

A stylized graphic of a sun and moon. The sun is on the right, with rays extending towards the left. The moon is on the left, with a crescent shape. The background is a light yellow color with a gradient.

APPENDIX C

Needs Assessment Memo

To: David Stillman, Transportation Manager, City of Cupertino
Matthew Schroeder, Senior Transit and Transportation Planner, City of Cupertino

From: Christopher Kidd, George Foster, David Wasserman, Cyrus Chimento, Kim Voros, and Jesús Contreras, Alta Planning + Design

Date: July 11, 2025

Re: Cupertino ATP: Needs Assessment Chapter

Introduction

Project Description

The Cupertino Active Transportation Plan (ATP) seeks to advance mobility for people walking, rolling, and biking in Cupertino. The ATP builds from the 2016 Bicycle Transportation Plan, the 2018 Pedestrian Transportation Plan, and the 2024 Vision Zero Action Plan – among others.

The Needs Assessment Chapter represents all the spatial analysis conducted by Alta as part of the Existing Conditions Phase of the project. The Needs Assessment Chapter aims to understand the underlying conditions of the transportation system, the demand for active transportation within Cupertino, and where future investments in the active transportation network might result in the largest benefits to people traveling within Cupertino.

Memo Overview

This memo and the analysis contained within will directly inform, in tandem with public input, the development of project recommendations and the prioritization of projects for implementation. This memo covers the following topics:

- [Summary of Findings](#)– overview of analysis and report
- [Network Comfort](#) – summary of analysis for the level of traffic stress for people walking and people biking
- [Active Trip Potential](#) – summary of analysis for trips under 5 miles taken by car that could potentially be made using active transportation
- [Stress-Adjusted Short Trips](#) – summary of analysis for where the most pressing network gaps exist, quantifying the number of potential active trips and the level to which those trips are deterred by uncomfortable roadway conditions.

Summary of Findings

The City of Cupertino has a high potential for additional active trips within the City, as more than 30% of all trips starting or ending within the City are less than 5 miles in distance. These are trips that could potentially be converted to walking, biking, or e-bike trips. However, to convert these trips to active modes, roadway users must first feel safe and comfortable enough to try modes other than driving.

The quality of the walking and biking network is a substantial determinant when people decide whether to take trips by walking or biking. The Bicycle Level of Traffic Stress (BLTS) and Pedestrian Level of Traffic Stress (PLTS) quantify the experience of a typical roadway user based on the conditions of the roadway.

The BLTS analysis found that most of Cupertino's major streets rank as LTS 3 or 4: streets with a high level of traffic stress that few residents would feel comfortable riding a bike on. Notable exceptions are locations where separated bikeways have been installed by the City, such as McClellan Road, Bubb Road, and Stevens Creek Boulevard.

The PLTS analysis found that major roadways have a high level of traffic stress for pedestrians across Cupertino, although this has sometimes been mitigated by new development that has built wider sidewalks with greater setbacks from the roadway. Many local neighborhood streets in western Cupertino lack sidewalks, which also increases the level of traffic stress for people walking.

Analysis of trips under 5 miles taken by driving (Active Trip Potential – ATP) shows a high volume of trips along the Stevens Creek Blvd corridor. The corridor is home to much of the City's commercial spaces, and many community destinations (such as Cupertino Library, De Anza College, and Quinlan Community Center) are located just to the north or south of the corridor.

Combining the BLTS/PLTS analysis with ATP analysis, the Stress-Adjusted Short Trips (SAST) analysis identifies the largest gaps in the network for people walking or biking, as well as the locations with the highest potential to generate walking and biking trips if new infrastructure were constructed. This analysis identifies the Stevens Creek Boulevard corridor as the area with the highest potential for new walking and biking trips, especially in proximity to De Anza College in the west and near the Rise (Former Vallco Town Center) area in the east.

Network Comfort

Level of comfort is an important consideration for where people walk, bike, or roll. Comfort can impact a user's willingness to travel, perceived distances, and perceived safety. To understand the level of comfort for different users and abilities, Alta conducted level of traffic stress (LTS) assessments that separately measured the pedestrian and bicycle comfort of each street and trail (Class I shared-use paths) in the City. For these analyses, Alta utilized City of Cupertino roadway data, dividing street segments where facilities or roadway conditions changed mid-block. LTS scores were determined by characteristics of a given roadway segment that affect a user's perception of safety and comfort. These analyses helped identify segments that represent the highest barriers to walking, biking, and rolling based on users' ability and comfort level.

The following section provides a summary of the findings for each analysis. Additional details on the methodologies used to calculate these analyses can be found in **Appendix A: Level of Traffic Stress Methodology**, **Appendix B: Active-Trip Potential Methodology**, and **Appendix C: Stress-Adjusted Short Trip Methodology**.

Pedestrian Level of Traffic Stress

The pedestrian level of traffic stress (PLTS) methodology used for this analysis was adapted from the Oregon Department of Transportation’s Analysis Procedures Manual¹ and was intended as a companion for the BLTS analysis. PLTS was determined by characteristics of a given roadway segment that affect the perception of safety and comfort for a person walking, including sidewalk presence and width, sidewalk buffer width and type, posted speed limit, and number of travel lanes. **Appendix A: Level of Traffic Stress Methodology** includes a more detailed description of the PLTS methodology. PLTS scores classify road segments into one of four levels of traffic stress, and like BLTS scores, PLTS considers the level of attention required in addition to the user experience, as shown in **Figure 1**.

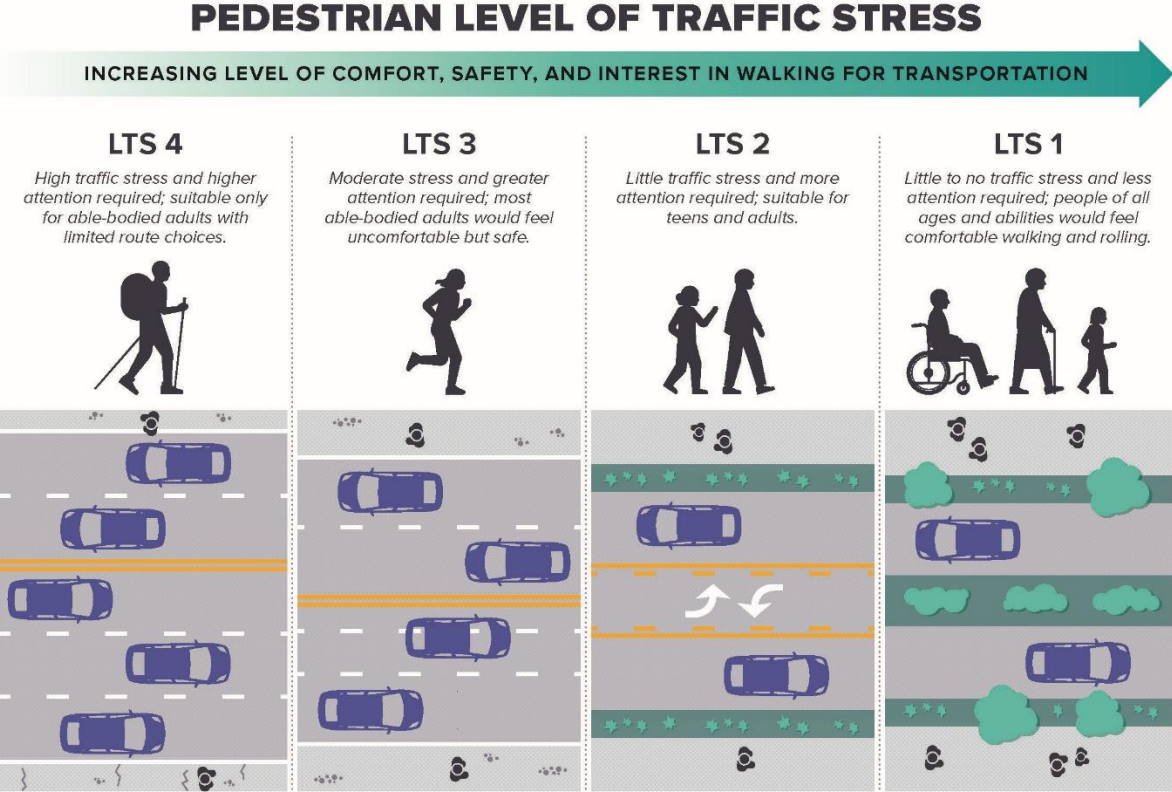


Figure 1: Pedestrian Level of Traffic Stress

¹ Oregon Department of Transportation. 2020. Analysis Procedures Manual Version 2. Transportation Development Division Planning Section: Transportation Planning Analysis Unit. <https://www.oregon.gov/odot/Planning/Pages/APM.aspx>

Findings

Similar to the results from the BLTS analysis, the PLTS analysis showed that many major roadways also represent high-stress environments for people walking and rolling, as shown in **Figure 2**. While many of these roadways include six-foot sidewalks on both sides, their lack of a buffer (space between people walking and motorists), faster speeds (i.e., posted speed limits over 30 MPH), and wider roadway widths (up to 8 lanes in some segments) detract from their LTS score. Some specific examples of higher-stress roadways include Wolfe Road, De Anza Boulevard, Homestead Road, and where Stevens Creek Boulevard crosses Highway 85. A few streets, notably Foothill Boulevard, not only have high speed limits and multiple lanes, but also an incomplete sidewalk network. Mary Avenue, an LTS 1 street for Bicycle LTS, is LTS 3 in its south-central portion due to missing sidewalks on one side of the street. Similarly, Bubb Road is missing sidewalks on both sides of the street in its northern portion, scoring an LTS 4 for pedestrians.

A substantial portion of local streets, especially in western Cupertino, have incomplete sidewalks or are missing sidewalks on one side of the street. These otherwise LTS 1 streets are shown on this map as LTS 2.

The Regnart Creek Trail and the Stevens Creek Trail provide essential low-stress routes for pedestrians, connecting to community destinations like the Cupertino Library. Areas which have received new development, such as Homestead Road or Steven Creek Boulevard (both between Wolfe Road and Tantau Avenue), have a low level of pedestrian traffic stress (LTS 2) due to the broad setback from the roadway, landscaped buffers, and wide sidewalks.

It is important to note that throughout various parts of the City, major roads are often the only connection to destinations. Stressful conditions experienced along these roads act as a barrier to walking and rolling, hindering connectivity within and across neighborhoods of the City. Furthermore, the far spacing between traffic signals along many of these major roads creates overly long walking paths for pedestrians to cross the street, furthering their exposure to high-stress conditions. Full results of the PLTS analysis are shown in **Figure 2**.

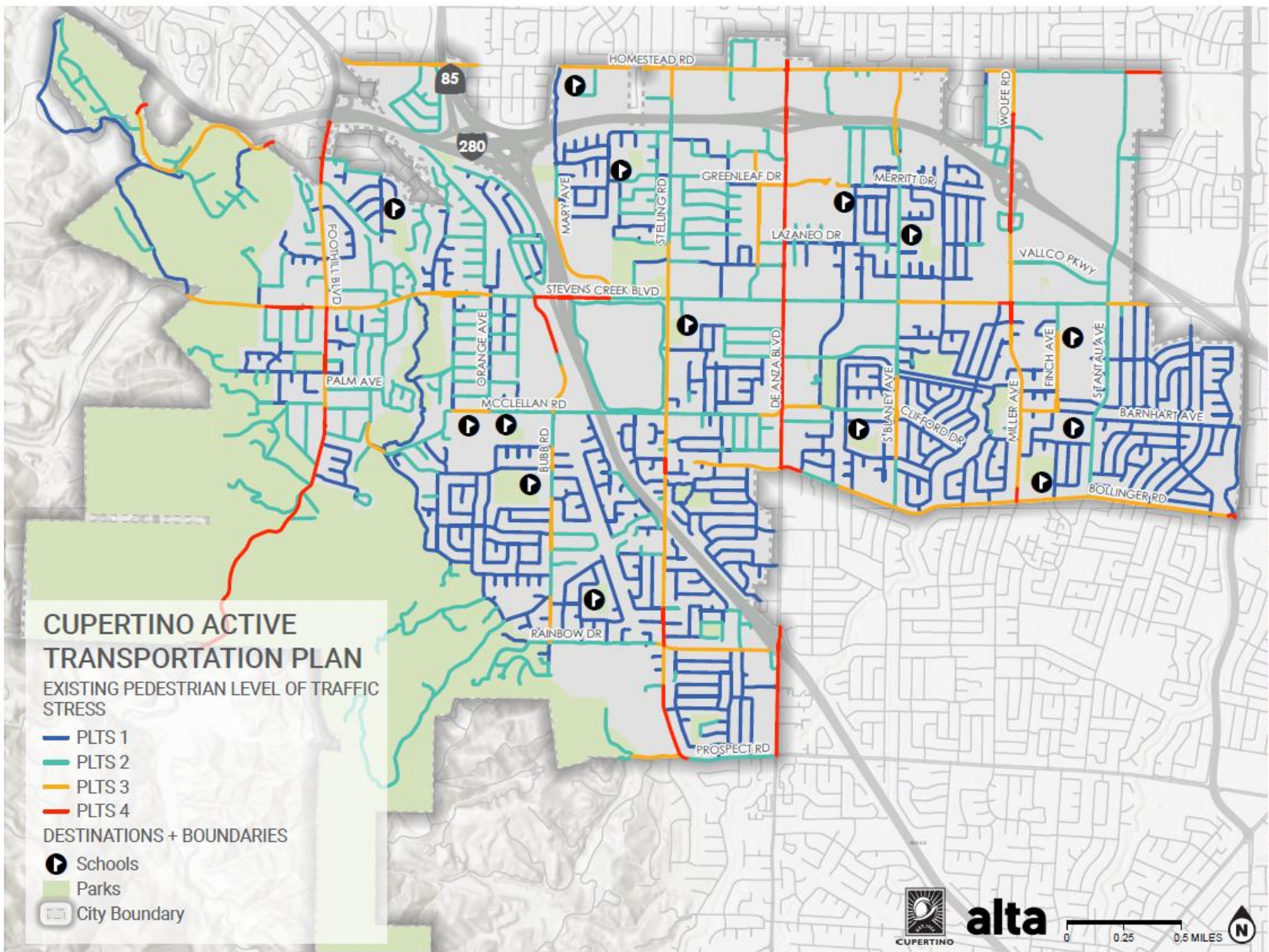


Figure 2: City of Cupertino Pedestrian Level of Stress Analysis

Bicycle Level of Traffic Stress

The bicycle level of traffic stress (BLTS) methodology used for this project is adapted from the 2012 Mineta Transportation Institute Report 11-19: Low-Stress Bicycling and Network Connectivity² and from research by Peter Furth³. BLTS was determined by roadway factors including posted speed limit, number of travel lanes, presence and width of parking lanes, as well as the presence and type of bicycle facility. **Appendix B: Level of Traffic Stress Methodology** includes a detailed description of the BLTS methodology. The combination of these criteria classifies a road segment into one of four levels of traffic stress, as shown in **Figure 3**. Interstate 280 and Highway 85, as limited-access roadways that do not allow for bicycle or pedestrian travel, were not scored for this analysis.

