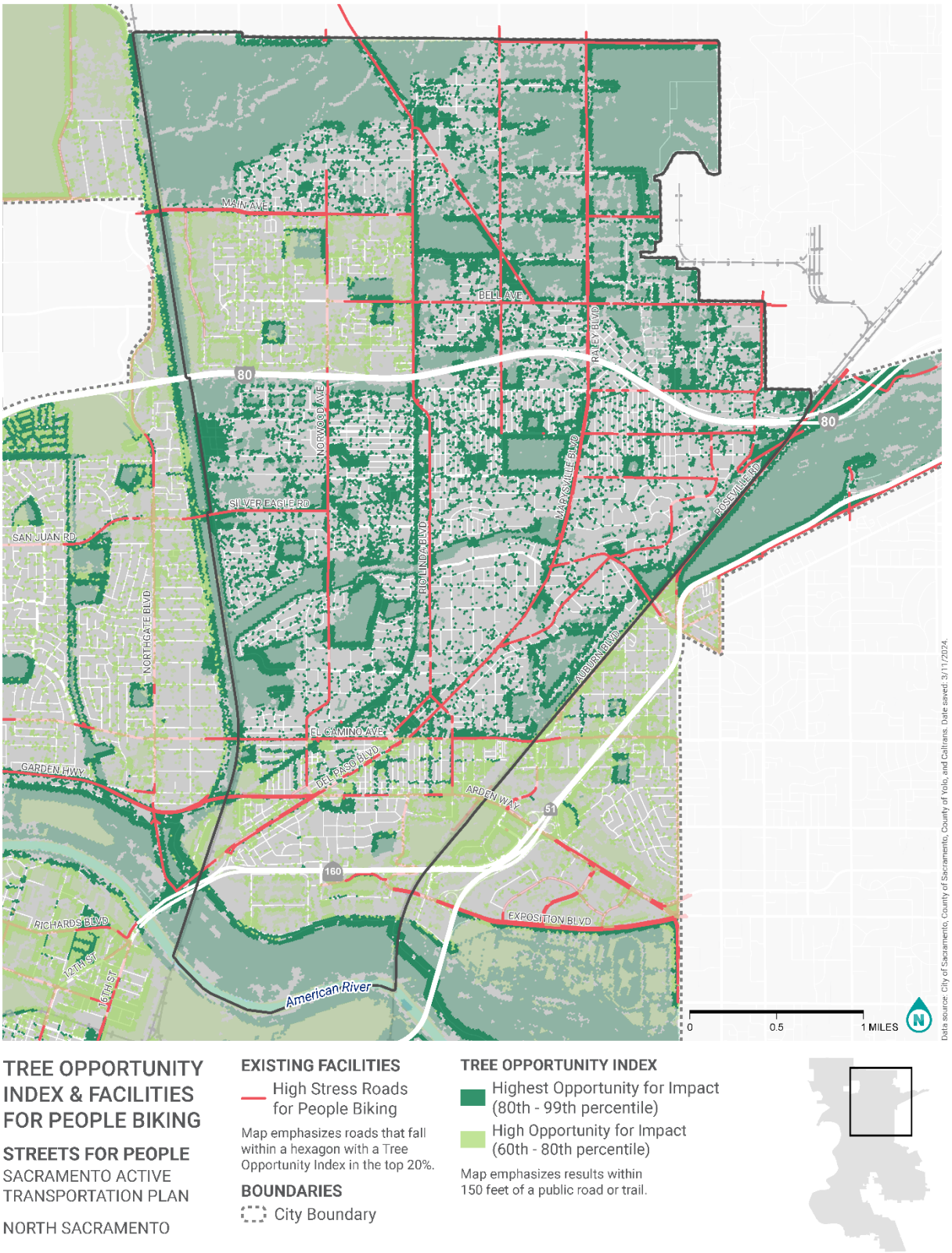
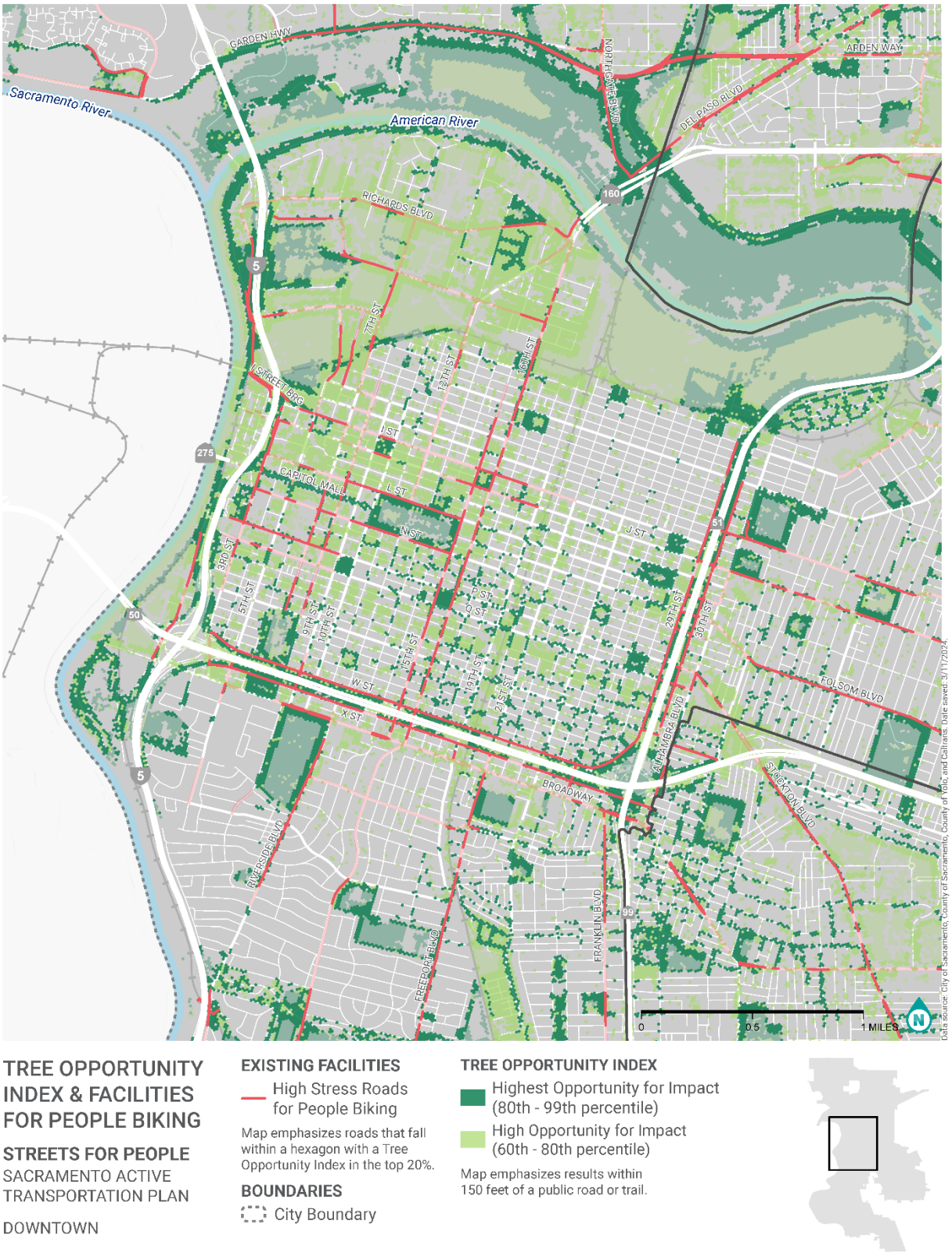