As noted in **Appendix B: Level of Traffic Stress Methodology**, there are various factors that influence the BLTS scores of a particular corridor. These include the presence (or lack thereof) of bicycle facilities, posted speed limits, the presence and width of on-street parking adjacent to bicycle facilities, the number of travel lanes of the corridor, and the presence of trails. For example, the BLTS score of a corridor that includes an existing Class II bike lane can be negatively influenced by the higher number of travel lanes (8 lanes) and higher posted speed limit (40 MPH). This is the case with De Anza Boulevard. Similarly, a corridor with no bicycle facilities and lower posted speed limits (25 MPH) may receive a higher (LTS 1 or 2) BLTS score. This is the case with Byrne Avenue between McClellan Road and Stevens Creek Boulevard.

² Mineta Institute. Mekuria M., Furth P., Nixon H. *Low-Stress Bicycling and Network Connectivity*. 2012. <https://transweb.sjsu.edu/research/Low-Stress-Bicycling-and-Network-Connectivity>

³ Furth, P. *Level of Traffic Stress*. 2012. <https://peterfurth.sites.northeastern.edu/level-of-traffic-stress/>

BICYCLE LEVEL OF TRAFFIC STRESS

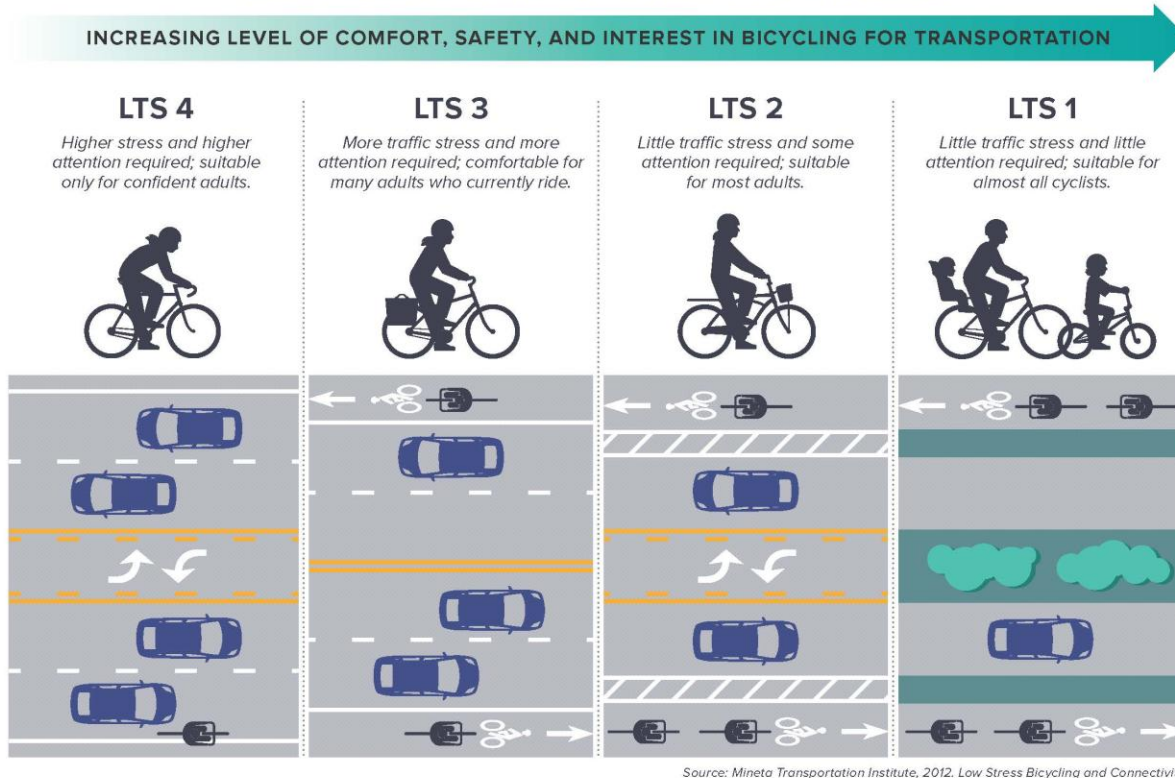


Figure 3: Bicycle Level of Traffic Stress

Findings

The BLTS analysis results showed that most major roadways in Cupertino, shown in orange and red (LTS 3 and 4, respectively) in **Figure 4**, represent high-stress environments for people biking, despite the presence of Class II bike lanes on many roadways. For example, Homestead Road, De Anza Boulevard, Wolfe Road, and Stevens Creek Boulevard, all arterial streets with existing Class II bike lanes, include a posted speed of 35 MPH or higher, which negates the presence of the bicycle facility and contributes to higher-stress for most people biking. Similarly, major Collector roadways such as Bollinger Road, Miller Avenue, or Foothill Boulevard also display a high level of traffic stress. Another area of high-stress is at freeway interchanges: De Anza Boulevard, Wolfe Road, Stevens Creek Boulevard, and Foothill Boulevard all show LTS 4 where they cross a set of off-ramps and on-ramps.

Conversely, Arterials and Collector streets with separated bikeways, such as Stevens Creek Boulevard (Wolfe Rd to Tantau Ave), McClellan Road, and Bubb Road, all show very low levels of traffic stress (LTS 1) for people riding bikes. Through the implementation of the 2016 Bike Plan, the City has begun to stitch together lower-stress east/west and north/south routes through Cupertino, aligning with the grid patterns of the City's street network. The Mary Avenue Bridge and the Class II bike lanes on Stelling Road provide low-stress connections over Interstate 280. McClellan Road provides an LTS 1 crossing of Highway 85 and connects to the LTS 1 Regnart Creek Trail further to the east.

Local roads provide more comfortable travel within neighborhoods (LTS 1 and 2), shown in blue and teal, while shared-use paths such as the Regnart Creek Trail provide separation and low-stress east-west alternatives to higher-stress roadways. The lack of connected low-stress corridors in parts of the City means that many trips require traveling on high-stress streets or stitching together indirect routes on low-stress streets. This increases travel times and may inhibit bicycling.

The development pattern of Cupertino is a typical superblock suburban pattern, with very few signalized cross streets of major roadways. This limits the ability to develop a network of local roads as an alternative to improving LTS conditions on major roadways.

Considerations

As previously noted, BLTS scores provide a data-driven assessment of existing roadway conditions for people bicycling. To improve BLTS scores, a jurisdiction may consider implementing buffers or physical barriers to create more separation between traffic lanes and bike lanes, reducing speed limits, or eliminating on-street parking, whenever feasible. For example, the BLTS score for roadways like Foothill Boulevard (BLTS 4 corridor) may be improved by implementing buffer areas with vertical delineators to create more separation between motorists and people biking. Similarly, corridors with Class II bike lanes with lower BLTS scores (BLTS 3 or 4) may improve their scores by ensuring that the bike lane is at least six feet wide and reducing roadway speeds to no more than 25 MPH when a parking lane is present or 30 MPH when a parking lane is not present. Finally, shared streets with no dedicated bicycle facilities can also achieve an LTS 1 when the speed limit does not exceed 25 MPH. Additional information on thresholds can be found in Appendix B: Level of Traffic Stress Methodology.

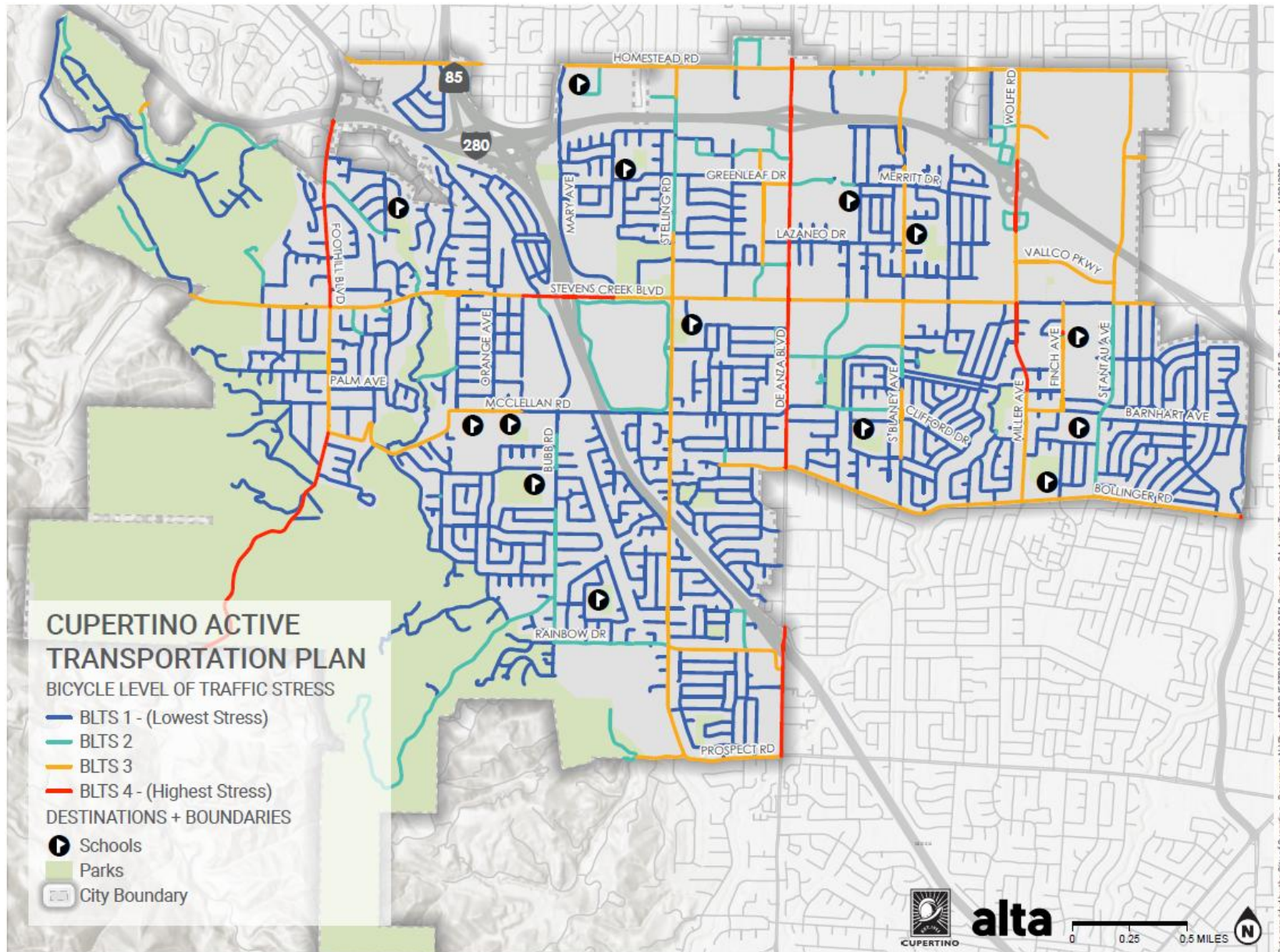


Figure 4: City of Cupertino Bicycle Level of Traffic Stress Analysis

Active-Trip Potential

Sustainable and active transportation is a key part of a climate strategy that involves reducing carbon emissions from transportation. Active modes often fill first- and last-mile gaps for transit trips and, on their own, may provide more flexibility for short trips that are not well-served by transit. Understanding demand for active transportation can help the City of Cupertino guide growth and development to support sustainable transportation by identifying areas where latent demand for active transportation may exist. Active-trip potential measures the proportion of all trips that may reasonably be made by active modes—like walking, biking, rolling, or e-micromobility—in a particular area. As trip distance is an important factor in mode choice, for this analysis, Alta made assumptions about reasonable distances for vehicle trips that could be replaced by walking, biking, rolling, and e-micromobility, based on trip distances from the 2022 National Household Travel Survey:

- Less than 1 mile – Walking
- 1 – 3 miles – Biking
- 3 – 5 miles – e-bikes or scooters

To this end, a neighborhood with high active-trip potential reflected a relatively larger percentage of trips beginning in that area that were under five miles. A neighborhood with lower active-trip potential reflected a greater percentage of longer trips beginning in that area. Areas of the City with a higher proportion of short trips are areas with the highest potential to convert vehicle trips to active trips. This analysis assumes that supportive infrastructure may encourage more people to convert short motor vehicle trips to active trips.

Alta completed this analysis using data from Replica Places⁴ in spring 2024. Alta accessed data on motor vehicle trips under five miles that either started or ended within Cupertino. Trips intersecting Cupertino were inclusive of driving trips on freeways and were thus excluded from the study dataset. This data is summarized to hexagons laid over the map of Cupertino, as low-density census block groups are irregularly shaped in western Cupertino and could skew the visualization of data. Using a hexagon system allowed for uniform visualization of trip patterns. Additionally, Alta accessed origin-destination data of vehicle trips under five miles to create the Flowmap (see below) of potential active-trip flows.

Findings

Alta created a [Flowmap](#) that visualizes potential active trips by origin-destination pair, represented as hexagons. **Figure 5** shows a screenshot for reference. The Flowmap displays the volume of vehicle trips by origin and destination that are short enough to be converted to active trips (under five miles). Thicker lines represent more trips between the origin and destination pair.

The analysis revealed particularly high numbers of short trips in and around the Stevens Creek Boulevard corridor, spanning from Tantau Avenue in the east to Highway 85 in the west. Highway 85 appears to be a general dividing line for active trip potential, as neighborhoods to the east of Highway 85 are denser and have more local destinations, while development west of Highway 85 is more dispersed with fewer nearby destinations. The area around the Apple headquarters in northeast Cupertino also shows the lowest potential for active trips, likely due to the high number of commuters traveling to and from work from outside the City.

⁴ <https://www.replicahq.com/>

The analysis also shows a high proportion of short trips in and around Homestead High School in the north. This may be partially attributed to the high rate of active modes used by students attending school, but could also be due to their open campus policy for lunch, which allows students to drive to nearby fast-food restaurants.

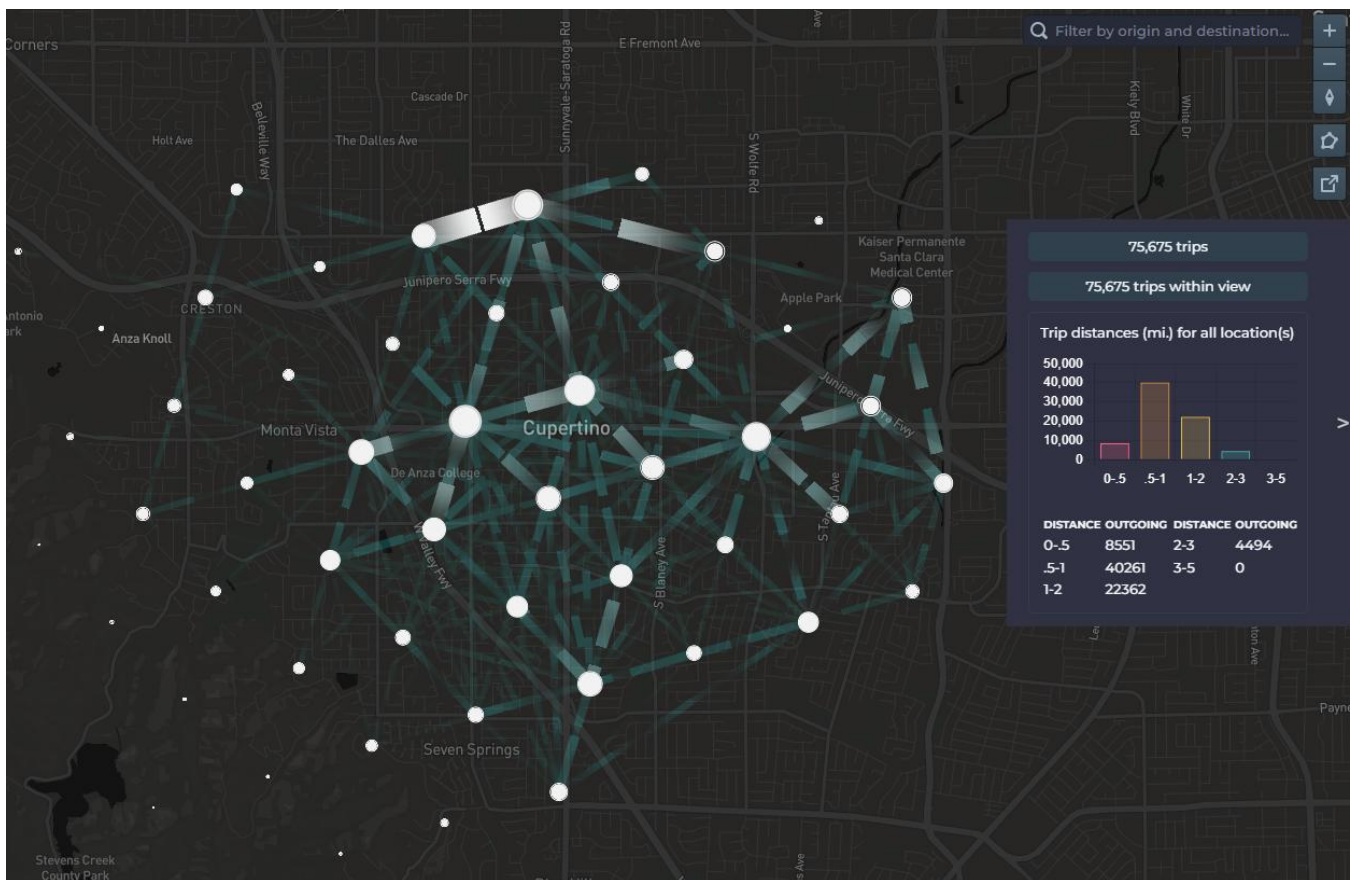


Figure 5: A screenshot of the Flowmap developed for the City of Cupertino

Active-trip potential measures the proportion of all trips that are short enough (less than five miles) to be made by walking, biking, rolling, or micromobility modes. Across Cupertino, 30% of vehicle trips that start or stop within the city limits are considered short enough to easily shift to active trips. As shown in **Figure 6**, areas of high active-trip potential are concentrated in central Cupertino, and active-trip potential steadily declines west of Highway 85. Active-trip potential for walking, biking, rolling, and e-bike/micromobility trips is shown in **Figure 7** through **Figure 9**. These areas of high active-trip potential indicate a potential need for more connected walking, biking, and rolling facilities, which would elevate the importance of any network gaps in these locations.