Figure 23. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets (Downtown)



TREE OPPORTUNITY INDEX & FACILITIES FOR PEOPLE BIKING

STREETS FOR PEOPLE
SACRAMENTO ACTIVE TRANSPORTATION PLAN

DOWNTOWN

EXISTING FACILITIES

High Stress Roads for People Biking

Map emphasizes roads that fall within a hexagon with a Tree Opportunity Index in the top 20%.

BOUNDARIES

City Boundary

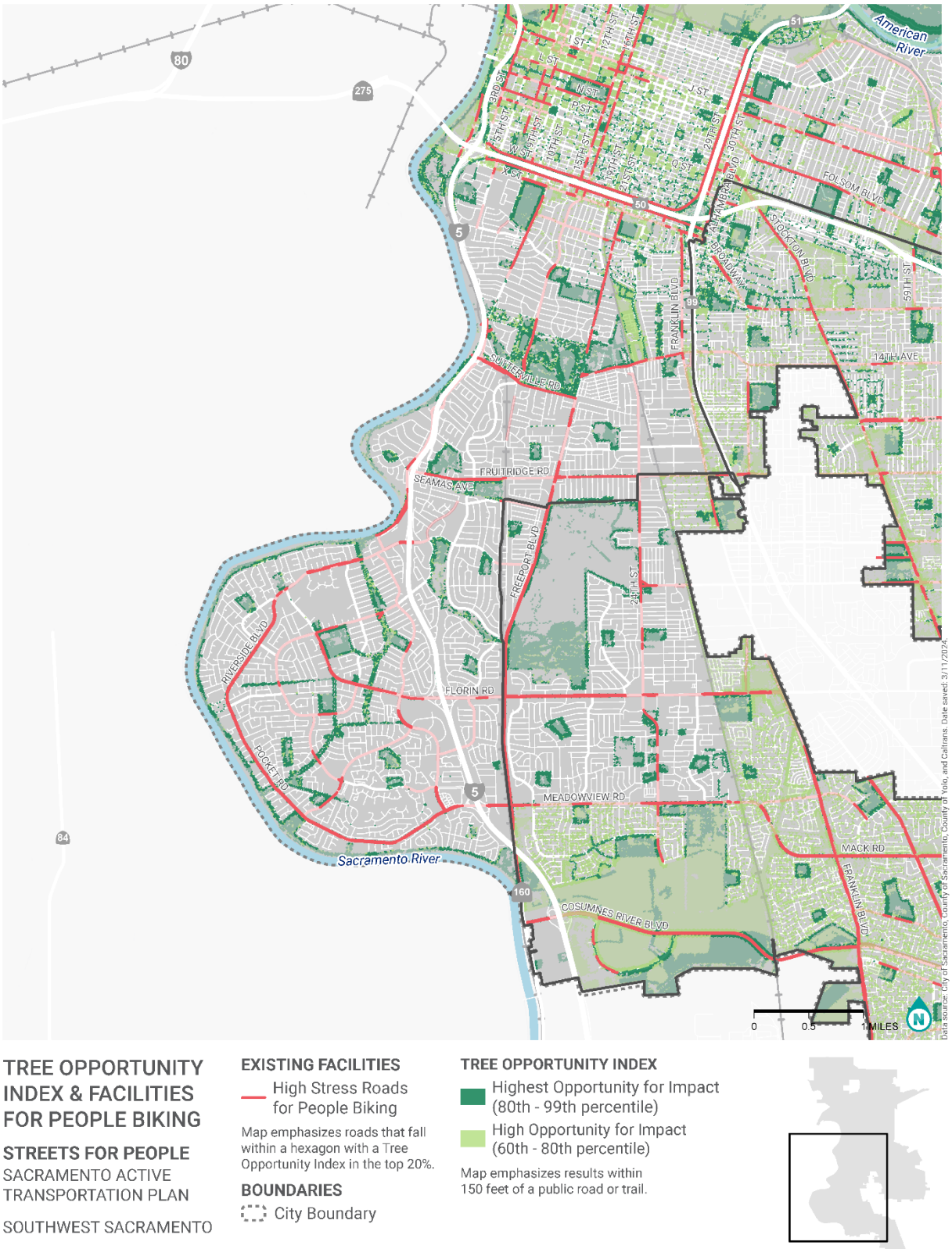
TREE OPPORTUNITY INDEX

Highest Opportunity for Impact (80th - 99th percentile)

High Opportunity for Impact (60th - 80th percentile)

Map emphasizes results within 150 feet of a public road or trail.

Figure 24. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets (Southwest Sacramento)



TREE OPPORTUNITY INDEX & FACILITIES FOR PEOPLE BIKING

STREETS FOR PEOPLE
SACRAMENTO ACTIVE TRANSPORTATION PLAN

SOUTHWEST SACRAMENTO

EXISTING FACILITIES
- High Stress Roads for People Biking

Map emphasizes roads that fall within a hexagon with a Tree Opportunity Index in the top 20%.

BOUNDARIES
- City Boundary

TREE OPPORTUNITY INDEX
- Highest Opportunity for Impact (80th - 99th percentile)
- High Opportunity for Impact (60th - 80th percentile)

Map emphasizes results within 150 feet of a public road or trail.