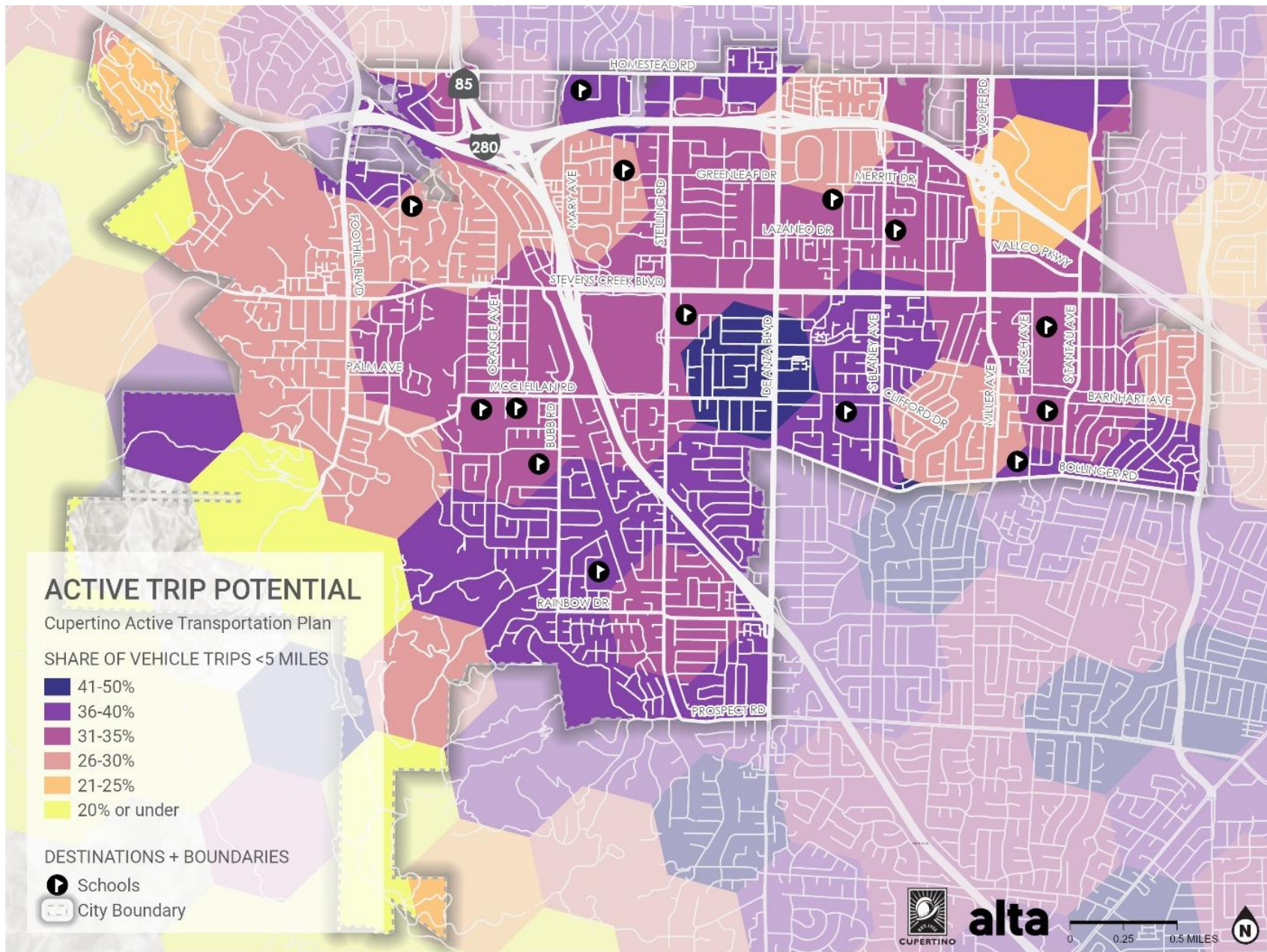


Figure 6: Active Trip Potential: All trips

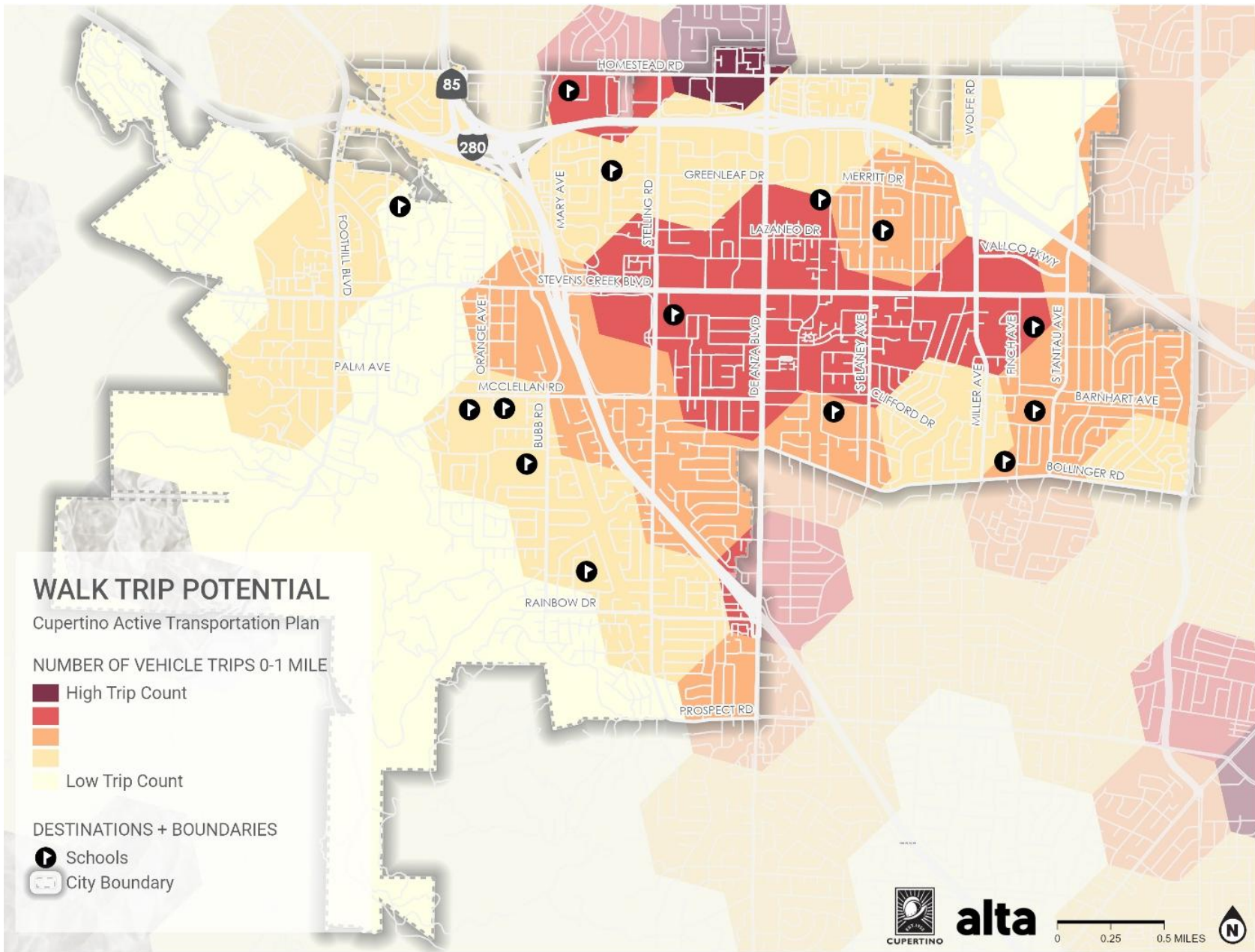


Figure 7: Walk Trip Potential

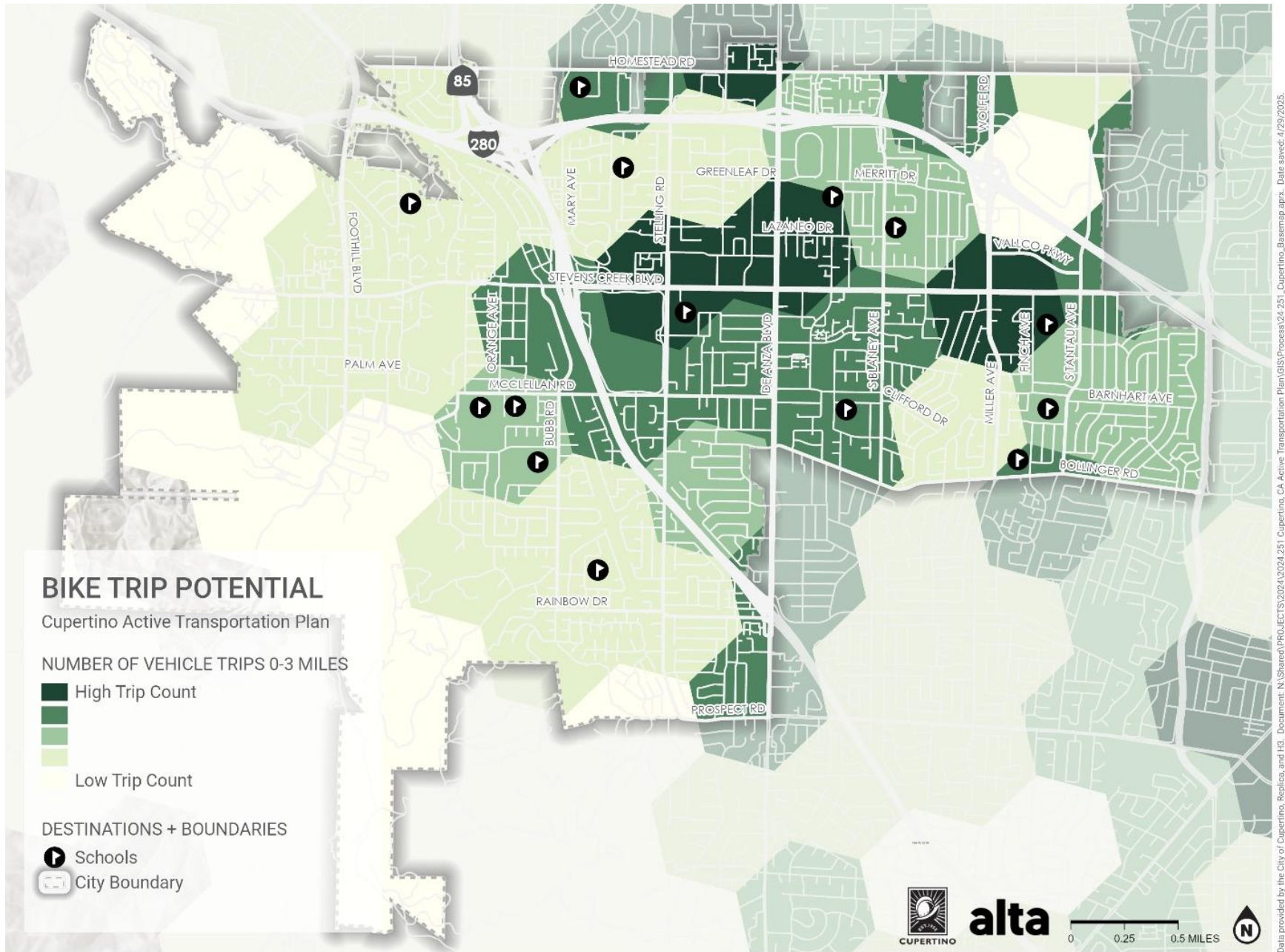


Figure 8: Bike Trip Potential

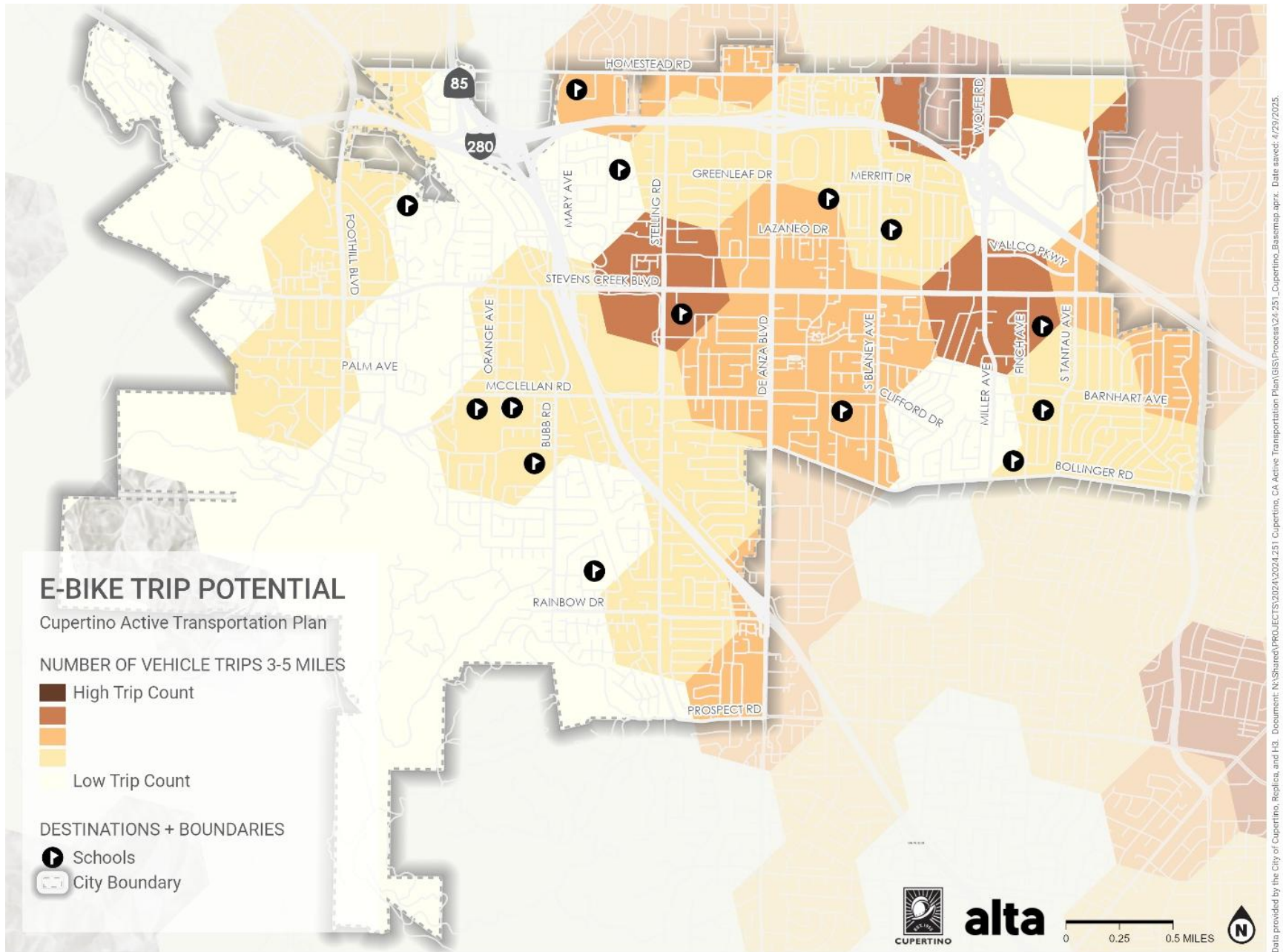


Figure 9: E-Bike Trip Potential

Stress-Adjusted Short Trip Analysis

When considering the greatest benefit which can be derived from investments in walking and biking, both the quality/comfort of the facility and the potential for more walking or biking trips must be considered. A facility must be high comfort/quality for a wide range of residents to be willing to use it, and the facility itself must be positioned to facilitate a high number of short trips to local destinations. The corresponding BLTS, PLTS, and ATP analysis in this memo set out to document those conditions.

But it is also well-established that small stretches of high-stress facilities (or high-stress barriers) among otherwise low-stress routes can be a significant deterrent to the adoption of walking or biking for short trips that are otherwise ideal for active transportation. The Stress-Adjusted Short Trips analysis utilizes a framework for assigning a perceived cost multiplier to roadway segments – essentially that people walking or biking experience high-stress segments to be longer than they actually are⁵ as illustrated in **Figure 10**. The actual multipliers to identify these stress adjusted travel times are documented in **Table 1**.

Higher-Stress Roads Feel Longer to Bicyclists and Pedestrians

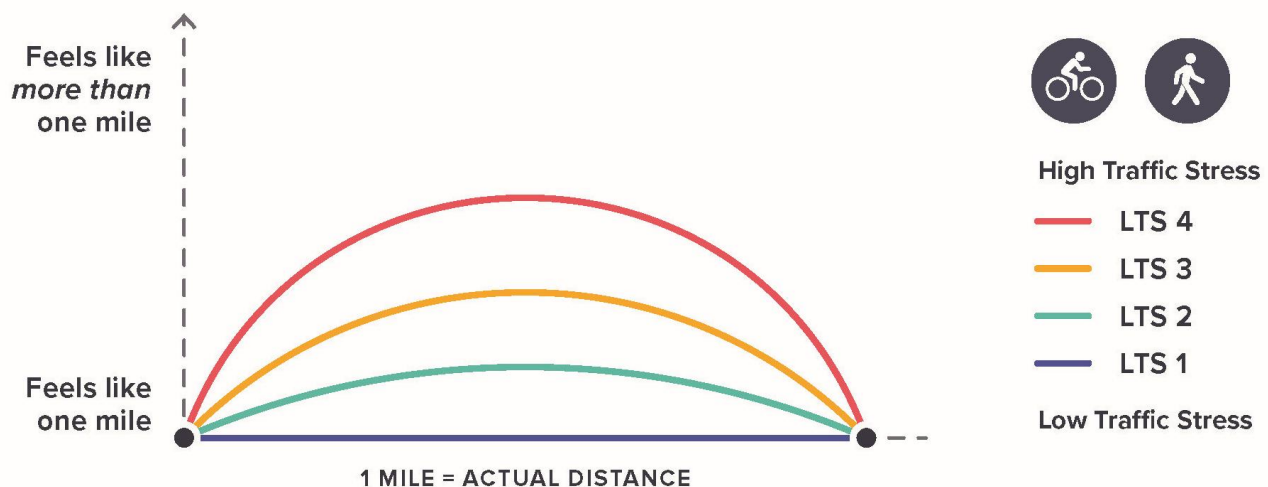


Figure 10 illustrates how higher stress segments can be perceived to have a longer travel time for the purpose of understanding network quality's impact on behavior.

⁵ NCHRP 08-149 Benefits of Active Gap Closure Study

Table 1 Level of Traffic Stress & Perceived Costs Multipliers from NCHRP 08-149

LTS Score	Pedestrian Impedance Multiplier	Bicycle Impedance Multiplier
LTS 1	1	1
LTS 2	1.5	2
LTS 3	3	3
LTS 4	8	6

Through the combination of BLTS/PLTS scores and the outputs of Active Trip Potential, the Stress-Adjusted Short Trip analysis identifies and quantifies underlying barriers to efficient and comfortable travel for short trips that are currently marred by significant levels of indirectness and perceived barriers to travel. This analysis demonstrates where people walking and biking will choose alternative routes to avoid particularly stressful street segments or crossings, and the corresponding impact that has on their willingness to use active transportation for short trips.

This analysis also integrates public feedback on barriers by inflating travel costs by 50% in areas that are low-stress and where the public has identified existing barriers to active travel. The zones identified for these inflated travel costs are located where planners identified a significant cluster of agreement in the public survey results regarding barriers. These barrier polygons are qualitatively determined based on the expert judgement of the active transportation planners reviewing the barrier results.

Once these network results and public-identified barriers were developed, Alta analyzed traffic stress-adjusted travel times between hexagon centroids within three miles for bicyclists and one mile for pedestrians, calculating straight-line distances, network travel times, and stress-adjusted travel times for each origin-destination pair. The team computed a gap score reflecting the likelihood that short trips would not shift to active modes due to large differences between straight line⁶ and stress-adjusted travel times, estimating intrazonal travel times based on those of immediately adjacent hexagon neighbors divided by two⁷. The formula used to identify these Gap Scores is below, representing the degree to which barriers are likely preventing short trips by active modes, given the routes available between zones.

$$\text{Gap Score} = \text{Short Trips} - \left(\text{Short Trips} * \frac{\text{Non-Stress Adjusted Travel Time (Straight Line)}}{\text{Stress Adjusted Travel Time}} \right)$$

These gap scores were spatially joined to hexagons, with higher scores assigned to hexagons intersecting with multiple high-gap trip lines. Alta conducted cross-tabulations of trip lengths and modeled travel times, estimating average disparities between raw and stress-adjusted times for key destinations. These findings, including key metrics on perceived versus actual travel experience, were integrated into the needs assessment memo and visualized through a series of maps.

⁶ Straight line travel times assume a 3 MPH walking speed and 10 MPH biking speed.

⁷ As each hexagon is the same size, the time it takes to travel to the centroids of its six neighbors divided by two is a rough approximation of the average travel time to travel from the center of a hexagon to its perimeter.

Key Findings

Highest Gaps

The areas with the top 10 highest gap scores for both walking and biking distances were found around Homestead High School, De Anza College, Cupertino High School, and crossing the Lawrence Expressway near the eastern border with San Jose. Around Homestead High School, barriers likely include I-280 and North Stelling Road. Near De Anza College, Highway 85, South Stelling Road, and Stevens Creek Boulevard present barriers to lower-stress travel. At Cupertino High School, Finch Avenue presents a barrier, and near John Mise Park, I-280 and the Lawrence Expressway are the major barriers. Many of these trips may be related to school access or the commercial areas along Stevens Creek Boulevard.

For walking distances, shown in Figure 11, high gap scores were also clustered in southern Cupertino in the area between Jollyman Park, Eaton Elementary School, and Meyerholtz Elementary School in San Jose. In this case, South De Anza Boulevard and Bollinger Road present major barriers to travel. These trips may be important for accessing nearby commercial areas or schools.

For biking distances, shown in Figure 12, high gap scores were also clustered in eastern Cupertino in the area between the Kaiser Medical Center, Cupertino High School, and John Mise Park. In this case, I-280, Pruneridge Avenue, Lawrence Expressway, and Stevens Creek Boulevard all present major barriers to travel. These trips might be important for accessing schools, medical care, or Main Street Cupertino.

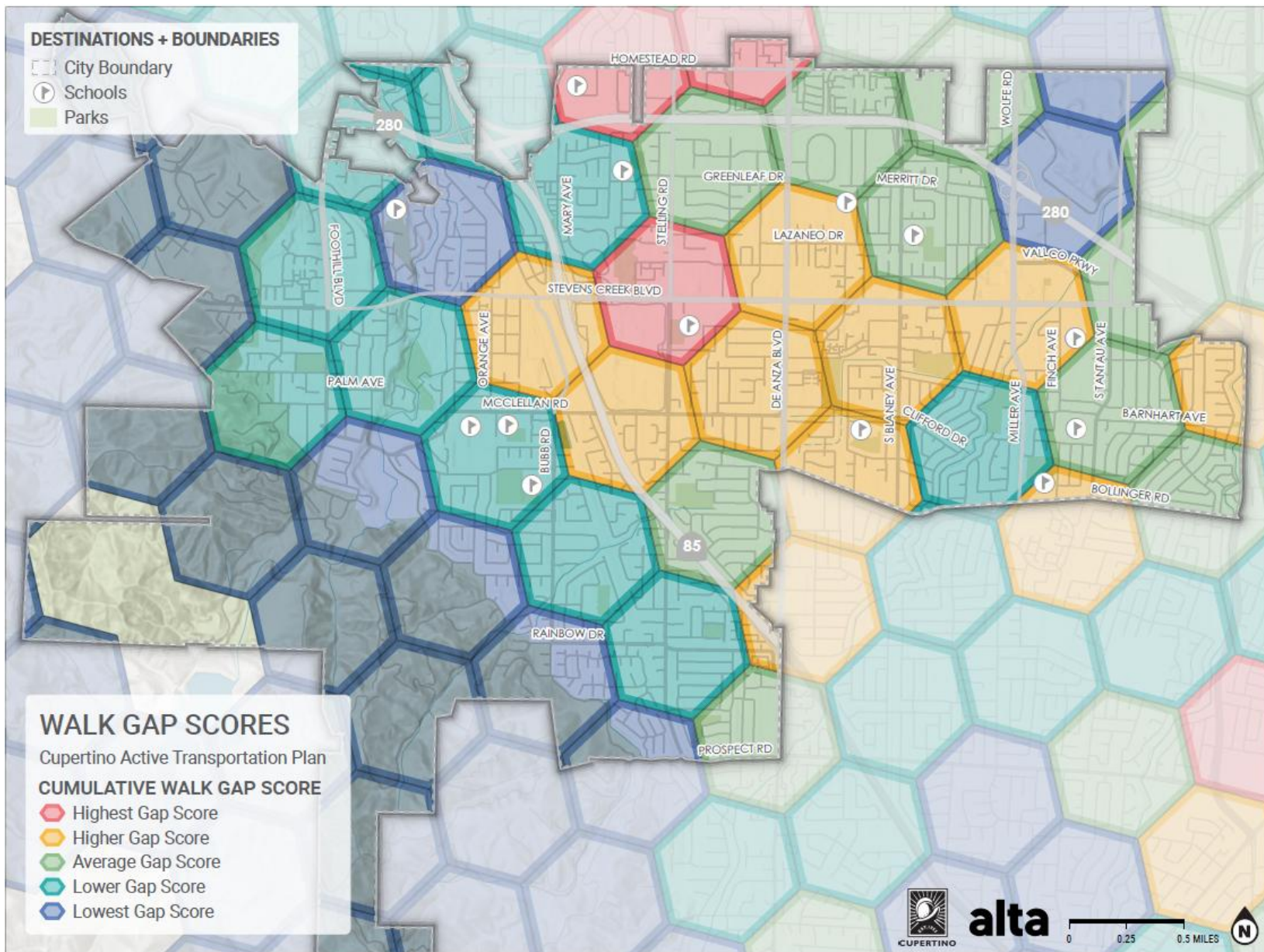


Figure 11 Walk Gap Scores

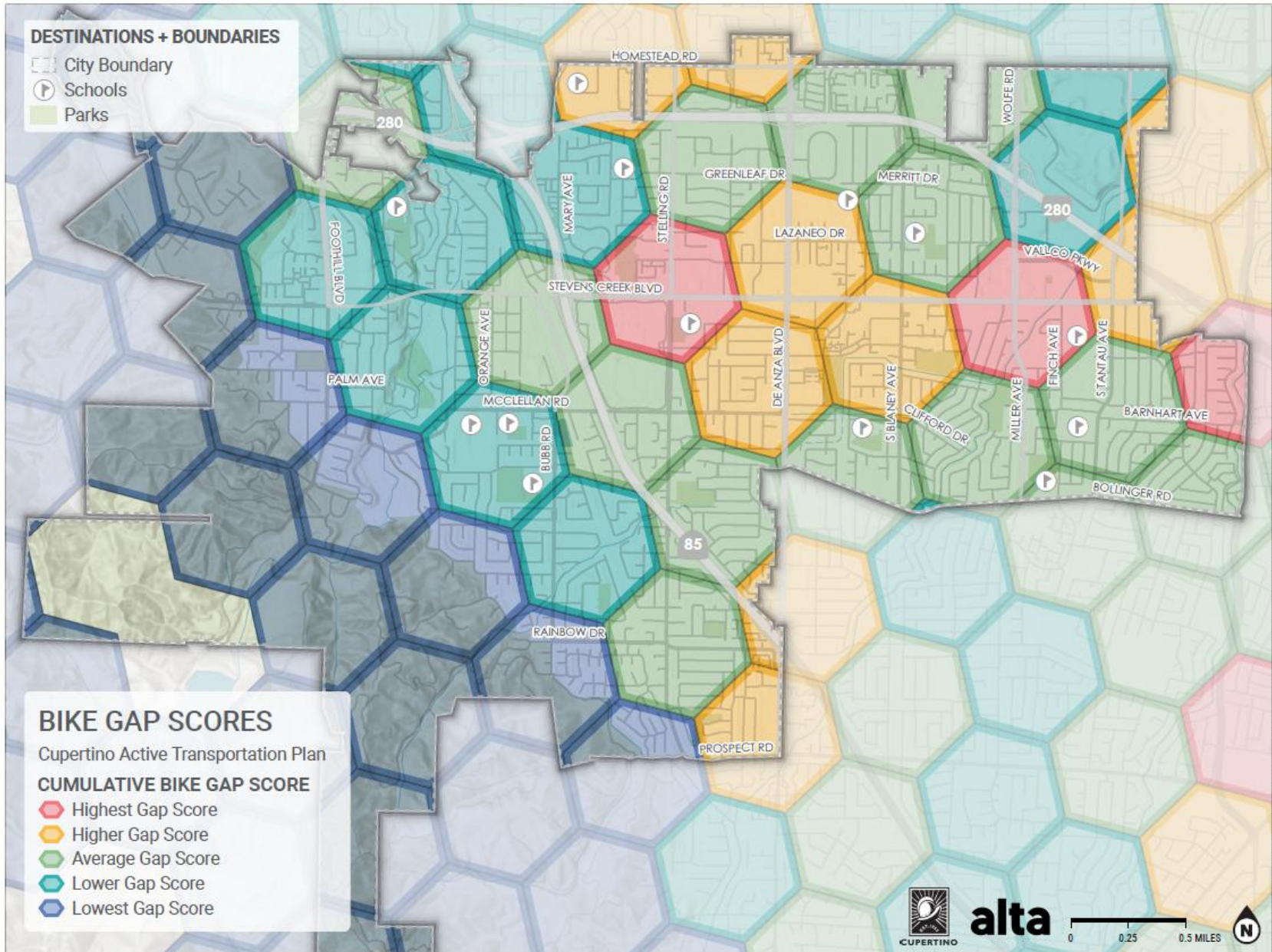


Figure 12 Bike Gap Scores

Detailed destination analysis

Based on public input during Phase 1 outreach, five zones were selected for detailed analysis of stress-adjusted travel impacts. This analysis combined all short trips from surrounding zones and developed a cumulative gap score for all trips ending within that zone. This analysis is shown in **Table 2** on the next page. These locations are:

- **De Anza College & Cupertino Memorial Park**, with the intersection of Stevens Creek Blvd at Stelling Rd near the center of the zone.
- **Civic Center & Cupertino Library**, including the Regnart Creek Trail and Wilson Park within the zone.
- **The Rise (Former Vallco Town Center) / Main Street & Cupertino Main Street**, including Cupertino High School south of Stevens Creek Boulevard.
- **Blackberry Farm & Stevens Creek**, with the zone centered between Stevens Creek Blvd in the north and McClellan Rd in the south.
- **West Cupertino “Tri-School” area**, encompassing the area south of McClellan Rd and west of Bubb Rd.

The De Anza College area had the highest gap scores for both walking and biking, while the Rise (Former Vallco Town Center)/Main Street area exhibited significantly higher gap scores for biking than for walking. Locations in western Cupertino (including both Stevens Creek and the “tri-school” area around Monta Vista High, Lincoln Elementary, and Kennedy Middle School) exhibited much higher gap scores for biking than for walking.

Table 2: Stress-adjusted travel times and gap scores for key locations in Cupertino

Priority Location	Mode	Straight Line Travel Time (Min)	Network Travel Time (Min)	Stress Adjusted Travel Time (Min)	Short Trips by Mode ⁸	Gap Score ⁹
De Anza College/ Memorial Park	Walking	19	26	57	3056	2264
De Anza College/ Memorial Park	Biking	12	16	28	14010	8926
City Center/ City Library	Walking	19	26	46	2534	1534
City Center/ City Library	Biking	12	16	27	11202	5852
The Rise (Former Vallco Town Center) / Main Street	Walking	19	26	57	2452	1778
The Rise (Former Vallco Town Center) / Main Street	Biking	12	16	33	12389	8279
Blackberry Farm/ Stevens Creek	Walking	15	24	53	462	342
Blackberry Farm/ Stevens Creek	Biking	10	15	25	2544	1454
West Cupertino/ Tri-School Area	Walking	17	28	48	923	610
West Cupertino/ Tri-School Area	Biking	11	15	21	4932	2165

⁸ For walking, this represents cumulative trips ending in this location that are less than 1 mile, and for biking it is cumulative short trips less than 3 miles ending in this location.

⁹ This is the cumulative gap scores for all trips ending in this location using the respective short trips.

Active Trip Gaps

The Stress-Adjusted Short Trip analysis also quantified the Gap Scores for individual pairings of origins and destinations for trips ending in Cupertino. This analysis visualizes both the number of short trips between locations and the Gap Score. This analysis provides a more granular understanding of the demand for trips between different locations, as well as the potential for new active transportation trips.

High Gap Scores for walking, in **Figure 13**, are concentrated on hexagons along Stevens Creek Boulevard, and destinations to both the north and south. Homestead Road near the intersection with De Anza Boulevard also shows a high gap score, as do trips crossing De Anza Boulevard near the City's southern border. Many of the areas with high gap scores are home to different schools (Homestead High School, De Anza College, and Cupertino High School) and parks (Jollyman Park, Wilson Park, and Cupertino Memorial Park). I-280 also acts as a substantial barrier to trips going north/south for pedestrians.

High Gap Scores for biking, in **Figure 14**, are also concentrated on hexagons along Stevens Creek Boulevard and Homestead Road. High gaps on Stevens Creek Boulevard cluster in the west, around De Anza College, and in the east, around The Rise (Former Vallco Town Center)/Main Street and Cupertino High School. There is also a high-scoring north/south gap between Stevens Creek Boulevard and Homestead Road along De Anza Boulevard. Gap scores starting and ending west of Highway 85 are much lower, suggesting fewer barriers to biking trips. The lowest gap scores are observed on hexagons along McClellan Road and the Regnart Creek Trail, exhibiting the benefit derived from the separated bike lanes and shared-use paths.

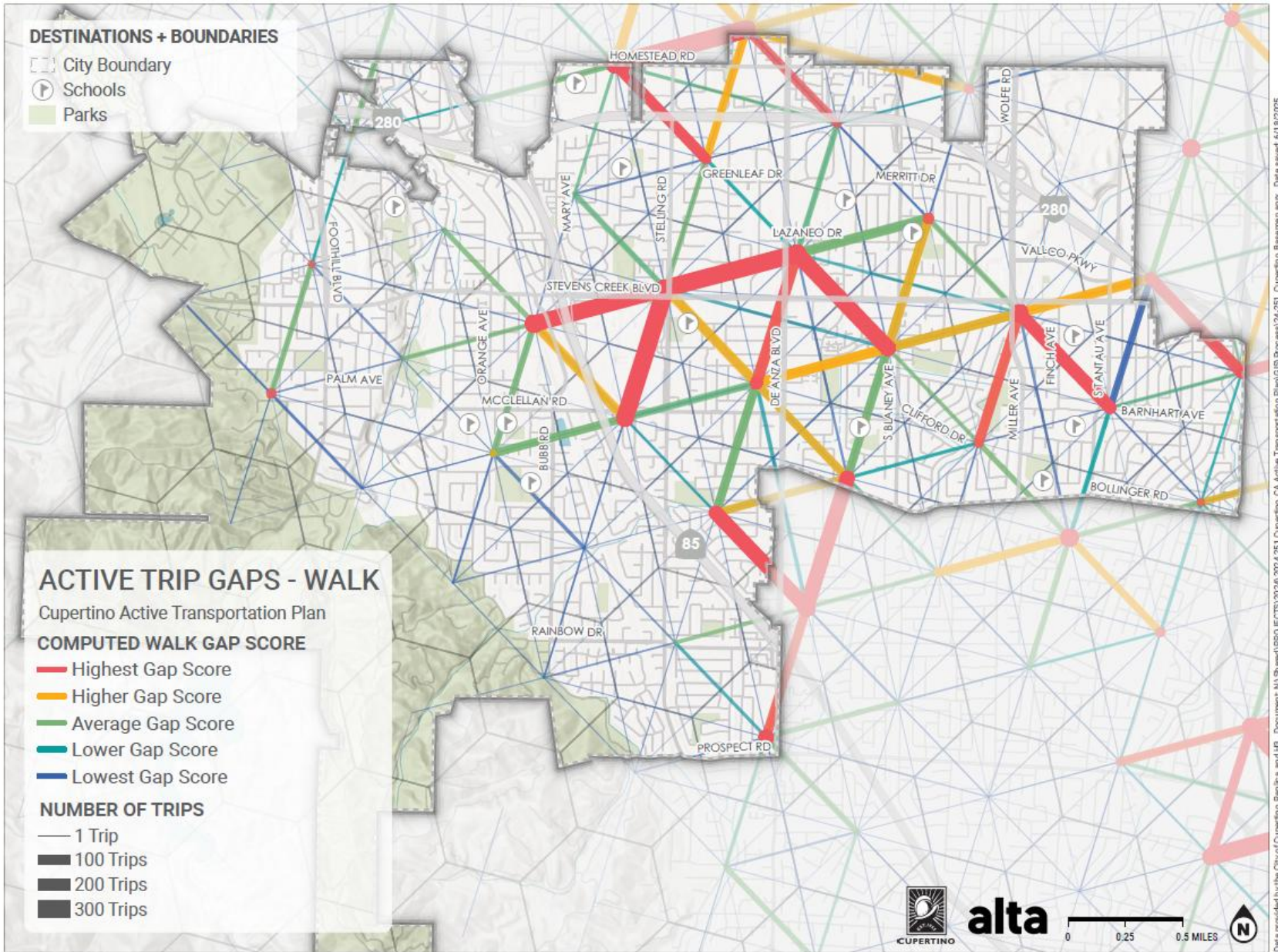


Figure 13 Active Trip Gaps for Walking

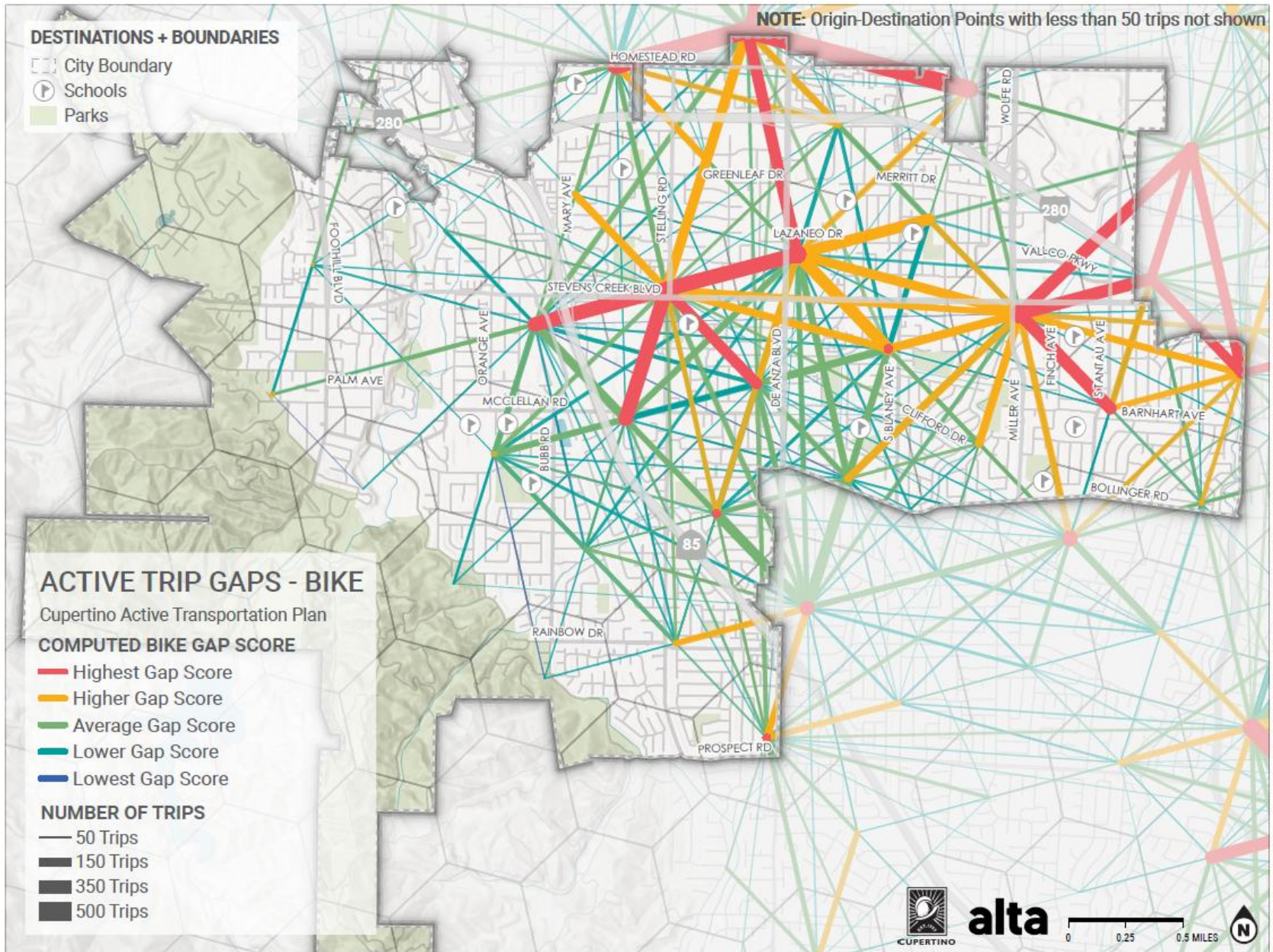


Figure 14 Active Trip Gaps for Biking

Considerations

This analysis utilizes short trips as a proxy for latent demand for active transportation, employing a market analysis approach to potential trips. This analysis took a simplified approach by picking easy-to-understand cut-offs for trips: < 1 mile for pedestrians, and < 3 miles for bicyclists. In theory, this could be more of a continuous cut-off based on the trip distance distributions for each of these modes of transportation, where flows could be adjusted according to the typical trip distances for walking and bicycling, respectively. Alta did not take this approach to avoid making the results less intuitive and more difficult to understand.