Figure 25. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets (Fruitridge/Broadway)

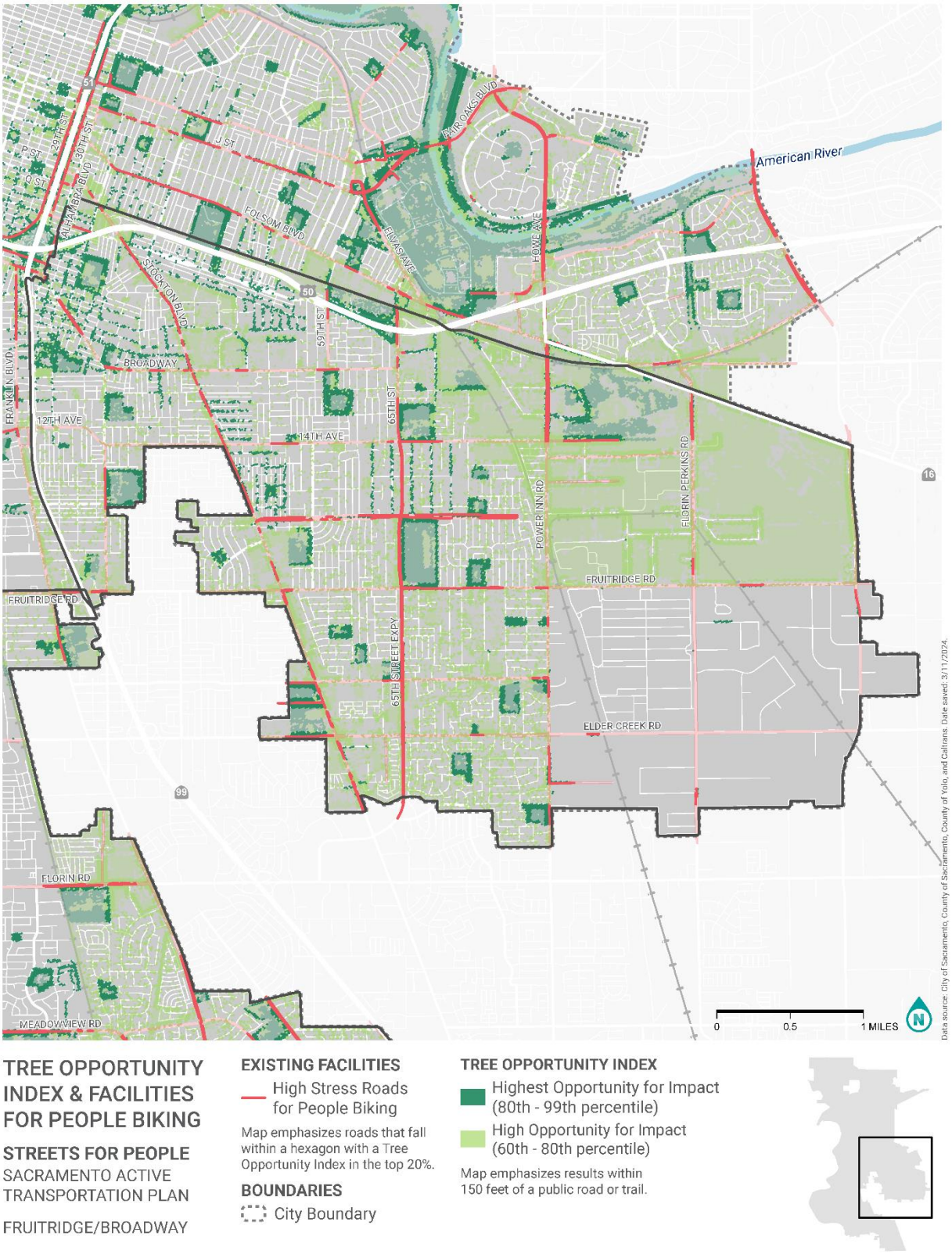
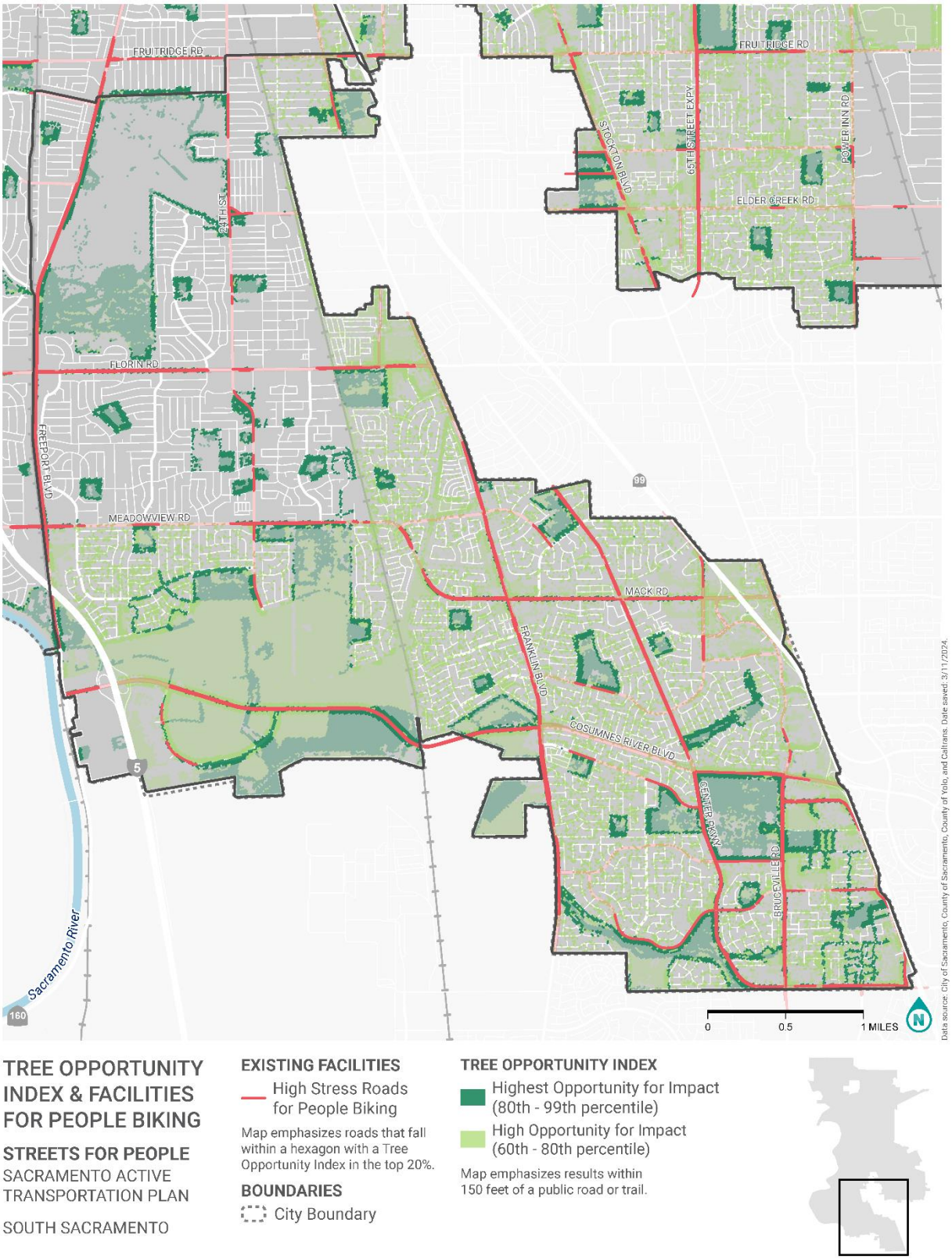


Figure 26. Areas of High Tree Opportunity with Existing Facilities for People Biking and High-Stress Streets (South Sacramento)



Conclusion

The findings point towards the necessity of a strategic approach to expanding the tree canopy, focusing on areas where it can provide the most benefit in terms of heat mitigation, environmental quality, and support for active transportation. There are areas where possible low-cost opportunities exist, but there are many areas of high need (i.e., low-tree canopy coverage, high heat exposure) that do not have open-planting locations for new tree planting. This was a common finding in equity focus areas within the city.

The identification of high-opportunity areas for tree planting, particularly in regions with substantial urban heat exposure and limited existing canopy coverage, underscores the potential for targeted initiatives to enhance urban resilience and active transportation infrastructure. Some land uses adjacent to the right of way including parks and school campuses had relatively high need and available planting areas that could be candidates for new tree canopy with appropriate coordination with relevant schools and agencies.

Next Steps

The validation and integration of data sources, including AI-derived tree canopy data, CHAT, and LiDAR land cover data, have laid a solid foundation for precise and informed decision-making, highlighting areas of need and potential for impactful tree planting, especially in the aforementioned Focus Areas (i.e., Fruitridge/Broadway, North Sacramento, and South Sacramento). Looking ahead, phase two of the analysis will pivot towards implementation, leveraging the Tree Opportunity Index to prioritize projects that align with the city's broader sustainability and active transportation goals, ensuring that future efforts are both strategic and impactful.

The analysis presented aligns with the goals set by the Sacramento 2040 General Plan's Implementation Actions of developmenting an Urban Forestry Plan (ERC-A-1) and updating Street Standards for Tree Canopy expansion (ERC-A.11)[19]. The findings indicate there are some opportunity areas for the city to leverage, but updating design standards to discuss an evaluation process on what to do in areas with high amounts of hardscape will be required to further advance key objectives of expanding city's tree canopy coverage.