Similarly, the network analysis approach employed for this analysis uses Level of Traffic Stress as an adjusted substitute for more complex street layout variables derived from behavior change literature, as shown in NCHRP 08-149. For example, the original studies on which these impedance adjustment factors are based include more complex variables, such as the degree and quality of tree canopy (green view factors). These factors are not directly evaluated by this analysis.

Next Steps

The results of this analysis will be combined with public input from Phase 1 outreach, conducted in the spring of 2025, to develop network recommendations for walking and biking in Cupertino. These recommendations will focus on closing critical gaps in the network, as well as areas of high potential for walking and biking trips, both of which were identified through this analysis.



To: Matt Schroeder, City of Cupertino
David Stillman, City of Cupertino
From: Kim Voros and Chris Kidd; Alta Planning + Design
Date: April 16, 2025
Re: Cupertino Active Transportation Plan – Level of Traffic Stress Analysis Methodology (DRAFT)

Project Description

The Bicycle and Pedestrian Master Plan Update recommends projects and key corridors for active transportation in Cupertino into the future. As part of the Active Transportation Plan, Alta will perform an analysis of the perceived stress from traffic by bicyclists and pedestrians while traveling throughout the Cupertino.

Level of Traffic Stress Analysis Proposed Methodology

Background

Alta will complete a level of traffic stress (LTS) analysis for the bicycle (BLTS) and pedestrian (PLTS) network, ranking streets and active transportation facilities from low stress (LTS 1, suitable for “all ages and abilities”) to high stress (LTS 4, suitable only to “strong and fearless” bicyclists and uncomfortable for pedestrians).

The bicycle level of traffic stress (BLTS) analysis estimates the level of comfort for people biking on a given roadway segment. The BLTS analysis helps identify where “gaps” or deficiencies in an active transportation network exist and provides a measure of how likely different types of riders, based on ability and comfort level, are to use the facility.

The pedestrian level of traffic stress (PLTS) analysis identifies existing areas that are low-stress for pedestrians, as well as the degree to which roadways must be improved in order to provide a comfortable experience for pedestrians of all ages and abilities.

Methodology

Alta's BLTS analysis methodology is adapted from the 2012 Mineta Transportation Institute Report 11-19: *Low-Stress Bicycling and Network Connectivity*.¹ BLTS is determined by characteristics of a given roadway segment that affect a bicyclist's perception of safety and comfort, including posted speed limit, number of travel lanes, and the presence and character of bicycle lanes. The combination of this criteria classifies a road segment into one of four levels of traffic stress:

- **BLTS 1** represents roadways where bicyclists of all ages and abilities would feel comfortable riding. These roadways are generally characterized by low volumes, low speeds, no more than two travel lanes, and traffic control measures at intersections. These roadways may have bicycle facilities; separated shared-use paths for bicycles also fall into this category.
- **BLTS 2** represents slightly less comfortable roadways, where most adults would feel comfortable riding.
- **BLTS 3** represents moderately uncomfortable roadways, where most experienced bicyclists would feel comfortable riding.
- **BLTS 4** represents high-stress roadways where only strong and fearless bicyclists would feel comfortable riding. These roadways are generally characterized by high volumes, high speeds, several travel lanes, and complex transitions approaching and crossing intersections.

The results of the BLTS analysis identify existing areas that are low stress for many bicyclists, as well as the degree to which roadways must be improved to provide a comfortable experience for riders of all ages and abilities.

Alta's PLTS analysis methodology is adapted from the Oregon Department of Transportation's *Analysis Procedures Manual*² and is intended as a companion for bicycle level of traffic stress (BLTS). PLTS is determined by characteristics of a given roadway segment that affect a pedestrian's perception of safety and comfort including sidewalk presence and width, sidewalk buffer width and type, posted speed limit, and number of travel lanes. PLTS scores classify road segments into one of four levels of traffic stress and, while similar to BLTS scores, PLTS considers the level of attention required in addition to the user experience:

- **PLTS 1** represents roadways where pedestrians of all ages and abilities would feel comfortable walking and require little attention to traffic.
- **PLTS 2** represents slightly less comfortable roadways that require more attention to traffic and are suitable for children over 10, teens, and adults.
- **PLTS 3** represents moderately uncomfortable roadways, where most able-bodied adults would feel uncomfortable but safe.
- **PLTS 4** represents high traffic stress and would be used only by able-bodied adults with limited route choices.

¹ Mineta Institute. Mekuria M., Furth P., Nixon H. *Low-Stress Bicycling and Network Connectivity*. 2012. <https://transweb.sjsu.edu/research/Low-Stress-Bicycling-and-Network-Connectivity>.

² Oregon Department of Transportation, Transportation Development Division Planning Section: Transportation Planning Analysis Unit. 2020. *Analysis Procedures Manual* Version 2. <https://www.oregon.gov/odot/Planning/Pages/APM.aspx>.

The results of the PLTS analysis identifies existing areas that are low-stress for pedestrians, as well as the degree to which roadways must be improved in order to provide a comfortable experience for pedestrians of all ages and abilities.

The BLTS and PLTS analysis is completed through an assessment of street segments using available spatial data. Each segment of the roadway or sidewalk along the roadway is evaluated based on its characteristics; if multiple scores are present within a segment, the highest (most stressful) score is used as the overall segment score. Particularly for PLTS, if two sidewalks are present on a street, the worst (highest scoring) result is mapped to the centerline. See **Appendix A** for BLTS methodology details and data assumptions, while **Appendix B** contains PLTS methodology details and data assumptions.

The LTS analyses will be based on available spatial data provided to Alta by the City of Cupertino, and at times enhanced with through desktop review where appropriate. The analysis is intended to identify gaps between low-stress areas as well as large facilities with high-speed traffic that could pose a barrier to bicycle or pedestrian activity, stress-adjusted short trip analysis as well as help to refine and prioritize project recommendations.

Appendix A



Appendix A: Bicycle Level of Traffic Stress Analysis

Overview

The bicycle level of traffic stress (BLTS) analysis estimates the level of comfort for people biking on a given roadway segment. The BLTS analysis identifies where “gaps” or deficiencies in a bike network exist and provides a measure of how likely different types of riders, based on ability and comfort level, are to use the facility.

Alta’s BLTS analysis methodology is adapted from the 2012 Mineta Transportation Institute Report 11-19: *Low-Stress Bicycling and Network Connectivity*.¹ BLTS is determined by characteristics of a given roadway segment that affect a bicyclist’s perception of safety and comfort, including posted speed limit, number of travel lanes, and the presence and character of bicycle lanes. The combination of this criteria classifies a road segment into one of four levels of traffic stress:

- **BLTS 1** represents roadways where bicyclists of all ages and abilities would feel comfortable riding. These roadways are generally characterized by low volumes, low speeds, no more than two travel lanes, and traffic control measures at intersections. These roadways may have bicycle facilities; separated shared-use paths for bicycles also fall into this category.
- **BLTS 2** represents slightly less comfortable roadways, where most adults would feel comfortable riding.
- **BLTS 3** represents moderately uncomfortable roadways, where most experienced bicyclists would feel comfortable riding.
- **BLTS 4** represents high-stress roadways where only strong and fearless bicyclists would feel comfortable riding. These roadways are generally characterized by high volumes, high speeds, several travel lanes, and complex transitions approaching and crossing intersections.

The results of the BLTS analysis identify existing areas that are low stress for many bicyclists, as well as the degree to which roadways must be improved to provide a comfortable experience for riders of all ages and abilities. Additionally, scenario testing can be used to determine how a roadway or route’s level of stress may change with improvements.

Methodology

BLTS analysis is completed through an assessment of street segments using spatial data and aerial imagery. Each segment of the roadway is evaluated based on its characteristics; if multiple scores are present within a segment, the highest (most stressful) score is used as the overall segment score.

Figure 1 illustrates the overall BLTS scoring process. Notes on data inputs and assumptions are found in Table 1. Segment scores are assigned as shown in Table 2 through Table 5.

¹ Mineta Institute. Mekuria M., Furth P., Nixon H. *Low-Stress Bicycling and Network Connectivity*. 2012. <https://transweb.sjsu.edu/research/Low-Stress-Bicycling-and-Network-Connectivity>.

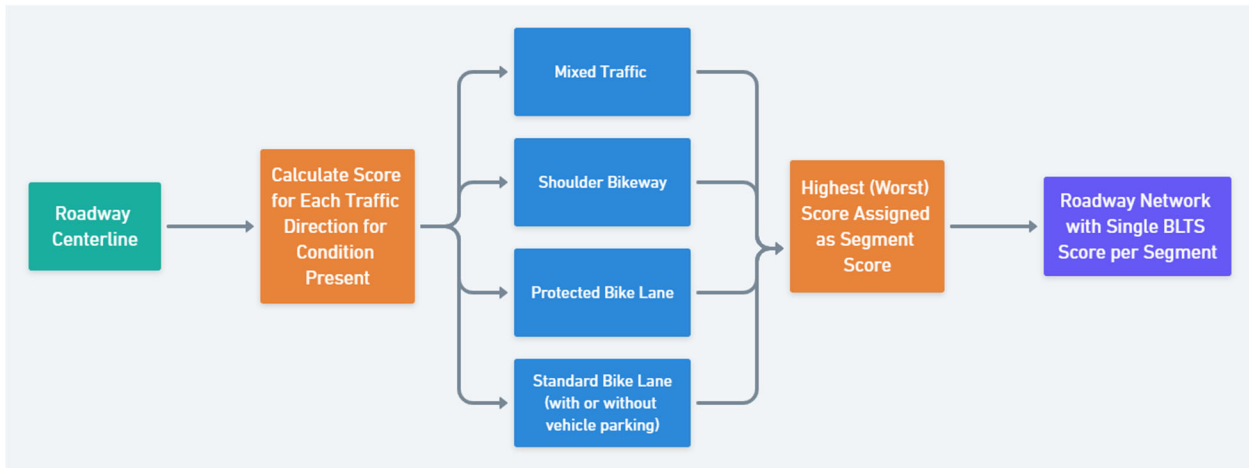


Figure 1: Bicycle Level of Traffic Stress Generalized Segment Scoring Process

Table 1: Data Inputs and Assumptions

Inputs	Notes	Assumptions
Bicycle Facilities	Bicycle lanes have a positive impact on BLTS and are a primary input for developing a BLTS model. The width of facilities can have an impact on the associated comfort level. Wider facilities provide greater comfort, especially on high-speed roadways.	Bike lane widths for all facilities within the City were verified through a desktop inventory. For buffered bike lanes, the buffer was included in the total facility width.
Speed Limit	High-speed roadways are considered to be less comfortable for bicyclists, particularly in mixed traffic or with minimal separation from motor vehicles. Low-speed roadways are considered more comfortable.	Speed limit data was available for roadways within the city limits.
Presence and Width of On-Street Parking Adjacent to Bicycle Lanes	On-street parking is particularly important for corridors on which bicycle lanes are present. BLTS is greater on bicycle lanes adjacent to parking than on bicycle lanes not adjacent to parking, due to the potential for “dooring” incidents.	The presence and width of on-street parking adjacent to bike lanes and buffered bike lanes was verified via desktop inventory.
Number of Lanes	The number of travel lanes corresponds with an increase in the roadway width, which has an effect on bicyclists’ level of stress. Roadways with fewer lanes are generally less stressful for bicyclists.	The number of lanes was verified for all roadways, except those classified as ‘Local,’ which were assumed to have two travel lanes.
Presence of Trails	Class I facilities can be a vital component of a municipality’s active transportation network. Increased separation from motor vehicles can improve comfort and safety.	Class I facilities are scored as a BLTS 1.

Table 2 through Table 4 specify the scoring criteria based on roadway configuration, speed, and bike lane/parking lane presence and width. The criteria are adapted from the original 2012 Mineta Institute report. These tables are used in combination to assign an overall BLTS score; if multiple scores are present within a segment, the highest (most stressful) score is used as the overall segment score. These tables are used in combination to create the segment, approach, and intersection scores described previously.

Table 2: Criteria for Bicycle Level of Traffic Stress in Mixed Traffic

Prevailing Speed or Speed Limit (mph)	Street Width		
	2–3 Lanes	4–5 Lanes	6+ Lanes
≤ 25	BLTS 1 or 2	BLTS 3	BLTS 4
30	BLTS 2 or 3 ¹	BLTS 4	BLTS 4
≥ 35	BLTS 4	BLTS 4	BLTS 4

1. Lower value is assigned to streets without marked centerlines or classified as local with fewer than three lanes.

Table 3: Criteria for Bike Lanes Not Alongside a Parking Lane

	BLTS 1	BLTS 2	BLTS 3	BLTS 4
Street Width (through lanes per direction)	1	2	More than 2	(no effect)
Bike Lane Width	6 feet or more	5.5 feet or less	(no effect)	(no effect)
Speed Limit (mph)	30 mph or less	(no effect)	35 mph	40 mph or more
Bike lane blockage ¹	Rare	(no effect)	Frequent	(no effect)

1. Bike lane blockage is part of Alta’s analysis methodology, but assumed to be rare by default.

Table 4: Criteria for Bike Lanes Alongside a Parking Lane

	BLTS 1	BLTS 2	BLTS 3	BLTS 4
Street Width (through lanes per direction)	1	(no effect)	2 or more	(no effect)
Sum of Bike Lane Width + Parking Lane Width	15 feet or more	14 or 14.5 feet	13.5 feet or less	(no effect)
Speed Limit (mph)	25 mph or less	30 mph	35 mph	40 mph or more
Bike lane blockage ¹	Rare	(no effect)	Frequent	(no effect)

1. Bike lane blockage is part of Alta’s analysis methodology, but assumed to be rare by default.

The tables above account for on-street bike lanes not separated from traffic. Protected bike lanes are automatically scored as an LTS 1.

Appendix B

Appendix B: Pedestrian Level of Traffic Stress Methodology

Overview

The pedestrian level of traffic stress (PLTS) analysis estimates the level of comfort for people walking on a given roadway segment. The PLTS analysis identifies where “gaps” or deficiencies in a pedestrian network exist, and provides a measure of how likely pedestrians are to use the facility, based on ability and comfort level.

Alta’s PLTS analysis methodology is adapted from the Oregon Department of Transportation’s *Analysis Procedures Manual*¹ and is intended as a companion for bicycle level of traffic stress (BLTS). PLTS is determined by characteristics of a given roadway segment that affect a pedestrian’s perception of safety and comfort including sidewalk presence and width, sidewalk buffer width and type, posted speed limit, and number of travel lanes. PLTS scores classify road segments into one of four levels of traffic stress and, while similar to BLTS scores, PLTS considers the level of attention required in addition to the user experience:

- PLTS 1 represents roadways where pedestrians of all ages and abilities would feel comfortable walking and require little attention to traffic.
- PLTS 2 represents slightly less comfortable roadways that require more attention to traffic and are suitable for children over 10, teens, and adults.
- PLTS 3 represents moderately uncomfortable roadways, where most able-bodied adults would feel uncomfortable but safe.
- PLTS 4 represents high traffic stress and would be used only by able-bodied adults with limited route choices.

The results of the PLTS analysis identify existing areas that are low-stress for pedestrians, as well as the degree to which roadways must be improved in order to provide a comfortable experience for pedestrians of all ages and abilities. Additionally, scenario testing can be used to determine how a roadway or route’s level of stress may change with improvements. The analysis is intended for use in urban areas specifically; while it can be used in rural conditions where pedestrian facilities exist, the methodology will yield a high PLTS score (greatest discomfort) where high-speed traffic is present.

Methodology

PLTS analysis is completed through an assessment of street segments using spatial data obtained from the client or from aerial imagery. Each segment of the roadway is evaluated based on its characteristics; if multiple scores are present within a segment, the highest (most stressful) score is used as the overall segment score.

PLTS considers elements of the pedestrian environment both individually (e.g., buffer type), and in combinations that are known to influence each other (e.g., sidewalk width and pavement quality). The analysis uses the following overall guiding principles:

- The presence of a complete sidewalk serves as the foundation of the pedestrian network.
- As the sidewalk width increases and sidewalk condition improves, the level of stress of the pedestrian environment decreases.
- Buffering width is the total distance between the sidewalk and motor vehicle travel lanes, including parking lanes, bike lanes, and landscaping. As width increases, the amount of separation between pedestrians and motor vehicles increases, and the pedestrian environment becomes less stressful.

¹ Oregon Department of Transportation, Transportation Development Division Planning Section: Transportation Planning Analysis Unit. 2020. *Analysis Procedures Manual* Version 2. <https://www.oregon.gov/odot/Planning/Pages/APM.aspx>.

- Buffer type describes the quality of the buffer that separates the sidewalk from the travel lanes. The presence of a buffer itself provides both actual and perceived safety benefits for the pedestrian, thus decreasing the stress of the pedestrian environment. A buffer with vertical elements is especially effective at increasing the safety of the pedestrian. Landscaping serves to enhance the pedestrian’s travel experience.

Scores for each element of the pedestrian environment are assigned to each segment of the sidewalk centerline, and the worst (highest scoring) of the elements is used. If two sidewalks are present on a street, the worst (highest scoring) result is mapped to the centerline.

Figure 1 illustrates the overall PLTS scoring process. Notes on data inputs and assumptions are found in Table 1. Segment scores are assigned as shown in Table 2 through Table 5.

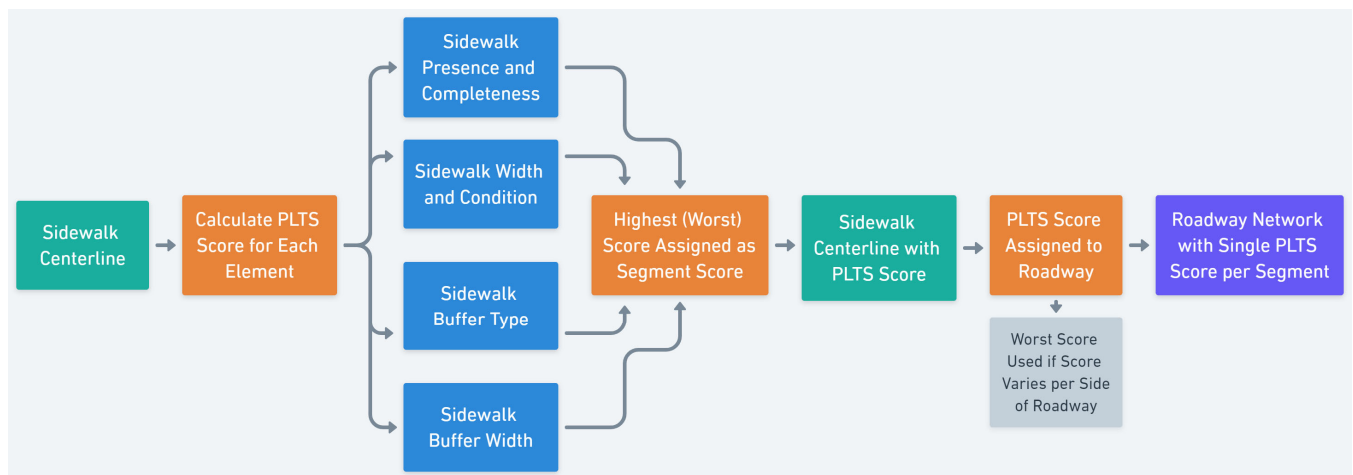


Figure 1: The Pedestrian LTS Scoring Process

Table 1. Data Inputs and Assumptions

Pedestrian Element	Rationale	Data Inputs
Sidewalk Presence and Completeness (Table 2)	The presence and completeness of sidewalk facilities is the baseline for measurement. At a minimum, sidewalks should be present and complete on most roadways to facilitate pedestrian travel.	Based on data from Cupertino and supplemented by manual review within study area.
Sidewalk Width and Condition (Table 3)	The width of the sidewalk can have an impact on the associated comfort level. Wider sidewalks provide greater comfort, especially on high-speed roadways. The condition of the sidewalk is primarily based on concrete quality.	Based on data from Cupertino and supplemented by manual review within study area.
Sidewalk Buffer Type (Table 4)	The buffer type changes the pedestrian experience as it can offer a range of perceived and actual levels of protection. High-speed roadways are considered to be less comfortable, and a more substantial buffer increases pedestrian comfort.	Based on data from Cupertino and supplemented by manual review within study area.
Sidewalk Buffer Width (Table 5)	Total buffering width is the summation of the width of buffer, width of parking, width of shoulder, width of curb and gutter, and width of the bike lane on the same side of the roadway as the pedestrian facility being evaluated.	Based on data from Cupertino and supplemented by manual review within study area.

Table 2 through Table 5 specify the scoring criteria based on sidewalk presence, sidewalk width and condition, buffer type, and buffer width, in relation to the existing roadway condition (factors such as speed and number of lanes). The criteria are adapted from the Oregon Department of Transportation *Analysis Procedures Manual*. These tables are used in combination to assign an overall PLTS score; if multiple scores are present within a segment, the highest (most stressful) score is used as the overall segment score.

Table 2: Pedestrian Level of Traffic Stress Based on Sidewalk Presence and Completeness

Number of Travel Lanes	Posted or Prevailing Speed					
	≤ 25 mph		30–35 mph		≥ 40 mph	
	2 Lanes	> 2 Lanes	2 Lanes	> 2 Lanes	2 Lanes	>2 Lanes
Complete Sidewalk on Both Sides ^{1,2}	LTS 1	LTS 1	LTS 1	LTS 1	LTS 1	LTS 1
Complete Sidewalk on One Side	LTS 2	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
No Sidewalk ³	LTS 2	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4

1. This deviation from the ODOT Methodology enables more deference to buffer accommodations identified in Table 4 and Table 5 while scoring network completeness.

2. Partial sidewalk coverage on a block is not considered complete.

3. Residential (OSM Highway class local) roadways without sidewalk default to LTS 2; roadways without sidewalk default to LTS 4.

Table 3: Pedestrian Level of Traffic Stress Based on Sidewalk Width and Condition

		Sidewalk Condition ³			
		Good	Fair	Poor	Very Poor
Actual/Effective Width (feet) ^{1,2}	< 4	LTS 4	LTS 4	LTS 4	LTS 4
	≥ 4 to < 5	LTS 3	LTS 3	LTS 3	LTS 4
	≥ 5	LTS 2	LTS 2	LTS 3	LTS 4
	≥ 6	LTS 1	LTS 1	LTS 2	LTS 3

1. Effective width is the available/usable area for the pedestrian clear of obstructions. Effective width does not include areas occupied by storefronts or curbside features.

2. For analysis purposes, a standard width of five feet was assumed for all sidewalks. For segments with sidewalks on one side, width is evaluated based on the width of the existing sidewalk to avoid conflicting with other tables.

3. Sidewalk condition is assumed to be good unless other information is available.

Table 4: Pedestrian Level of Traffic Stress Based on Physical Buffer Type

Buffer Type ¹	Prevailing or Posted Speed			
	≤ 25 mph	30 mph	35 mph	≥ 40 mph
No Buffer (curb tight)	LTS 2 ²	LTS 3	LTS 3	LTS 4
Solid Surface	LTS 2 ²	LTS 2	LTS 2	LTS 2
Landscaped	LTS 1	LTS 2	LTS 2	LTS 2
Landscaped with Trees	LTS 1	LTS 1	LTS 1	LTS 2
Vertical	LTS 1	LTS 1	LTS 1	LTS 2

1. Combined buffer: If two or more of the buffer conditions apply, use the most appropriate (typically the lower-stress type).

2. If no centerline is present (residential street) or the street is traffic calmed (including sporadic vertical separation such as street furniture, street trees, lighting, planters, surface change, and so on), then the PLTS can be lowered by one PLTS level.

Table 5: Pedestrian Level of Traffic Stress Based on Physical Buffer Width¹

Total Number of Travel Lanes (both directions) ³	Total Buffering Width (feet) ²				
	< 5	≥ 5 to < 10	≥ 10 to < 15	≥ 15 to < 25	≥ 25
≤ 2	LTS 2 ⁴	LTS 2	LTS 1	LTS 1	LTS 1
3	LTS 3 ⁴	LTS 2	LTS 2	LTS 1	LTS 1
4–5	LTS 4 ⁵	LTS 3	LTS 2	LTS 1	LTS 1
6 ≥	LTS 4 ⁵	LTS 4 ⁵	LTS 3	LTS 2	LTS 2

1. Source: Based on Oregon Department of Transportation *Analysis Procedures Manual*, Table 14-23.

2. Total buffering width is the summation of the width of buffer, width of parking, width of shoulder, width of curb and gutter, and width of the bike lane on the same side of the roadway as the pedestrian facility being evaluated.

3. One-way facilities are assumed to have their lanes multiplied by 2 to represent exposure to lane crossing.

4. If no centerline is present (residential street) or the street is traffic calmed (including sporadic vertical separation such as street furniture, street trees, lighting, planters, surface change, and so on), then the PLTS can be lowered by one PLTS level.

5. Sections with a substantial physical barrier/tall railing between the travel lanes and the walkway (such as might be found on a bridge) can be lowered to PLTS 3.



To: Matt Schroeder, City of Cupertino
David Stillman, City of Cupertino
From: Kim Voros, Chris Kidd, and Cyrus Chimento; Alta Planning + Design
Date: April 24, 2025
Re: Cupertino Active Transportation Plan – Active Trip Potential Analysis Methodology

Project Description

The Bicycle and Pedestrian Master Plan Update recommends projects and key corridors for active transportation in Cupertino into the future. Active modes often fill first- and last-mile gaps for transit trips and in their own may provide more flexibility for short trips that are not well-served by transit. As part of the Active Transportation Plan, Alta will conduct an active trip potential analysis to identify areas of Cupertino where people make numerous short trips and there is strong potential to see a reduction in vehicle trips if supportive infrastructure were available for people to choose active modes of travel for these short trips.

Active Trip Potential Analysis Methodology

Background

Understanding demand for active transportation can help the City of Cupertino guide growth and development to support sustainable transportation by identifying areas where latent demand for active transportation may exist, and supportive infrastructure could encourage more people to convert motor vehicle trips to active trips. Where there is high active trip potential but there are low numbers of active trips, it may indicate unsupportive infrastructure or long distances from key destinations. While emerging technologies such as e-bikes and e-scooters provide new options, ranges, and convenience, their ability to convert motor vehicle trips is still dependent on the surrounding land use and transportation context. This memo presents the methodology for that analysis.

Methodology

Alta will use Replica Places¹ model data specific to the California-Nevada Megaregion from Spring 2024 for this analysis. See **Appendix A** for additional information on Replica.

Alta will filter the Replica data to include only trips that:

- Intersect the study area (start, end, or pass through)
- Are made by the driver of a private vehicle or Transportation Network Company (TNC) vehicle (not passengers)
- Are 5 miles or less in length

¹ <https://www.replicahq.com/>

Alta will aggregate and analyze trip data based on H3 resolution 8 hexagon geometries and focus on the typical patterns observed during weekdays except where otherwise noted (Figure 1). H3 resolution 8 is generally the smallest level of aggregation available for Replica data.

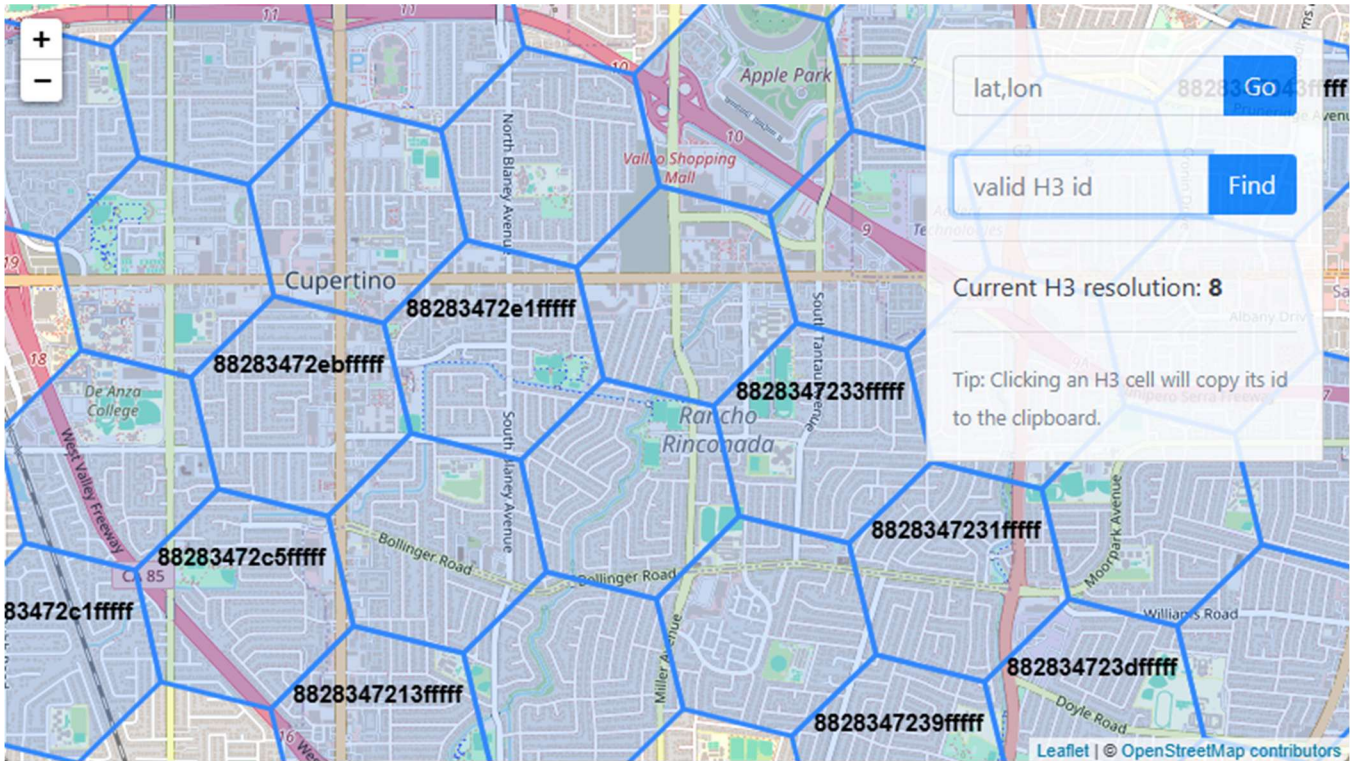


Figure 1. Example of H3 resolution 8 hexagon size in Cupertino, from the [H3 Viewer](#).