Following the development of recommendations for the *Streets for People: Sacramento Active Transportation Plan*, Alta will identify recommended projects that align with tree planting opportunities and assign points based on their average TOI score. These results will be used to identify projects where active infrastructure improvements and tree planting can align with the City's sustainability investments. This integration may also inform a set of recommendations specifically targeting vegetation and tree planting enhancements.

[19] City of Sacramento 2040 General Plan. (2024) https://www.cityofsacramento.gov/community-development/planning/major-projects/general-plan

Appendix

Appendix A - Review of Analysis Inputs

This appendix delineates the analytical foundation laid by three pivotal data sources: AI-derived tree canopy and planting areas, the California Heat Assessment Tool (CHAT) for assessing heat vulnerability, and the City of Sacramento's LiDAR land cover data. It succinctly outlines the datasets and details the validation effort taken of AI-generated data against city datasets and aerial imagery to ensure its relevance for to the analysis.

Analysis Inputs

The three major data sources included in this analysis come from the following sources:

- AI Derived Tree Canopy and Planting Areas data20 – Tree Canopy & Planting Areas
- California Heat Assessment Tool (CHAT) – Heat Vulnerability and Predicted Extreme Heat Events
- City of Sacramento – LiDAR Land Cover

This section describes each dataset and highlights the efforts undertaken by Alta to validate the AI-derived data.

AI Derived Tree Canopy and Planting Areas

This analysis relies on a data source that uses artificial intelligence (AI) to identify and extract spatial data features from high resolution aerial imagery. This analysis leverages AI-derived data to identify the existing tree canopy, sidewalk planter boxes (vegetated area between the sidewalk and the road), and vegetated medians. The data product also identifies the width of the planting areas. The AI-derived data is shown in Figure 27.

Data Validation

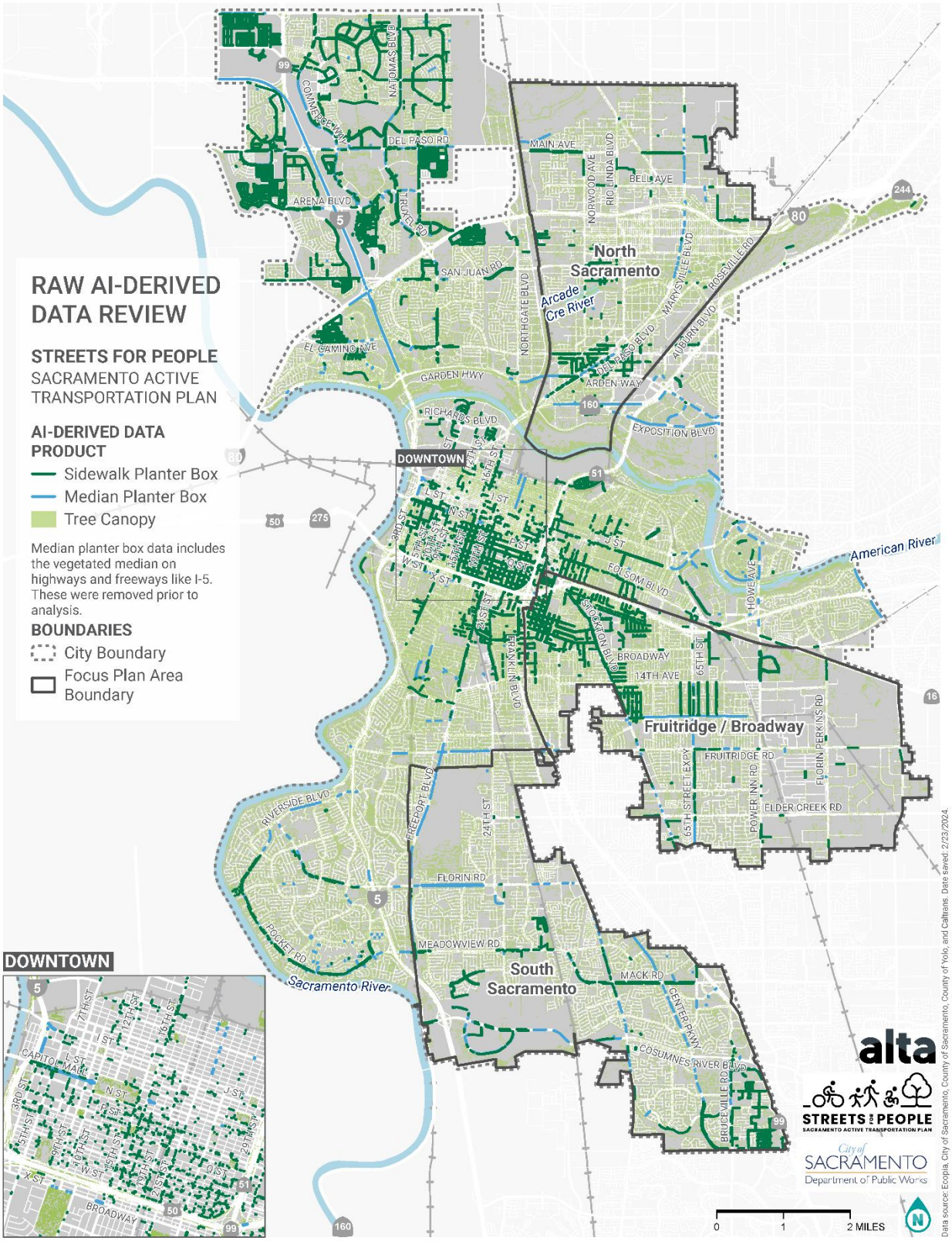
Alta reviewed the AI-derived data and compared it to City provided datasets and aerial imagery to evaluate its accuracy. This section describes the methods and findings of this validation effort.