Alta will use the Replica data to create a table of origin-destination pair hexagons with trips summarized to the origin hexagon by trip distance to approximate trips that could be replaced by one of three active modes based on typical trip distances for those modes:

- Trips 0-1 miles: potential walking trips
- Trips 1-3 miles: potential bike trips
- Trips 3-5 miles: potential e-bike trips

The results of this will be static heatmaps of the City of Cupertino, visualizing the number of trips 0-1 miles, 1-3 miles, or 3-5 miles starting in each hexagon, representing the potential of active trips.

Another way to visualize the Active Trip Potential is using origin-destination lines. To create origin-destination lines, Alta will use a custom-built tool to plot lines between hexagon centroids and symbolize the lines based on the number of trips. We will do this for trips 0-1 miles, 0-3 miles, and 0-5 miles. Alta will also use the results to create a custom digital Flowmap², to allow for easy exploration of the origin-destination data.

See Figure 2 for a generalized visualization of the Active Trip Potential analysis methodology.

² <https://www.flowmap.blue/>

Limitations

Barriers to Active Trip Making

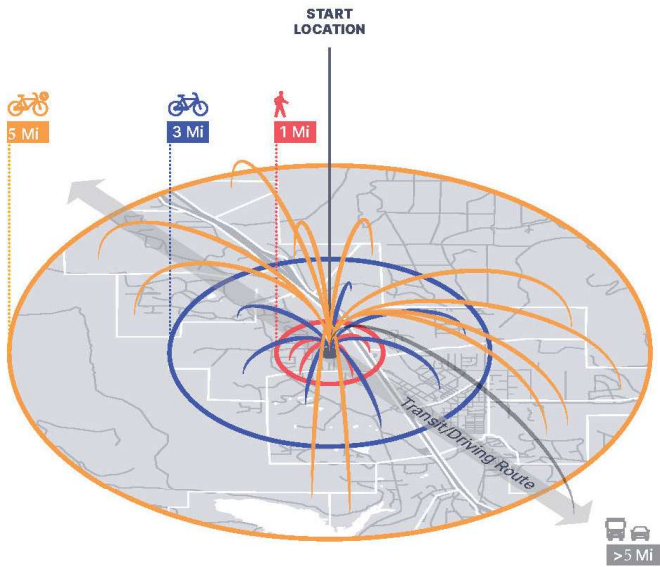
While short trips are indicators of trips that can potentially be met using active modes, it is unrealistic to expect all short trips can be converted to active transportation. Even if supportive infrastructure is provided, there are several personal, structural, or trip-specific reasons why a trip would still be made by non-active modes, including but not limited to:

- **Heavy Loads.** In many cases, cargo bikes can support many types of grocery or shopping trips, but some heavy loads are often bulky or heavy enough to warrant the use of the vehicle.
- **Multiple Passengers.** While some cargo bikes can accommodate small children, people carrying multiple passengers or who do not feel comfortable navigating a loaded cargo bike (which can make it more difficult to maintain balance) may still opt for a vehicle.
- **Trip Chaining.** Some trips are chained in a way that makes it difficult to envision using active transportation for the entire tour/trip. For example, a person typically walks half a mile to work but on occasion needs to travel from work to a doctor's appointment that is two miles away. On these days, they might drive to work rather than walk.
- **Seasonal Weather.** Active trips become more difficult to accomplish in some weather conditions. While walking and biking trips may still be viable in many instances, there may be sometimes where it is inadvisable, such as in heavy rain, a heat wave or unhealthy air conditions.
- **Topography.** Hilly routes may discourage walking or biking unless a person has access to an electric bike or scooter.
- **Bike Parking.** Lack of secure bike parking may discourage bike use for certain trips. However, this could be included in bicycle and pedestrian infrastructure improvements.
- **Formal occasions.** If someone needs to wear formal clothing for an event, including work, they may be less inclined to walk or ride a bike if they would be unable to shower or change clothes at their destination.
- **Structural barriers:** Some people experience structural barriers to active travel, regardless of the specific trip. These include concerns about the security of one's bike while parked, the cost of purchasing a bike or e-bike, harassment from police or passerby, or street crime.
- **Personal Limitations.** Some members of the community may have an impairment that prevents them from comfortably walking or may not know how to ride a bicycle.
- **Personal Preference.** Some members of the community may elect to never bike or walk even if an all ages and ability network is provided in a community.

Data Quality

The travel behavior data that forms the basis of this analysis is sourced from Replica Places. Replica rates its certainty as medium certainty for bicycle and pedestrian trip counts by origin H3 hexagon, because volumes are relatively low compared to vehicle trips. Vehicle trips are given high certainty because there is a larger sample size of these trips.

Active Trip Potential



Active Trip Potential (ATP)

Identifies trips whose distances are short enough to be accommodated by walking or biking.

Our evaluation of ATP includes looking at the number of trips less than three miles.

Different modes are suitable for different trips based on the transportation options that support them.

-   **Walk Trip Potential**
(0-1mi)
-   **Bike Trip Potential**
(1-3mi)
-   **E-Bike Trip Potential**
(3-5 mi)
-   **Drive and Transit Trip Potential** (>5 mi)

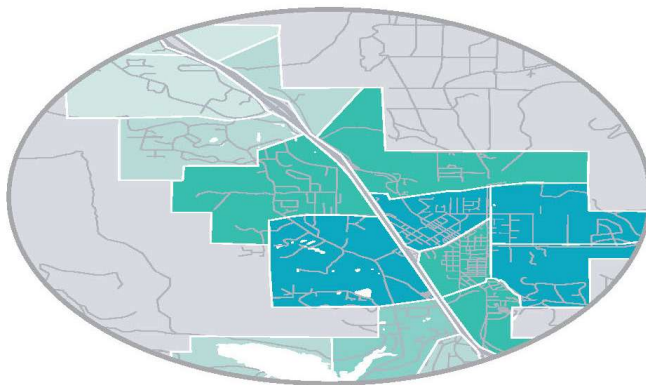


Figure 1. Active Trip Potential Concept Explainer.

ATP Zonal Summary

When we look at all the activity occurring within a zone, we scrutinize both the estimated number of trips in the zone and their lengths. Locations with high rates of short trips are potential candidates for active transportation investments.

ATP TRIPS

% of Trips less than or equal to 3mi

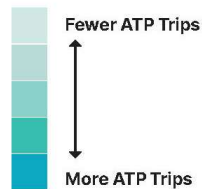


Figure 2. This Active Trip Potential Explainer helps illustrate the concept behind stratifying trips by trip distance to understand whether they could be met by walking, biking, or e-biking.



To: David Stillman, Matt Schroeder, Cupertino, CA
From: David Wasserman, Kim Voros, Alta Planning + Design
Date: 4/16/2025
Re: Stress-Adjusted Short Trip Analysis Methodology

Needs Assessment

This memo documents how Alta will approach synthesizing the level of traffic stress (LTS) and active trip potential (ATP) analysis in Task 3.3 with the community input collected in Task 2 to diagnose the fundamental obstacles that make short trips feel indirect, stressful, and inconvenient.. This combined dataset allows us to isolate short trips in which circuitous routing or high stress suppresses walking, biking, and micromobility uptake.

Network Assessment of Short Trips

Alta’s existing conditions analysis will yield two specific deliverables that can be used to further understand network level gaps in low-stress connectivity between areas of high potential demand. They are:

- Network Level LTS Scores – For bicyclists and pedestrians we will have analysis for the bikeway network (BLTS) and the pedestrian network (PLTS), ranking streets from low stress (LTS 1) to high stress (LTS 4). This analysis identifies major barriers to bicycle and pedestrian travel based on these measures’ representation of the travel experience of users on the facility.
- Active Trip Potential – Alta will have short trips < 3 miles and < 1 mile represented across the study area. Trips < 3 miles can serve as a measure of potential demand for bike travel and trips < 1 mile can serve as a measure of demand potential for pedestrian travel for further analysis.

Alta intends to combine these two analyses through an advanced network analysis that will uncover the underlying barriers to efficient and comfortable travel for short trips which are currently marred by significant levels of indirectness and perceived barriers to travel. The steps to this analysis can be summarized in the following way:

- **Set up Perceived Costs to Travel** – Based on the traffic stress scores, Alta will use weights from a soon to be published NCHRP 08-149 Benefits of Active Gap Closure Study assign travel costs for the respective LTS scores for bicycle and pedestrian travel on the network. Higher stress segments will have been modeled as requiring a higher “perceived” travel time to traverse relative to low stress segments as illustrated in **Figure 1**. The actual multipliers to identify these stress adjusted travel times are documented in **Table 1**.

Higher-Stress Roads Feel Longer to Bicyclists and Pedestrians



Figure 1 Illustrates how higher stress segments can be perceived to have a longer travel time for the purpose of understanding network quality's impact on behavior.

Table 1 Level of Traffic Stress & Perceived Costs Multipliers from NCHRP 08-149

LTS Score	Pedestrian Impedance Multiplier	Bicycle Impedance Multiplier
LTS 1	1	1
LTS 2	1.5	2
LTS 3	3	3
LTS 4	8	6

- Public Feedback Integration** – Alta will review the barriers people identify in public feedback to identify areas where they agree and do not agree with the LTS results. Where they do not agree, Alta will inflate travel costs by 50% in areas that are low stress that the public has identified existing barriers to active travel.
- Assemble Short Trips Matrix** – Alta will assemble a short trips OD matrix of lines that will be converted into stop and end points for each flow at the centroids of the hexagons used to evaluate short trips similar to those shown in **Figure 2**. These centroids were served as inputs for network analysis.

Alta Civic Analytics Explainer

Active Trip Potential

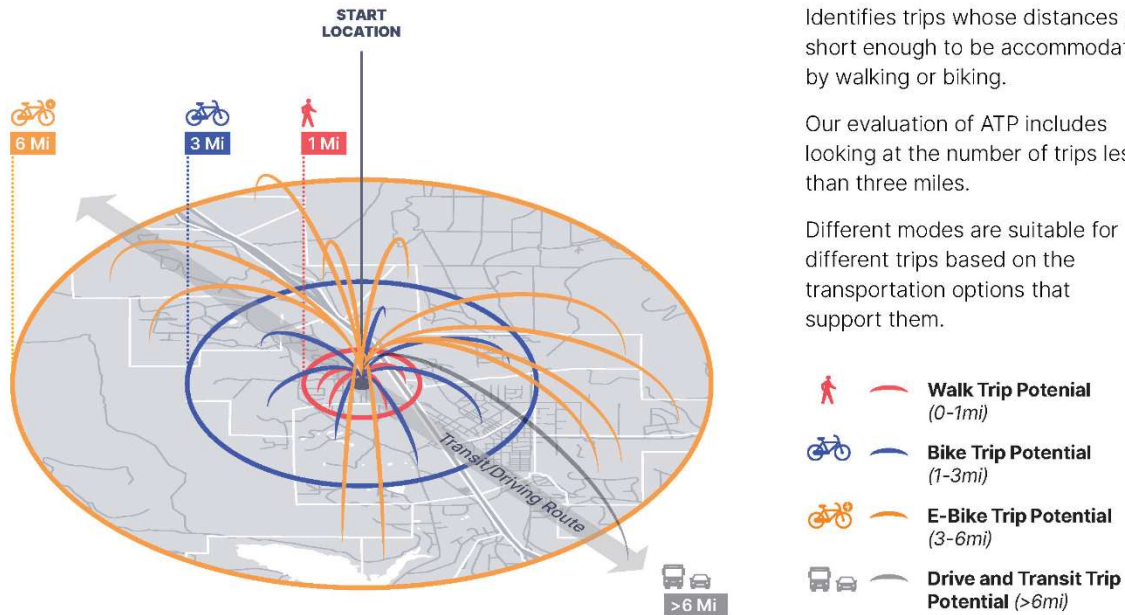


Figure 2 Alta Explainer on active trip potential and how short trips can help identify latent demand for active travel.

- **Compute Travel Times** – Alta will evaluate the traffic stress adjusted travel times between every hexagon centroid in the study area within three miles for bicyclists and one mile for pedestrians. For every centroid-to-centroid pair, there will be created a straight-line distance, a network travel time, and a stress adjusted network travel time.
- **Compute Flow Gap Score** – Alta will join the network analysis results for short trips to create a bicycle and pedestrian gap score for each OD pair. The gap score represents “gap trips” or short trips that are unlikely to be converted to active modes because of high differences between straight-line distance travel times and a stress-adjusted travel time. This gap score will be based on the following formula:
 - $Gap\ Score = Short\ Trips - (Short\ Trips * \frac{Non-Stress\ Adjusted\ Travel\ Time\ (Straight\ Line)}{Stress\ Adjusted\ Travel\ Time})$
 - Intrazonal trips will be joined to the network by assuming the travel times between a hexagon’s immediate six neighbors can represent the intrazonal travel time used to compute gap scores.

- **Spatially Overlay Gap Scores with Hexagons** – OD line gap scores will be spatially joined to the hexagon layer to count the gap trips that land in that hexagon. Hexagons will have a higher score if they have multiple lines touching them with high numbers of gap trips.
- **Gap Analysis Tabulations** – Results will have cross-tabulations of origin-destination (OD) trip lengths against corresponding modeled travel times, including both raw and stress-adjusted values. For select key destinations, Alta will estimate the average difference between stress-adjusted and non-stress-adjusted travel times specifically for short-distance trips, highlighting disparities in perceived versus actual travel experience. Key statistics such as the typical short trips perceived travel times and the difference in raw and perceived travel times at key destinations will be integrated into the needs assessment memo.
- **Map Gap Scores** – Results will be put into a series of maps identified in the next section.

Expected Map Outputs

The final maps will produce maps illustrating OD flows that have stressful routes between them and high active trip potential. This mapping can provide clear insights into how infrastructure and stress impact travel choices, identifying areas for active transportation investment.

There will be several maps created for this analysis. For each mode between walking and biking, Alta anticipates creating the following maps:

- One will be the OD lines with their stress adjusted travel times as the color, and the number of short trips between zones as the thickness.
- Another will be the OD lines with their color and thickness being the gap score computed between zones.

Informing Project Recommendations

Alta anticipates the results from this analysis being used as part of prioritization of project recommendations in the next phase by identifying where there are large areas with possible mode shift potential in the form of short trips that would be improved by an all ages and ability network. This analysis could be used alongside safety, equity, and public engagement results to identify high priority recommendations by mode.