Planting Areas

AI-derived data was the only data source available for the location and width of medians with planting opportunities. With no equivalent city data source to validate against, Alta used aerial imagery to quality check the provided data for presence and measured width of the medians. AI-derived data provides width in meters which we converted and rounded to the nearest foot. The widths documented in the AI-derived data inventory are consistently within a foot of the width when measured from aerial imagery sources. In general, our review for presence did not discover any errors of omission for planted medians.

[20] Ecopia https://www.ecopiatech.com/

Figure 27. Raw AI-Derived Data



Sidewalk Planting Areas

The sidewalk inventory provided by the City of Sacramento indicates those with planter boxes between the sidewalk and the street, but no information on the width of the planting area. Alta used this inventory to validate the location of sidewalk planting areas identified in the AI-derived data. A comparison of the sidewalk planting areas identified by the city inventory and in the AI-derived data is shown in **Figure 28**. The city inventory tends to overestimate the planting areas available, typically by assigning planter boxes to the entire block of sidewalk, when the planting areas may only exist on a portion of the block or be restricted by driveways. However, AI-derived data tends to underestimate the available planting areas, primarily in areas where there are many trees that obstruct the view of the ground. Because of the analysis design, these missing planting areas do not impact the outcome of the analysis, because they would have been removed during scoring anyway given that they already have trees planted in them. The Alta team recommends that this dataset not be treated as a complete inventory but as a point of comparison with existing inventory efforts conducted by the City.

Figure 28. Comparing AI Derived data and Existing Sidewalk Planter Box Data from City

Tree Canopy Data

This analysis used tree canopy data from AI-derived data to identify the existing tree canopy coverage and filter tree planting locations to exclude those that already have trees. Alta compared the results of the AI-derived tree canopy extraction to the LIDAR data collected in 2016 as a quality check. Figure 29 shows a sample of the AI-derived data extraction in green, overlaid with the LIDAR tree canopy land classification data in yellow. In general, there is alignment in the identification of tree canopy between the two data sources. There are 19 square miles of tree canopy identified in the LIDAR inventory and 16.2 square miles identified in the AI-derived data. About three-fourths of the AI-derived canopy overlaps with the tree canopy identified in the LIDAR inventory. The AI-derived data, conducted in 2023, is more recent than the 2016 LIDAR inventory and captures recently planted trees like those shown in Figure 29 along the median on Pocket Road. Additionally, the AI-derived data captures the growth and expansion of the tree canopy from young trees that grew over the past seven years since the LIDAR inventory was conducted. The LIDAR inventory is often more generous at classifying the area between trees as canopy, whereas AI-derived data will distinguish the individual trees. This could account for most of the discrepancy between the area of coverage as both the data sources and methods of classification between AI-derived data and the LIDAR data vary so much.

Figure 29. LIDAR and AI-Derived Tree Canopy Data Comparison

California Heat Assessment Tool

The California Heat Assessment Tool (CHAT) is a publicly funded resource aimed at public health practitioners that provides census tract level data on heat vulnerability and future extreme heat events. This analysis uses two CHAT data products: predicted future heat health events (urban heat exposure) and urban-rural temperature delta (urban heat island effect). Future heat health events are estimated using a large-scale climate model for the year 2040, based on climate change projections. Urban-rural temperature delta is based on historic data from 2015 provided by the California Environmental Protection Agency. Figure 30 shows urban heat exposure data provided by CHAT at the census tract level.

LIDAR Land Cover

Sacramento has a LIDAR land cover dataset collected from aerial imagery in 2016 at a 1-meter resolution. Each square cell is classified based on the land cover type covering most of the cell. Figure 31 shows the grass and low-lying vegetation layer that is used to identify pervious areas that could currently support new tree plantings in off-street locations, and the tree canopy data that was used to validate the AI-Derived tree canopy data.

Figure 30. California Heat Assessment Tool (CHAT) Data Review

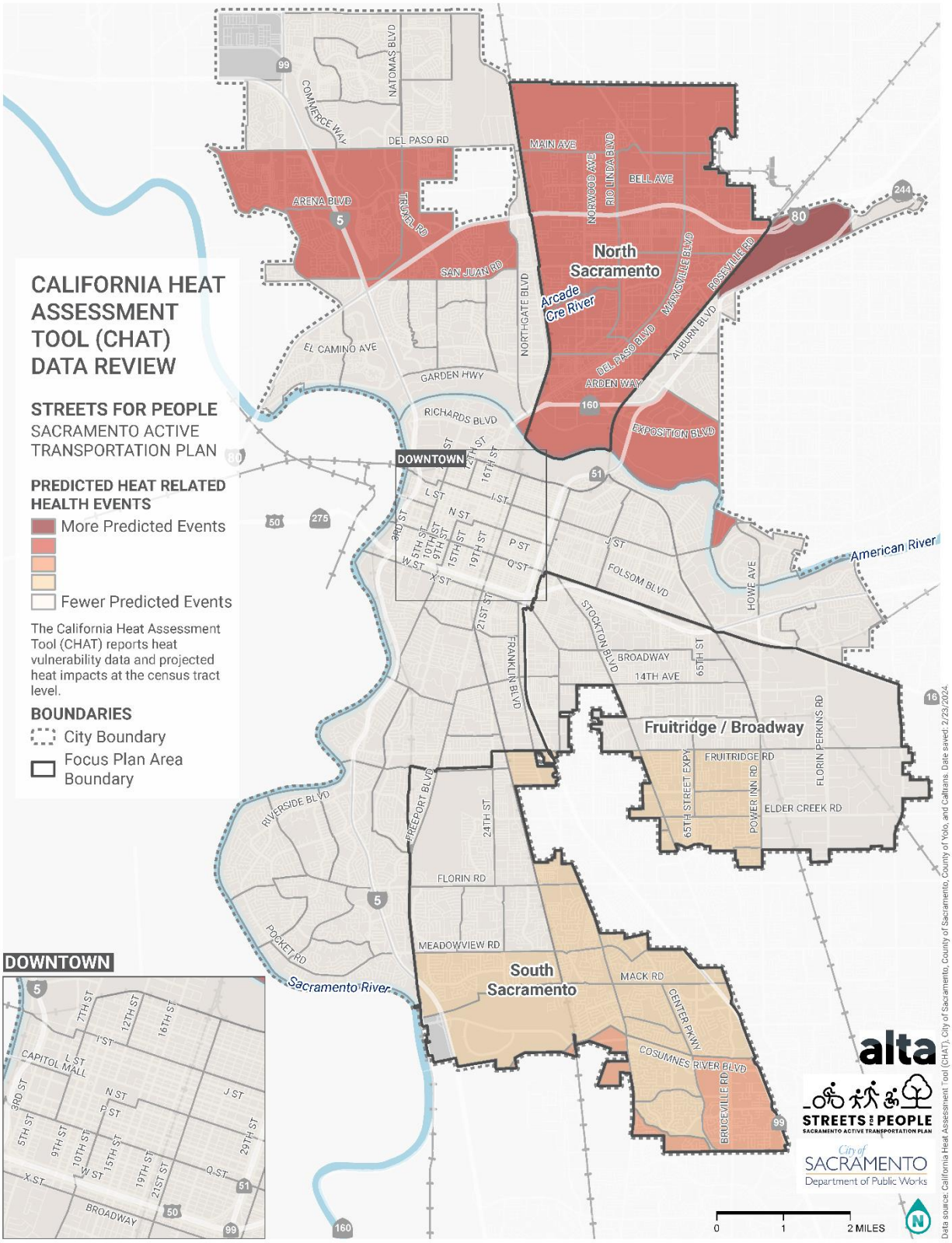


Figure 31. LIDAR Land Cover Data Review